Resource Management and Biodiversity Conservation to Achieve Sustainable Development Goals

Souvenir & Abstract e-Book

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CONTENT

Prof. Carmelo Dazzi
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Inaugural Address

Updating the Soil Paradigm to Achieve the Sustainable Development Goals

On behalf of the European Society for Soil Conservation - ESSC, I wish to express my deepest sympathy for you, Indian friends and colleagues and to the people of India, suffering so much in these COVID-19 days. We are with you in these difficult moments, and hope that all together we will recover as soon as possible. It is a great honor for me to welcome you on behalf of the European Society for Soil Conservation.
The European Society for Soil Conservation was founded in Ghent, Belgium on November 4, 1988 by a small group of researchers from various European countries. During the 32 years that have elapsed since its beginnings, the Society has made great strides. For now, it constitutes an important international network of soil scholars from 47 countries.

The activity of the Society in the organization and support of scientific meetings, the backing of soil conservation studies, cooperation with institutions and with persons on conservation initiatives, the publication of studies and documents, are all things we greatly value, and of which we are proud. However, social progress, the development of the schools of thought, as well as knowledge and scientific approaches to the soil, lead us to rethink old and new challenges with broader and intertwined aims, taking up the continuous process of review and criticism of scientific methods.

It is in this context that we are looking at the role and functions of the soil in the natural systems in a perspective of Resource Management and Biodiversity Conservation to Achieve the Sustainable Development Goals. Soils constitute the path of life on the surface of the planet, and provide for the multiple assets, services and functions for the society. Soils produce and contain all the elements necessary to life. They filter and purify water that crosses them; they regulate courses of water and restock the water table; they store greenhouse gases; they are a vast reserve of genetic resources. Soils sustain a great part of the earth's biodiversity; they supply building materials (for animals as well as man) and provide for industry and handcrafts. Soils contain mineral resources; they are the physical basis for infrastructure essential to working and recreational activities for human beings. They may even contain archaeological and historical findings.
We are aware since ancient times of the importance of the soil for the humankind. Indeed, 2000 years ago, Cicero referred to the destruction of the forests in North Africa and the resulting bare areas as similar to a desert, but we can affirm that all the functions of the soil were largely unaltered for centuries. The problems arose during the industrial era and increased alongside the development of technology and man's needs. The use of agricultural land was intensified, often to beyond the limit of resilience, new soils were created for the cultivation of species that gave high profits; wide surfaces were destined to urban and industrial development, as well as to waste disposal.
The second half of the XX century was particularly disastrous. Throughout the world, agricultural, industrial and urban development invalidated the capacity of soils to produce goods and services. In many cases man's pressure on the soils reached such an intensity that the pedological order, which represents the rule for soils,

was transformed in total disorganization, in pedological chaos and then in the annulment of the pedo-diversity.
When man’s action went over the limits of soil vulnerability, processes of degradation set in and got worse. In some cases, they started a chain reaction of degradation in other environmental resources.
“*Homotechnologicus*”, descendant of “*homosapiens*”, has been forced to live in ever-bigger cities, feed on fast food and think on the web, breathe air conditioning in hyper-technological offices and impersonal lofts. Rarely does he stop and reflect on how much his well-being is connected to the soil and other primary resources, nor does man learn from the lessons history has taught.
One of these warnings, which is important for Europeans, comes from the story of ancient Rome and the events leading to the decline and fall of the Roman Empire in the West (476 A.D.). Historians maintain that Rome fell due to the decadence of its leaders, the corruption of its emperors and to the superior military tactics of the barbaric invaders. There is obviously a lot of truth in this. However, the same historians reveal that the greatest cause of the decline is due to the slow process of fertility loss in the soils and consequently to their productive capability.
The reduced agricultural production resulted in ever-diminishing harvests that were not sufficient to maintain the lifestyle of Roman citizens and their army or to supply enough wealth to maintain the great infrastructures of the Empire (roads, aqueducts, monuments etc).Italy was rich in forests at the beginning of Roman civilization, but the organization of the Empire and the demands from Rome, which was a real megalopolis with over a million inhabitants, led to transforming forests into pastures or agricultural land. The result was deforestation of most of the land surrounding the Mediterranean basin. The same happened in Italy thathad been stripped of most of its woodland towards the end of the Empire.
The transformation of forest soils into pastures or arable land seemed to work at first because the soils were rich in organic matter and nutrients and they produced abundant crops. Unfortunately, deforestation left the soils exposed to the elements. The organic matter diminished due to oxidation and the nutrients were washed away by the rain that was also an agent of erosion.
This progressive decline in soil fertility started just when Rome began to depend on agriculture as an alternative to its unsuccessful conquests. During the final period of the Empire, agriculture gave over 90 per cent of public income and products from the land were of vital importance to its survival.
They therefore tried to intensify agricultural production in order to provide food for citizens and soldiers. This led to further exploitation of land that was already exhausted and caused a continuous slow depopulation of the country that lasted for the whole period of the Empire. In some provinces of North Africa and along the entire Mediterranean basin, almost half of the arable land had been abandoned by the end of the third century.
Weakened by the depletion of its energy system, the Empire then fell. Basic services were reduced. The immense infrastructure on which it was based fell into ruin. Soldiers could no longer keep enemies at bay and barbaric hordes began to weaken the Empire, beginning from its farthest lands. Towards the end of the fifth century, the invaders reached Rome. Its population, which had reached a peak of over a million, fell to under 30 thousand. Rome was reduced to a mass of rubble, a hard lesson on how pitilessly the earth can react.This lesson from history should make us think about the close relationship between the quality of soils and the quality of our life!
From the first concepts of soil as an essential resource for food production, other views or conceptual models have been added gradually, which have answered the different socio-economic needs of each historical period.
At the moment, the size and sensitivity of the natural environment oblige the scientific community to devote time to different aspects of the study of soil functions; to consider new approaches, orientations and methods, and to give an answer to the growing demand for information and scientific knowledge about the soil, generated from very different sectors: scientific, academic, environmental, agricultural, forestry, landscape, planning, administration, etc.
The way we use the land and its soils, could give a big hand in mitigating global warming. The report on "Climate Change and Land" of the IPCC, presented last year in Geneva, draws a future of floods, droughts and deserts that devour green areas. The report shows that about a quarter of greenhouse gas emissions come from misuse of the soils. To respect the agreements of Paris is not enough to cut emissions. We need to practice a sustainable management of the natural resources and the soils in particular, preserving soil security and conserving its biodiversity. The world climate has already changed. Heat waves and extreme events increasingly lead to soil degradation and desertification. The drought is increasingly affecting southern Europe along with many poor areas of the world.

The IPCC report points the finger at the cancellation of green areas like marshes, pastures, mangroves and forests, the "lungs of the planet". In addition, stresses the importance of the food chain. One third of the products is lost or thrown and is responsible for up to 10% of emissions in the food system.
This will produce more conflicts and migrations, with enormous social costs because arable soils will expand more and more to the North, while in tropical and subtropical areas we will have more droughts and desertification. We need to change our relationship to the environment, to the soil and to the food.
The general issue of this Conference “Resource Management and Biodiversity Conservation to Achieve Sustainable Development Goals” stresses that never as today the future of humankind depends from the soils and from their conservation!
When there is to protect a value, individuals must become a group, a political movement, and make the law consider that value as a fundamental value to man.
We are a scientific society, not a political group. Our tools are the findings of scientific researches and we use these findings to generate and to give information as well as knowledge about our natural resources. We must be so clever to be able to propose guidelines and courses of action to society, which will contribute to an effective and sustainable management of the natural resources.
This Conference is on the way to be a great opportunity for Soil Scientists to stimulate deep reflections on the importance of the Resource Management and Biodiversity Conservation for humankind, paying special attention to the new challenges and opportunities concerning the Soil issues “*sensulato*”. Undoubtedly, in the economic scenario after coronavirus, huge fluxes of money will be assigned to support the economy of many social and economic sectors, and only crumbs of money will be allocated to the scientific research in soil science.
To me the most important question is: Which is the role of the soil scientist in the society?
A big role, I suppose!
We, soil scientists are convinced of the importance and relevance of the soils. Now we must be so wise and so clever to improve the societal perception of the soils.
How to do this?
We must be pragmatic. We must consider that “Money makes the World go round”!
Therefore, we must start to consider the soil not only as a natural resource but, mainly as an economic resource!!
In this context, congresses and conferences like this one can play an important role in bringing together experts from several disciplines, to try to give a value to the benefit we obtain from the soil. This will allow to soil to acquire more and more consideration in all spheres of the society and to humankind to achieve the sustainable development goals starting from the last one: the partnership for sustainable development.
Enjoy the conference and, on behalf of the ESSC and personally, thank you very much.

Carmelo Dazzi

Dr. Sanjay Arora
Secretary, ANRCM & Convener

About ANRCM

The Academy of Natural Resource conservation and management was established in Lucknow formed by a group of professionals, scientists, conservationists, researchers, students, farmers and all those who pledge to work for the wise use and management of precious finite and limited natural resources.

The Academy is a non-profit making organization devoted for the cause of conservation, development, management and sustainable use of resources like water, soil, land, forest and environment. The Academy is mandated to take up activities like generating awareness, sharing and disseminating knowledge and advanced techniques and approaches for conservation and management of resources. In this endeavor, we planned to organize National Seminar during March 2020 and we got overwhelming response from participants all over the country but we could not accomplish it due to Covid-19 pandemic and we will be hosting it as soon the situation improves.

Also, taking the opportunity of World Population Day, the National Webinar was organized on July 11 2020 with the Theme: Impact of Population Pressure on Natural Resources and Environment through video-conferencing.

The Academy has also successfully organized two days National Conference on “Technological Approaches for Resource Conservation and Management for Environmental Sustainability (TARCMES)” to celebrate its foundation day on August 16-17, 2020 through virtual mode and more than 480 participations registered for this web-conference.

The Academy intends for half-yearly e-Journal “Journal of Natural Resource Conservation and Management” and to publish bulletins on various themes of NRCM as well Newsletter, books and other useful study material for young professionals and students.

I on behalf of ANRCM convey my gratitude to the distinguished and renowned speakers who have agreed to our request to deliver talks in the International Web Conference and thankful for the blessings of our Chief patron Dr. G.B. Singh and Patron Dr D.K. Sharma and the efforts made by Executive council of ANRCM specially Organizing team.

I am delighted to inform that we have received overwhelming response from participants and nearly 600 participants from India and abroad registered for the International Web-Conference on *Resource Management and Biodiversity Conservation to Achieve Sustainable Development Goals*. We are sharing this web-conference live/video on Youtube and other social networks including the official website www.anrcm.org and facebook. Awareness on-line quiz for participants is being organized on September 11 and 12, 2020.

I am happy that Prof. Rattan Lal, World Food Prize Laureate 2020 accepted our invitation to deliver plenary talk during the International Web-conference and many renowned international and national experts and resource persons like Prof. Ildefenso Pla Sentis, Prof. Carmelo Dazzi, Prof. Miodrag Zlatic, Dr. Warshi, Dr N.S. Rathore, Dr Ashok K Patra, Dr. SHR Sadeghi, Dr. S. Dutta, Dr. Mahesh Gathala and many more who accepted to deliver talk in the conference.

I hope the participants will surely be enlighten by the talks from the experts and will share knowledge during these two days of International web-conference.

Sanjay Arora

Dr. Sanjay Swami
Professor
School of Natural Resource Management, CAU, CPGS-AS, Barapani
& Organizing Secretary

About the International Web Conference

It is indeed a great pride for me in organizing this important International Web Conference on *Resource Management and Biodiversity Conservation to Achieve Sustainable Development Goals* under the patronage of the Academy of Natural Resource Conservation and Management (ANRCM), Lucknow (UP), India during 11^{th} to 12^{th} September, 2020.

At the outset, on behalf of the Academy and on my personal behalf, I would like to extend a warm welcome to Prof. (Dr.) Rattan Lal, the World Food Prize Laureate 2020 and Distinguished Professor, The Ohio State University, USA, other distinguished key speakers, lead speakers and dear participants of this conference.

Friends, natural resources are the basis of human life. We use varied natural resources in different ways to satisfy our needs. However, these resources are not infinitely available for human use. Not only non-renewable but also renewable resources are limited. In many regions of the world, this general problem of shortage is aggravated by the degradation and destruction of natural resources. This is mainly due to overuse or a non-adapted use of the available resources. Farmers in all countries are now facing double challenge to improve the productivity and yield of crops, while preserving resources.

The health of ecosystems on which we and all other species depend is deteriorating more rapidly than ever. We are eroding the very foundations of our economies, livelihoods, food security, health and quality of life worldwide. In earlier times, various wild crops, different millets, etc. were grown and the biodiversity and the ecosystem was balanced or conserved. But, with the advent of modern agriculture, focus is made mainly on paddy, wheat, maize, etc. and as a result, the biodiversity is confining or declining and many of the species are marching towards extinction. The replacement of landraces with a few genetically uniform varieties depletes genetic diversity and provides ideal conditions for pests, diseases and adverse climatic changes and creates genetic vulnerability.

These problems are easy to understand but very difficult to resolve. See, in 2030, the population will be 9 billion inhabitants, against 7 billion today, a growth which will demand 70% increase in agricultural production by 2050. Only the introduction of effective solutions that allow farmers to improve productivity while preserving resources will enable to meet these challenges. Therefore, with the target of achieving a better and more sustainable future for all, an integrated approach of 193 countries of the UN General Assembly designed 17 interdependent goals in 2015 in the form of Sustainable Development Goals (SDGs) and intended to achieve by 2030 under agenda of 'Transforming Our World: The 2030 Agenda for Sustainable Development.' Each of the SDGs are designed with several set targets and respective indicators with UNSD Indicator Codes which when achieved, will indicate the achievement of the concerned goal. A total of 169 targets are there for the SDGs with each SDG having 5 to 20 targets (average of 10) with each target having 2 to 3 indicators to measure the progress towards achieving the goal.

The theme of the web conference is chosen very appropriately as most of the sustainable development goals and their targets can be achieved, if we focus on better resource management and biodiversity conservation. Thus, resource management and biodiversity conservation are two major and critical pre-requisite to achieve sustainable development goals.

The Web Conference will focus on five major themes:

- Efficient Soil, Water and Energy Management under Diverse Ecosystems
- Biodiversity Conservation, Resource Management and Ecological Restoration for Sustainable Development
- Precision Agriculture and Climate Smart Approaches for Sustainable Management of Resources
- Agriculture Diversification, Nutrient Management, Soil Health and Innovative Options for Environmental Sustainability
- COVID-19 Impacts on Agriculture, Policy Responses and Livelihood Security

I would like to place on record that around 600 participants form different countries are participating in this conference. This shows their keen interest in sharing research findings and innovative ideas. I am confident that the conference will deliberate on all the issues related to Resource Management and Biodiversity Conservation and will come out with some concrete recommendations to formulate guidelines to face the challenges ahead.

In the last, I am thankful to the Academy for providing me the opportunity to organize this important event. I wish the International Web Conference a grand success.

Sanjay Swami
Organizing Secretary

International Web-Conference

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Eco-Intensification of Agroecosystems to Realize the Sustainable Development Goals of the United Nations

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Agriculture and Environment

The dramatic increase in agricultural production in India and globally since the 1960s is attributed to massive inputs of fertilizers, pesticides, energy for farm operations and manufacture of inputs, and water for supplementary irrigation and processing of food for value- addition and enhancing the shelf life. In addition, there has also been some horizontal expansion of the area under cropland and grazing land. Between 1961 and 2017, the global human population increased from 3.05 billion to 7.55 billion, cereal grain production from 736 million tons (Mt) to 2980 Mt, and the per capital annual cereal grain production from 241 kg to 395 kg. However, there is a serious problem of soil erosion by water and wind. The global transport of sediment by world rivers is estimated at 36 Gt (Walling, 2008), and secondary salinization affects 20% of the cultivated land and 30% of irrigated land (Machado and Serralheiro, 2017). As much as 24% of the Earth's land are is affected by soil degradation processes (Bai et al., 2008). Eutrophication of surface water, because of the transport of fertilizers and manure from agroecosystems, has caused problems of algal bloom in the Great Lakes, Gulf of Mexico, Chesapeake Bay in North America; Lake Taihu in China; Baltic Sea in Europe; and may other regions of agricultural intensification.

Atmospheric concentration of CO_2 reached 708 ppm in 2018 and is increasing by 2.3 ppm/yr (WMO, 2019). However, the wildlife populations have declined by more than two-thirds between 1970 and 2020 (Briggs, 2020). Thus, the ecological footprint of agricultural intensification must be managed. Simply put, humanity must reconcile the need for achieving food and nutritional security with the necessity of improving the environment. It is not "either/or": we must have both.

Eco-Intensification: Sustainable Management of Soil, Water, and Energy

The growing trends in soil and environmental degradation must be reversed by judicious land use and appropriate management of soil, water, and energy through eco-intensification of agroecosystems (Lal, 2019). Eco-intensification can improve productivity and restore the environment even under the harsh climactic conditions of Sub-Saharan Africa (Folberth et al., 2014) and globally (FAO, 2011). The strategy is to enhance and sustain agronomic yield by optimizing critical ecosystem services (ESs) rather than by excessive and indiscriminate use of inputs (e.g., agrochemicals, irrigation, plowing, monoculture). Ecological intensification comprises of the natural functionalities of an ecosystem (Tittenell, 2014). The strategy is to develop and adapt multifunctional agroecosystems which sustain production and enhance nature. In other words, it is a nature-based viable alternative to high-input farming (Kleijn et al., 2018). This approach translates science into practice for achieving both food and environmental goals. The goal of eco-intensification is also to use energy inputs wisely and prudently.

Sustainable Development Goals and Eco-Intensification

Sustainable Development Goals (SDGs), or the Agenda 2030, were adopted by the United Nations in 2015 as a 15-year plan involving a universal call for action to enhance human wellbeing and improve the environment (U.N. 2015). Of the 17 SDGs, there are five which are directly pertinent to eco-intensification of agroecosystems and sustainable management of soil, water, and energy: SDG #2 (Zero Hunger), #3 (Good Health and Wellbeing), #6 (Clean Water and Sanitation), #13 (Climate Action), and #15 (Life on Land). Eco-intensification of agroecosystems is critical to achieving these goals. Appropriate components of agroecosystems, to be adapted and fine-tuned under site-specific conditions, include the following: i) adoption of no-till farming, ii) retention of crop residue mulch, iii) incorporation of cover crops during the off-season, iv)use of integrated nutrient and pest management based on recycling, biofertilizers, and supplemental but judicious use of synthetic fertilizers, v) restoration of soil health through sequestration of soil organic carbon (SOC) by creating a positive soil/ecosystem carbon budget, vi) use of conservation-effective measures that conserve soil and water, and vii) integration of crops with trees and livestock. These components are also pertinent to achieving land degradation neutrality (LDN) goals of the UNCCD under SDG #15 (Lal et al., 2012; Cowie et al., 2018). Furthermore, India has accepted the target of restoring 26 M ha of degraded lands by 2030 (UNCCD, 2019).

Actions Needed Between 2020 and 2030 to Realize the Sustainable Development Goals

Important steps are needed globally to find viable alternatives (e.g., solar, wind, hydro) to fossil fuels, and to use C-neutral or C-negative fuel sources. In addition to phasing out fossil fuels, agroecosystems must be managed to create a C sink for atmospheric CO_2in soil and vegetation, and reduce the emissions of CH_4, N_2O, and black C (soot) by reducing in-field burning of crop residues and minimizing the use of traditional biofuel for household energy. Deforestation-induced land use emissions of about 1 Gt C/yr (Friedlingstein et al., 2020) must be minimized by preserving/protecting rainforest, peatlands and wetlands. Soil restoration must be critical to achieving LDN. The goal is to make sustainable management of soil and agriculture as an integral component of the strategies to achieve SDGs and address the COVID-19 pandemic (Lal, 2020a; Lal et al., 2020). Soil protection must be promoted through consideration of the Rights-of-Soil (Lal, 2020b).

Ensuring Global Peace Through Soil Restoration

Degraded soils and denuded lands, recurring droughts and intensifying heat waves, low crop yields and perpetual hunger are major causes of political instability and civil strife. Sustainable management of soil, to eliminate hunger and malnutrition, is essential to global peace and harmony (Lal, 2015). Following the truism "health of soil, plants, animals, people, and the environment being one and indivisible" also necessitates adopting the strategy of restoring degraded ecosystems and using soil and natural resources prudently.

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Soil and Water Use and Management under Climate Change for Sustainable Agricultural Developments

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Introduction

Soil and water are fundamental to the needs of man life, and plays a central role in determining the quality of our environment. In the future the role of soils and water in some crucial aspects for man's life, like food production, earth hydrological cycle and air composition will be constantly increasing. The increased human influences on soils, both through the expansion and intensification of agricultural activities with inappropriate land management practices, and the growth of number and size of populated areas, frequently results in widespread processes of soil and water degradation, and in increased production of domestic and industrial wastes (Pla, 2019). Associated to the land and soil degradation there is a decrease in available good quality water for agriculture, urban and industrial needs, and a decrease in biological diversity. Based mainly on land and soil degradation, and the associated hydrological changes, there are increased risks and problems of food and water supply for mankind, and of "natural" disasters like droughts, flooding, landslides, sedimentation, etc. It is also worth to mention the contribution of changes in soil cover and soil degradation to global climate changes. Continuing shrinkage of quality water supplies for different uses (human consumption, irrigation, etc) points out the importance of water conservation besides soil conservation. An integrated approach in the use, management and conservation of soil and water resources is further justified by the close relationship between soil and water quantity and quality. The processes of soil and water degradation are closely linked through unfavourable alterations in the hydrological processes determining the soil water balance and the soil water regime (Pla, 1998). They are also conditioned by the climatic conditions and by the use and management of the soil and water resources. This will become more important under the previewed effects of global climatic changes, which would mainly affect hydrological processes in the land surface, mostly related to the field water balance (Pla, 2019).

Land degradation has a wider scope than soil degradation in that it covers all negative changes in the capacity of the ecosystem to provide goods and services (including biological and water related goods and services – and - also land-related social and economic). Under particular climate conditions, the processes leading to land degradation are affected both by the soil properties and by the use and management of the land. Frequently, the influence of changes in use and management of the land is even more important than the changes in climate, associated or not to climate changes, in increasing the risks of land degradation and derived effects (Pla, 2019). Therefore, the control of land degradation and its effects will depend on an adequate planning of the use and management of soil and water resources. Land-use planning strategies must be based on adequate integrated management of soil, water and crops, to increase sustained agricultural productivity, taking into account that inappropriate land use often is tied to local socio-economic and political issues.

Soil and Water use and management under global changes

Global change is a term widely used to describe the effects of natural and human activities on the Earth. The global change includes world scale changes in many aspects of the globe environmental systems, including besides climate, other physical, chemical and biological processes. In many cases, the human systems are now the main drivers of such changes, induced by population growth and development, affecting resource use, energy consumption, land use and land cover, land degradation and related consequences. At present nearly 50% of the land surface has been transformed by direct human action, and more than 50% of the accessible freshwater has been appropriated for human purposes. Additionally underground water resources are being depleted rapidly in many places.

Frequently global changes connected with human activities is confused or only used in reference to global climate change, more specifically global warming, occurring primarily as a result of human-induced enrichment of the atmosphere with greenhouse gases. But global change, either in its natural or human induced forms, extends well beyond climate change. Although we cannot forget the future potential effects of climate change (global warming), other kinds of changes are at present of more immediate and pressing concern from the point of view of human welfare.

Land degradation is related to climate and soil characteristics, but mainly to deforestation and inappropriate use and management of the natural resources soil and water. It leads both to a non sustainable agricultural production and to increased risks of catastrophic flooding, sedimentation, landslides, etc, and effects on global climatic changes (Pla, 2002). The problems of soil and water degradation and derived effects are increasing throughout the world, partially due to a lack of appropriate identification and evaluation of the degradation processes and of the relations cause-effects of soil degradation for each specific situation, and the generalized use of empirical approaches to select and apply soil and water conservation practices. In some occasions, the wrong selection or application of soil and water conservation practices and structures may increase land degradation processes and derived environmental impacts.

Economic and social problems, connected to population pressure, market changes and prices, and technical needs, may produce drastic and sudden changes in land use and management, which may increase the potential hazard of land degradation and side effects (Pla, 1993). The processes of land degradation affect the conservation of soil and water resources, because they are strongly linked to unfavourable changes in the hydrological behaviour affecting soil water balance and soil moisture regime. They are related to soil and climate characteristics, but inappropriate land use and management is the main factor responsible of those processes. In the past decades, the degradation of previously naturally vegetated or productive agricultural lands, leading in many cases to barren, desertified landscapes, has dramatically extended in many regions of the World. The reasons are mainly unfavourable biophysical conditions and negative human impacts. The negative human impacts are mainly through inadequate land use, including deforestation, overgrazing, and deficient agricultural practices, leading to soil erosion, salinization and vegetation degradation, as a consequence of drastic changes in the water balance. This might be further aggravated by the ongoing threat of climate change (Fig 1).

In some countries or regions of the World, agricultural production patterns and practices have changed over the last century, becoming highly mechanized, capitalized and specialized, emphasizing labor-substituting technologies, which focus on the generation of short-term cash flow. In the absence of sufficient economic incentives for conservation, this type of agriculture incorporates no concern for long-term sustainability of production. In others, population growth and lack of resources have obliged to intensify the use of marginal lands without appropriate conservation practices, which is leading to land degradation and non sustainable agricultural production.

Globalization has fundamentally changed the way food is produced, and has shifted the drivers of land use change. As people migrate into cities and diets shift, the demand for land-based commodities has increased, and global market forces are now replacing rural population pressure as the principal driver acting on natural systems. Sites of production are separated from those of consumption, creating production systems defined by consumer demand in one region that influences the crops planted in another. These are typically cash crops, increasingly grown on large, industrial scale plantations destined for export to consuming centers abroad instead of meeting subsistence needs locally. Expansion of those production systems that are oriented toward distal consumption, has emerged as an important driver of deforestation and land use changes in developing countries in the tropics and subtropics.

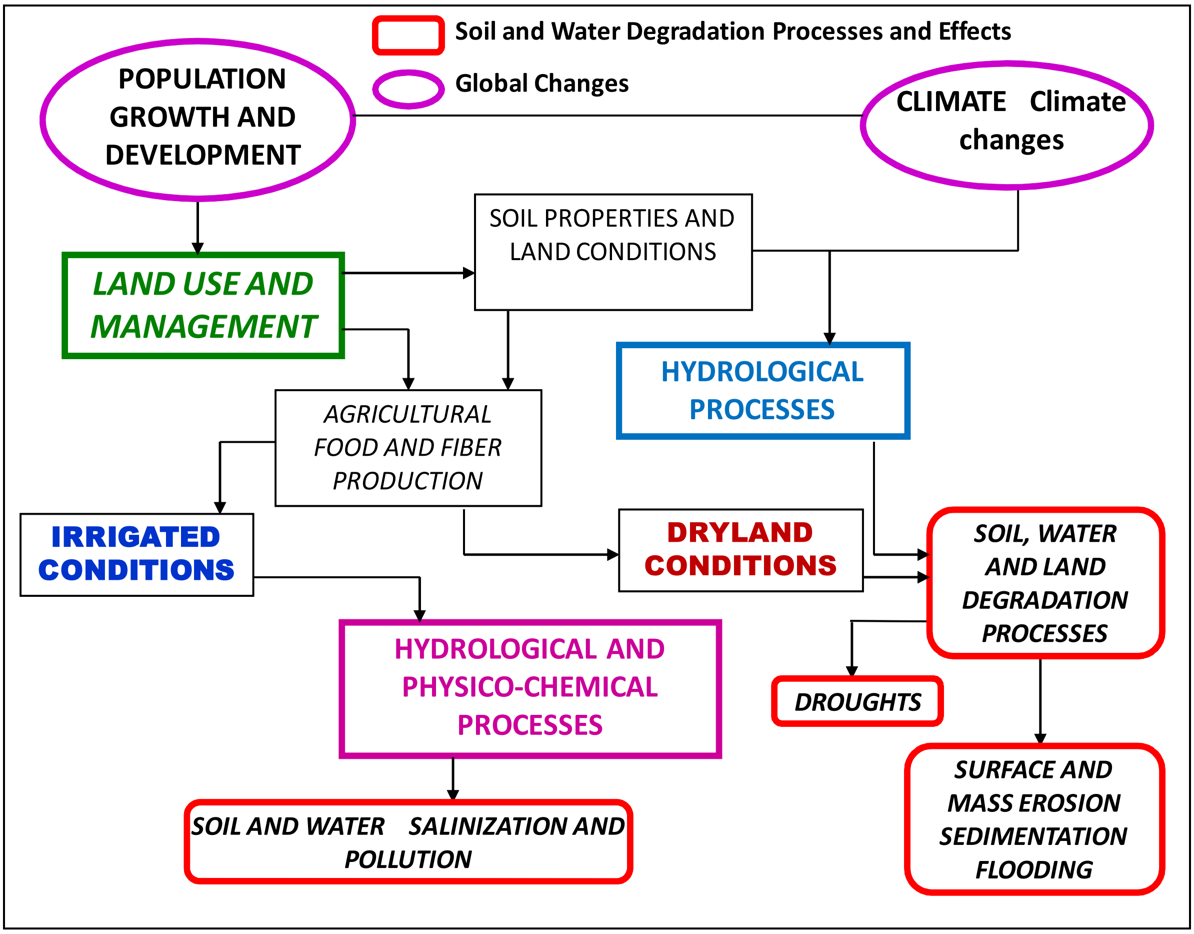


Figure 1. Scheme showing the interaction of global changes and land use and management on hydrological processes leading to soil, water and land degradation and derived effects, both under dry-land and irrigated conditions (Pla 2019).

The last decades have seen increasing demand and high market prices for food and energy crops, mainly soybeans and palm oil, that have led to drastic and unregulated changes in the use and management of large areas of land, resulting in new and worsening problems of soil and water degradation.

Land use planning for sustainable agricultural developments

Sustainable land use must be based on a balance among competing technical, social, economic and environmental considerations. The lack of multi-objective focus on land use planning has produced an unilateral approach to resource utilization, taking not into account the interdependence of environmental, production and social factors. The consequence has been problems of soil and water degradation, resulting from non appropriate land management practices and conflicting land uses. As a result, not only the inherent productive base of the land resource affected, but the off site impacts accrues significant social costs, which in most cases have failed to be acknowledges and quantified. Off-site impacts of soil and land degradation frequently generate more concern than the effects on the land or soil itself, due to their visibility.

The decrease of risks and derived problems of land degradation, depends on an appropriate land use and management planning for sustainable development. Planning and implementing land use properly leads to fewer degradation problems, achieving both short-term and log term benefits. In planning land use, there must be considered the requirements and limitations affecting both the crops, the management and the environment. It is important not only to assess the risk of degradation, but also to have a sound understanding of the causes and processes of degradation and of the possibilities available for their control.

Land use planning covers the whole range of activities, from legislation and extension work to physical assessment. Technical and socioeconomic solutions are equally important. Improved cash income, more efficient markets and wise technology are the basic ingredients in any project seeking better land use. The most difficult taskl in developing those projects lies in the identification and coupling of practices that are ecologically sound, as well as technically and financially viable. There is also a gap on how to carry out land use planning and how to collect and interpret the required information.

Most of the countries have little or nothing land use planning strategies, but rely on short term programs and projects to deal with land degradation problems once they occur. Many plans and programs have concentrated on the symptoms rather than the causes of the problem (Sanders 1992), without taking into consideration that land degradation is only the physical manifestation, or symptom, of inappropriate land use and poor management.

Conservation of soils and water is the most important part of land-use planning, and must be inserted into the whole context of land-use planning for land development. Soil conservation programs must be seen as the development and application of land-use systems that preserve or enhance soil productivity. The factors responsible for detrimental land use must be identified and removed before the adoption of new land use systems. For justifying soil conservation projects within land use planning programs, it is necessary to make an economic analysis in terms of costs and benefits. There are required data relating soil degradation to productivity loss, but sometimes the losses and gains are mainly off-site than on-site.

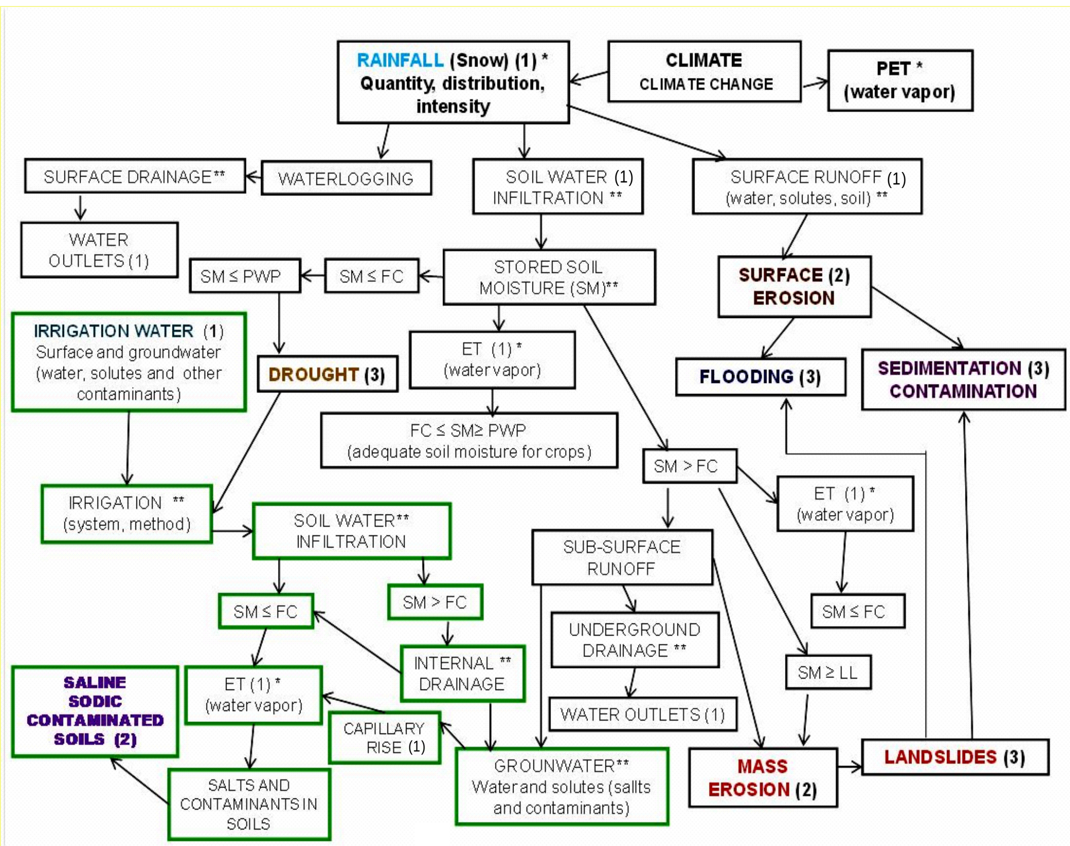
The development of new and improved technologies for increasing production of crops, wood, cattle, etc, to satisfy requirements of food, fiber, fuel, shelter and cash must ensure that the natural basic resources soil and water, on which land degradation is based, are not depleted. Sustainable land management focuses in technology that minimizes risk, increases or guarantees production, and ensures the integrity of the resource base. It must match agro technology to the particular agro environment, not only to meet the goal of stabilized and increased yields, but also to protect the land resource base, so that it is conserved for future generations (Virmani and Eswaran 1991).

The planning framework for the achievement of sustainable land management must consider and be aware of the increased complexity of environmental processes and problems derived of land degradation, from local to regional, to national and to global dimensions. That understanding is essential for developing a realistic approach for the prevention of land degradation and for the achievement of sustainable land use.

Planning land use and management is a dynamic and iterative process, and plans must be considered only points of departure rather than rigid projects. Any plannification should allow for continuous refinements as experience is gained through in site adequate monitoring, and should reconcile what have to be done, based on biophysical factors, and what can be done, based on socio-economic conditions, and capability and interest of land users.

The cost-effectiveness of expenditures on land use planning and management may be greatly increased if a goal balance is previously established, and multi-objective planning is used as a basis for decision making. For this we have to aware that although the general principles of the control of soil degradation are the same everywhere, there are no ready-made solutions to land degradation which can be applied universally, and each situation requires land use planning strategies adapted to its own complex local conditions and circumstances. Therefore, alternatives of land use strategies must allow the governments or responsible organizations to choose the one more suitable to the particular biophysical and socio-economical characteristics and limitations.

For an adequate planning of soil and water management it is required a good understanding and prediction of the interaction between climate characteristics and soil properties, under different scenarios of changing climate and changing land use and management practices and systems. These complex interactions may be integrated over time using simulation modeling based on hydrological processes (Fig 2). The generated information may be used in planning strategies for land use, and in the selection of the soil and water management practices, based on probabilities of success, levels of risk and long term sustainability. Models must be based on well established cause-effect relationships for prediction, and flexible enough to be able to include the variety of possible soil-climate-use and management situations, and to be constantly improved as more is known about the influence of specific land and climate characteristics on the soil water balance and derived soil and water degradation processes.



SM: soil moisture; ET: evapo-transpiration; PET: potencial evapo-transpiration; FC: field capacity; PWP: permanent wilting point; LL: liquid limit; (1) Water entries and losses; (2) Soil degradation processes; (3) Natural disasters; *Affected by climate changes; **Affected by land and water management

Figure 2. Flow diagram showing the relations of climate change, and soil and water management with soil degradation processes and related effects, based on hydrological processes. It has been used to predict soil water balance, soil moisture regime and derived soil degradation processes under different scenarios of climate, soil and soil and water management (Pla, 1997, 2005, 2006)

Figure 3 shows an example of how the direct and indirect influences of climate change could affect the factors responsible for growth and production of different crops under semiarid Mediterranean climate conditions (Pla 2010). The average annual rainfall of 500-600mm is very irregularly distributed, with the greatest rains in autumn-spring, a very dry summer, and very large variability in totals from one year to another (300-800 mm). Rainfall is typified by many storms in autumn, and occasionally in spring of high concentration and intensity. Climate change may increase the irregularity of this rainfall, the frequency of dry years and the probability of extreme events.

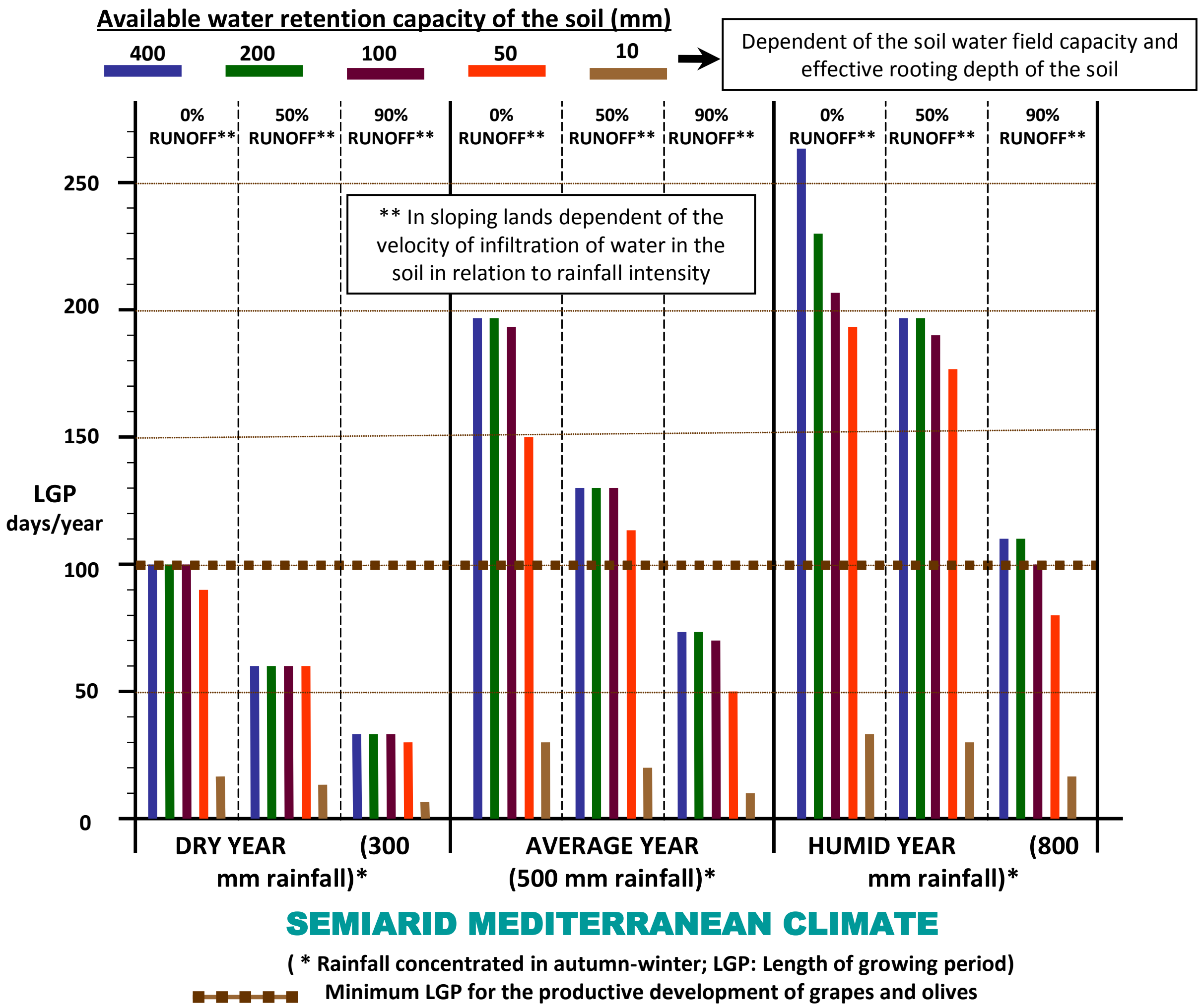


Figure 3 Potential length of the growing period in days/year (LGP) under semiarid Mediterranean climate conditions, as affected by the main critical factors derived of climate changes, land use & management and soil degradation (Pla, 2010; Pla et al, 2005).

It may be concluded, that the evaluation for sustainable land use and management systems and their spatial distribution, must be based on climate, soil, topography and related information, providing the physical framework for the evaluation. The following step would be the use of process-based simulation models, accompanied of field monitoring, using land-based data as variables for a dynamic description of the most relevant land qualities related to productivity and degradation. The results must allow to make predictions of potentially land degradation processes under changing climate, cropping, management and socio-economic conditions. When integrated with GIS, modeling and monitoring to evaluate sustainability , they can provide the basis for large scale decisions in planning land use and management. The final considerations at strategic level of land use and structural changes must bring together not only the physical data and predictions of particular processes, but also an evaluation of land use as it may be affected by both the processes within particular agro ecosystems and by policy, management and socioeconomic effects.

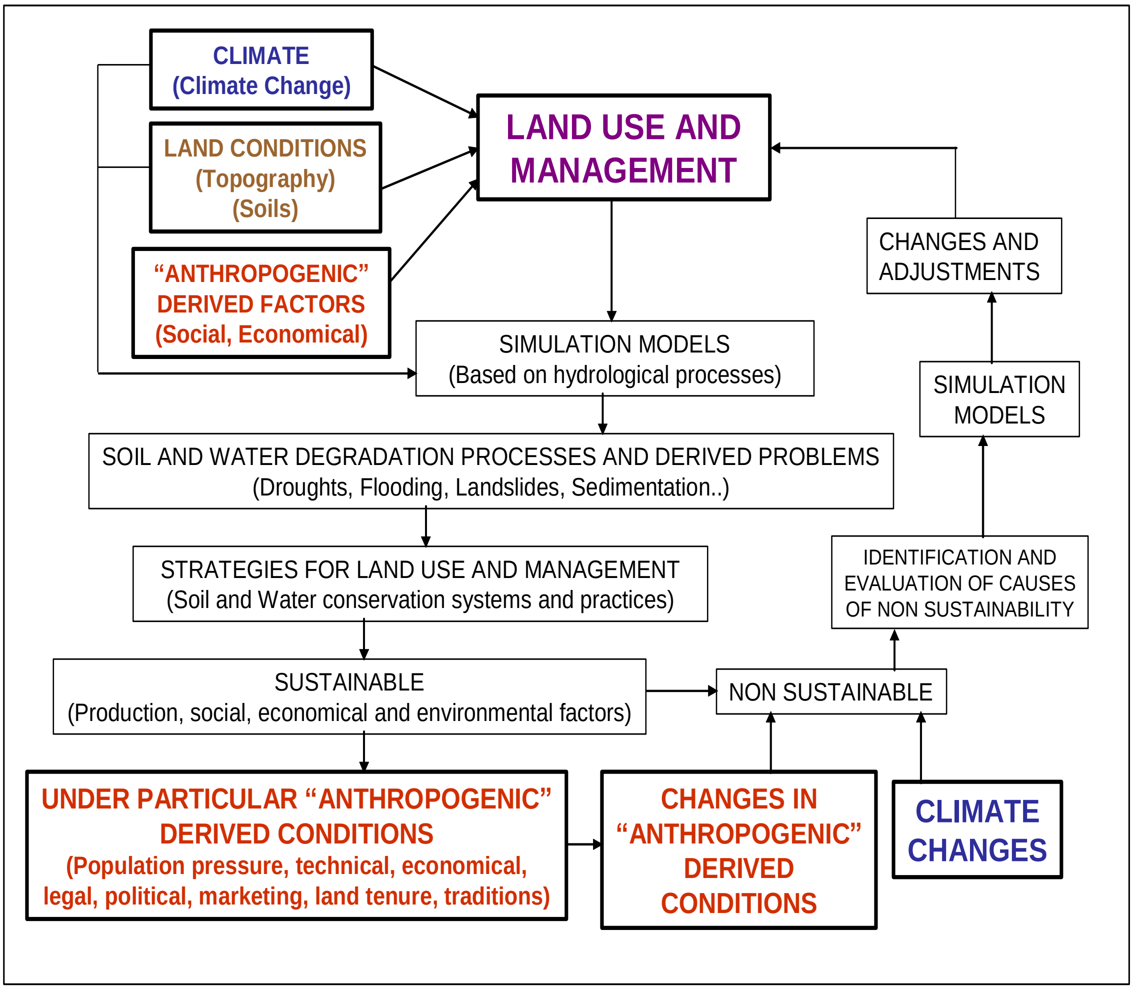


Figure 4 Schematic steps to be followed, using hydrological based models, for planning sustainable land use and management under given biophysical and social economic conditions, and to adjust them to global changes derived of changes in the social economic factors and on the human induced climate changes (Pla 2019)

Figure 4 shows in a very simplified way the interactions of the different conditions and processes leading to potential land degradation processes and effects, both on-site and off-site, and the steps to be followed for land evaluation and land-use planning leading to effective soil and water conservation for sustainable land use and management, in different biophysical and socio-economic scenarios.

Conclusions

Successful agricultural developments depend on productivity and sustainability. Although gains in productivity can be achieved manipulating and improving components in land management, sustainability may be limited by the high cost and limited availability of inputs, by the resource use efficiency, and by social and environmental factors.

There are clear evidences that the new agro-industrial developments, especially in the very large areas incorporated to mono-cropping in the last decades, are leading to various problems of soil and water degradation and derived effects, affecting the economic, environmental and social sustainability of such developments

The conclusion is that there is required a new focus and orientation in the evaluation, research activities and solutions related with soil and water conservation problems, taking into consideration the complex interactions among different factors, including changing social and economic conditions, leading to policies and decisions about land use and management in each case. More attention has to be given to the permanent, not so apparent at short term, effects on soil and water resources and their consequences on future food production, hydrology, climate change and natural disasters. A hydrological approach to the evaluation and prediction of soil degradation processes would be essential for an adequate development, selection and application of sustainable and effective land use and management practices.

Soil degradation processes invariably have geological, chemical, physical, hydrological, biological, economical and social dimensions, and lasting solutions will only be found if the complexity of problems is recognized by adequately trained researchers and appropriate strategies devised, with an interdisciplinary and more integral approach

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Watershed Resources Management!

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Introduction

The proper and sustainable management of diminishing resources at appropriate scale is a vital task for managers, experts, and decision makers to fulfill ever-increasing demands of the growing population. Whilst existing and even increasing distress syndromes in different ecosystems prove an imbalanced situation governing the entire world. In this connection, no integrated approach has been persistently adopted for the management of the available resources. In the present article, it has been attempted tofirstly picture diminishing situation in global resources. The appropriate scale of watershed as a biophysical system will be secondly introduced for the proper management of the resources. Two important approaches of monitoring based conservation and adaptive management of the resources will be ultimately advised as the best sustainable remedies for addressing human-created and expected issues dealing with watershed resources management across the globe.

Main Issues

Nowadays, ecosystem services as provisioning, regulating, supporting, and cultural benefits to humans gifted by the natural environment have been fully disordered due to sickness of the ecosystems. This is not even limited to a particular ecosystem but it is a pandemic getting worse and worse.Despite attempts made to value ecosystem services and make them more valuable to the people, a declining propensity is seen in proper functionality of the ecosystems (Bullocket al., 2011; Hazbavi and Sadeghi, 2017; Sadeghi and Hazbavi, 2017; Hazbavi et al., 2020). It is mainly resulted from the human needs and greed both of which are manageable up to some extent. Ever-increasing of the population in the world and with higher growth rates in developing countries (FAO, 2001) as well as changes in life style led to many other issues. More growth in food production compared to that of population growth specifically proves changes in levels of demands and more ability of the human in exploiting resources and probably more wastage of food productions. It can be concluded from the literatures that manyissues are resulted from human sourced activities found almost in 80% of the world (Benayas and Bullock, 2012; Davudirad et al., 2016; Yaghmaei et al., 2018; Sadeghi et al., 2019).

It is obvious from the governing conditions that the world would not be enough to fulfill human demands. Hence, a change in of manner of thinking for the resources management is crucial. Ecological restoration has therefore been regarded as a main strategy for increasing the provision of ecosystem services as well as reversing biodiversity losses (Shiklomanov, 2000; Bullock et al., 2011). However, it is clear that all different types of services are fully integrated and no single service can be targeted in isolation. Besides on-going problems, sometimes new, unforeseen, and uncontrollable issues like current COVID19 Pandemic create new enigma and misfortunes.

Watershed Scale

A watershed is a topographically defined area such that all the precipitation falling into the area leaves from a main outlet. Studies on the watershed level integrate all processes occurring within the boundaries of a given watershed (Flotemersch et al., 2015). Because of its integrating nature, watershed may include several fauna and flora species, soil types, microclimates, and stockholders collaboratively result in a complex hydrologic behavior. Watershed studies provide ecosystem level data which incorporate all ecosystem processes, but does not distinguish between individual processes or their relative importance (Flotemersch et al., 2015; http://lawr.ucdavis.edu/classes/ssc219/biogeo/watersh.htm, 2020). Considering particular specification of the watersheds, the best spatial scale to protect valuable resources of an area is a watershed. A watershed-scale approach to planning allows for the integrated management of human activities and natural resources, protection of important water resources, reaction to future issues such as population growth and climate change (Washington Stormwater, 2020).

Watershed Resources Management

Considering a watershed provides a range of ecosystem services that are valued by the society. Although the importance of water as an exploitable commodity for human use and a provisioning service of the ecosystem is primarily viewed in many regions, but the wider range of benefits of watershed services has had well introduced outside of scientific circles (Flotemersch et al., 2015). As reported by Farber et al. (2002), the quality and quantity of services generated by watersheds are rapidly declining because of accelerating rates of land-use change, water consumption and climate change inter alia leading to global deterioration of freshwater biodiversity (Butchart et al., 2010). Accordingly, the integrity indicators for proper watershed resources management are needed to comprehensively monitor all different aspects of the watershed ecosystems. The following criteria are suggested for such indicators:

1. Assessment of integration among different components of the watershed
2. Description of the degradation of a watershed (watershed distress syndrome, EDS)
3. Reflectionof the function and structure of a watershed
4. Representation of the sustainability of human-coupled watersheds
5. Presentation of the goal of natural resources and watershed management (Space specific)

Besides the key indicators have to be sensitive to stresses, simple and easy to apply, strong scientific basis, possible to quantify, anticipatory in responses to stresses, and targeted to the goal of management.Through applying this approach, the severity (quantity leading to conservation strategies), the quality (leading to biodiversity assessment), and the locality of degradationacross the watershed and corresponding stressors will be designated. It is in the same line with 4R approach or program of Right source, Right rate, Right time, and Right place as basic concept for best management practices for adopting appropriate watershed resources measures.

Conclusion

From the state of resources available resources at the watershed level, it can be clearly understood that if an appropriate management strategy is not adopted immediately, the next generation and even current population will nearly face serious shortages in fulfilling vital needs. Undoubtedly, there is an immediatetime to quicklymonitor the amount, quality, and even spatial distribution of affecting factors on destruction of the watershed behaviors. The watershed adaptive management has to be then planned based on the results of monitoring of ecosystem distress syndromes. Such approaches must be implemented widely in the whole world and particularly for developing countries with more conflicting interestsif new global targets are to be achieved for managing current unprecedented issues leading to meetbasic needs of growing population.

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Global Perspective of Organic Farming

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Organic agriculture is an alternative production system and has gained more growth recently due to changes in consumer awareness lifestyle and income (Mariyono *et al.* 2018 and Trukhachev *et al.* 2018). In 2017, organic agriculture was practised in 181 countries by approximately 2.4 million farmers (The World of Organic Agriculture, 2019 and Kovalchuk *et al.* 2014). In 2017, global organic farming increased from 11 million hectares in 1999 to 69.8 million hectares. The maximum areas used for organic farming, as of 2017, were in Australia (35.6 million hectares), Argentina (3.4 million hectares), and China (3 million hectares). The maximum numbers of organic enterprises were in India (835,000), Uganda (210,300), and Mexico (210,000). According to the research of the Forschungsinstitut fur biologischen Landbau (FiBL), organic production has been expanding rapidly in the world (FiBL, 2019). In Europe, agricultural land area for organic production has increased tenfold over the last 10 years. The area under organic farming is increasing at a slower rate in countries where the process began a relatively long time ago (Germany, the Netherlands, and France) (Novak *et al.* 2016). The organic market in the world is now 97.0 billion US$ (F1BL & IFOAM, 2020). The organic area in India is 3.56 million hectare including certified forest areas (17.8 lac ha certified cultivated area + 17.8 lac ha wild certified area). The organic market from 8.37 lakh registered organic farmers in the country is valued at Rs 6000 crores with an annual growth rate of 12-15 percent. India is fast becoming a major base for production and supply of organically produced agricultural products to the world market. India has developed National Standards under NPOP programme. APEDA and the National Centre of Organic Farming under Ministry of Agriculture is promoting organic farming as facilitator across the country and providing various assistance to organic entrepreneurs and farmers in India. In this paper, global perspectives of organic agriculture have been discussed.

Global acceptance of principles of organic agriculture

All countries adopting certified organic agriculture adopt the fundamental rules on which principles of organic farming work which are as follows:

- The principles are to be used as a whole. They are composed as ethical principles to inspire action.
- These principles are the roots from which organic agriculture grows and develops. They express the contribution that organic agriculture can make to the world and a vision to improve all agriculture in a global context.
- Agriculture is one of humankind's most basic activities because all people need to nourish themselves daily. History, culture and community values are embedded in agriculture.
- The principles apply to agriculture in the broadest sense, including the way people tend soils, water, plants and animals in order to produce, prepare and distribute food and other goods.
- They concern the way people interact with living landscapes, relate to one another and shape the legacy of future generations.
- The principles show that organic farming is much more than the renunciation of agro-chemicals. Organic agriculture is based on the following principles.
  - The principle of health
  - The principle of ecology
  - The principle of fairness
  - The principle of care

1. **Principle of health**: The principle of health aims that organic agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible. Important facts under principle of health are as follows:

- This principle points out that the health of individuals and communities cannot be separated from the health of ecosystems - healthy soils produce healthy crops that foster the health of animals and people.
- Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being.
- Immunity, resilience and regeneration are key characteristics of health.
- The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings.
- In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being.
- In view of this, it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

2. Principle of ecology: The principle of ecology aims that organic agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them. Important facts under the principle of ecology are as follows:

- This principle roots organic agriculture within living ecological systems. It states that production is to be based on ecological processes, and recycling.
- Nourishment and well-being are achieved through the ecology of the specific production environment. For example, in the case of crops this is the living soil; for animals it is the farm ecosystem; for fish and marine organisms, the aquatic environment.
- Organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature. These cycles are universal but their operation is site specific.
- Organic management must be adapted to local conditions, ecology, culture and scale.
- Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources.
- Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity.
- Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

3. **Principle of fairness:** The principle of fairness aims that organic agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities. Important points under the principle of fairness are as follows:
   Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings.

- This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties – farmers, workers, processors, distributors, traders and consumers.
- Organic agriculture should provide everyone involved with a good quality of life and contribute to food sovereignty and reduction of poverty.
- It aims to produce a sufficient supply of good quality food and other products.
- This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behavior and wellbeing. Natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations.
- Fairness requires systems of production, distribution and trade that are open and equitable and account for real environmental and social costs.

4. Principle of care: The principle of care aims that organic agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment. Important points under principle of care are as follows:

- Organic agriculture is a living and dynamic system that responds to internal and external demands and conditions.

- Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being.
- Consequently, new technologies need to be assessed and existing methods reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken. This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture.
- Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient.
- Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time.
- Organic agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering.
- Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes.

Existing global policies

Globally, many interventions, regulations in the form of government policies designed to enhance the practice and culture of organic farming. Almost every country around the world focuses on production of organic based food products. Status of organic agriculture around the globe is given in table 1. In the present scenario USA is at top and has the maximum organic market with the net worth of 40 billion euros (Lernoud *et al.* 2017). Next to USA is Germany with the market worth of 10 billion euros (Schaack *et al.* 2019), followed by France and China with net market share of 7.9 and 7.6 billion euros respectively (Willer *et al.* 2019). The organic market in France achieved fastest growth rate of 18 % (Bio Eco Actual, 2019). In case of producers of organic products, India is on the top with highest numbers (Assocham *et al.* 2018). These statistical data is of special importance for policy makers to understand the perspectives of organic agriculture around the world and also help them to implemented more profitable and people oriented policies.

Table-1: Status of Organic agriculture in the world at a glance

Indicator	World	Top countries
Countries with organic activities	2018: 186 countries	
Organic agricultural land	2018: 71.5 million hectares (1999: 11 million hectares)	Australia (35.7 million hectares) Argentina (3.6 million hectares) China (3.1 million hectares)
Organic share of total agricultural land	2018: 1.5 %	Liechtenstein (38.5 %) Samoa (34.5 %) Austria (24.7 %)
Wild collection and further non-agricultural areas	2018: 35.7 million hectares (1999: 4.1 million hectares)	Finland (11.3 million hectares) Zambia (3.2 million hectares) Tanzania (2.4 million hectares)
Producers	2018: 2.8 million producers (1999: 200'000 producers)	India (1'149'371) Uganda (210'352) Ethiopia (203'602)
Organic market	2018: 96.7 billion euros (2000: 15.1 billion euros)	US (40.6 billion euros) Germany (10.9 billion euros) France (9.1 billion euros)
Per capita consumption	2018: 12.8 euros	Switzerland (312 euros) Denmark (312 euros) Sweden (231 euros)
Number of countries with organic regulations	2018: 103 countries	

Number of affiliates of IFOAM – Organics International	2018: 779 affiliates from 110 countries	Germany - 79 affiliates India - 55 affiliates China - 45 affiliates United States - 48 affiliates

Table 2. Current status and global policy initiatives in the organic farming sector

World's Regions	Current Status of Organic Market	Policies & Legislations	References
Europe	● In 2017, Organic farmland reaches up to 12.6 million ha. ● 250000 organic product producers reported in 2016 in EU. ● 2nd largest consumer of organic food (retail sales of 34.3 Billion euros). ● Import of 3.3 Million tons of organic food products, reported in 2018.	● National action plan. ● EU rural development program. ● Main target is to double the organic land proportion. ● Scheme of compensation for management of organic farms.	Lernoud *et al.* 2017
Asia	● Total cultivated organic land is 6.1 million ha (0.4% of total agricultural land). ● 25 % hike is observed in organic farmland area in between 2016-2017. ● China is on the top with largest organic cultivated area followed by India. ● Estimation of 9.6 billion euros market of organic farming in Asia.	● Establishment of OFDC by China in 1994 for organic products certification. ● Establishment of CAAC (China) in 2002. China instituted CNOPS in 2005. ● Cluster program by Indian government "Parampragat krishi vikas yojana" brings about 500,000 acres under organic farming. ● India initiates value chain based organic farming scheme in northeast regions. ● Scheme for integrated development of horticulture (India) was implemented from 2014-15. ● Introduction of national mission for sustainable agriculture.	Lernoud *et al.* 2017, FiBL, 2017, Paull *et.al.* 2008, Datta *et al.* 2017
North America	● Presence of 7% agricultural land. ● 2.2 million ha land under organic farming. ● In 2017, FiBL and IFOAM estimated 48.7 billion dollars net worth of organic market.	● USA in 1990 passes organic food production act to regulate production and processing of organic food. ● Initiation of National Organic Program. ● USDA labelling of products.	Ellsworth, 2001, Willer *et al.* 2018
Germany	● 8% increase has been observed in organic cultivated land. ● 10.91 billion Market with	● Framing of Organic farming act by the German government. ● Establishment of BOLW for	Schaack, 2019

	average growth rate of 5.5% since 2018.	improvement of organic farming. ●Uniform Ecolabel on organic products is used since 2001.	
Australia	●Australian organic market is with net worth of 2.4 billion dollars. ●88% growth rate has been observed since the year 2012. ●12% of Australians are now committed purchasers of organic products.	●Development of private certification organizations in the period of 1980s. ●These organizations come under AQIS in 1990. ●Establishment of BFA and NASAA for the promotion of organic practices. ●Adoption of national standard in 1992 which later amended in 1998.	Lawson *et al.* 2018, Wynen and Fritz, 2018
Denmark	● World's leading nation in organic farming. ● Having share of 8.4% in global market.	●Government in 1987 adopted the organic farming act. ●In 1992, Government starts providing Grant in aid for organic research. ●Introduction of permanent subsidies to farmers of organic agriculture sector in 1994. ●Initiation of Education program of farmers working in organic fields in 1995. ●Permanent organic payments and flat conversions replace the permanent subsidies in 2004.	Agriculture, Ministry of food A and F of D. Organic production in Denmark. 2012 Daugbjerg, 2010

Productivity, Economics and Technical Efficiency

Current organic agriculture performs well in several sustainability domains, like animal welfare, farm profitability and low pesticide use, but yields are commonly lower than in conventional farming. There is now a re-vitalized interest in increasing yields in organic agriculture to provide more organic food for a growing, more affluent population and reduce negative impacts per unit produced. However, past yield increases have been accompanied by several negative side-effects. Here, we review risks and opportunities related to a broad range of sustainability domains associated with increasing yields in organic agriculture in the Northern European context. We identify increased N input, weed, disease and pest control, improved livestock feeding, breeding for higher yields and reduced losses as the main measures for yield increases. We review the implications of their implementation for biodiversity, greenhouse gas emissions, nutrient losses, soil fertility, animal health and welfare, human nutrition and health and farm profitability. Our findings from this first-of-its-kind integrated analysis reveal which strategies for increasing yields are unlikely to produce negative side-effects and therefore should be a high priority, and which strategies need to be implemented with great attention to trade-offs. For example, increased N inputs in cropping carry many risks and few opportunities, whereas there are many risk-free opportunities for improved pest control through the management of ecosystem services. For most yield increasing strategies, both risks and opportunities arise, and the actual effect depends on management including active mitigation of side-effects.

Beside a long list of policies and legislations, few reasons and challenges have been identified for lower efficiency of these policies. These are:

a) Lower productivity rate.

b) Lack of global standards for organic processing and production.

c) Higher consumer costs.

d) Issues in maintaining consistency in food quality.
e) Lack of required infrastructure and supply chain management.
f) Lack of awareness between the people.
g) Lack of professionals.

Organic Agriculture in 21st Century

In 21st century, organic agriculture has transitioned from phase organic 1 & 2 to now in phase organic 3.0 where a blend of organic and other innovative farming systems is needed. Significant barriers exist to adopting these systems, however, and a diversity of policy instruments will be required to facilitate their development and implementation. A brief information on Organic 1.0, Organic 2.0 and Organic 3.0 is mentioned here.

Organic 1.0

The organic timeline can be measured in approximately 100 years: from the early days of imagining organic by those who saw the connections between how we live, eat, and farm, our health and the health of the plant (what we call 'Organic 1.0'); to the forming of the movement and the codification of standards and enforced rules that have established organic in 82 countries with a market value of over $72 billion per year (what is termed 'Organic 2.0').

Organic 2.0

Organic 2.0 shaped the visions of the pioneers into a piratical reality. Organic has inspired producers and consumers alike and has changed unsustainable habits around the globe. There is evidence of positive impacts in a wide range of important issues including consumer health, biodiversity, animal welfare and the improved livelihood of producers. The standards maintained by state government and private organizations mainly define minimum requirements for organic production and processing. However, they often fail to entirely meet the principles of health, ecology, fairness and care, at the core of the organic philosophy.

Organic 3.0

Organic 3.0 concept seeks to change this, by positioning organic as a modern, innovative system which puts the results and impacts of farming in the foreground.

The overall goal of Organic 3.0 is to enable a widespread uptake of truly sustainable farming systems and markets based on organic principles and imbued

The concept of Organic 3.0 seeks to address the previously outlined challenges by positioning organic as a modern, innovative system which puts the results and impacts of farming in the foreguard. Diverse priorities and challenges like for example climate change resilience and adaptation, access to capital and adequate income, animal welfare, availability of land, water, seed, healthy diets, and avoidance of waste in food and farming systems cannot possibly all be folded into an ever-expanding set of standards and rules. Thus, a more holistic and dynamic model is needed.

Policies to support Organic Farming

The second-generation problems of green revolution in the country have promoted agricultural scientists and policy makers to re-evaluate to current agricultural practices and investigate alternative protection methods. Presently, up to 30% area is default organic in India. About 10% of total agriculture land in India can be brought under organic production method. In India, it has been estimated that there is 20 crore potential consumer and a domestic market Rs 3000 Cr. there are niche area is terms of potential medicinal herbs, crops, fruit and vegetable which can up-scaled for organic farming through technological backstopping, mass awareness, cooperative management and group certification.

Limited availability and high prices could be considered a barrier related to the immature character of organic markets in India. Thus, supply-rather than the demand- is the larger issue today, even though, on a quick note, one also hears complaints of non-availability of markets. Strategies to achieve this include supporting the conversion to organic production through reduced cost of certification and organic input production, arranging supplies from different regions of the country in order to encourage the pooling of produce from small farmers into larger consignments and providing vital institutional and technical support to this organic production in niche and potential areas of the country. Moreover, knowledge and ecological awareness are particularly important not only for organic farmers but for consumers, processors, teenagers and children as well. Research and Policy support is required to minimize following gaps to upscale organic agriculture in the 21st century.

Beyond organic

More than 40 years after Earl Butz's comment, we are in a new era of agriculture, as reflected in the words of current US Secretary of Agriculture Tom Vilsack: "Organic agriculture is one of the fastest growing segments of American agriculture and helps farmers receive a higher price for their product as they strive to meet growing consumer demand"93. Moreover, organic agriculture has been able to provide jobs, be profitable, benefit the soil and environment, and support social interactions between farmers and consumers.

Although organic agriculture has an untapped potential role in global food and ecosystem security, no one farming system alone will safely feed the planet. Rather, a blend of organic and other innovative farming systems, including agroforestry, integrated farming, conservation agriculture, mixed crop and livestock, and still undiscovered systems, will be needed for future global food and ecosystem security.

Equal adherence to all four sustainability goals of production, environment, economics and social wellbeing does not limit but encourages farmers and researchers to innovate. Te challenge facing policymakers is to create an enabling environment for scaling-up organic and other innovative farming systems to move towards truly sustainable production systems. Tis is no small task, but the consequences for food and ecosystem security could not be bigger. To make this happen will require mobilizing the full arsenal of effective policies, scientific and socioeconomic advances, farmer ingenuity and public engagement.

Pathways for future development of organic agriculture

Future development of organic farming

As organic farming continues to grow, it also evolves and transforms. The evolution of organic farming can be divided into three stages: (1) the pioneer stage (1925–1980), where organic farming began as a response to the environmental, economic and social problems caused by industrialization and the adoption of agrochemicals; (2) the legitimation stage (1980–2015), where the principles were codified into standards and legally mandated regulatory systems; and (3) the mainstreaming stage (2015-present), where organic farming systems are moving from being a niche to an accepted solution to the challenge of sustainable food production (Niggli et al. 2016). The latter is referred to as "Organic 3.0" and aims at promoting organic food and farming systems as a modern and innovative approach to farming based on organic principles. As opposed to the current approach of certified organic agriculture, Organic 3.0 does not enforce a set of minimum rules to achieve a final static result but is outcome-based and continuously adaptive to the local context. As a culture of continuous improvement through stakeholder-driven initiatives for the transformation of food and farming systems towards higher levels of resilience, sustainability and systemic health, Organic 3.0 is motivated by innovation, transparency and inclusion, while remaining based on local priorities. Methodologically, Organic 3.0 applies a holistic systems approach and also accounts for external costs of agriculture. As such, research in Organic 3.0 will require methodological innovations in evaluating ecosystem and economic performance (Arbenz 2014).

Pathways of future research

Most of the current research on organic food and farming systems addresses the needs of the Organic 3.0 or mainstreaming stage. Therefore, TIPI advocates for three main pathways for future research on organic food and farming systems follow (Table 2). Pathway 1 improves and enables organic farming systems to become a widely preferred land use system in rural areas worldwide. Pathway 2 improves and enables organic food and farming systems to feed the world and conserve the planet's natural resources. Pathway 3 enables organic food and farming systems to produce healthy food in a fair way for the well-being of all. These three pathways are proposed as a way to have secure food and protected ecosystems in the future (Niggli et al. 2016).

From these visions, we derived the following strategy for global organic food and farming research and innovation, which may be implemented by following the three pathways and associated research implications mentioned above.

Strategies of organic food and farming systems research

Through a lengthy strategic planning process that included researchers and the beneficiaries of organic farming research, TIPI identified three strategic research approaches, which will help advancing global organic food and farming systems research and innovation in the context of the three pathways described above ("rural empowerment", "eco-functional intensification" and "healthy and fair food"; Niggli *et al*. 2016):

1. Develop research methods appropriate for organic food and farming systems.
2. Renew partnerships between farmers, farm advisors, scientists and consumers.
3. Integrate technological, social and ecological dimensions of innovation.

Following these three strategic approaches is likely to lead to a transformation of food and farming systems towards higher levels of resilience, sustainability and systemic health, the achievement of which will require a restructuring of how research is conducted. Disciplines will be required to interact in a way they have not done previously. Metrics for performance should be developed to look at more than short-term productivity and profitability, without neglecting the need for sufficient production or to make profits. To conduct valid, evidence-based research on organic food and farming systems, research needs to continue to rely on well-designed, maintained and controlled experiments that meet the standards of scientific peer review. However, unlike most experimental research carried out in the past, novel research will require multidisciplinary teams who integrate components research into holistic farming system approaches.

Pathways for future development of organic food and farming systems with corresponding visions and research implications (source: Niggli et al. 2016)

Pathway	Vision	Implications for future research
Pathway 1: Organic agriculture will become the preferred land use system in rural areas worldwide.	Organic agriculture will be the preferred land use model and thus empower rural economies. Viable local economies will attract people, improve livelihoods and halt migration to cities. Organic farming will intensify partnerships between consumers and producers by fostering dialogues between them. Through best use of natural and social resources, organic agriculture will be a powerful intensification strategy in rural areas and for subsistence farming.	Develop value added food chains in rural economies; sourcing regional, high-quality foods from organic farms and using local processing, packaging and labelling units to create new products by traditional food techniques and innovative technologies
		Include all stakeholders in setting research priorities; farmers, traders, processors, researchers, retailers, consumers and future generations should all be involved in improving the quality of rural life and sharing the benefits of organic farming
		Establish farmer-researcher innovation groups to boost co-innovation in rural areas
		Improve the economic viability of short food chains through information and communication technologies, as well as social media
		Specify models, metrics and key indicators and use them to collect and analyse data about the comparative environmental and social costs of organic and conventional agriculture
Pathway 2: Secure food and ecosystems through eco-functional intensification	Eco-functional intensification will increase the availability of food and stabilize food supplies. Use of non-renewable resources and off-farm inputs will become obsolete. High standards	Adopt a perspective that soil, plant and animal health is the norm to investigate, understand and develop preventive measures (cultural, physical and biological), aiming at replacing the routine use of pesticides and animal medicine
		Breed crops and livestock that are better adapted to local conditions as well as low external input systems and have sustainable yields and greater nutritional

	in animal welfare will be maintained and sustainable ecosystem management will be state of the art. Organic farming will minimize negative trade-offs between productivity and sustainability, making it the benchmark for the responsible and precautionary use of science in food and farming systems. Organic farmers will be the best agricultural ecosystem managers, co-researchers and resource optimizers.	quality
		Employ modern scientific methods to test, validate and, where appropriate, adjust traditional knowledge and locally adapted systems to improve the resilience of farming systems
		Design farming system and natural habitats that enhance functional biodiversity, increase abundance of pollinators, biological control agents and other beneficial organisms, efficiently cycle nutrients, and create buffer zones to protect critical ecological areas
		Increase sustainable yields through improved crop rotations, polycultures, nutrient recycling and variety selection
		Enhance soil building to increase organic matter, sequester carbon, maintain and improve soil fertility and improve systems' resilience, particularly in tropical and arid zones
Pathway 3: Organic agriculture will produce healthy food in a fair way for the well-being of all.	Healthy diets, consisting of fresh and whole foods with intrinsic qualities, will be a standard and are only minimally altered by processing. In terms of taste, regional variation will be preferred over artificial design. Organic farmers, food processors and distributors will jointly spearhead the transition to more conscious consumption patterns and the renaissance of authentic traditional foods. Members of the organic movement will be innovative in the design of cooperative and participative models of transport and safe and traceable food systems.	Investigate the interactions between (organic) food quality and human health, looking at the effects of nutrient density, secondary plant nutrients, and reduced contamination with pesticides and other chemicals
		Develop and improve technologies to recover organic wastes, so that they can be safely and efficiently returned to the soil ("cradle-to-cradle")
		Evaluate biodiversity between (inter-specific) and within (intra-specific) species of plants and animals for their ecological resilience and the health well-being of animals and humans
		Examine and adapt traditional food processing using modern techniques to improve the quality and performance of natural, authentic and heritage foods without losing their essential characteristics
		Investigate the causes of and ways to prevent contamination with pesticides, genetically modified organisms and other contaminants prohibited in organic production and handling from entering organic food chains
		Invent and develop more ecologically friendly packaging that is made from renewable resources, can be reused and is recyclable

Future Challenges

Organic farming aims for human welfare without harming the environment and follows the principles of health, ecology, fairness and care for all including soil. The modern concept of organic farming combines the tradition, innovation and science. Although, history states that the movement for organic way of life recognized in 1905, it could gain ground after realizing the ill effects of modern agriculture in the late 1990's. In 1905, the

British botanist Sir Albert Howard, often referred to as the father of modern organic agriculture, documented traditional Indian farming practices, and came to regard them as superior to conventional agriculture science. During 1940, In Japan, Masanobu Fukuoka, a microbiologist working in soil science and plant pathology, quit job as a research scientist, returned to his family's farm, and devoted the next 30 years to develop a radical no-till organic method for growing grain, now known as "Fukuoka farming". Many other practices such as Rishi krishi, Natueco farming, Homa farming, Panchagavya Krishi and bio dynamic farming are associated with organic agriculture. The reports indicate organic farming can minimize energy consumption by 30.7% per unit of land by eliminating the energy required to manufacture synthetic fertilizers and pesticides and by using internal farm inputs, thus reducing fuel used for transportation. India can emerge as global leader due to the presence of large number of organic producers (almost 6.5 lakh producers) and they need to be supported with technical knowledge and inputs besides marketing infrastructure. The research results available for little over a decade confirms the yield advantage in many crops such as basmati rice, maize, cotton, chickpea, soybean, groundnut etc. However, the major impediment for growth of organic farming in India is yield reduction in the initial years due to swift switch over from inorganic to organic, wide gap between availability of organic source of nutrients and requirement and lack of pest and disease management options. Most of the organic growers have expressed that lack of support price for organically grown crops and marketing infrastructure as the major constraint in promotion of organic agriculture. Although, much progress on research in organic farming has been done, the new emerging areas of human health benefits, understanding the economics with environmental markets, climate friendly farms and carbon farming with organic farming system models needs to be addressed in future. The certification systems of grower group, participatory guarantee system, know your farm and know your food should be promoted in large scale.

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Climate Smart Nutrient Management Approaches in Smallholder Farming System

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Climate smart nutrient management is key towards food as well as nutritional security to meet the food demand of ever-growing world population under climate challenged scenario. The plant nutrition process can be impacted by climate change at multiple scales resulting in reduction in quality and quantity of staple food. Increase in temperature creates variation in water regimes impacting plant nutrient availability. Elevated levels of CO_2 in the climate change scenario will also impact plant nutrient uptake. The problem is more severe in tropical climates including small and marginal small holder farmers of South Asia and Sub-Saharan Africa. Therefore, it is time to think about how appropriate nutrient management practices can help us to adapt or mitigate climate change impacts on agricultural production systems. Fertilizer use could be at the crux of sustainable intensification of production systems around the world as we prepare to face the food security challenges imposed by climate change. The nutrient management protocols need to be selected appropriately to work as a major intervention option independently as well as to cater the needs of other management practices such as conservation agriculture and drought tolerant breeding programs. The objectives of the nutrient management plans are to provide support to production system under stress scenario. The nutrient management plans should also help in using nutrient prudently to minimize the foot prints in the environment by increasing nutrient use efficiencies without much compromising the quantity and quality of the produce. One the options of such nutrient management guidelines include 4R nutrient stewardship, precision agriculture, enhanced efficiency fertilizers, etc. The4R Nutrient stewardship principles of applying the right source of nutrients, at the right rate and time, through a right method provides a handy tool to achieve sustainable intensification even at the face of climate change. These nutrient management guidelines should guide the success and better adoption by gelling with other climate smart practices such as conservation agriculture. The study also highlights the influence of varied farm typologies in adaptation of climate smart agriculture. The present study provides the concept of different nutrient management options along with a review of its practical application towards mitigating global warming potentials.

Climate change impact on smallholder farming system

Smallholder farmers are one of the most vulnerable groups to climate change, yet efforts to support farmer adaptation are hindered by the lack of information on how they are experiencing and responding to climate change. More information is needed on how different types of smallholder farmers vary in their perceptions and responses to climate change, and how to tailor adaptation programs to different smallholder farmer contexts. It is estimated that globally there are about 475 million smallholder farmers who cultivates in less than 2 ha of land. Most of them are poor, experience food insecurity, and live in highly precarious conditions. Smallholder farmers are highly vulnerable to climate change because most depend on rain-fed agriculture, cultivate marginal areas, and lack access to technical or financial support that could help them invest in more climateresilient agriculture.

Nutrient management and climate change

Impact of nutrient management in developing climate resiliency is an emerging area of research. The review of significant number of studies have established the relationship between nutrient management strategies under climate stress situations and maintaining and/or increasing productivity. The research outcomes suggest that without the application of suitable nutrient management, it will not be possible to maintain the productivity levels that are needed to feed the additional billions of people the world is expected to have by 2050.

A sound scientific approach that applies concepts in agronomy, soil science, and conservation agriculture will be needed to maintain sustainable and productive agricultural systems for stable food security (Adams et al., 1998). The present study aims to highlight the major pillars of nutrient management, their roles in stress management, and scope of integration with other climate smart management practices.

Climate change and fertilizer use

Fertilizer, particularly nitrogenous fertilizer use, is often cited as a causal factor of climate change, and reduced use of nitrogen is sometimes promoted as a mitigation approach. However, nitrogen is also the most limiting nutrient in major production systems, particularly in the tropics. Plant nutrition, in general, can be impacted by climate change at multiple scales. High ambient temperature and change in water regimes due to change in rainfall pattern may fundamentally impact how nutrients are accessed by crops. Increasing soil moisture deficit due to drought slows down water-dependent diffusion and mass flow of nutrients to the roots, and impaired root growth due to moisture stress decreases the capture of less mobile nutrients such as phosphorus. Higher frequency of high-intensity rainfall events can cause erosion leading to loss of nutrient-rich top soil and surface-broadcast fertilizer, as well as leaching of nitrates and potassium from soil, thereby leading to fertility depletion. Increase in atmospheric temperature over time due to global warming may increase soil moisture deficits and reduce ion diffusion and mass flow of nutrients. Additional carbon at predicted elevated levels of CO_2 in the atmosphere is anticipated as one of the indicators of climate change.

Considering the above, it is probably time that we start thinking about how appropriate nutrient management can help us adapt or mitigate climate change impacts on agricultural production systems. Fertilizer use is and would be at the crux of sustainable intensification of production systems around the world as we prepare to face the food security challenges imposed by climate change. The 4R Nutrient stewardship principles of applying the right source of nutrients, at the right rate and time, through a right method provides a handy tool to achieve sustainable intensification even at the face of climate change. Evidences across the globe showed that research and extension efforts on precise 4R recommendations in crops and cropping systems have provided rich dividends in terms of increased crop productivity and farm income, while adapting and mitigating climate change.

Climate smart nutrient management

Agriculture practices need to be climate friendly and therefore nutrient management should be climate smart. There are several climate smart nutrient management options that are discussed below.

Precision Nutrient Management

Precision nutrient management tools use layers of GIS information including reliable weather data and soil databases, remote sensing information, digital terrain data and other information with erosion and hydrological models to conduct site-specific simulations across field and natural ecosystem. Precision conservation agriculture could be the key component of utilizing all these advanced tools of nutrient management together or as and when required for developing sustainable nutrient management protocols. The application of precision conservation agriculture helps optimizing available resources through best site-specific land and field practices, contributing to rapid yield increases. A combination of 4R nutrient stewardship, along with timely field operations and weeding, plant spacing, and populations could make significant yield improvement without any investment, simply by improving synchronization of management with the crop uptake demands of an even plant population. Additionally, precision conservation agriculture has also been successful in adding of other agrochemicals and lime. As with the fertilizer, the lime is precisely applied around the root zone of each plant to improve the environment around the plant root zone and use the minimal resources more effectively. For example, optimizing the date of planting of maize (*Zea mays* L.) in Zimbabwe is the key to maximize productivity. The traditional farming systems in Zimbabwe do not capitalize the synchronization of planting with better growing conditions for maize. In general, due to tillage constraints, many farmers plant late in Zimbabwe, reducing their yield potential. The adoption of precision conservation agriculture could help farmers improve synchrony of planting with the environmental conditions of the growing season to help increase average maize yields. This can be achieved without large investments, enabling many more farmers to be food secure and to sell surplus product.

4R Nutrient Stewardship

4R Nutrient Stewardship is an innovative approach for fertilizer best management practices that considers economic, social, and environmental dimensions of fertilizer management and is essential to sustainability of agricultural systems. The concept is simple: apply the right source of nutrient, at the right rate, at the right time, and in the right place. All farmers, irrespective of the size of farm, knowledge and awareness levels, consider what fertilizer to apply, how much, when and how before making a fertilizer application decision in any crop. The 4R Nutrient Stewardship principles connects these fertilizer application decisions to scientific principles and guides the application decisions specific to crops, soils and local site. It is considered the foundation of precise management of nutrients in any production system. The key scientific principles and examples of practices for application of the right source of nutrient, at the right rate, at the right time, and in the right place are given in Figure 1.

The four "rights" provide a simple checklist to assess whether a given crop has been fertilized properly. Asking "Was the crop given the right source of nutrients at the right rate, time, and place?" helps farmers and advisors to identify opportunities for improvement in fertilizing specific crop in each specific field.

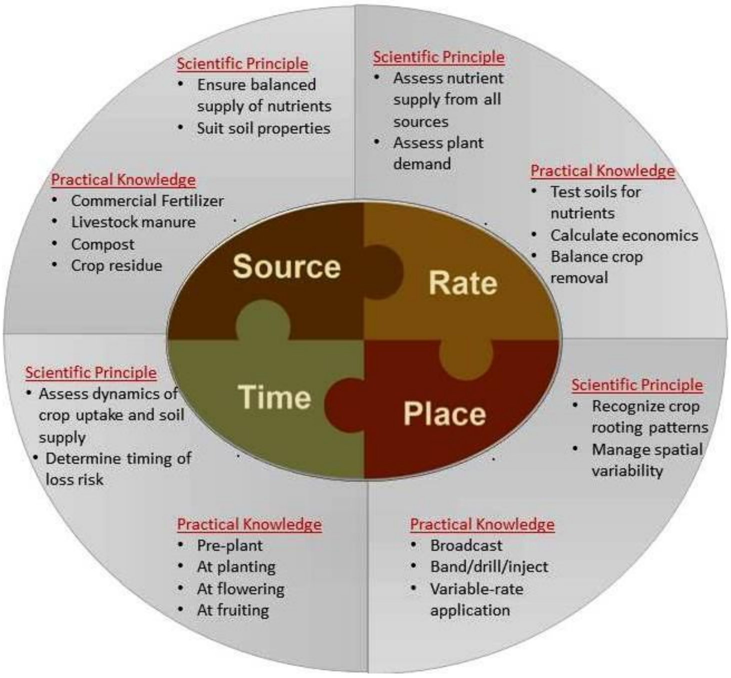

Figure 1. Examples of key scientific principles and associated practices of 4R Nutrient Stewardship. Source: Adapted from Majumdar et al., 2018.

On-farm application of 4R

Producing more yields per unit area would require a correspondingly larger quantity of plant nutrients, from one source or another. Such intensification process needs on-farm application of 4R-based nutrient management to limit the potential of greenhouse gas emission under high-input agriculture. However, farm-specific 4R nutrient management is a knowledge-intensive process. The Nutrient Expert® fertilizer decision support tool for rice, wheat and maize, developed by IPNI and its partners, is a recent innovation for developing field-specific 4R-based fertilizer recommendation for individual farmers. The tool is based on the principles of site-specific nutrient management (SSNM). It utilizes information provided by a farmer or a local expert to suggest a meaningful yield goal for his/her location, and formulates a fertilizer management strategy required to attain the yield goal. The required information about the production system is gathered through a set of simple, easily answerable questions that analyses the current nutrient management practices and develops guidelines on fertilizer management which are tailored for a particular location, cropping system, farmer resource availability, while considering the organic inputs as a part of the system nutrient balance. Combined use of Nutrient Expert® and GreenSeeker™ minimized the environmental footprint of wheat production under no-till system in northwestern India. The estimated total carbon footprint, i.e., global warming potential (GWP) per Mg of wheat grain production and per US$ of net return, was lower for Nutrient Expert® (NE)-based strategies than other nutrient management strategies.

A similar study in summer maize in North-Central China showed that the fertilizer recommendation from the Nutrient Expert® tool reduced the calculated total N2O emission, total greenhouse gas (GHG) emission, and GHG emission intensity were 35.1 and 17.5%, 35.2 and 18.4%, and 37.3 and 17.4% lower in the NE-based fertilizer recommendation when compared with the farmers' practice and soil test-based fertilizer recommendation, respectively.

Fertilizer N management for reduced methane emissions

There is conflicting information in the literature on the effects of fertilizer N management on CH4 emissions. The presence of rice plants under flooded culture and the type of fertilizer N applied were reported to affect the emissions of CH4, N2O, and N2. Application of ammonium–based fertilizers (e.g. urea, ammonium sulphate) can increase rice growth and stimulate plant-related CH4 emissions, but this enhanced emission may be countered by ammonium effects on the inhibition of CH4 oxidation. Literature reports of inhibitory and stimulatory effects of ammonium fertilizers on CH4 emissions were mentioned in a report with maize and soybean (Glycine max L.) in the eastern U.S. corn belt, which indicated CH4 was absorbed by soils receiving fertilizer N application (urea ammonium nitrate or UAN) while manured soils emitted CH4. In China, increasing the ammonium N rates from medium to high levels, within the range of typical N rates in China, did not appear to modify CH4 emissions. Methane oxidation was stimulated by fertilizer or compost N, but when applied together, CH4 oxidation was inhibited.

Nutrient Management and Conservation agriculture

Conservation agriculture (CA) is promoted as an important crop and soil management practices for climate smart agriculture. The practice is particularly beneficial for addressing major soil and climatic constraints that limit crop productivity in smallholder farming system of South Asia (SA) as well as Sub-Saharan Africa (SSA). Along with three well established components of CA – minimum tillage; permanent organic soil cover; and diversified crop rotations, nutrient management is considered a key factor for the success of the practice. Advanced nutrient management strategies, such as 4R Nutrient Stewardship, SSNM, and Precision Agriculture have helped smallholder farmers of South Asia, Sub-Saharan Africa and other regions improving productivity and profitability as well as environmental stewardship. Combining site specific nutrient management strategies with CA practices are critical for large-scale adoption of conservation agriculture. Moreover, a combination of these two will definitely help for adaptation of a practice having compliance with climate smart agriculture.

Recommendation of nutrient management strategies as per farm typology

A major challenge in the dissemination of the technology is associated with the fact that the agronomic guidelines do not fit the farmer resource endowment capacity. As a result, when the technology fails to cater the need of the farmers, the chances of its adoption goes minimal. No matter how strong the associated and used science is, it ends up with very lower acceptance rate. A slower adaptation rate of climate smart agricultural practice on global scale might strengthen the above expression.

Studies argue that climate change-related education through improved extension contact and exposure to mass media can strengthen integrated farm activities that strengthen farm income. Additionally, farmer associations or groups should be given adequate attention to facilitate climate smart technology adoption as a means to climate change mitigation and resilience. In a different study at a total of 300 household heads in Segou Region of Mali, showed significant differences in the observed and potential adoption rates of the climate smart agricultural (CSA) technologies and practices,such as - drought tolerant crop varieties, micro-dosing, organic manure, intercropping, contour farming, farmer managed natural regeneration, agroforestry and climate information service. The study reported that the most adopted technology was the organic manure (89%) while the least adopted was the intercropping (21%). The observed adoption rate varied from 39% to 77% according to the CSA options while the potential adoption rates of the technologies and practices ranged from 55% to 81%. This implies an adoption gap of 2% to 16% due to the incomplete diffusion or lack of awareness of CSA technologies and practices which must be addressed by carrying out more actions to disseminate these technologies in the CSV. Results showed that education, number of workers in the household, access to subsidies, and training have a positive effect on the adoption of most of the CSA technologies and practices. The adoption of drought tolerant varieties and micro-dosing are positively correlated with access to subsidies and training. Therefore, both the study suggests that efforts should be focused concomitantly on the diffusion of CSA options as well as the lifting of their adoption barriers. And it is true that the barrier exits both at demand (user/farmer) as well as supply (technology provider) sides.

To lift the adoption barrier, we have to provide a solution that would cater the needs of both users as well as technology providers. Therefore, a major need is to understand the farm typology and farmer resource endowment capacity before suggesting a recommendation protocol for a single farmer as well as group of farmers.

Conclusions

Sustainably producing enough food from limited land and water resources under the overarching influence of climate change is a serious challenge. Of the several factors contributing to global food security, use of mineral fertilizers accounts for 40-60% of the global food production. The current and future food demand can be achieved through efficient and adequate use of mineral fertilizers. However, inappropriate fertilizer use, coupled with non-scientific ways of applying fertilizers, could increase the greenhouse gas emissions and contribute to global warming and environmental pollution.

The appropriate use and management of fertilizers following proper guidelines, such the principles of 4R Nutrient Stewardship is an essential part of climate-smart nutrient management. Scientific studies across the world clearly establish that adoption of 4R-based fertilizer management has the potential to increase food production in a sustainable way without jeopardizing the environmental sustainability. Several studies also identified other challenges such as Fe and Zn nutrition of humans and progressive nitrogen limitations in soils that are associated with climate change, and could be addressed through appropriate nutrient management. Use of enhanced efficiency and controlled-release fertilizer sources also offer potential scope for minimizing nutrient losses to the environment while sustainably increasing food production. There is a need to popularize such technologies for use by farmers and this could be achieved with the integration of farm typologies in the recommendation part so that the prescription could cater the need of the farmers. Large-scale dissemination of climate-smart nutrient management practices may ensure sustainable intensification of crop production to address food and nutritional security concerns, especially in South Asia and Sub-Saharan Africa.

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Soil Fertility Management in Various Ecological Belts of Nepal

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Background

Over the past decades, population growth in Nepal is at faster pace and because of rapid urbanization of cultivated area; the food produced within the country could not feed the ever-increasing hungry stomach. Hence, since eighties, Nepal has become one of the cereal importers. One of the factors for increasing production of crops is nutrient- its availability and uses. Nepal do not have its own chemical fertilizer plant, therefore, has to rely on imports from other countries. However, due to slow mineralization of nutrients coupled with timely unavailability of fertilizers in hills and mountains of Nepal, farmers generally use farm yard manure or other organic sources of nutrients. The main source of nutrients in hills and mountain of Nepal is organic based and chemical fertilizer is used as supplementary to organic sources of nutrients. Of the total fertilizer imported in the country only 3% is distributed in the mountain area, 30% in mid hills while the rest 67% is distributed and used in the terai region (Agriculture and Livestock Diary, 2077). Terai being plain and bordered with India and also due to open border system between India and Nepal, there is fertilizer trade between Indian trader and Nepali farmers which are never reported in national database.

Ecology and Cropping System

The country is divided into five physiographic regions: Terai, Siwalik, Middle mountain, High mountain and High Himalayas with only three ecological belts Terai, Hills and Mountains. The cropping system varies with the ecology. In terai, there is intensive cultivation of major cereal crops like rice, wheat and maize whereas in hills and mountains the cultivation of minor crops and vegetables are mostly dominant. The variation in cropping system influence the soil fertility management practices too. In terai region, due to intensive cultivation the system of soil fertility management is primarily inorganic and organic sources of nutrients are used as supplementary inputs. But in hills and mountain region, organic sources of nutrients are used as primary inputs and inorganic nutrients are considered as supplementary. Because of this reason, in terai, mostly improved varieties of crops along with hybrids are used so that nutrients can be easily supplemented while in hills and mountain, mostly local crop varieties are mostly grown so that these varieties respond well to mere application of nutrients. In Terai area, mostly rice, wheat, maize, vegetables, fruits, etc. are grown whereas in hills most maize based cropping system is dominant. In mountain region, temperate fruits, beans, potato and millets are popularly grown.

Fertilizer Demand and Use

There is no domestic production of chemical fertilizers in Nepal and all chemical fertilizer requirements have to be met through imports. Nepal has total cultivated area of 3091000 ha and cultivable are of 1030000 ha (Agriculture and Livestock Diary, 2076). Fertilizers are used for most of the crops in Nepal. Most of the fertilizer is consumed in terai region (67%) where cereals are produced mostly, followed by low and mid hill (30%) and high hill (3%) (SP Pandey and D Joshy, 2000). A total fertilizer sale in the country for the year 2074/75 and 2075/76are 384734 and 334004 metric tons respectively in which 67% of the total sale is urea (Agriculture and Livestock Diary, 2076). Farmers generally use urea only thereby resulting imbalance use of the fertilizer leading to soil acidity. Potassic fertilizer sales in the country for the same yearsare only 2.23% and 2.14% respectively of the total fertilizer and remaining 31% is DAP. Nepal Agricultural Research Council recommended fertilizer dose for almost all crops but the recommendation is not followed because of unavailability of fertilizer in time, high price of chemical fertilizer, remoteness and inaccessibility.

Based on the crop requirement and cultivated area of most crops, it is attempted to estimate fertilizer requirement for the country. Data pertaining to crop area and fertilizer dose for each crop is taken from Agriculture and Livestock Diary and personal communication with the commodity coordinators. Detail of the estimated fertilizer requirement along with major crops- its area is given in Table-1.

Table-1: Estimated fertilizer requirement for major crops in Nepal

Crops	Area (ha)	OPV area (ha)	Dose of fertilizer	FYM (ton)	Hybrid area (ha)	RDF hybrid	Total DAP req (ton)	Total urea reqd (ton)	Total MOP required (ton)	FYM reqd (ton)
Rice	1469545	1419545	100:30:30	10	50000	120:40:30	96752	303646	73183	73183341
Maize	954158	811034	120: 60:40	10	143124	180:60:40	124231	244736	63356	63356091
Wheat	706843	706843	100:50:50	10			76692	139580	58668	58667969
Fruits	130449	130449	200:150:150	60			42461	48972	32482	32481801
Vegetables	286864	286864	70:50:40	30			31125	37972	19048	19047770
Oilseeds	224595	224595	60:40:20	6			19495	25733	7457	7456554
Potato	195173	195173	70:50:40	30			21176	25835	12959	12959487
Sugarcane	78609	78609	120:60:20	10			10235	18628	2610	2609819
Legumes	311382	311382	20:40:20	5			27028	8649	10338	10337882
Total	4357618						449196	853751	280100	57284080

Though the total requirement of the chemical fertilizer is almost 15 lakh metric tons but the active demand for these fertilizers is only 8 lakh metric ton. Despite this demand, the government could supply less than 4 lakh metric ton. There is always less than 50% supply of chemical fertilizers of the active fertilizer demand. Among many fertilizers in global market, Nepal supplies only urea, DAP and MOP. Urea occupies the highest amount of import (63%) followed by DAP (35%) and the rest 2% import is of MOP (as per the data of 2075/76). The government subsidy on fertilizer is also aligned with the proportion of fertilizer import in the country. Urea being import in comparatively huge amount, also has a subsidy of more than 60% in its price and for DAP and MOP only 34% and 30% respectively is given subsidy by the government.

Status of Organic Fertilizer

Since Nepal do not have any chemical fertilizer plant, the government of Nepal focusses on organic fertilizer production in the country. Heavy subsidy was given for machinery items for the establishment of organic fertilizer industries in the country. At the moment, there are 24 organic fertilizer companies registered in the Ministry of Agriculture and Livestock Development but only few companies are producing and selling organic fertilizers in market. There are other companies running without proper registration and few companies are importing organic fertilizers from other countries. Vista et al, 2019 reported that 78 different soil agrochemicals such as micronutrients, PGR/Hormones/Enzymes/Soil Conditioners are available in Kathmandu valley. Among them, 35 were micronutrients (only 7 were found registered in the Ministry) and these micronutrients are complexed in nature mostly blended with primary nutrients; 35 were PGRs / Enzymes / Hormones (None was registered) and remaining 8 were soil conditioners (2 under process of registration). Most of the PGRs/Enzymes/Hormones were found containing sea weed extract with various enzymatic acid, amino acid, humic acid, fulvic acid etc. Nepalese manufacturing companies were playing the important role in fulfilling the demand of nutrient based agro-chemicals. In recent days, use of biochar is gaining popularity in farming community. Integration of legumes or mixing of legumes with other crops has been common practice since long time. Therefore, about 70% of the total land is free from chemicals.

Soil Fertility Status

The soils of Nepal are mostly acidic. According to the data of 2015, 53% of the soils of Nepal is acidic, 33.51% is neutral and only 13.49% of the total soil is alkaline (Dawadi and Thapa, 2015). Most of the soils of Nepal has low organic matter content. About 45% of the soil has low organic matter content, 41% has medium and the rest 14% has high organic matter content in the soil of Nepal. Similarly, 56% of the soil has low total N content, 30% has medium and remaining 14% has high total N content. Phosphorus availability depends on soil pH and the available phosphorus content in Nepalese soil is in decreasing trend. About 42% of the soil has low, 27% of the soil has medium and the rest 30% has high available phosphorus content. The soil of Nepal primarily had high potassium content but now the situation is changing. About 50% of the soil has low potassium content, 26% has medium and rest 24% has high potassium content in the soil. In a nutshell, it can be said that the nutrient status of soil is depleting with time and replenishment of the soil nutrient is a must for sustained crop production.

Soil Fertility Management in Terai

Since intensive cultivation persist in Terai with improved varieties of major cereal crops, the nutrient management is critical. There is practice of high fertilizer use compared to other ecological belts. The trend of soil fertility management has also been changing. Earlier, farmers use to till the land with mould board plough and hence every farmer has oxen for ploughing. Now the situation has changed. Due to mechanization in agriculture, heavy machineries are used for ploughing the field and have contributed to the shortage of organic manure in Terai. Farmers have now stopped keeping oxen that were once the source of organic manure, few farmers' rear milching cattle but the cattle dung are used as fuel for cooking. This also has aggravated the decline in organic matter content in the terai and the same situation prevails in hills and mountains.

Majority of the farmers in terai use chemical fertilizers to replenish soil nutrients and for crop production. FYM or compost is used as supplementary in terai. Due to higher intensive cropping, the practice of green manuring is not much common. However, integration of legumes in the cropping system is a common practice. Biofertilizers are rarely used during the productions of legumes and other crops as well.

Rice based cropping system is mostly dominant in terai. Therefore, the demand for nutrients is higher in terai region. To fulfil the N demand, azolla application was once popular but this practice also has been decreasing. Biogas slurry are mainly used for vegetables. Farm yard manure, compost, vermicompost, crop residue incorporation, etc. are mostly prevalent but they are not sufficient enough to meet the demand of the crop. Hence, mineral fertilizers are mostly used to meet the crops' nutrient requirements.

Soil Fertility Management in Hills and Mountains

Hill farming is compost based and most of the farmers use organic manure as a major source of nutrients. Since little amount of the chemical fertilizer is supplied to the hills and mountains of Nepal, mineral fertilizer is used as supplements for plant nutrients. Farmers that adopt organic farming use cattle urine, biogas slurry and other organic sources like ash, forest soil, crop residue, etc. for replenishing soil nutrients. In recent years, vermicomposting and biochar have gained popularity in some areas. Legumes specially, beans are one of the major crops and due to this the fertility of the soil is maintained to some extent. Most of the temperate fruits are not fertilized well. The indigenous soil nutrients play key role in supplying nutrients to most of the crops. The crops grown are less nutrient requiring and the yield of the crops over years do not fluctuate much. Therefore, still some of the soils in hills and mountains are all organic by default.

Soil Fertility Management through organic inputs

Organic farming has been advocated to be the best alternative to mitigate problems of conventional farming. In Nepal, various organic products, such as; animal urine, cattle dung, compost, green manures, biogas slurry, oilcakes, crop residue management, poultry manure, pig manure, burnt ash, vermicompost, biofertilizer (such as blue green algae, Rhizobium, Azotobactor, Trichoderma, etc.), azolla, commercial organic fertilizer, etc. are used for maintaining soil fertility. Nepal has many promising locally available green manuring crops (Table-2) but all farmers do not go for green manuring because of the time consumed by these green manuring crops. Results of the long-term soil fertility trials from 9 different locations showed higher yield through balanced application of FYM and chemical fertilizer (Vista and Khadka, 2019). FYM significantly contributed the pool of soil organic matter and available nutrients (Nitrogen, Phosphorus and Potassium). Whatever the research findings have recommended, the exact technology is not fully adopted by farmers but it can be said that farmers are well aware about the importance of soil organic matter. Hence, farmers use mostly organic sources of nutrients followed by mineral fertilizer. These practices have proved that they are well followers of Integrated nutrient management.

Table-2: Locally available promising green manuring crops

S. N.	Type of Green Manure	N %	P%	K%
1	Titepati*(Artemesia vulgaris)*	2.4	0.42	4.9
2	Siris (*Albezialebec*)	2.9	0.765	2.69
3	Taramandal (*Helianthus annus*)	4.96	0.87	5.23
4	Banmara (*Eupatorium gladiosa*)	2.35	0.71	5.43
5	Asuro (*Adhatodavasica*)	4.3	0. 88	4.49
6	Ankhetari (*Walsuratrijuga*)	2.57	0.4	1.2
7	Khirro (*Sapium insigne*)	2.79	0.79	0.89

Source: D. Joshy, 1997

Summary

Despite many opportunities and constraints in crop production, majority of the farmers in Nepal replenish less than 50% of the total nutrients removed by crops through organic and inorganic sources. Thus, mining of soil nutrient resources leads to decline in soil fertility and ultimately crop production. Large amount of organic manure and chemical fertilizers is needed to meet the crop nutrient requirements and therefore, government should increase the import of chemical fertilizers and should encourage farmers to make quality organic manure through different government schemes. Keeping soil health at the central of all production systems, government should formulate and adopt suitable program benefiting both farmers and the country. However, the soils in sloppy hills are facing a threat of erosion, acidification and constant nutrient losses. Therefore, a sustainable approach for managing soil fertility is the need of the day.

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Conservation Agriculture for Enhancing Resource Use Efficiency and Crop Productivity

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Introduction

Conventional agriculture, based on tillage and being highly mechanized, has been accused of being responsible for soil erosion problems, surface and underground water pollutions, and more water consumption. Moreover, it is implicated in land resources degradation, wildlife and biodiversity reduction, low energy efficiency and contribution to the global warming problems (Boatmann*et al*., 1999). Hence, conservation agriculture (CA) is a way to cultivate annual and perennial crops, based on no vertical perturbation of soil (conservation tillage), with crop residues management and cover crops, in order to offer a permanent soil cover and a natural increase of organic matter content in surface horizons. The main environmental consequences of this method have been investigated worldwide with the objective of presenting a synthesis of the available studies and documents to the farmers and scientific communities. It stresses the very beneficial impacts of conservative way of cultivation on the global environment (soil, air, water and biodiversity), compared to conventional agriculture.

CA allows most soils to have a richer bioactivity and biodiversity, a better structure and cohesion, and a very high natural physical protection against weather (raindrops, wind, dry or wet periods). Soil erosion is therefore highly reduced, soil agronomic inputs transport slightly reduced, while pesticide bio-degradation is enhanced. It protects surface and ground water resources from pollution and also mitigates negative climate effects. Hence, CA provides excellent soil fertility and also saves money, time and fossil-fuel. It is an efficient alternative to traditional agriculture, attenuating its drawbacks.

Conservation Agriculture Definition and Goals

The term Conservation Agriculture refers to the systems of raising crops without tilling the soil with retaining crop residues on the soil surface. Conservation Agriculture is a management system that maintains a soil cover through surface retention of crop residuals with no till/zero and reduced tillage. CA is described by FAO (http://www.fao.org.ag/ca) as a concept for resource saving agricultural crop production which is based on enhancing the natural and biological processes above and below the ground. As per FAO definition CA is to i) achieve acceptable profits, ii) high and sustained production levels, and iii) conserve the environment. It aims at reversing the process of degradation inherent to the conventional agricultural practices like intensive agriculture, burning/removal of crop residues. Hence, it aims to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs. It can also be referred to as resource efficient or resource effective agriculture.

Conservation agriculture systems require a total paradigm shift from conventional agriculture with regard to management of crops, soil, water, nutrients, weeds, and farm machinery (Table 1.1).

Table 1.Some distinguishing features of conventional and conservation agriculture systems

Conventional agriculture	Conservation agriculture
• Cultivating land, using science and technology to dominate nature	• Least interference with natural processes
• Excessive mechanical tillage and soil erosion	• No-till or drastically reduced tillage (biological tillage)
• High wind and soil erosion	• Low wind and soil erosion
• Residue burning or removal (bare surface)	• Surface retention of residues (permanently covered)

• Water infiltration is low • Use of *ex-situ* FYM/composts • Green manuring (incorporated)	• Infiltration rate of water is high • Use of *in-situ* organics/composts • Brown manuring/cover crops (surface retention)
• Kills established weeds but also stimulates more weed seeds to germinate • Free-wheeling of farm machinery, increased soil compaction • Mono cropping/culture, less efficient rotations	• Weeds are a problem in the early stages of adoption but decrease with time • Controlled traffic, compaction in tramline, no compaction in crop area • Diversified and more efficient rotations
• Heavy reliance on manual labor, uncertainty of operations • Poor adaptation to stresses, yield losses more under stress conditions • Productivity gains in long-run are in declining order	• Mechanized operations, ensure timeliness of operations • More resilience to stresses, yield losses are less under stress conditions • Productivity gains in long-run are in incremental order

Principles of Conservation Agriculture

Conservation agriculture practices perused in many parts of the world are build on ecological principles making land use more sustainable. Adoption of CA for enhancing RUE and crop productivity is the need of the hour as a powerful tool for management of natural resources and achieve sustainability in agriculture. Conservation Agriculture (CA) basically relies on 3 principles, which are linked and must be considered together for appropriate design, planning and implementation processes. These are:

Permanent organic soil over

A permanent soil cover is important to protect the soil against the deleterious effects of exposure to rain and sun; to provide the micro and macro organisms in the soil with a constant supply of "food"; and alter the microclimate in the soil for optimal growth and development of soil organisms, including plant roots.

Minimal mechanical soil disturbance

The soil biological activity produces very stable soil aggregates as well as various sizes of pores, allowing air and water infiltration. This process can be called "biological tillage" and it is not compatible with mechanical tillage with mechanical soil disturbance, the biological soil structuring processes will disappear.

Diversified crop rotations

The rotation of crops is not only necessary to offer a diverse "diet" to the soil micro organisms, but also exploring different soil layers for nutrients that have been leached to deeper layers, can be "recycled" by the crops in rotation. Furthermore, a diversity of crops in rotation leads to a diverse soil flora and fauna.

Status of Conservation Agriculture in India and Abroad

Globally, CA is being practiced in about 125 Mha area. The major CA practicing countries are USA (26.5 M ha), Brazil (25.5 M ha), Argentina (25.5 M ha), Canada (13.5 M ha) and Australia (17.0 M ha). In India, CA adoption is still in initial phases but CA based crop management technologies are being practiced in about 43 M ha in addition to 1.5 million hectares under laser land leveling. The major CA based technologies being adopted is zero-till (ZT) wheat in the rice-wheat (RW) system of Indo-Gangetic plains (IGP). In other crops and cropping systems too, the conventional agriculture based crop management systems are gradually undergoing a paradigm shift from intensive tillage to reduced/zero-tillage operations. In addition to ZT, other concept of CA need to be infused in the system to further enhance and sustain the productivity as well as to tap new sources of growth in agricultural productivity. In this context, the role of CA in improving efficiency, equity and environment is well recognized in other parts of the world. The CA adoption also offers avenues for much needed diversification through crop intensification, relay cropping of sugarcane, pulses, vegetables etc. as intercrop with wheat and maize and to intensify and diversify the RW system. The CA based farming systems help in integrating crop, livestock, land and water management research in both low- and high-potential environments.

In India, efforts to adopt and promote conservation agriculture technologies have been underway for nearly for last two decadesbut it is only in the last 8-10 years that the technologies are now finding rapid acceptance by the farmers. Efforts to develop and spread conservation agriculture have been made through the combined efforts of several State Agricultural Universities, ICAR institutes and Rice-Wheat Consortium for the Indo-Gangetic Plains. The spread of technologies is taking place in India in the irrigated regions in the Indo-Gangetic plains where rice-wheat cropping system dominates. Conservation Agriculture systems have not been properly tried or promoted in other major agro-ecoregion like rainfed semi-arid tropics, the arid regions of the mountain agro-ecosystems.

Potential Benefits of CA

Adoption and spread of ZT wheat has been a success story in North-western parts of India due to (1) reduction in cost of production by Rs 2000 to 3000 ha^{-1} (Malik *et al,* 2005); (2). enhance soil quality i.e. soil physical, chemical and biological conditions (Gathala*et al*, 2011b); (3) in the long-term, enhance C sequestration and build-up in soil organic matter constitute a practical strategy to mitigate GHG emissions and impart greater resilience to production systems to climate change related aberrations (Saharawat*et al*, 2012); (4). reduce incidence of weeds, such as *Phalaris minor* in wheat (Malik *et al,* 2005); (5) enhance water and nutrient use efficiency (Jat*et al* 2012); (6) enhance production and productivity (4-10%) (Gathala*et al.* 2011a); (7) advances sowing date(Malik *et al*, 2005); (8). reduce greenhouse gas emission and improve environmental sustainability (Pathak *et al.* 2011); (9) avoids crop residue burning, loss of nutrient, environmental pollution, reduces serious health hazard (Sidhu *et al,* 2007); (10) provides opportunities for crop diversification and intensification like in sugarcane based systems, mustard, chickpea, pigeonpeaetc (Jat*et al,* 2005); (11). enhances resource use efficiency through residue decomposition, soil structural improvement, increased recycling and availability of plant nutrients (Jat*et al.,* 2009a); and (12). surface residues as mulch control weeds, moderate soil temperature, reduce evaporation, and improve biological activity (Gathala*et al.* 2011b). Keeping in view ZT wheat benefits, the CA based crop management technologies have been tried in other cropping systems in India, but there are large knowledge gaps on CA based technologies and henceforth, there is a need to develop, refine, popularize and disseminate these technologies on large scale.

Constraints for Adoption of Conservation Agriculture

Conservation agriculture has problems both for scientists and the farmers to overcome the past mindset and explore the opportunities. Hobbs and Govaerts (2010) however, noted that probably the most important factor in the adoption of CA is overcoming the bias or mindset about tillage. It is argued that convincing the farmers that successful cultivation is possible even with reduced tillage or without tillage is a major hurdle in promoting CA on large scale. In many cases, it may be difficult to convince the farmers of potential benefits of CA beyond its potential to reduce production costs, mainly by tillage reductions. CA is now, considered a route to sustainable agriculture. Spread of Conservation Agriculture, therefore, will call for scientific research linked with development efforts. The followings are the few important constraints which come across for promotion of CA.

- **Lack of appropriate seeders especially for small and medium scale farmers :**Although significant efforts have been made in developing and promoting machinery for seeding wheat in no till system but successful adoption will call for accelerated effort in developing, standardizing and promoting quality machinery aimed at range of crop and cropping sequences, permanent bed and furrow planting systems, harvest operations to manage crop residues etc.

- **The wide spread use of crop residues for livestock feed and fuel** : Specially under rainfed situation, farmers face the scarcity of crop residues due to less biomass production of different crops. There is completion between CA practice and livestock feeding for crop residue. This is a major constraint for promotion of CA under rainfed situations.

- **Burning of crop residues:** For timely sowing of next crop and without a proper machinery for sowing under CA system, farmers prefer to sow the crop in time by burning the residue. This has become a common features in rice-wheat system in north India. This creates environmental problems for the region.

- **Lack of knowledge about the potential of CA to agriculture leaders, extension agents and farmers**: This imply that the whole range of practices in conservation agriculture, including planting and harvesting, water and nutrient management, diseases and pest control etc. need to be evolved, evaluated and matched in the context of new systems.

- **Skilled and scientific manpower**: Managing conservation agriculture systems, will call for enhanced capacity of scientists to address problems from a systems perspective, be able to a work in close partnerships with farmers and other stakeholders and strengthened knowledge and information sharing mechanisms.

Policy Issues

Conservation agriculture has been recognized as a potential tool for reversing the process of natural resource degradation, and resource conservation for promoting sustainable agriculture in the region. However, its spread is not yet satisfactory, which worries researchers, planners and developmental agencies. There is need of developing policy frame work and strategies for promotion of CA. The policy issues are : Up-scaling Conservation Agriculture, Research and Development for promotion of CA, Resource database of agencies involved on CA, Building partnership among agencies working on CA, Credit and subsidy to farmers to buy the equipment, machinery, and inputs.

Conclusion

Conservation agriculture has been recognized as a potential system for promotion of sustainable form of agriculture in India/Asia/ world. Conservation agriculture implies a radical change from traditional agriculture. There is a need for policy analyses to understand how conservation technologies integrate with other technologies that promote conservation agriculture. It is, therefore, a challenge both for the scientific community and the farmers to overcome the past mindset and explore the opportunities that Conservation Agriculture offers for sustainable agriculture.

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Efficient Water Management Under Diverse Ecosystems Particularly HKH Region

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Introduction

The unprecedented anthropogenic activities, in the last century alone, have altered the demographic, economic, and technological trends throughout the world modifying the environment in which humans live. The humans are not only the drivers of environmental change but also have impacted the climate. The rate of global climate change has had many environmental and socio-ecological implications including change in spatial and temporal distribution of type and amount of precipitation, runoff, extreme events, climate induced migration, natural resource use and management, governance etc. Anthropogenic activities and land use changes are altering the quantity and quality of our freshwater resources.

Water is a key element for not only sustaining life but also for economic wellbeing of humans. From agriculture to industries, water is required as a basic ingredient throughout the product process of food and goods. In the past, the unsustainable use and management of water resources has led the world to a critical stage where the world is facing water scarcity. The natural distribution of water on the earth is unequal but the unsustainable use of water in various sectors has exacerbated the problem. While water is renewable, there is a fix amount of it in the form of underground aquifers, large water bodies, water vapours etc. These water bodies have been subjected to different polluters as a consequence of production various goods. It is especially unfortunate that the unsustainable water use practices are to achieve short term economic goals without any remorse to the permanent/long term ecological damage (Cosgrove, 2015). Increasing global population is a one of the major factors here. Recently, the percentage water use demand is two times higher than the population growth. This means that more and more regions of world are becoming water stressed. The change in the water demand and supply paradigm has rendered the future uncertain for the global population where water demand is rising in urban, domestic, and industrial water sectors, alike.

Water Management Systems

Irrigation has been an integral part of human civilization. For the past 3000 years, it is practiced in the mountain. From time immemorial, surface irrigation methods have been followed. Water as a basic irrigation component has different management systems in different geographies. The overall efficiency of irrigation system depends heavily on the area slope, aspect, climatic conditions, soil, topography and crop. For example, in the mountain region of HKH, water from glaciers and rivers are diverted to flow via water channels. In comparison, the regions in south which receive less rainfall, rain water harvesting (storing water in large tanks and ponds) is widely used for domestic as well as for agricultural purposes.Despite the fact that 10 major rivers originate from the HKH mountain region, water continues to be a scarce commodity. People face water shortage not only for irrigation but for domestic uses as well. The increasing pressure on the ecosystems and lack of management is resulting in further declining of water sources.

Three of the water systems in the HKH region are discussed below majorly from an indigenous point of view. These are community led management systems which are very much being revived on communal, institutional and regional level. These inplace systems are facing a plethora of challenges in the changing socio-economic and climatic conditions and have a vast scope of sustainable revival through technological innovations.

Kuhl

Due to topographic restrictions and geologic makeup, there is a limited scope boring tube wells, canals and lift irrigation in the mountain regions. In many of the villages in mountain valleys, the source of irrigation water is generally local nullahs. To use the water from surroundings for irrigation, the most common source used are local water channels called Kuhls. The idea around using Kuhls for irrigation purposes dates back to Babylonian times. It is one of the most common and conventional ways of bringing water to the crops. These kuhls are commonly found in West Himalayas cold deserts; Himachal Pradesh in India and in Hunza Valley in Pakistan (See Fischer 2016, Baker 2006, Kruetzmann, 2000). The Kuhls in the cold deserts of Himachal Pradesh (India), Skardu and Hunza Valley (Pakistan) are built gravity led channels and are built along a gradient. Water is diverted into a channel on a gradient so that it flows along a contour under the effect of gravity to reach the terrace/field.

The Kuhls or water channels are constructed and managed by the community usually without government assistance. The kuhls are improvised accordingly to the villagers local knowledge, need and preference.

1. In dry temperate zone, wooden water channels are made to divert water from its source. The diverted water is used for irrigating different levels of terraces. These

2. In the lower areas of Himachal Pradesh, bamboo pipes are used as irrigation channels.

3. In west Himalayan cold deserts, kuhls are built along the natural gradient along the river/nullah. The kuhls are used to divert water for optimum harnessing. The natural gradient is used effectively because the kuhls are at higher level than the fields.

4. In one of the districts of Himachal Pradesh (Kinnaur), kuhls are dug in the ground. The underground kuhls are usually covered with slates whenever they either passes through a village are its difficult to dig one. Sometimes, wooden channels using tree trunks or thick branches are also used.

Karez

Karez is a unique irrigation system that is practiced in over 20 countries including Pakistan, Iran, China and Chile. It is speculated that karez originated in Iran about 3000 years ago. In Pakistan, this old irrigation system is confined to the province of Balochistan. Karez is strictly a community-enterprise whose sustainability depends on community needs and preferences. Karez is managed by tribal tradition and does not abide by any written laws or rules.

There are various types of Karazes in Balochistan namely:

1. Alluvial fan or piedmont karez: The alluvial fans develop at the mountain foothills. The mother wells are bored to draw water from the underlying aquifers. They are steadier source of supply of water and have longer life as compared to the other types. Most of the karez found are alluvial fan type.

2. Infiltration gallery karez: It depends on the oozing water from the cracks and joints of rocks. They are short lived and have small quantity of water.

3. Rain-fed karez: It is dependent on rainfall for the supply of water and only become functional after rain. They usually dry up a few days after the rainfall.

4. Spring karez: This type of Karez utilizes spring water. The life span of spring karez varies from days to several hundred years depending on the size of spring/aquifer and quality of maintenance.

Like kuhl, karez also works under the effect of gravity. It is quite a sophisticated technique and uses no mechanical pump. In karez technology, a tunnel is used to conduct groundwater from source to surface which is made by digging a trail well at an appropriate site on the alluvial fan (which is the most common type of karez). The site selection is a very interesting method. Local experts use experience and knowledge to ascertain the presence of water (see Khan, 1995). A minimum of 460 m (500 yards) distance is maintained between the two karez sites so that the new doesn't adversely affect the flow of the existing ones (Source: Nadeem Ahmad, 2016)

Karez tunnel require annul or bi-annual cleaning otherwise the debris material including sand, and gravel etc may fall into the tunnel and choke it. There has been a significant decline in the Karez practice in the few decades. The shift in livelihood patterns and options has greatly impacted this local practice. Many people chose to migrate in search of a better life abandoning agriculture and Karez. Others invested in businesses and have moved away from agriculture. Some people have also shifted from karez to tube wells for acquisition of water. Since karez is a community based system, there is no lawful obligation on people to keep this practice alive.

Spring and other water management practices

Spring water serves for water needs of millions of people in the mid-hills of the Hindu Kush Himalaya (HKH). Springs are groundwater discharge points that appear where aquifer intersects with the ground surface. Water usually seeps out of rock pores, fissures, fractures, or depressions. It naturally follows any discharge point and would have a recharge area from which the discharged water is derived. Since spring water is basically groundwater, it is important to consider the whole spring shed whilst preparing any spring water conservation/management strategy. Sometimes, work done in one watershed without considering groundwater flow to another watershed can be ineffective or counterproductive.

Unfortunately, throughout the entire Hindu Kush Himalayan (HKH) region more and more springs are either drying up or their discharge is reducing because of negligence and mismanagement. Several factors including erratic rainfall, seismic activity and ecological degradation associated and land use changes are impacting mountain aquifer systems.

Groundwater, from springs in the mid-hills of the HKH, is an important contributor to river base flow, but the exact extent of this contribution is not known due to limited scientific studies and evidence. The role and contribution of springs to overall water budgets in the region is poorly understood. Groundwater is overexploited in the western plains, while it remains largely untapped in the eastern plains

1. Small ponds for spring water collection: In Himalayan cold deserts and temperate wet Himalayas, spring water is collected in small reservoirs which are scattered at intervals on the high uplands. Water is drawn from these ponds when required for irrigating crops and also for drinking purposes. It is a common practice.

2. Harvesting of dew and fog water: After monsoon season, humidity levels remain high (85%) in some valleys and plains. Traditionally in the hills, the fields are ploughed at early morning before the dew evaporates. After ploughing, the moisture gets mixed with soil and is well retained by the soil. If soil is clayey in nature, the dew water in soil remains for a long period and contributes to overall soil moisture.

3. Roof water harvesting: During monsoons (the rainy season), roof water is collected in dugout structures in the lower areas of Himachal Pradesh and some lower Himalayan regions of Pakistan. These structures have different names in different areas such as "diggi" in Kangra district and '"Khati" in Hamirpur and Bilaspur districts. These structures are dug in the ground and are lined with hard rocks to prevent the percolation of water. These ponds are also used for surface water.

4. Harvesting of rain water: In the hills of eastern, central and western Himalayas, the rains are erratic and torrential. A high percentage of rainwater flows as run-off and stream flow washing away fertile soil. In order to prevent soil erosion, excess rain water is stored in the farm ponds. Farm ponds are especially useful during the dry seasons when water is scarce. The stored water in ponds and depressions is used for irrigation and domestic purposes. Such ponds are constructed near the place of residence. It is also stored in dugout structures. The sediments in water settle down in the ponds with time reducing the infiltration/percolation losses.

5. Harvesting of water from snow melting: Water ponds are constructed to harvest water. These are locally called zing in Ladakh area. The melt water from the snow is collected in these water ponds. The water tang and irrigation kuhls are lined with Pang (Spang) Grass to control water seepage and side water losses. The grass is said to be as impermeable as polythene or cement. The farmers in Ladakh claim that Pang (Spang) grass is even better than the other two to keep the percolation losses in check. However, there is no scientific evidence of this claim.

Conclusion

Natural and human systems are capable of adapting changes in the existing knowledge and technology commonly referred to as autonomous adaptations. Most common example of this is of farmers. Based on their indigenous understanding of their land, crop and the local precipitation patterns they make adjustment to their crop mix and planting dates. Some adaptations are beyond the meagre capacity of small land farmers and require institutional input and investment. There are many technologies and methods available to transform the existing water management systems to more efficient and beneficial. These technologies range from the use of nanotechnology to space-based monitoring systems. These comprehensive and accessible databases will allow communities and institutions to gain better insights into ongoing practices and make appropriate decisions.

Water managers will have to be familiar with a wide range of applicable disciplines and be able to interact with a variety of professionals, stakeholders and users. These managers need sufficient technical, economic, social, financial, and environmental skills to be able to engage in dialogue with the professionals and affected stakeholders in the regions where improved water management is needed. They need to understand policy makers' short-term political commitments, and be able to facilitate the conciliation of politicians' initiatives with long-term sustainable water resource policies. Scientists, engineers, managers, policy makers and stakeholders must work cooperatively together to identify and develop strategies to sustain largely ignored ecosystem values. A fundamental scientific challenge is to be able to specify the spatial and temporal scales needed to understand and manage for ecosystem resilience and sustainability.

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ABSTRACTS

Proximal sensing of nitrogen needs by crops: Using wheat as a plant indicator

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Introduction: The advancements in remote sensing in combination with sensor technology, both passive and active, enable growers to analyze an entire crop field, its local features and crop conditions. Nutrient deficiency, and in particular nitrogen deficiency, may cause substantial crop losses. This deficiency needs to be identified immediately. A faster the detection and correction, a lesser the damage to the crop yield.

In the present work, an applicability of digital color imaging to monitor nitrogen uptake in crops is demonstrated. Canopy nitrogen (N) status relates strongly to canopy chlorophyll content and the strength of green color. Proximal sensing by RGB camera is a tool that has the potential to assess N content at leaf of plant for sensing nitrogen in crops.

Theory: An algorithm was programed and calibrated with machine learning software and artificial Nural Networking (ANN) to include crop simulation model (DSSAT) target function of dry matter (DM) and %N from a photograph.

Materials and Methods: Input data from smartphone application delivered to a server and its output returned to users with %N and recommended options for best management of N fertilization.

Results: The data replicated laboratory measurements with linear Lab vs Camera model that displayed a unit slope with r^2= 0.93.Critical nitrogen level decreased gradually from about 6% to 2% with DM increase from 0 to 14,000 kg ha^{-1}. Maximum N uptake calculated from photo and laboratory was 324 kg ha^{-1} and 318 kg ha.$^{-1}$ respectively, with insignificant difference between them. The N-application treatments affected maximum grain yield, reaching 7.0 Mg ha^{-1} for the late-ripening cultivar and 6.1 Mg ha^{-1} for the early-ripening one .The approximate N-use efficiency (i.e., grain/N weight) was 19 and 21 kg grains per 1 kg N for early- and late-ripening cultivars, respectively.

Summary: The determination of N application based on the smartphone photograph proved to be useful by saving time and expenses for growers who have access to smartphones and can use them for N application and management. We examined the feasibility of smartphone to determine N% and its derivatives Nitrogen Nutritional Index (NNI) as a tool for using in a farming management of nitrogen fertilization. The camera output was validated against laboratory tests for total N uptake. A greenhouse experiment with spring wheat resulted in r^2>0.9 and a slope of a unit. Using simple RGB camera for determination of N uptake by a crop is a rapid and cost effective. Regarding wheat fertilization management, final conclusions cannot be drown here for two reasons. First the experiment was conducted in a greenhouse and not in the field and second it was tested only during a single experiment. In order to obtain conclusive results more experiments should be made. However, the test demonstrated again that we have developed a useful tool to conduct fertilization management in the field.

Neccessity for Soil Management for Sustainability

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Abstract

According to the natural characteristics, Serbia is predisposed to erosion processes. However, both worldwide and in Serbia, a large percentage of erosion processes are contributed by anthropogenic factors. The activity of man can be both negative and positive, depending on the degree of awareness of the importance of using natural resources on the principles of sustainability.

Preventing the degradation of torrential floods and erosion processes contained in the sustainable management of land resources, which includes the use of participatory methods. The paper presents the participation of the community in the management of natural resources (CBNRM – Community Based Natural Resources Management), according to which the community becomes the primary implementer, with the assistance and under the supervision of professional services. In the case of public participation in the sustainable management of land resources of Grdelica Gorge (South Serbia), shows the socio-economic and ecological approach of the local population.

One of the significant participatory approach programme is WOCAT (World Overview of Conservation Approaches and Technologies) which was also implemented in Serbia. Within the WOCAT program in Serbia, the best conservation technologies and approaches were recorded, which were derived not only from experts but also from local farmers/villagers. These technologies and approaches have entered the world database, whose use can certainly act in the prevention of torrential floods.

This paper also presents a model of sustainable management of land resources, adapted to the conditions of hilly areas of Serbia, which includes the planning of production on sloping terrain from the aspect of land resources, then the needs of the population for certain localities particular production, and profitability of planned production. Regarding ecological effects of the model of SLM, soil loss is reduced under the level of tolerance in the researched area. Economic effects of the established model of SLM, proved by Benefit-Cost Analysis, are on the satisfactory to significant level. These reasons are enabling people to stay and survive in these regions.

Key words: *land degradation, sustainable management, environmental effects, economic effects*

Gender differentiated impacts from weather extremes: Insight from rural communities in South India

Stefanos Xenarios

Several studies focus on the effects of climate variability on female and male gender relations as perceived through various biophysical and socio-economic aspects. More emphasis is given on the impacts of extreme weather events on rural communities of less developed regions. The results are often interpreted in a qualitative manner through policy measures that may reduce gender inequalities. However, the interpretation of the qualitative results to more crisp and measurable outputs is often not attained while the validation of the findings is rarely ensured. The current study suggests a gender-differentiated impact framework based on qualitative and quantitative components for the assessment of climate variability effects on rural communities in south India. Fifteen villages mostly practicing rice farming in Andhra Pradesh and Telangana states were selected as representative drought-prone case studies. The study results advocate that the qualitative outcomes were validated from the quantitative approach but for a few cases which could be attributed to methodological and case-specific differentiations. Policy recommendations are made on common gender trainings in water-resistant crops and livestock activities for the alleviation of drought impact and abatement of gender inequalities. Also, entrepreneurship workshops for women could enhance gender balance and diverse family income from the current sole dependence on farming revenues. Regional climate adaptation programs could be better implemented when the specific features and capacities of local communities are taken into consideration.

This is an extract of the publication, Xenarios S, Kakumanu KR, Sekhar NU and Kallam S.R (2017) Gender differentiated impacts from weather extremes: insight from rural communities in South India, Environmental Development, https://doi.org/10.1016/j.envdev.2017.05.002

Soil and Water Use and Management under Climate Change for Sustainable Agricultural Developments

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Abstract

Soil and water resources are the basis for present and future food production and water supply for an increasing population, and plays a central role in determining the quality of our environment. In the future, the role of soils and water in some crucial aspects for man's life, like food production, earth hydrological cycle and air composition, will be constantly increasing. Both resources are submitted to increasing pressure under global change effects, including population growth, land use and management and global climate changes. The growing human influence on lands, through the expansion and intensification of agricultural activities and increased number and size of populated areas, results in a changing environment, frequently associated to widespread soil and water degradation, due to inappropriate land use and management. Those degradation processes and the associated hydrological changes may result in increasing risks and problems of food and water supply for mankind, and in more frequent "natural" disasters like droughts, flooding, landslides, sedimentation, etc. The amount of water available to irrigated agriculture is also being progressively limited by degraded land and water systems, competition from other economic sectors, and by climate change in some regions. It is also worth to mention the contribution of changes in soil cover and soil degradation to global climate changes. Soil hydrological processes may be the main critical factors affecting the quantity and quality of crop production, both under dry-land and irrigated conditions. The processes of soil degradation are closely linked through unfavorable alterations in the hydrological processes determining the soil water balance and the soil water regime. They are conditioned by the climatic conditions and by the use and management of the soil and water resources. Successful agricultural developments depend on productivity and sustainability. Although gains in productivity can be achieved manipulating and improving components in land management, sustainability may be limited by the high cost and limited availability of inputs, by the resource use efficiency, and by social and environmental factors. Economic and social problems, connected to population pressure, market changes and prices, and technical needs, are leading to drastic and sudden changes in land use and management, which may increase the potential hazard of land degradation and side effects. In some countries or regions of the World, agricultural production patterns and practices have changed over the last century, becoming highly mechanized, capitalized and specialized, emphasizing labor-substituting technologies, which focus on the generation of short-term cash flow with no concern for long-term sustainability of production. In others, population growth and lack of resources have obliged to intensify the use of marginal lands without appropriate conservation practices, which is leading to land degradation and non sustainable agricultural production.

Keywords: Sustainable agriculture, soil management, hydrology, environment, food production

Surface water pollution due to vehicle washing activities

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Abstract

Wastewater generation is one of the biggest challenges associated with increasing economic activities, urbanizations and population. Globally, over 80% of wastewater is released to the environment without adequate treatment. Disposal of wastewater into the inland water resources lead to deteriorations in water quality and quantity that impact not only the aquatic ecosystem, but also the availability of safe water for human consumption. Natural water bodies are made the end points of wastewater from point and non-point sources, causing an environmental and public health hazards largely in the developing countries. Within the Hindu Kush Himalayan (HKH) countries, a large proportion of wastewater is discharged directly into the closest surface water bodies or informal drainage channel, sometimes without or with very little treatment. Among the different types of wastewater, vehicle wash wastewater has been identified as the potential source of pollution either as surface runoff or inappropriate discharge. Vehicle washing is a highly water consuming process that involves the use of chemicals and generates potentially toxic wastewater containing a wide range of pollutants such as petroleum hydrocarbon wastes, nutrients, surfactants, mud, sand, organic matter, and heavy metals. Disposal of such contaminated wastewater into surface water bodies can adversely affect water quality, aquatic habitat, and biotic communities such as benthic macroinvertebrates and fish. Vehicle wash wastewater should be treated by constructing simple cost-effective treatment plants and the pollutant levels monitored before disposing of the surface water bodies and the environment or for reuse. Reusing treated vehicle wash wastewater is important for protecting the environment and effective utilization of water resources.

Keywords: Wastewater, vehicle wash wastewater, surface water, water quality.

Carbon sequestration in soils under annual crop cultivation: challenges and way forward

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Abstract

Deterioration of soil fertility lead to low soil productivity and it prevents cost-effective crop production, paving the way to land degradation. Generation of marginal lands in Sri Lanka is on the increase and about 50% of the arable land area has been subjected to fertility decline. Application of organic soil amendments to soil is a viable option to enrich soil organic carbon (SOC) pools and restore soil fertility. Department of Agriculture (DOA) in Sri Lanka has identified application of organic fertilizers like compost and animal manures in fertilizer recommendations for annual crops. Studies indicated that in annual crop cultivation, relative use (RU) of organic fertilizers ranged from zero to nearly 500 %, where values greater than 100% indicate farmers apply fertilizers more than the DOA recommended dosage. Decomposition rate of organic fertilizers in soil determines their contribution to replenishing SOC pool. A research conducted with farmers' fields, tea plantations and forests in an agricultural landscape in WU3 agroecological region in Sri Lanka, indicated that the frequency of soil disturbances affect SOC content and mineralization rates. Despite heavy inputs of animal manures, frequently disturbed (FD) soils under annual cropping had significantly lower ($p<0.05$) active C and total C (580 mg/kg and1.95 %, respectively) compared to less disturbed soils (LD) from tea plantations and forests (1,002 mg/kg and 6.33 %, respectively). Carbon mineralization potential under FD was significantly higher ($p<0.05$) than LD. When decomposition rates of animal manures and crop residues are high in soil, these should be added repeatedly in high quantities to achieve significant improvement in C sequestration. However, repeated high application of organic fertilizers could lead to nutrient pollution, unhealthy decline in soil bulk-density and spread of heavy metals and antibiotic resistance determinants in environment. Further, limitations with material availability severely restrict farmers from following recommended practices. Therefore, it is crucial to consider other methods to improve C sequestration in farm fields. Including deep rooted crops in crop rotation and application of recalcitrant forms of carbon as soil amendments are such methods. Temporary immobilization of nutrients is a challenge when applying recalcitrant C to soil. A multi-locational experiment conducted in DL1b, IM3c and WM2b agroecological regions (soil types: Alfisol, Ultisol and Entisol respectively) in Sri Lanka indicated that biochar (BC) and incubated mixture of cattle manure and sawdust (CS) can be used together with synthetic fertilizers effectively to improve SOC content and soil fertility. Application of BC and CS with fertilizers improved maize yield significantly greater than fertilizer alone treatment in all three locations. Residual effects of BC application had positive impact in improving SOC pool than CS application. Biochar application resulted in high cation exchange capacity, potentially mineralizable N, and carbon management indices in the field contributing positively for yield improvements. Therefore, materials containing recalcitrant C can be integrated in nutrient management in annual cropping to improve SOC.

Theme I
Efficient Soil, Water and Energy Management under Diverse Ecosystems

Farm level soil, water and energy conservation through efficient irrigation practices

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Abstract

Irrigation, the process of applying controlled amounts of water to plants at needed intervals, is essential for agriculture in order to meet our increasing food and fiber production needs. Agriculture accounts for the Nation's largest water usage which is about 80 percent of the country's annual water consumption. Water conserving efficient irrigation technologies and water management practices are gaining important role in reducing energy as well as water use, nowadays. The major cause of energy wastage in irrigation systems includes the use of damaged or improperly sized pumps, worn out nozzles and improperly sized fittings which adversely affects the irrigator's degree of control over water applications. In turn, this may lead to crop stress, reduced yields, runoff, erosion, and other associated problems. Efficient irrigation systems focus on use energy-efficient equipment and designs and also minimize the amount of unnecessary water use, adding to the energy savings. Hence, irrigation water management encourages the application of water in a quantity to meets the need of the growing plant and thereby avoids extensive soil saturation and runoff. In general, Technological advances for improved irrigation include more efficient irrigation systems where water release can be controlled so that crops receive only the required amount (e.g. pressurized irrigation systems such as drip and sprinkler irrigation systems). Also, automatic irrigation systems that include wireless sensors and GPS technology can improve site-specific and volumetric precision of water applications by matching the needs of the soil and crops. Irrigation efficiency can also be enhanced by altering farming practices, such as crop rotation (growing of different crops in succession on a piece of land to avoid exhausting the soil and to control weeds, pests, and diseases.) and conservation tillage practice (leaving a previous year's crop residue on the field to reduce soil erosion and runoff) that improves the soil moisture conservation.

Keywords: *Soil and water conservation, irrigation, energy efficient irrigation technologies, water use efficiency, irrigation water management*

Resilience and interactive effects of soil depth and slope position on soil chemical characteristics as affected by fencing under semiarid tropical environments

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Abstract

The information on soil properties is crucial to the understanding of productivity of soils undergoing erosion overall as the latter can result in decline in soil quality and crop production in the area. On the complex topographies and sloping landscapes where soil redistribution not only depends on erosion and deposition by water but also influenced by anthropogenic activities and biophysical activities. Thus, fencing can be simple and viable solution to manage with anthropogenic activities in area. Thus, the present study examined the resilience and variation of soil chemical properties as affected by interactions of depth and slope position under fencing and without fenced treatments in the foothills of Shivalik's. Keeping these points in view, the present investigation was conducted at DR Bhumbla Zonal Research Station for Kandi Area, Ballowal-Saunkhri in district SBS Nagar, Punjab, India following the Factorial Randomized Design. The treatment (2) comprises fenced and without fencing, the sub-treatments (3) such as upper, middle, and lower slope position and the sub-sub treatments were soil depths (4 ; 0-5cm , 5-10 cm , 10-15 cm and 15-20 cm) , and replications (3). Thereby 72 soil samples were collected and analysed. However, the samples were analysed for their chemical characteristics following the standard procedures. The fencing improved the organic C, total N, available and citric acid soluble phosphorous, available, and citric acid soluble potassium, Ca, and Mg contents etc. Also, fencing maintained better resilience of soils by improving both the soil quality and productivity in the area. However, the major changes occurred in soil chemical characteristics on upper slope position compared to lower slope position.

Keywords: *Watershed, slope position, soil quality, anthropogenic activities*

Temporal and Spatial Variations of Salt Affected Soils at Dubti/Tendaho State Farm, North Eastern Ethiopia

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Abstract

In irrigated arid and semi-arid areas of Ethiopia particularly in Afar region, salinity is a serious problem but clear information about its status and distribution is lacking.The purpose of this study was to investigate temporal and spatial variations of salt affected soils at Dubti/Tendaho state farm. About 69 surface soil samples (0 – 30 cm) were randomly collected using stratified simple random sampling technique and seven soil profiles were opened. Satellite images of the years 1972, 1994, and 2014 were analyzed through supervised classification methods and mapped using GIS. OrdinaryKriging interpolation technique was also used to map the spatial variability ofsalt affected soils in the study area. The result showed that from the year 1972 to 2014, the extent of saline-sodic and sodic soils increased by 9.04 and 15.97% while normal and saline soils decreased by 14.76 and 10.25%, respectively. Based on the recent satellite image (2014) information,about 80% of Dubti/Tendaho state farm is dominated by salt affected soils (27.14% saline, 29.22% saline-sodic and 23.36% sodic soils). Similarly, the predicted map using Kriging also indicated thatabout 82% of Dubti/Tendaho state farm is dominated by salt affected soils (29.0% saline, 30.63% saline sodic and 22.54% sodic soils).Evidences obtained from the soil profiles show that more than half of the study area was occupied by shallow (< 2 m) ground water with poor quality due to high level of salinity in it. Generally, the results revealed that the expansion rate of salt affected soils has been increasing with time and space. From this study, it is possible to infer that if the present irrigation practice is continuing, it is expected that most of the cultivated lands will become sterile within a short period of time. Thus, it needs to be monitored regularly in order to secure up-to-date knowledge of their extent to improve management practices and take appropriate actions.

Keywords: *GIS, ground water quality, irrigated lands, ordinary kriging, salt affected soils*

Hydro-geochemical investigations in Upper Ganga Basin, India

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Abstract

Rivers are the most important natural resource for human development but it has become more polluted by indiscriminate disposal of sewage, industrial waste and overabundance of human activities, which affects its physico-chemical characteristics. The Himalayan river Ganga, which has the largest river basin, also considered as sacred in Indian culture and tradition, is the lifeline of more than 45% of the country's population. Any change in the quality and quantity of the Himalayan tributaries of River Ganga under the climate change regime will impact the quality parameters of River Ganga. Some studies on the chemical characteristics of melt water discharged from glaciers indicate that chemical activity is more intense in these regions than in tropics. Keeping in view the importance of Himalayan Ganga Basin, fifteen sampling sites have been selected covering River Bhagirathi, Alaknanda and River Ganga upto Haridwar for water quality assessment in Upper Ganga Basin and to investigate geochemical weathering processes controlling hydrochemistry of the river waters and monitored on monthly basis from September 2016 to December 2018. Analysis of various water quality parameters show that all parameters are well within permissible limits of river water quality, except COD and TSS. Upon comparison, it was observed that COD values at 11 locations existing in the River Bhagirathi, Alaknanda and River Ganga are above the limit prescribed by CPCB, which may be attributed to anthropogenic pollution, while TSS values are above the limit at all the locations, which may be attributed to unstable and young Himalayan geology, from where silt and rocks are easily carried off. Deforestation in the catchment area of the river and rapid urbanization in river flood plains also enhances TSS. These sediments get deposited during the course of the river flow. Hydro-chemistry of the river waters revealed that calcium and magnesium are dominant cations while sulphate and bicarbonate are dominant anions. Weathering of rocks is the dominant mechanism controlling the hydrochemistry of basin. Hydro-chemical data was also processed to understand the geochemical processes controlling the chemical composition of river water using Scatter Plots and Gibbs Plot. Gibbs plot revealed the rock dominance controlling world water chemistry. The waters of thisrock-dominated end-members are more or less in partial equilibrium with the materials in their basins. The relative high contribution of (Ca+Mg) to the total cations (TZ^+), high (Ca+Mg)/(Na+K) ratio and low (Na+K)/TZ^+ ratio indicate carbonate weathering could be the major source for dissolved ions in the river waters. Reverse ion exchange process controls the chemistry of river waters of the region, which may be due to the excess of Ca+Mg. Carbonation and coupled reactions involving carbonate weathering and oxidation of sulphide are the main proton supplying geochemical reactions controlling the rock weathering in the study area.

Keywords: *Upper Ganga Basin, COD, TSS, Scatter plots, Carbonate weathering*

Annual and seasonal rainfall variability of Shillong, Meghalaya

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Abstract

Climate variability, particularly, that of the annual precipitation, has received a great deal of attention worldwide. The magnitude of the variability of the factors changes according to the locations. Since Rainfall is one of the most significant meteorological parameter. Meghalaya is spread over an area of 22,429 square kilometres and lies between 20.1^o N and 26.5^o N latitude and 85.49^o E and 92.52^o E longitude. Climate of the study area varies from tropical to temperate. Monthly meteorological data of 26 years (1992-2017) for Umiam, Shillong station in Meghalaya was collected and analysed for the rainfall variability. The homogeneity test revealed that annual and seasonal rainfall time series are homogeneous for Umiam station in Meghalaya. Annual rainfall varies from 1808.20 mm to 3096.90 mm with an annual mean rainfall value of 2369.84 mm. The coefficient variation (CV) for annual, SW monsoon, NE monsoon, winter and summer season was 13.82, 16.50, 33.05, 96.88 and 23.74 per cent respectively. Less variation was found for the annual and south west monsoon rainfall. The share of SW monsoon rainfall, NE monsoon rainfall, winter season rainfall and summer season rainfall is about 64.63%, 13.22%, 1.38% and 20.76% respectively.

Keywords: *Rainfall, coefficient variation, meteorological, seasonal, variability, Shillong*

Effect of scheduling of irrigation with mulch under different planting methods on sugarcane juice quality

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Abstract

Sugarcane is most efficient crop for converting solar radiation into plant biomass. The major producing states are Uttar Pradesh, Maharashtra, Tamilnadu, Karnataka and Gujarat in which leading state Uttar Pradesh having the 26.78 lakhs hectare area and average cane productivity 81.10 t/ha with sugar recovery 11.50 per cent. An experiment was conducted during 2016-17, 2017-18 and 2018-19 at research farm of genda singh sugarcane breeding and research institute, Seorahi, Kushinagar, Uttar Pradesh under AICRP on sugarcane. The experiment consist of four combination of planting methods and mulching practices i.e. (P_1) conventional flat planting 75 cm row spacing with organic mulch @6 t/ha, (P_2) conventional flat planting 75 cm row spacing without mulch, (P_3) paired row trench planting 120:30 cm row spacing with organic mulch @ 6 t/ha and (P_4) paired row trench planting 120:30 cm row spacing without mulch and three irrigation schedule (IW/CPE ratio) with irrigation water depth 7.5 cm i.e. I_1- 0.60, I_2- 0.80 and I_3- 1.00 were tested in strip plot design with three replications. Recommended dose of N:P:K ratio was 180:80:60 kg per hectare and applied before onset of monsoon. Sugarcane variety CoSe 11453 was planted in spring season. The experimental field was medium in organic carbon, medium in available phosphorus and low in potash with pH 8.15. The experimental findings on the basis of pooled data of three years revealed that paired row trench planting 120:30 cm row spacing with organic mulch @ 6 t/ha practice recorded significantly higher commercial cane sugar (13.64 t/ha) over remaining treatments of planting practices. Brix, CCS per cent and purity per cent were not affected significantly by the different planting practices and irrigation scheduling treatments but maximum value obtained in paired row trench planting 120:30 cm row spacing with organic mulch @ 6 t/ha and irrigation scheduling IW/CPE 1.0 ratio (21.12, 12.78 and 87.84, respectively). Irrigation scheduling IW/CPE 1.0 ratio recorded significantly higher commercial cane sugar (13.03 t/ha) over remaining irrigation scheduling except irrigation scheduling IW/CPE 0.8 ratio.

Keywords: *CPE ratio, mulch, irrigation scheduling, juice, quality*

Effect of irrigation levels and weed management on phytotoxicity in chickpea

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Abstract

Chickpea is one of the major Rabi pulse crop. Chickpea is a poor competitor to weeds because of initial slow growth rate and limited leaf area development. Weeds affect growth, yield and quality of crop plants adversely and reduce soil fertility, compete with the crop plants for soil moisture, nutrients, space and sunlight. Although, cultural and mechanical methods of weed control are still in practice, high costs compel the farmers for alternative cheaper and easier method of weed control. Introduction of herbicides has made it possible to control wide spectrum of weed species effectively in pulses. Now numbers of herbicides are available in the market. Proper use of herbicides may manage weeds during critical crop-weed competition period and thereby help in enhancing the productivity of crops. But in Chickpea there is no post emergence herbicide available which makes it labour intensive to control weeds in chickpea. Application of any post emergence herbicide causes phytotoxicity in chickpea which may or maynot recover. Different herbicides were applied in chickpea fields to assess the phtotoxicity in chickpea at different irrigation levels. Number of irrigations and time of irrigation did not showed any effect in phytotoxocity caused by herbicides in chickpea. Phytotoxicity was observed in plots treated with imazethapyr and metribuzin as post emergence. In imazethapyr treated plots there was 100% phytotoxicity rated as 10 by Central Board of Insecticides within 3 days after application in which plant turned to light green colour and formed tendril like structure, leaves became very narrow. In metribuzin treated plots there was 90-95% phytotoxicity rated as 10 by Central Board of Insecticides in which necrosis and death of plant occurred within 3 days after application. Recovery was observed 10 days after application.

Optimization of Irrigation and Fertigation levels for Turmeric in Western Zone of Tamil Nadu

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Abstract

Field experiments were conducted at Agricultural Research Station, Bhavanisagar to optimize the irrigation and fertigation levels for turmeric under different lateral spacing. The experiment was laid out in split plot design with two replications and it consists of three irrigation levels of 80, 60, 40 per cent pan evaporation at a lateral spacing of 90 cm and four irrigation levels of 120, 100, 80, 60 per cent pan evaporation at a lateral spacing of 150 cm in combination with three fertigation levels of 125, 100 and 75 per cent of recommended N & K. The results revealed that drip irrigation at 40% of PE with lateral spacing of 90 cm recorded lower water use (721 mm) and higher WUE (46.21 kg/ha mm). But significantly higher and comparable yield was recorded in drip irrigation at either 80 or 60% of PE (37.22 and 36.5 t/ha) with lateral spacing of 90 cm and 120% of PE with lateral spacing of 150 cm along with 100% recommended dose of N & K (35 tha^{-1}). Economical returns were higher in 80% of PE with lateral spacing of 90 cm with 100 recommended doses of N & K.

Keywords: *Drip irrigation; Fertigation; Lateral spacing, Turmeric, Water use efficiency*

Suchitha– An Innovative Thermochemical Technology for Proper Solid Waste Management

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Abstract

Safe and hygienic solid waste disposal remains to be a challenging task in spite of several technological options already available. The problem is getting aggravated in metros and large cities where the population density is very high and availability of land for waste processing or disposal is limited. Hence a method for quick conversion of waste to manure is the only practical solution to address this problem. The Department of Soil Science and Agricultural Chemistry, College of Agriculture, Vellayani, Kerala Agricultural University, had developed a new patented technology (Patent No: 321857) for quick thermo chemical conversion of degradable wastes to value added organic manure (Sudharmaidevi *et al.*, 2017). The novel process is hygienic, efficient and is most suitable for processing of waste at source, thus avoiding the problems connected with transportation to processing units. The thermochemical organic manure produced from biodegradable waste are fortified and popularized as suchitha and the physical and chemical properties were studied using standard methods. The organic manure had blackish brown colour, neutral reaction, no odour and free flowing texture. The mean moisture content is about 16% and total carbon percentage ranges from 22.6%-24.2%. The mean percentage of nutrients were reported as – N (2%), P (0.95%), K (1.1%), Ca (2700 mg kg^{-1}), Mg (1200 mg kg^{-1}), S (650 mg kg^{-1}), Fe (620 mg kg^{-1}), Mn (25.1 mg kg^{-1}), Zn (66.6 mg kg^{-1}), Cu (14.5 mg kg^{-1}), and B (0.55 mg kg^{-1}). Thus, the technology thoroughly tested at laboratory and at field levels ensures that the thermochemical organic fertilizer can be used safely for agricultural purposes.

Keywords: *Thermochemical organic manure, Biodegradable waste, Nutrient content*

Low Cost Rooftop Level Rain Water Harvesting

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Abstract

Banka district is located in between latitude 24.7757° N and longitude 86.8220° E at an altitude of 85 - 247 meters above Sea level (MSL) having annual average rainfall of 800 mm and area 3,019 km². But due to mountainous area rain water runoff in river. This paper introduces a new technique to rainwater harvesting which can be easily used in both rural and urban areas: it collects and stores rainwater directly in the already existing well. Our rainwater harvesting system intended for direct domestic and agriculture use. For this chamber prepared having coarse stone, charcoal and small stone for filtering the water. NICRA village were having total 26 non functional well. In 2018 renovate the entire well through NICRA project then connect the drainage of roof of nearby house to well through plastic irrigation pipe. So, all rain water goes to well and recharge the ground water level. Average rain in Katoriya was more than 800 mm, hence 800 liter water/ meter^2. Average roof surface were 225 m^2/ house and total 73 pucca house were connected through the well. Here 80% of the rainfall is assumed to be effectively collected, hence 131.4 lakh litre rain water were preserved by the villagers. It reflects the increase water level of well by average 3.75 ft in April. in the well It affects the ground water level of the village. Collection in well were more efficiently prevent the losses through evaporation of water. Dairy farmers used this water for drinking and cleaning of farm and average 47 litres / cow/day were wastage from farm. Which were collected and used for growing green fodder and kitchen garden. 10 cows dairy were collect 376 litre water/day with 80% efficiency and sufficient for irrigation of 2 acre green fodder. Also soak pit prepared at 9 hand pump and wastage water was preserved to recharge ground water. Rainwater harvesting can be an important alternative to increase available domestic water and sustain groundwater.

Keywords: *Roof rainwater, Dairy wastage, Ground water*

Effect of deficit irrigation and plastic mulch on growth and production of drip irrigated tomato under naturally ventilated polyhouse

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Abstract

The effect of deficit irrigation and mulch on growth and production of drip irrigated tomato under the naturally ventilated polyhouse was studied through field experiment. In this study, six different treatments (i.e., irrigation at 100 per cent ETc level with mulch (T_1), 90 per cent ETc level with mulch (T_2), 80 per cent ETc level with mulch (T_3), 70 per cent ETc level with mulch (T_4), 60 per cent ETc level with mulch (T_5), 100 per cent ETc level without mulch (T_6)) with four replication were consider for their effect on crop growth and crop yield inside the naturally ventilated polyhouse. Tomato (Lycopersicon esculentum Mill, Dev Variety) plants were grown under the naturally ventilated polyhouse. The plant height, number of leaves and individual fruit weight were found to be highest in case of 80 per cent irrigation level with mulch. The highest yield (119.04 t/ha) was also recorded in the same treatment. Thus, the results revealed that all the vegetative parameters and quantity parameter were found maximum at drip irrigation level equal to 80 per cent of crop evapotranspiration with mulch under the naturally ventilated polyhouse.

Keywords: *Deficit irrigation, drip irrigation, naturally ventilated polyhouse, plastic mulch and tomato crop.*

Low Cost Perennial Water Harvesting Structure, Jalkund For Sustainable Livelihood of The Nungbrang Village of Imphal East District, Manipur, India

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Abstract

Water is the main criteria for success of any kind of farming system or agriculture based enterprises and we cannot do anything without water. Further, it is also a fact that agriculture is totally rainfed in North Eastern Hilly (NEH) region where everything is dependent on the seasonal rains. The region is characterized by varying topology that is largely affected by high seepage flow and flash runoff. Dual effect of water in the form of heavy rainfall during monsoon and water scarcity during post monsoon is severe in this region. Existing High seepage and infiltration of water are the main limiting constrain in storing of rain, runoff and river water, and its later use for irrigation purposes and Integrated Farming system in NEH region. The main problem with the small land holdings along the riverine area were unavailability of water due to sandy soil having high seepage and infiltration rate where construction of farm pond is not feasible for taking up farming activities by harvesting the water throughout the year. Many river which could provide water year round to trap the water for taking up different farming activities and also for household consumption in the localities. A low cost water harvesting technology called Jalkund (5 layer HDPE Geomembrane sheet of 300 micron) of size 5m x 4m x 1.5m having 30000 liter water capacity has been developed in riverine area at farmer's field of Imphal East District, Manipur. The cost incurred for construction of the structure was estimated to Rs. 10,560/-. The harvested water were utilized for growing vegetable crops (Kharif and Rabi) and rearing of poultry, Piggery and fisheries which act as a primary source of income for the farmers inhabited in riverine area of the district. Using stored water economically in various farm activities is the most acceptable and profitable one particularly to those in the riverine area, who are the worst suffering for storing of water in the riverine area having sandy soil of high seepage and infiltration rate. This economically viable and easily adoptable low cost technology needs to be popularized among the large section of farmers for increasing their income.

Keywords: *Low cost, perennial, water harvesting, Jalkund, Riverine area, river water, Integrated farming system*

Precision Water Management in Different Rice Establishment Methods

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Abstract

By 2050 the world's population will reach 9.1billion, a 50% increase in the population compared to 2000. India has 4% of the world's resources and 18% of the world population. Post-independence the population of the country has increased almost nearly fourfold and growth is expected to continue up to 2050 by which it will stabilize. The demand for food is also increased to satisfy the needs of the increased population. The world's freshwater availability is 2.70% among them 69% of freshwater is used for agriculture. The day to day water resources is reduced due to the increase of population, urbanization, and climate change.

Rice is a staple food crop in the south and south East Asia and plays an important role in Indian agriculture. India ranks 3rd in area and 2nd in production. Rice production systems are classified into different categories based on the regions in which they grew. The irrigated rice production system covers 44% while the rainfed rice production system occupies 45% in the total global rice production area. Rice consumes around 4000-5000 liters of water to produce one kg grain, which is three times higher than the other cereals. Rice is a semi-aquatic plant and the farmers are habituated to irrigate as much as possible through continuous land submergence based on the wrong notion that yield could be increased with increased water use. Serious concern has been raised regarding the depletion of water resources, groundwater reduction, lowering of the water table due to rice cultivation in India.

The major methods of rice cultivation are puddled transplanted rice (PTR), aerobic rice system (ARS), and System of rice intensification (SRI). Among these methods, some of the methods of the establishment can reduce the usage of water compared to conventional types of rice cultivation. Precision water management is the best solution for water usage and wastage in rice production. Precision water management (PWM) is related to the judicious use of water to achieve sustainable management of water. It refers to the precise application of quality water at the right time, right place, and right stage of crop growth but uniformly across the selected area. Dry seeded rice technologies offer a significant opportunity for conserving irrigation water by using rainfall more effectively.

Keywords: *precision water management, aerobic rice system, system of rice intensification, puddle transplanted rice.*

Irrigation and nutrient coupling on growth, yield, fruit quality and water use efficiency of Indian Jujube in an Inceptisol

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Abstract

The sustainability of quality fruit production in Indian jujube is adversely affected by improper irrigation and nutrient management. Accordingly, the field study comprising of four irrigation levels (drip irrigation at 0.8, 0.6 and 0.4 of pan evaporation (E_0) and surface irrigation at 1.0 IW/CPE with 50 mm depth) and three nutrient management (100% RDF, 75% RDF + 25% RDF as vermicompost and 50% RDF + 50% RDF as vermicompost) was conducted in an Inceptisol during 2018-2019 on growth, yield attributes, fruit yield and water use efficiency of crop. The results showed that tallest tree height (3.72 m), greatest tree circumference (0.32 m), maximum fruits per tree (563), highest fruit weight (15.5 g) and maximum fruit yield per tree (8.42 kg) were recorded with drip irrigation schedule at 0.8 E_0 coupling with 100% RDF which were superior to other treatment combinations barring a few. The shortest growth, yield constituents and fruit yield were demonstrated with drip irrigation schedule at 0.4 E_0 with 50% RDF + 50% RDF as vermicompost. Seasonal ETa was 373.6, 409.4 and 446.4 mm for drip irrigation at 0.4, 0.6 and 0.8 E_0, respectively and 694 mm for surface irrigation. Maximum CWUE of 18.87 g/tree/mm was obtained with drip irrigation at 0.8 E_0 with 100% RDF. About 55.7-75.5% water was saved due to drip irrigation schedules which could bring additional area of 55.5-85.8% under drip irrigation for jujube. The predicted highest fruit yield of 9.02 kg/tree was obtained with 277.8 mm irrigation water. This model approach could be served as a guideline to yield potential allocation decision related to limited irrigation water supply and can thus be fruitful to jujube growers in the Indo-Gangetic plains or similar agro-climatic regions.

Keywords: *Gravity drip irrigation, nutrient management, fruit yield, water use efficiency, jujube*

Irrigation scheduling in mango (*Mangifera indica* L.) for higher water use efficiency

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Abstract

Mango is the most important fruit crop in India with highest area and production. India is the world's largest producer by a wide margin, with more than 40% of global production. India produced 18.77 million tons of mango of the total world mango production. One-fifth of the total fruit produced in the country is mango next to Banana. The mango is cultivated in the largest area of 2,500 thousand ha and the production is around 18 million tonnes, contributing 40 % of the total world production of mango. The main mango producing states in India are Uttar Pradesh (23.72%), Andhra Pradesh (18.13%), Telangana (9.61%), Karnataka (9.46%), Bihar (7.28%%), Gujarat (6.09%), Maharashtra (4.74%) and Tamil Nadu (4.36%) (Anonymous, 2016). Water and plant nutrients are two key inputs for enhancing the mango productivity. A study was conducted at farmer's field during the years 2017-18 and 2018-19 to compare different irrigation regimes under deficit irrigation and different irrigation scheduling methods with and without fertigation. It was observed that water use efficiency was best in mango plants irrigated with PRD (Partial Rootzone Drying) mode at 50% Etc supplemented with fertigation but yield was compromised whereas, mango plants irrigated with PRD mode at 75 % Etc supplemented with fertigation resulted into better quality and yield in mango cv. Dashehari grown in rainfed areas. RDI (Regulated Deficit Irrigation) at 50 % and 75% of Etc also gave better results over control.

Keywords: *Mango, Deficit irrigation, Fertigation, yield*

Conservation Agriculture-Principal, problems and prospects in Indian Conditions

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Abstract

Conservation agriculture has potential to improve the use efficiencies of natural and man-made resources, carbon sequestration and soil health (physical, chemical and biological). It improves the sustainability of agriculture by mitigating GHG emission and adapting to climate change. However, the utilization/ exploitation of the CA practices needs to be optimized across locations, crops and cropping systems based on sound benefit-cost economics. It needs interventions at all levels: by farmers, researchers, extension personnel and policy makers to analyze and understand how conservation theologies integrate with other technologies that promote CA. It is, therefore, a challenge for both the scientific community and farmers to overcome the past mindset and explore the opportunities that Conservation Agriculture offers for sustainable agriculture. Conservation agriculture offers a new ideal approach for agricultural research and development different from the conventional one, which mainly aimed at achieving specific food grains production targets in India. A shift to CA has become a necessity in view of widespread problems of resource degradation, which accompanied the past strategies to enhance production with little concern for resource integrity. Conservation agriculture offers an opportunity for arresting and reversing the downward spiral of resource degradation, decreasing cultivation costs and making agriculture more resource – use-efficient, competitive and sustainable. Because with huge benefits there are also many constraints in adoption of CA, so it is necessary to break the mind set of peoples regarding tillage. A complete shift from intensive tillage to zero or minimal tillage needs extensive educational programme by demonstrating the benefits accrued by conservation agriculture.

Keywords: *Conservation Agriculture, Sustainable, Degradation.*

Optimization of parameters for microbial degradation of Benzo-α-Pyrene

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Abstract

The present study focuses on microbial degradation of benzo-α-pyrene (BaP), which is a prime carcinogen produced as a result of incomplete combustion of organic compounds. Bacterial species were isolated from coal tar contaminated site and screened on the basis of their growth in presence of BaP. In the present study, optimization of parameters was performed using response surface methodology (RSM) employing 3-level Box-Behnken for BaP degradation using bacteria in minimal medium. Various process parameters viz. pH (A: 6.0–8.0), temperature (B: 25–35° C) and shaking speed (C: 50–150) rpm were chosen for optimization. Maximum BaP degradation was found to be 84 ± 1 (%) at central values of all the factors viz., pH 7.0, temperature 30 °C and shaking speed 100 rpm after 15 days of incubation period. It was well in close agreement with the predicated value obtained by RSM model yield 85%. Kinetic study demonstrated that BaP degradation fitted first order kinetic model. Degradation of BaP was confirmed using FTIR analysis. The study concludes microbial degradation as an effective and sustainable technique to remove of BaP from environment.

Keywords: *BaP, Microbial degradation, Optimization, FTIR*

Proficiency of water purification system against bacterial contamination in water

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Abstract

Groundwater is the major source of drinking water and engages almost 50% of the world's total population to rely on it. But due to increased urbanization, industrialization, pollution and population, not only the level of groundwater is depleting but also its quality is degrading and the impurities are increasing in both physiochemical and biological respect. To overcome the flaw of quality at domestic level, various water purification systems that are available in the market viz; RO (Reverse Osmosis), UV (Ultraviolet), UF (Ultrafilteration), Activated Carbon, Sediment filter, TDS (Total Dissolved Solid) controller, Mineralizer, etc, can be employed. Different water purification system shows different capabilities based on the technology followed or the principle of action. In present study, the two most commonly used water purifiers that work on the principle of reverse osmosis and the action of germicidal-UV rays (UV-C), namely RO+UV purifier and UV purifier have been studied to eradicate bacterial population (special reference to Total coliform and E. Coli) present in water. To determine the bacterial population in the water samples, Idexx Quanti-Tray method has been used which can efficiently detect Total coliform and E. coli, simultaneously. To discern the efficacy of water purifiers, the contaminated water samples were passed through both the purifiers and the purified water samples were incubated for the duration of 9 hours, 18 hours and 24 hours at 4^{o}C. None of the purified water sample of both the purifiers showed the growth of either bacteria after 9 hours of incubation. The water sample purified by UV purifier showed the growth of both Total coliform and E. coli after 18 hours and 24 hours of incubation. Where else the water samples purified by RO+UV purifier showed only the growth of Total coliform after 24 hours of incubation period. The reappearance of bacteria is linked with the shortcoming of inactivation of bacteria rather than killing of them. This study suggests intake of water purified by RO+UV purifier within 24 hours of post-purification or should consider the appropriate treatment before consumption, such as chlorination and disinfection, to minimise the risk of waterborne diseases.

***Keywords**: Idexx Quanti-Tray, Total coliform, Escherichia coli, RO+UV purifier, UV purifier*

Development of various rainwater harvesting structures to strengthen groundwater and increase crop productivity in semi-arid areas - A case study

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Abstract

This paper presents the development of rainwater harvesting structures and their impact on water availability and use of rainfed crops. The concept of rainwater harvesting involves a comprehensive approach to developing and conserving water resources. Artificial recharging of groundwater resources to replenish groundwater resources is a commonly followed and costly method. Different methods are suggested to the farmer based on different methods for rainwater harvesting. The methods adopted for rainwater harvesting technologies introduced by ICAR-CRIDA, Krishi Vigyan Kendra, Ranga Reddy District, Telangana are to harvest rainwater in KVK adopted villages that have such as structures percolation tank, farm pond and currently non-functioning wells for artificial recharging and reuse of conserved rainwater. This study discusses rainwater harvesting as an effective tool for water management using a different method. The general goal is to preserve the water supply to annual crops, vegetables, pastures, orchards and animals in dry areas without pressing groundwater. The groundwater level was closely monitored and the groundwater level was increased. The water yield / recovery rate before and after the intervention of the various wells indicated that the recharge rate increased from 10% to 15%. Express to increase the groundwater level in the wells in the surrounding areas and increase the availability of drinking water for livestock. There are 15 to 20 open wells and bore wells around the designed watershed area, some of which are defunct. Based on the date collected from the observation wells and the perception of the farmers, it was found that the water levels in the vicinity of the surrounding farm ponds increased by 2 to 6 m and in the surrounding area by 2 to 8 m. Percolation tanks. A total of 30 wells (50%) were completely affected by water conservation measures in the watershed area. Evaluation studies conducted on the performance of structures in the village have indicated that different structures that are properly designed, constructed in relation to groundwater recharge can estimate efficiency at approximately 78 to 91%. It serves the dual purpose of water augmentation and groundwater recharging. Percolation tanks have been put into actual practice, with much talk about the comprehensive development of surface and groundwater for their conjunctive use. After the development of various structures, the wells are recharged and the crop intensity is increased and 50 to 60 farmers per individual structure can benefit from these interventions. The impact of technology is surprisingly staple and very visible.

Keywords: *Rainfall, Rainwater harvesting, Watershed, Ground water recharge and reuse.*

Adoption of Conservation Agriculture: A sustainable approach towards an efficient resource management and soil health restoration

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Abstract

Conservation agriculture (CA) is characterized by minimal soil disturbance, diversified crop rotations, and surface crop residue retention to reduce soiland environmental degradation while sustaining crop production. CA involveschanging many conventional farming practices as well as the mindset of farmersto overcome the conventional use of tillage operations. Although adoption of CA isincreasing globally, in some regions it is either slow or nonexistent. While the effects of CA onSOC worldwide are variable, with both increases and decreases observed, in regionswhere soil and climatic conditions are favorable for biomass production and where thesystem does not negatively impact yield, then CA can lead to higher amounts of SOCrelative to conventionally managed systems, particularly in the surface of the soil profile.Where greater SOC occurs, these are also often accompanied by improvements in soilstructure, water infiltration and soil water storage, plant nutrient availability, microbialbiomass and diversity, and yield. However, where CA is used in certain environments (e.g., cold, wet environments with poorly drained soils) or where the CA system hasnot been well-adapted to local conditions, taking into account the specific agronomic, social, and environmental challenges present, then it may not be a successful system ofmanagement.

Innovations for Climate Resilience in Rainfed Conditions in Village Warkhed, District Akola of Maharashtra State

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Abstract

Under dryland condition kharif crops mainly depends upon the rainfall, its onset, intensity and distribution which is highly unpredictable in this region and hence the productivity of the dryland crops is getting very low. In order to evaluate and disseminate the improved rainfed agro-technologies, on farmers field under different themes viz. rainwater management through in-situ and ex-situ moisture conservation practices and foliar sprays were conducted at village Warkhed, Taluka-Barshitakli, district Akola of Maharashtra State during 2018-19 to 2019-20 under National Innovations on Climate Resilient Agriculture project of AICRP for Dryland Agriculture. This study clearly indicated that advantage of adopting all improved rainfed agro-technologies for different crops in comparison with traditional farmer practices. Improved dryland technologies resulted in overall increase in crop production from 5.00 to 20.67 % over the farmers practice. The percent increase in yield was highest with adopting of various in-situ moisture conservation measures in soybean (11.11 %) and in cotton (10.36 %) and foliar spray of nutrients in cotton crop (10.46 %) and intercropping of soybean with pigeonpea with increase in equivalent yeild of (8.41%) over sole soybean. Hence, on farm interventions carried out through NICRA-project showed the worth of improved rainfed varieties and management practices for improved agro-technologies. NICRA project with its strong link between the technology developed by the scientist and the user of the technology is putting larger impact for the adoption of improved dryland agro technologies. This project also provides the feedback for refinement and upscaling improved dryland agro-technologies.

Keywords: *rainfed, innovative interventions, in-situ moisture conservation, foliar sprays, intercropping.*

Initial and conditional probabilities of South-west monsoon rainfall at Rajouri

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Abstract

Rajouri district occupies an area of about 2630 sq. km with peculiar physical features and lies in between 33° 42' N latitude and 74° 13' E longitude at an elevation of 950 meters above the mean sea level. The District is situated in the west of Jammu Province of Jammu Kashmir Union Territory, India and is surrounded by the Poonch, Reasi and Jammu Districts. Daily rainfall data of recent past 25 years (1994 - 2019) recorded at meteorological observatory of Agro Meteorological Field Unit, Regional Agricultural Research Station Rajouri of SKUAST – Jammu and were analyzed to understand the probability of South-west monsoon. The climate of the location is influenced by South-west monsoon in *Kharif* and Western disturbances in *rabi* season. After analyzing the initial and conditional probabilities of rainfall, it was observed that initial probability of receiving 10 mm rainfall increases sharply from 23rd meteorological week (46%) from 01st week of June to 31st meteorological week (75 %) by the end of July. It remains more than 75% in the 26th, 27th, 28th and 29th meteorological week which are the main rainy weeks. After 37th meteorological week, the rainfall probability decreases sharply indicating the cessation of rainy season. The conditional probability of dry week increase onwards 37th meteorological week up to 52nd meteorological week. The conditional probability of dry week is highest during 47th meteorological week. It can be concluded from this study that rainy season in the Rajouri extends from 23rd week to 36th week and the sowing of rainfed crops like maize and *kharif* pulses can be taken up during this period.

Keywords: *Rainfall, South-west monsoon, Rajouri, Initial and conditional probabilities*

Water Quality Assessment for irrigation purposes in Yamuna River

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Abstract

The present study is focused on water quality assessment of Yamuna River for irrigation along the stretch from Poanta Sahib in Himachal Pradesh to Delhi. A total of 26 water samples were collected in June 2019 and measured for various physicochemical parameters. The water is alkaline and moderate to very hard in nature with total hardness up to 742.1 mg/l. Electrical conductivity, Residual Sodium Carbonate, Percent Sodium, Sodium Adsorption Ratio, Kelley's Ratio and Magnesium Ratio indicate that the water can be used for irrigation under most of the conditions. The majority of the samples fall under C2S1 and C3S1 categories on the US salinity diagram and excellent to good, and good to permissible category on the Wilcox diagram. However, two Samples from urban drains at Najafgarh and Noida fall on the boundary of C3S1 and C3S2 category reflecting their unsuitability for irrigation. 19 samples show higher values for Kelley's ratio (>1) due to the presence of high sodium content with respect to the alkaline earths. Chemical parameters suggest huge discharge of pollutants in Yamuna river after entering Delhi. This is also supported by the presence of high Na^{+}, NH_4^{+} and NO_3 in the samples taken from various sites near Delhi.

Keywords: *Yamuna River; Water quality; Irrigation*

Weed Management of Wheat in Rice Based Cropping System Under Conservation Agriculture System

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Abstract

A field experiment was conducted at Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu in *Rabi* 2015-16 and *Rabi* 2019-20 to study the weed dynamics and crop productivity of wheat in rice based cropping system under conservation agriculture. The experiment was laid out in split plot design with 3 replications. The tillage and residue management treatments (CTW, ZTW, ZTW+residue) were kept in main plots and weed management treatments (herbicidal, integrated and unweeded) in sub-plots. For weed management in wheat, sulfosulfuron + metsulfuron (30+2 g/ha) at 30 DAS and sulfosulfuron + metsulfuron (30+2 g/ha) at 30 DAS *fb* one hand weeding were taken for herbicidal and IWM treatment, respectively. *Anagalis arvensis*, *Melilotus indica, Medicago spp., Phalaris minor, Rumex spp., Vicia sativa, Ranunculus arvensis* were observed in wheat under different tillage and residue management treatments. The density of *Phalaris minor, Rumex spp., Ranunculus arvensis, Anagalis arvesnsis*, *Melilotus indica* and *other weeds were lower in* ZT-wheat+residue plots as compared to CT-wheat and ZT-wheat. However, density of *Medicago spp.* significantly lowers in CT-wheat as compared to ZT-wheat. Lowest weed density and weed biomass were recorded in ZT-wheat+residue as compared to CT-wheat and ZT-wheat. Among the weed management treatments, the integrated weed management (sulfosulfuron + metsulfuron 30+2 g/ha at 30 DAS *fb* HW at 45 DAS) recorded significantly lowest density and biomass of weeds with highest grain yield and benefit cost ratio as compared to herbicidal treatment (sulfosulfuron + metsulfuron 30+2 g/ha). In zero-tillage+ residue plots improvement in infiltration rate was also noticed over initial values. Thus, ZTW+residue along with integrated weed management have been found suitable for wheat in rice based cropping system under conservation agriculture.

Keywords: *Conservation agriculture, Wheat, Residue, Tillage, Weeds*

Effect of Soil Moisture and Calcium Carbonate content on Leaf Reddening in Bt. Cotton

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Abstract

The present investigation entitled on Nutrient Status of Cotton Growing Soils and Cotton Crop in Nanded District of Maharashtra. In that Twenty four fields were finalized and forty eight soil samples (0-30 & 30- 60 cm depth) and twenty four red and green leaves with petioles were collected for laboratory analysis. Results founds, soils were slightly to moderately alkaline and calcareous in nature (6.1 to 32.9%)and calcium carbonate was found increased with depth. Moisture content in root zone 0-30 cm and 30-60 cm at square formation stage of cotton in the month of October was varied from 26 to 45 and 23 to 65 per cent respectively. Soil moisture shows significant negative correlation with $CaCO_3$ content in soil (r = -0.84) indicating that the $CaCO_3$ content in soil increased leds to decreased the moisture content in soil, whereas significant positive correlation with N, K, Mg, Mn, Zn, Cu and B. (r = 0.83, 0.76, 0.75, 0.81, 0.58, 0.48 and 0.51, respectively). Moreover, the significant negative correlation between $CaCO_3$ content in the soil and available nutrients *viz*. N, Mn, B, Mg, K, Cu and S. (r = -0.85, -0.85, -0.81, -0.70, -0.66, -0.58 and -0.41, respectively) and others are non-significant negative correlated.The correlation between $CaCO_3$ in the soil with chlorophyll and anthocyanin pigment in red leaves was found significant r = -0.54 and r = 0.55 respectively.This indicate that the calcium carbonate increases in soil reduces the available soil nutrient which adversely affected the chlorophyll formation and increase the accumulation of anthocyanin pigment in cotton leaves at square formation stage.From the above however concluded that the concentration of $CaCO_3$ content in root zone was found high which reduced the soil moisture and availability of nutrients in soil. This creates the stress of nutrients in cotton leaves at square formation stage and crop inducing the stress of nutrient dominated by N followed by Mg, Fe, Mn, K, B, P and Cu. This causes reduction in chlorophyll and increased anthocyanin pigment, which induce the reddening in Bt. cotton.

Keywords: *$CaCO_3$, Soil moisture, Cotton crop*

Drought Phenomena its Occurrence and Cost Effective Technologies for Mitigating its Impact

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Abstract

Drought is generally attributed to deficiency in rainfall over a certain period resulting in water shortage affecting the socio-economic conditions of the people. It impacts almost all spheres of life resulting in crop failure low productivity, depletion of water resources and drinking water scarcity leading to steep increase in prices of essential commodities, rural unemployment, malnutrition and other health problems and social unrest. Droughts are recurring phenomenon and most of the regions of the country particularly rainfed generally have to confront the droughts once in 3-5 years. In view of the serious detrimental effect of droughts on the agricultural sustainability, economy and well being of the people, it is of paramount importance that concerted short and long term efforts are directed to mitigate and manage the detrimental impacts of droughts in rainfed areas by adopting integrated watershed management approach comprising of cost effective technologies for rainwater harvesting to store and recharge groundwater both in rural and urban areas, *in-situ* soil moisture conservation in rainfed regions and integrated farming systems. The drought management in irrigated areas, however, should include adoption of cost effective technologies including on-farm water management for optimal use of limited water, low water requiring cropping system and regulated groundwater withdrawal. The on-farm water management practices including proper land leveling, irrigation scheduling and well designed irrigation methods suiting the existing topography, soil and source and quality of water go a long way in effecting optimal use of available water resource. The cost effective and viable technologies should aim at averting shortage of food, water and fodder on long term basis.

Assessing the influence of nutrient management and irrigation method on growth of two different rice cultivars - Uma and Kanchana

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Abstract

Rice (*Oryza sativa* L.) is one of the principal staple food crops. Globally, India ranks first in rice area and second in rice production after China. Severe water shortages are developing in many countries and water for agriculture is becoming increasingly scarce. Water requirement of rice is very high. Typically water input for rice varies between 660 to 5280 mm. Water scarcity is one of the most threatening issues with respect to rice cultivation. In addition, Climate change also hampers the rice production, which would seriously impair food security. Water saving techniques is very much essential for sustaining the rice production under changing climate scenario in humid tropical Kerala. Several strategies are in place to reduce rice water requirements, such as alternate wetting and drying (AWD). Even small savings of water due to a change in practices will translate into a significant bearing on reducing the total consumption of fresh water for rice farming. With this background, a study was attempted to evaluate the water and nutrient management strategies for improving the rice productivity in two rice cultivars Uma and Kanchana. Under irrigation treatments two conditions were attempted a) Water logged (flooded) and b) Alternate wetting and drying (AWD). Nutrient management practice treatment comprises of a). 0 % application of Nitrogen (T_1); b). 100 % application Nitrogen (T_2) and c). 120 % application of Nitrogen (T_3). The results from the current study showed that rice cv. Uma treated with 120% Nitrogen under flooded condition, produced higher growth and yield parameters. Rice cv. Kanchana with 0% Nitrogen under AWD produced the lowest crop growth and yield parameters. Among the methods, flooded condition performed better when compared to AWD conditions. To conclude, flooded condition along with 120 % of recommended dose of inorganic fertilizers will result in higher rice productivity.

Keywords: *Rice, Alternate Wetting and Drying, Nitrogen, Climate Change*

In-Situ Conservation of *Kharif* Moisture for Timely Sowing of Wheat in *Rabi* Season under Rainfed Conditions of Rajouri

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Abstract

Wheat-Maize being the sole cropping sequence which is the most prominent crop rotation in the district. Wheat (*Triticum aestivum*) is the second most important staple food crop after maize, cultivated in about 40 thousand hectare with production and productivity of 62784 quintals and 15.70 quintals/ha, respectively in Rajouri district. However, weather is a critical factor influencing the production of crops in this region. Being rainfed, timely rainfall in district viewed as a dominant climatic element influencing timely sowing and ultimately the yield of wheat crop. The frequent dryspells during the sowing time greatly influence the crop productivity and become the limiting factor to achieve potential productivity. Hence, to overcome with untimely rainfalls at the time of sowing of wheat crop as experienced in last few years an experiment was formulated to study the effect of In-situ conservation of *kharif* moisture for timely sowing of wheat in *Rabi* season under rainfed conditions in the form of On Farm Trials (OFTs) during *Rabi* 2017-18 and 2018-19 and conducted at five locations in each season. The experiment comprised of 3 treatments: T1- Farmer practice (Sowing after rainfall), T2- After harvest plough and heavy planking, T3- After harvest plough and heavy planking + Mulching with maize straw. Results indicated that the integration of plough and heavy planking with maize straw mulching was more effective in timely sowing of wheat crop during untimely rainfalls. Combination of after harvest plough and heavy planking + Mulching with maize straw resulted in significantly higher yield of Wheat (26.86 q ha^{-1}) as compared to after harvest plough and heavy planking alone (25.20 q ha^{-1}) and farmer practice (23.48 q ha^{-1}). Adoption of improved sowing technology increased yield by 12 per cent over farmers' practices. The economical parameters indicated that net profit of ₹25754 ha^{-1} was recorded with treatment T3 over farmer practices ₹ 21833 ha^{-1}. Benefit cost ratio for after harvest plough and heavy planking + Mulching with maize straw and farmer practice was 1.95 and 1.82, respectively.

Keywords: *Wheat, rainfall, mulching, conservation technology*

Conservation Agricultural Practices and Soil Nitrogen Losses through Erosion in foothill Shivaliks

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Abstract

The foothill Shivaliks face an acute problem of soil erosion owing to topography and rainfall pattern. This is further aggravated by poor management practices. A study was undertaken in the erosion prone kandi area of Jammu to assess the influence of conservation agricultural practices (CAP) on losses of soil nitrogen through eroded sediments and runoff under maize crop. Three tillage variations i.e. conventional tillage (CT), minimum tillage (MT) and zero tillage (ZT) were employed, and were combined with management practices such as intercropping (i), mulching (m) and residue retention (30%) (r). Runoff and the sediments collected during major rainfall events were analyzed for nitrogen and the amount of N lost was quantified based upon total runoff and soil loss. A significantly higher concentration of NO_3-N was observed in runoff from zero tillage plots. NO_3-N losses in runoff occurring throughout the growing season were maximum in ZT which was statistically at par with CT, MT, ZTm and ZTr while the minimum amount of NO_3-N loss occurredd in MTm (1.86 kg ha^{-1}) which was statistically at par with all other treatments except ZT. Although the ZT reduced quantity of nutrient loss in sediments, but it showed an increase in the amount of surface runoff. This increase in surface runoff may be generated due to low infiltration capacity of NT soils developed as a consequence of surface crusting. Nitrate in the runoff came fundamentally from fertilizers and manures. Total ammonical N loss in runoff was maximum in CT (0.547 kg ha^{-1}) while the minimum NH_4-N loss occurred in ZTr (0.362 kg ha^{-1}). High losses in MT, ZT and CT was due to higher runoff from these tillage practices. Maximum Kjeldahl N loss was observed in CT while the minimum amount of N loss in sediments occurred in ZT with mulching and ZT with residue retention (30%). Unlike runoff water, which was not affected by tillage practices in general, there was significant difference in the amount of sediments eroded, which translated into higher amounts of Kjeldahl N being lost under conventional tillage systems. ZT reduced the total amount of sediment losses in runoff through better aggregation. Also, the decomposition of OM produced sticky substances which bind the mineral particles into aggregates. This binding agent for aggregates near the surface prevents sediment losses and ultimately N losses through erosion. The application of residue or mulches or intercropping with pulses effectively reduced the N losses mainly because of the reduction of runoff under these treatments while the maximum amount of sediment loss occurred in CT as tillage played significant role in accelerating soil N loss through exposure of soil to erosion.

Keywords: *Erosion, Nitrogen, Conservation Agriculture, Tillage, Mulching, Cover Crops*

Effect of Drip Irrigation Level and Micronutrient Application Method on Yield of Indian Mustard (*Brassica juncea* L.)

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Abstract

An investigation entitled "Effect of Drip Irrigation Level and Micronutrient Application Method on Productivity of Indian Mustard (*Brassica juncea* L.)" was conducted at Agronomy farm, S.K.N. College of Agriculture, Jobner, District Jaipur (Rajasthan). Geographically Jobner is located at 75^{0}28' East longitude and 26^{0}05' North latitude and with an altitude of 427 metres above mean sea level in Jaipur district of Rajasthan. The region fall under Agroclimatic Zone IIIa of Rajasthan state named as Semi-arid Eastern Plains. A field experiment was laid out in split plot design with three drip irrigation level (0.4, 0.6 and 0.8 IW/CPE ratios) in main plot and four micronutrient application method (control, soil, foliar and fertigation) in sub plot and replicated four times. The results indicate that the grain and straw yield of mustard was significantly influenced by different drip irrigation levels and micronutrient application method. The drip irrigation level at 0.6 IW/CPE ratio recorded significantly higher seed yield (18.06 q/ha) and straw yield (66.31 q/ha) as compared to 0.4 IW/CPE ratio. The 0.6 IW/CPE ratio improved the seed and straw yield of mustard by 14.44 and 15.06 per cent over 0.4 IW/CPE ratio. In case of micronutrient application methods, fertigation observed significantly higher seed yield (19.73 q/ha) and straw yield (70.66 q/ha) over all other application method. The fertigation increased seed and straw yields by 39.23 and 25.30 per cent over control and 13.58 and 12.33 per cent over soil application. Foliar application also significantly increased seed and straw as compared to control and soil application. Henceforth, on the basis of this study, it can be concluded that the drip irrigation level at 0.6 IW/CPE ratio and micronutrient application through fertigation recommended owing to improved seed and straw yield of mustard as compare to other treatments besides proving itself economically viable.

Keywords: *Fertigation, mustard, irrigation, foliar application, yield*

Biostimulants: Source of Mitigation of Moisture Stress in Cow Pea

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Abstract

Biostimulants are the substances or living organisms applied to the plant or soil that increase the quality attributes of the plants, enhancing the crop quality, nutrient efficiency, stress tolerance translocation and yield. They have the potential to enhance germination, increase crop growth vigour and eventually improve cowpea leaf yields. Drought is prolonged shortage of water supply, it may be atmospheric or physiological. Drought is the major abiotic stress factor that causes extensive losses to agriculture production worldwide. It may cause oxidative stress and ionic stress in crop plants. The accumulation of proline appeared to be in response of drought injury rather than a drought tolerance mechanism. Cow pea is grown mostly under rain fed and semi arid regions. Cow pea growth can be promoted by stimulating nutrient uptake, chelating nutrients, providing plant growth hormones, or enhancing plant hormonal activity. Leaf extract of some plants or seaweed act as biostimulants in Vigna, it helps in stem thickness, increase the number of leaves and length. Biostimulants helps cow pea to thrive under drought condition. Drought causes increase in the concentration of osmo-protectants like proline, glycine betaine in the tolerant genotypes. Biostimulants beneficially influence cow pea to grow under various stress because these are the sources which can be used to mitigate all type of stress. Now a days biostimulants are used as approach to increase the productivity or increase the physiological traits of crop tends to optimize the agriculture system.

Conservation Agriculture- A climate smart approach for Carbon enrichment

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Abstract

Conservation agriculture can be considered as a practical agro-ecological approach to achieve sustainable agriculture intensification, as it imparts soil ecosystem services like carbon sequestration and also supports sustainable crop production through maintenance of soil health. An understanding of conversion of atmospheric carbon to soil organic carbon, as imparted by different soil management practices with varying degrees of tillage and residue retention is necessary for up keeping soil health as well as mitigating climate change. The impact of long-term conservation agriculture on vertical distribution of soil carbon stock under Rice-Wheat cropping system was evaluated in a sub-tropical climate with calcareous soil, using aplatformof eleven years old at Pusa, Samastipur, and Bihar. The highest soil organic carbon stock was observed in the treatment with zero tillage practice with residue retention which was about 86% higher over the conventional system, resulting a significantly superior carbon build up rate under zero tillage plots. An increment in carbon enrichment ratio along with recalcitrant index in zero tillage treatments reflected the global warming curbing ability of conservation agriculture. The treatment under zero tillage practice with residue retention is recommended as the best land management practice to improve soil health through enrichment of soil organic carbon which bears the signature of climate resilientness of conservation agriculture.

Keywords: *Carbon stock, Conservation agriculture, Climate resilientness.*

Emitter spacing under point and disc source flow geometry for surface drip irrigation

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Abstract

Water is becoming a precious natural resource and need to be utilized efficiently and wisely. Indiscriminate and non-judicious use of irrigation water has spelled disasters all over the globe where due attention was not given for its proper utilization and combating after effects. With increasing population, industrialization, urbanizations, improving and changed human behavior indicates severe water crises in the years to come. Ground waters reserves are depleting in the country like India at a much faster rate increasing cost of pumping, risk to land subsidence besides socio-economic and environmental problems. Water quality deterioration, safe disposal and or re-utilization of industrial and domestic effluents are the real and burning problems of the day. Environmental degradation is globally known phenomena and cannot be ignored. The solution of above problem is to use available natural resources in a most scientific way. Agriculture alone uses nearly 80 to 95% of available water resources. There is huge loss nearly 40 to 60% associated with conventional irrigation methods. Drip irrigation is the latest variation of irrigations having irrigation efficiency up to 98% as a future water use techniques. Drip irrigation is becoming important method to apply irrigation water precisely with least field losses. It also allows use of poor quality irrigation water safely. Drip irrigation with its variations cover large varieties of crops in the field. Largely spaced plantations and close growing crops in lines are well suited for drip irrigation. Emitters are to be fixed over a lateral to meet the uniform water distribution criteria. For line growing crops wetted front of individual point source emitter should touch each other (Ben Asher and Phene, 1993). This approach of emitter spacing calculation has serious drawback of leaving dry soil on and below the soil surface in the middle of emitters. The plants may not get sufficient moisture for deep or lateral spread. An overlapping wetted front criterion was developed in the present study to minimize the dry region in the centre. Ben Asher et al. (1986) proposed effective hemi-sphere model for predicting wetted front advance from surface point source. The model is quite simple and requires only average change in volumetric moisture content as single input parameter to the model. Ben-Asher considered diameters of wetted fronts as spacing between the emitters when wetted front starts touching each other. About 27.32% of the area remains dry when wetted front touches each other. This area reduced 11.60% with overlapping wetted front criterion. Overlapping of wetted fronts may cover dry region. The proposed equation may be used for routine emitter spacing calculation. The approach could be also useful for adjusting spacing between the emitters calculated by other methods.

Keywords: *Drip irrigation, irrigation efficiency, emitter spacing & hemi-spherical model*

Evaluation of evapotranspiration models for estimating reference evapotranspiration in sub-tropic region

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Abstract

This study aimed to assess the Performance of the different evapotranspiration models. The objective was to determine the most accurate model for estimating reference evapotranspiration (ET0). Performance Evaluation of all the ET_0 models on the limited weather data basis is prerequisite for selecting an alternative approach in accordance with available weather data such as maximum air temperature, minimum air temperature, mean relative humidity, solar radiation and wind speed. Therefore, standard recommended FAO-56 Penman Monteith (FAO56-PM) model locally calibrated FAO-56 P-M model, Hargreaves-Samani (H-S) model, Jensen- Haise (J-H) model, Rohwer and Travert ET_0 based model were used to estimate monthly reference evapotranspiration(ET_0) at Gwalior (Madhya Pradesh), India. Further, the performance of all these ET_0 methods were evaluated by error analysis between observed ET_0 value using FAO-56 PM model and ET_0 values estimated using all other ET_0 models. The result showed that the Hargreaves-Samani, Rohwer and Trabert model systematically underestimated ET_0 in all months .Jensen-Haise (J-H) model was found lower value of RMEA, MAE and MAPE (1.056),(0.852), (19.299).Travert model with highest value of R^2(0.980) RMEA(4.326) , MAE(4.183) and MAPE (80.596) and H-S model with lower value of R^2 (0.820). J-H model best performed on the basis of RMSE. Based on overall results it was concluded that the ET_0 based model provides average monthly accurate estimate of reference evapotranspiration compared to other models.

Keywords: *Reference evapotranspiration, Sub-tropic, Madhya Pradesh*

On-farm rainwater harvesting for vegetable production using low cost polyhouses in NEH region

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Abstract

Farmers of hilly state of the north eastern region grow a variety of vegetables mostly inside polyhouses. Vegetables require frequent watering and sufficient water supply for the better yield good-quality produce. Insufficient availability of irrigation water is one of the major problem towards the low productivity of vegetables in the region. In the state of Sikkim availability and shortage of water occurs in the winter season mainly due to drying of natural springs and other natural causes. Hence, proper on-farm water availability and management is essential for increasing the yield of vegetables and making it a profitable venture. Rainwater harvesting from low cost polyhouses is one of the alternatives that may be adopted in the hilly terrains of Sikkim to overcome this problem. Considering above fact, water harvesting system for the polyhouse was developed with affordable drip irrigation system for 100 m^2 area. Semi-circular PVC gutter size of 150 mm was used for collection of water. Collection efficiency was estimated to 90 percent. The potential for the monthly harvestable rainwater from the polyhouse varies from 200 litres for the month of November to 32,000 litres in the month of August in Sikkim condition. Results revealed that can further improve the water use efficiency and maximize the crop-yield.

Keywords: *Polyhouse, low cost, rainwater, on-farm, vegetables*

Efficient water management system in diverse ecosystems

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Abstract

Among the earth elements, water plays the most crucial role in sustaining life in diverse and varied ecosystems. Currently, water scarcity is among the biggest environmental challenges that the world is facing. Apart from the repercussions of climate change, water mismanagement and inefficient use has also exacerbated the problem. Several scientific and indigenous water management systems are being adopted and revived by different stakeholders to combat the issue of water scarcity. This presentation will cover three knowledge systems regarding efficient water management in different ecosystems within the HKH region. In addition, the relational context of water in a broad social system will also be briefly discussed.

Reservoir water spread area estimation using different image classification techniques

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Abstract

Sustainable use of reservoirs is a challenging task because of accumulation of sediment in a reservoir which leads the reduction in useful storage capacity of the reservoir. This emphasizes assessment of reservoir sedimentation for better water resource management and to implement appropriate conservation strategies. To assess the deposition of sediment in a reservoir hydrographic survey or remote sensing based techniques are used in general. In conventional and remote sensing based techniques reservoir water spread area estimated at different water levels is the only dynamic input to quantify the sediment deposited in a reservoir. Therefore, in this study Nagarjuna Sagar reservoir located in Telengana has been chosen to estimate the water spread area at the water level 155.78 m. To estimate the water spread area image classification techniques such as Maximum Likeliwood Classification (MLC), Band Threshold (BT) and Normalized Difference Water Index (NDWI) were used in this study. Landsat-8/OLI having 30 m resolution was employed to interpret the water spread area. Interpretation of Lansat-8 data reveals that the MLC, BT and NDWI produced a water spread area of 170.92 Mm^2, 180.74 Mm^2 and 172.49 Mm^2 respectively. Comparison of Landsat-8 data with a high resolution data reveals the best methodology to be employed to quantify the sediment in a reservoir.

Keywords: *Reservoir sedimentation, Water Spread Area, Remote Sensing Technique*

2-D Flood Simulation Using HEC HMS and HEC RAS for Vamsadhara River Basin

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Abstract

The study looks at Flood Stimulation for Vamsadhara river basin which also knows as Banshadhara is one of the important east flowing rivers between Rushikulya and Godavari in Odisha and Andhra Pradesh states in India. The river originates from the border at Thuamul Rampur in Kalahandi District and Kalyansinghpur in Rayagada district in Odisha and travels for a distance of about 254 km. the total catchment area of the river basin is 10,830 sq.km, Vamsadhara river basin occupies 8,015 sq.km in Odisha and the remaining 2,815 sq.km in Andhra Pradesh. Vamsadhara river is a non-perennial river so the only source of flow was rainfall due to heavy rainfall in 2006 the river was over flooded which caused lots of losses either economic or loss of life. In this paper, the methodological approach was adopted, focused on the hydrologic modelling System (HEC-HMS) and the hydraulic modelling (HEC-RAS) with a combination of watershed modelling System and Geographic Information System (GIS). Centre for hydrological and remote sensing (CHRS) 4kmx4km gridded rainfall data and central water commission (CWC) observed flow is chosen as a case to examine the modelling framework. The model consists of a rainfall–runoff model (HEC-HMS) that converts precipitation excess to overland flow and as well as precipitation excess input to the 2-D hydraulic model (HEC-RAS) unsteady state flow. The aim of this study was flood inundation behaviour of Vamsadhara River during extreme flood events 2006. HEC RAS model simulated reulsts compared with observed flow and it is well mach with observed. Forcing the model with forecasted precipitations can also help with flood warning system by generating pre-flood inundation maps.

Keywords: *Hydrologic. Hydraulic, Flood, Simulation, Watershed*

Productivity and profitability of major rainfed *rabi* crops as affected by traditional and mechanized planting

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Abstract

Wheat, mustard, chickpea and pea are major crops of rabi season under rainfed areas of Jammu region. However, yield levels of these crops especially under rainfed areas are very low and are being declined due to improper sowing methods like broadcasting, no use of farm machineries and various other un-improved agronomic practices. Recent tests have demonstrated that use of farm implements can produce crop yields better than conventional methods of agricultural practices. Further, labour cost and other input cost (fuel, seed & fertilizer) can be reduced to a major extend. Sowing of seeds through drill make possible the sowing at specified rate, proper depth and in rows which later permit inter row cultivation, interculture operations and also provides good environment for proper root and plant development. Crop yield increased generally about 15-25 per cent as compared to conventional broadcasting method. In this regard, field experiments were conducted at Research Farm of ACRA, Rakh Dhiansar, SKUAST-J, J&K UT during rabi 2018-19 and 2019-20 to study the influence of different sowing methods on major rabi food grains. Treatments comprised of three methods of planting viz., multi crop seed drill, recommended practice (line sowing), farmers' practice and four crops wheat, mustard, chickpea and field pea with 12 treatment combinations and 3 replications laid out in factorial RBD design with the objectives to assess the impact of mechanized planting on growth and yield of different rabi crops and saving of energy with mechanized planting in comparison to other methods. The results revealed that significantly higher dry matter accumulation, yield attributes, grain and straw/stover yield and rain water use efficiency (RWUE) of different rabi crops like wheat, chickpea, pea and mustard were obtained when these crops were grown with Multi crop seed drill and followed by sowing with recommended practice (line sowing). Statistically lowest dry matter accumulation, yield attributes, grain and straw/stover yield and rain water use efficiency (RWUE) of the crops were observed in farmer's Practice. Higher net returns and B:C ratio of different rabi crops was also obtained when the crops were grown with Multi crop seed drill, followed by sowing with recommended practice (line sowing). The lowest net returns and B:C ratio values for all the crops were recorded in farmers' practice. Hence, it is concluded that mechanization may increase agricultural production and profitability on account of timeliness of operation and more efficient utilization of inputs. The mechanization should be encouraged in rainfed areas which might increase farm productivity, and ensure sustainable production of crops. The energy output and energy ratio was also maximum for all the crops when sown with multi-crop seed drill.

Keywords: *Wheat, chickpea, field pea, mustard, multi-crop seed drill, economics*

Effect of intercropping on physico chemical properties of the soil in subtopics of Jammu

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Abstract

Agroforestry is an old practice which has significant effect on the soil. Agroforestry is intentional combination of of forest and agricultural species on same piece of land to increase productivity and income. Trees positively affect the environment and the microclimate under them. Leaf fall helps to improve the soil by forming humus which increases the organic carbon in the soil. A study was conducted at agroforestry research farm SKUAST chatha Jammu, to find out the the effect of agroforestry combination with vegetable crops on the soil properties. The results of the trial showed that the physico- chemical properties were significantly influenced by tree shade. In kharif season tomato, brinjal and okra were cultivated while in Rabi season spinach cabbage and potato were grown under the the poplar shade. Soil moisture, pH, E.C., N, P, K and O.C. were measured to study the effect of canopy and intercropping. Results of the study revealed that the percentage of nitrogen, phosphorus, potassium and organic carbon was significantly influenced by the shade under poplar.

Daily river flow forecasting using wavelet ANN hybrid models

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Abstract

The advance time step streamflow forecasting is of paramount importance in controlling flood damage. During the past few decades, artificial neural network (ANN) techniques have been used extensively in streamflow forecasting and have proven to be a better technique than other forecasting methods such as multiple regression and general transfer function models. This study uses discrete wavelet transformation functions to preprocess the time series of the daily gauge and discharge flow data into wavelet coefficients of different frequency bands for the Jamshedpur site of Jharkhand, India. Effective wavelet coefficients are selected from the correlation analysis of the decomposed wavelet coefficients of all frequency bands with the observed flow data. The input data for wavelet transformation was selected using the Gamma test. The preprocessing of data using wavelet transformation was done in Matlab software. The best model using wavelet transformation obtained was compared with a simple artificial neural network (ANN) techniques. The results found that the preprocessing of data with wavelet transformation was superior over the simple artificial neural network techniques. Thus, wavelet techniques will useful for design engineers in hydraulic structure.

Keywords: *Gamma Test, Wavelet ANN, Coefficient of determination, RMSE, Jamshedpur*

2-D flood simulation using hydrodynamic model for Nagavali River Basin

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Abstract

The study looks at Flood Stimulation for Nagavali river basin which also known as Langulya is one of the important east flowing rivers between Rushikulya and Godavari in Odisha and Andhra Pradesh states in India. The river originates from thehill near Lakhbahal village in Thuamul Rampur block in Kalahandi District and Kalyansinghpur in Rayagada district in Odisha and travels for a distance of about 256 km. the total catchment area of the river basin is 9205 sq.km, The length of Nagavali river 161 km in Odisha and the remaining 95 skm in Andhra Pradesh. Nagavali river is a non-perennial river so the only source of flow was rainfall due to heavy rainfall in 2006 the river was over flooded which caused lots of losses either economic or loss of life. In this paper, the methodological approach was adopted, focused on the hydrologic modelling System (HEC-HMS) and the hydraulic modelling (HEC-RAS) with a combination of watershed modelling System and Geographic Information System (GIS). Centre for hydrological and remote sensing (CHRS) 4kmx4km gridded rainfall data and central water commission (CWC) observed flow is chosen as a case to examine the modelling framework. The model consists of a rainfall–runoff model (HEC-HMS) that converts precipitation excess to overland flow and as well as precipitation excess input to the 2-D hydraulic model (HEC-RAS) unsteady state flow. The aim of this study was flood inundation behaviour of Nagavali river during extreme flood events 2006. HEC RAS model simulated reulsts compared with observed flow and it is well macth with observed. Forcing the model with forecasted precipitations can also help with flood warning system by generating pre-flood inundation maps.

Keywords: *Hydrologic. Hydraulic, Flood, Simulation, Watershed*

THEME- II
Innovative Approaches & Policy Responses for Agricultural Sustainability and Livelihood Security

Nutrient budgeting using NUTMON –model for Sustenance of Soil Fertility in Humid Tropical Kerala

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Abstract

Mining of nutrients from soil is a major problem causing soil degradation and threatening long-term food production in developing countries. Decision Support Systems (DSS) / models are interactive computer software that help decision makers utilize data and models to solve unstructured problems. In this paper an attempt was made using NUTMON model for carrying out nutrient audits, which includes the calculation of nutrient balance at micro (plot/field) and meso (farm) level and evaluation of trends in nutrient mining/enrichment. A nutrient budget is an account of inputs and outputs of nutrients in an agricultural system. NUTrient MONitoring (NUTMON) is a multiscale approach that assess the stocks and flows of N, P and K in an well defined geographical unit based on the inputs *viz.,* mineral fertilizers, manures, atmospheric deposition and sedimentation and outputs of harvested crop produces, residues, leaching, denitrification and erosion losses. The nutrient budgeting study was carried out using NUTMON model for 2 farms in Palakkad district by adopting the standard procedures and calculations (*viz.*, 1. Organic 2.Integrated nutrient management (INM). The calculated nutrient balances at crop activity level indicated a negative balance for nitrogen, phosphorus and potassium in crops like paddy, coconut, arecanut and banana. At farm level, the integrated nutrient management farm showed N balance as negative, whereas P and K balance was positive. The organic management farm, showed a positive balance for N, P and K. The results revealed that the nutrient management practices are not appropriate and sustainable in INM farm. The management options to mitigate this mining by manipulating all inputs and outputs in a judicious way with an integrated system approach are suggested and discussed.

***Keywords**: Nutrient balance, Inputs, Outputs, Fertilizers, nutrient mining, NUTMON*

Role of Tribals in Conservation of Biodiversity in Pir Panchal Ranges of Rajouri &Poonch districts of Jammu & Kashmir, India

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Abstract

Rajouri and Poonch are predominantly hilly districts with mid and high hills ranging from 1000 m to 3400 m ASL of Pir Panchal Ranges. This range of mountains is home to diversified flora and fauna species, some of which are peculiar to only this part of the mountain range. This mountain range is also home for Tribal Nomads (Bakerwals) of twin districts who migrate on foot to these heights during summers and stay in pasture lands upto September each year. These nomads use their vast knowledge of herbs and other plants to survive in the harsh mountains and make use of the diversified herbs for food, human medicine, as repellant for wild animals and also for the treatment of ailment of their sheep, goats and horses.Many of the plants conserved by tribal people are used as repellants for snake and scorpions, for setting bone fractures by traditional healers, for curing wounds or arthritis and for treatment of various fevers with decoctions. Their vast knowledge of herbs as medicines has been a source of knowledge for a number of scholars who have made several efforts to record all these herbs for their conservation. This area also harbors various wild species of cultivated crops of these two districts and are a reliable source of various desirable characters for our crops. As per an estimate, 11.95% of the world's biodiversity has been conserved by ethnic people in many waysin India. Their role in conservation of a local goat breed has been recently recognized and the local goat breed has been named" Bakarwali" after the Bakarwal tribe who has been most instrumental in conservation of the biodiversity of Pir Panchal ranges. With the rapid development in the twin districts and setting up of raod network in Pir Panchal ranges, the movement of these nomads has been confined to roads and the use of traditional routes from mountain ranges and dense forests are being minimized thereby leading to loss of knowledge of these herbs among new generations of this tribe. There is urgent need to fecilitate these tribals and make use of their vast knowledge of flora and fauna of these mountain ranges. Conservation of diversity, sustainable management, propagation of such valued flora and their in-situ as well as ex-situ conservation need to be assured.This will not only conserve the biodiversity, but will also help us in make use of hidden genetic resources for developing new varieties of desirable characters and values. KVKs can play an important role in this process by creating awareness among these tribals through trainings, group discussions and on site awareness camps.

Keywords: *Tribals, Rajouri Poonch, Biodiversity, Conservation*

Good agriculture practices in mandarin (*Citrus reticulata* Blanco); perception and factors affecting awareness among farmers at Gulmi, Nepal

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Abstract

The study was conducted to access the knowledge level, perception, and factors affecting awareness of Good Agriculture Practices among mandarin growers in Gulmi district, Nepal during May/June 2020. 100 producers were interviewed with pre-tested semi-structured questionnaires for the data collection. The farmers were categorized into GAP aware and unaware based on the criteria made by the group discussion with the leading farmers and mandarin experts. Descriptive statistical tools including binary logistic regression, index of agreement, t-test, and χ^2 –test were used to analyze data. The result revealed that 39% of the total respondents knew about the GAP for mandarin. Out of ten selected standards, GAP related to human welfare (98%) were adopted by the majority of respondents, and GAP related to planting materials (29%) were found to be least adopted. The entire respondents agreed to the fact that GAP produced fruit have a nicer appearance and better quality, meets national and international standards, and enhances the exportability of fruits but 61.5% of respondents didn't agree that GAP helps in providing subsidy from governmental organizations. The output of the binary logit model suggested that an increase in participation in training and contact with extension agents have a significant effect on awareness of GAP. The major production problems were technical constraints followed by disease and insects, lack of irrigation, the high price of inputs, and marketing. Hence, awareness programs and training regarding GAPs is must to increase the productivity of the mandarin.

Keywords: *GAP; Nepal; Binary logit; Extension agents; Training*

Performance of *Wheat* and *Mustard* in AgroForestry System under Terai Conditions of U.P.

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Abstract

Agroforestry system as an ecological sustainable land use option alternative to the prevalent subsistence farming patterns for conservation and development. It is an old traditional practice but recently named as an Agroforestry. A large area is available in the form of boundaries, bunds, block plantation, wastelands where this system can be adopted. Eucalyptus and Poplar is a cropland agroforestry trees species planted along with various annual crops like paddy, wheat, cereals, oilseeds and other cash crops farmers land. The main purpose of this review to provide/generates an idea about how Eucalyptus and Poplar behaves with associated crops, i.e interaction between both components. Both components are studied in many aspects, comprises outcome of crop yields which depends upon the age of trees; along with nutritional studies of Eucalyptus and Poplar at various age groups. This review mainly includes Economical aspects of Wheat and Mustard taken by farmers as pure crops and simultaneously intercropped with Eucalyptus and Poplar and their growth and price trend. Due to effect of intercrops on growth parameters of Eucalyptus, it is seen that trees along with intercrops gain much more better growth than trees grown isolated in all the ages. This might be due to better care,use of fertilizers,frequent irrigations schedules for intercrops. Litter production is also higher in trees intercropped than trees which are without any intercrops. In the study of nutrients (NPK) it is reviewed that all the three nutrients increase as the age of trees increases. It is also seen that total addition of nutrients to the soil through litterfall is lower in isolated fields than the intercropped fields. The extent of enrichment in soil properties depends on tree species, management practices and the quantity and quality of litter and their decay rate. Moreover, the leaf litter deposition from tree vegetation and resultant soil acidity might also affected intercrop yield. Owing to these negative effects, the positive effects, like increased organic matter content from leaf litter decomposition might have resulted in improvement in porosity, texture, essential nutrient and yield improvement of Kharif and Rabi crops. Further, litterfall and decomposition are the two major processes responsible for soil enrichment in agroforestry systems. In the study it is observed that nutrient contents of soil, after five years of duration, is higher in sole Eucalyptus and Poplar than the intercropped fields. As the depth increases, N and K are decreased in sole as well as in intercropped fields. Phosphorus is dramatically different. In 0-15 cm layer is less than 15-30 cm layer. And again in 30-45 cm layer it is again less than 0-15cm layer.It is because P leaches from 0-15 to 15-30cm strata. Yield of intercrops is low in the fields which are cultivated along with trees. The height of intercrops is higher under Poplar than intercrops under Eucalyptus. This might be due to leaf pattern and its canopy shade. Non significant results were obtained for tillers per plant and effective tillers per plants in wheat, however, more tillers were found in pure cropping. In Mustard primary branches per plant and seeds per siqua were at par under Eucalyptus, Poplar and pure cropping. Yield parameters such as secondary branches per plant, siliqua per plant and test weight were significantly higher in pure cropping. The grain and straw/stover yields of both the crops under Eucalyptus and Poplar decreased significantly as compared to open fields (crops without Eucalyptus and Poplar). Light intensity in Wheat and Mustard under Eucalyptus and Poplar reduced, as compared to pure crops. Net returns from crop grown with Eucalyptus, & Poplar and sole cropping revealed that maximum income (Rs.82819=00/ha) was recorded in pure cropping (monoculture) of wheat, whereas net returns from Mustard grown Eucalyptus,& Poplar and sole cropping revealed that maximum income (Rs.67275=00/ha.) and whereas negative net returns of Rs.3943.47/ha(under 4years Eucalyptus) and also negative net returns Rs. 8731=00/ha (under 5 years

Poplar) was recorded in Mustard oil. The combination of agricultural crops with Eucalyptus and Poplar trees for pulpwood production can bring a higher profit than pure plantings. The profitability of Eucalyptus and Poplar planting by farmers varies with the farm gate prices and yields of the trees, which in turn depend on the quality of the soil, the spacing, and the technology of production.The opportunity cost of the land is an important factor affecting the net return to the planters.

Evaluation of different alternate landuse systems for rainfed sub-tropics of Jammu

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Abstract

Rainfed areas are fraught with low farm productivity because of poor integration of natural resources on dwindling land holdings. Just growing field crops not only results into meager net returns but also make the rainfed farmers more vulnerable to adverse weather conditions. Besides this, the farmers also have the requirement for green fodder to feed cattle, timber not only to cater household needs but to supplement income by selling it out in the market and fruits to improve household nutrition and income supplementation through sale of surplus produce in the market. Alternate land use system involving horticulture, agroforestry, perennial grasses along with field crops holds the promise to optimally fulfill food grains, green fodder and timber needs of the farm household besides providing income supplementation under rainfed situation while making rational use of on-farm resources. An alternate landuse experiment comprising of agri-horti-silvi-pastoral components viz., Guava (var. L-49), agroforestry plants (*Melia* Spp.), perennial grass (*Setaria* Spp.) were evaluated to develop an alternate landuse system for rainfed conditions of Jammu was initiated in 2017-18. Guava and *Melia* were planted alternatively within each row following 6m×6m spacing. In the 6m wide alleys; maize and black gram was sown at 60cm x 60cm and 30cm x 30 cm during *kharif* whereas, wheat and gobhi sarson was sown at 20 cm (R-R) and 45cm X 15cm, respectively during *Rabi*. During *kharif*, sole maize grown under maize-wheat system (cereal-cereal) registered maximum yield of 3320 kg/ha with highest values of net returns, B:C ratio and rain water use efficiency (RWUE) to the tune of Rs.43896, 2.87 and 6.26 kg/ha-mm, respectively. However, the maize recorded grain yield of 2510 kg/ha under agri-horti-silvi-pastoral system (Guava + *Melia* + *Setaria* Spp.+ Maize- Gobhi Sarson) wherein the maize was sown in the alleys formed by horti-silvi-pastoral component whilst the lowest values of maize equivalent yield (1863 kg/ha) during *Kharif* was observed under agri-horti-silvi-pastoral system (Guava + *Melia* + *Setaria* Spp.+ Black gram - Gobhi Sarson) wherein black gram was sown in the alleys formed by Guava, *Melia* and *Setaria* species. However, maximum mean yield of 3385 kg/ha was obtained in sole maize under maize –wheat system. During *rabi*, sole wheat under maize-wheat system (cereal-cereal) registered maximum yield of 2950 kg/ha with highest values of net returns, B:C ratio and RWUE to the tune of Rs.55500/ha, 3.41 and 8.6 kg/ha-mm, respectively. However, wheat crop recorded grain yield of 2565 kg/ha under agri-horti-silvi-pastoral system (Guava + *Melia* + *Setaria* Spp.+ Blackgram - wheat) wherein the wheat crop was sown in the alleys formed by horti-silvi-pastoral components while the lowest values of wheat equivalent yield (1392 kg/ha) during *rabi* was observed under agri-horti-silvi-pastoral system (Guava + *Melia* + *Setaria* Spp.+ Maize -Gobhi Sarson) wherein gobhi sarson was sown in the alleys formed by Guava, *Melia* and *Setaria* species.

Keywords: *Agri-Horti-Silvi-Pastoral, Alternate Landuse systems, Maize equivalent*

Studies on Revival and Conservation of Kashmir Ambri Apple

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Abstract

Apple (*Malus domestica*) cultivar, kashmir Ambri Apple , a niche crop popularly know to be the king of fruits is considered to be an Apple variety indigenous to India with its origin in Kashmir the fruit is preferred for its attractive pink cheeks , sweet taste , crispness, fragrant flavour and aroma besides good keeping quality under ambient conditions. The Ambri what's the most dominant, popular and commercially accepted variety of Apple grown in Kashmir before the western introduction of coloured Delicious group of Apple in late 1970s. Over the years, shift of consumers preference to delicious apple for its red coloured prominent lobe fruit over and above it's precocious , self - fruitfulness and regular bearing habit attributed to its horizontal spread with corresponding decline in acerage under Ambri plantation owing to its long gestation period and peculiar biennial bearing habit of traditional Ambri orchard. Thus, rendering the confinement of this indegineous variety to the four walls of the house to be grown as a plant of hobby and legacy. However dwindling low productivity of our orchards witnessed on account of monoculture, attainment of self unfruitfulness and self incompatibility over the years decides emergence and susceptibility to biotic and abiotic stresses had led to rethinking of revival of our indigenous fruit crops, the Ambri Apple in particular. Pioneering studies for the revival and establishment of Ambri Germ plasm bank were initiated during 2012 at SKUAST- K. Seven(07)genotypes were selected during 2011 through the process of suvey , selection and identification of tree of merit(TOM) of elite strains from Ambri hot spots of district Shopian and Pulwama. Trial was laid to to study the influence of M.9 dwarf rootstock on gestation period of Ambri scion.Budwood from identified TOM was bench grafted on M.9 rootstock and plant as per technical programme. Novel achievement of the trial was that plants on M.9 rootstock bloomed in 4th year of grafting compared to 12th year on seedling Ambri plantation.The study revealed a major breakthrough in reduction of gestation period of Ambri genotypes from 12 to 4yrs only with single intervention of dwarfinf rootstock,The study has laid foundation for establishment of Kashmir Ambri germplasm repository for revival and popularization through multipronged strategy involving several other technological interventions at Division of Fruit science, Skuast-Kashmir asan initiative towards Biodiversity conservation of Heritage Heritage crops of Kadhmir.

Keywords: *Kashmir Ambri Apple, revival, gestation period, M-9, germs plasm*

Bottom-up effect of difference genotypes of ber, *Ziziphus mauritiana* against bruit borer, *Meridarchis scyrodes* Meyrick

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Abstract

Differences in genotypes of ber plant characters May effects on insect-plant herbivore interactions and variation in genotypes traits is responsible for modify the bottom-up effects. We evaluated the performance of different genotypes of *Z. mauritiana* against fruit borer, *Meridarchis scyrodes* Meyrick under field conditions in the semi-arid region of India. On the basis of pooled data, the ber genotypes under study indicated significantly low incidence of fruit borer in Safeda (13.27%) followed Tikadi (14.01%). Significantly greater incidence of fruit borer was registered in Sanaur-5, Chhuhara and Sanaur-2 with a magnitude of 75.09, 72.90 and 71.78 %, respectively. Basis of fruit borer, *M. scyrodes* incidence; Safeda, Tikadi, Darakhi and Illaichi were considered as resistant; BS-75-1, Gola, Goma Kirti, Seb and Umran were found moderately resistant; Dandan, Mahawali, Jogia, Sukavani, Narma, Reshmi and ZG-3 were found to be susceptible whereas, Banarasi Karaka, Banarasi Pawandi, Chhuhara, Kaithali, Mundia, Sanaur-2 and Sanaur-5 were highly susceptible to fruit fly. The flavinoid content (187.79 mg/100g) was found to be maximum in Illaichi followed by Safeda (179.03 mg/100g) and minimum in Chhuhara (40.68 mg/100g). The tannin content (511.57 mg/100g) was found to be the highest in Safeda followed by Tikadi (502.79 mg/100g) and the lowest in Chhuhara (264.78 mg/100g). Phenols content was highest in Safeda (239.01 mg/100g) followed by Darakhi (234.96 mg/100g) and lowest in Sanaur-5 (119.51 mg/100g) with values significantly higher in resistant and lower in susceptible genotypes. The minimum fruit length (17.18mm) in Illaichi, fruit width (18.81mm) and pulp: stone ratio (2.12) in Tikadi and pericarp thickness (0.25mm) in Sanur-5 were found but maximum fruit length (43.17mm) in Umran, fruit width (33.4mm) in Dandan, pulp thickness (1.16mm) in Safeda and pulp: stone ratio (27.13) in Mundia genotypes, respectively. The phenols (0.96), Tannins (0.95), flavonoid (0.95) contents and pericarp thickness (0.88) had significant negative correlations with percent fruit infestation of fruit borer, *M. Scyrodes*. The fruit length (0.50) and pulp: stone ratio (0.77) showed significant positive correlations with percent fruit infestation of fruit borer, *M. scyrodes* and flavonoid contents explained 91.40% of the total variation in fruit borer, *M. scyrodes* infestation. Two principal components (PCs) were extracted which explained the cumulative variation of 88.48 %. PC1 explained 64.34 % of the variation while PC2 explained 24.14 % of variation. In conclusion, growers can adopt the potential resistant genotype (Safeda) of *Z. mauritiana* with minimal financial investment to obtain higher yields.

Keywords: *Meridarchis scyrodes, Z. mauritiana, genotypes, bottom-up effect, plant-insect interactions*

Evaluation of Yellow Vein Mosaic Virus Resistant Single Cross Hybrids for Yield and Quality Traits in Okra (*Abelmoschus esculentus* L. Moench)

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Abstract

Okra or Bhindi (*Abelmoschus esculentus* (L.) Moench is an annual, herbaceous crop belongs to family Malvaceae. It is one of the most popular vegetable crops cultivated throughout world. Because of high consumer demand and thereby better price, farmers grow okra widely during both rainy and summer seasons. Yellow Vein Mosaic Virus (YVMV) is devastating viral disease transmitted through white fly (*Bemesia tabaci*) in okra. The disease affects the quality of fruit and yield adversely necessitated to develop YVMV resistant cultivars. The development of YVMV disease resistant cultivar, 64 germplasm was screened for various characters and at flowering, selfing was done for homogeneity of the planting materials. Out of this germaplasm, 8 cultivars/Lines were selected and twenty eight cross hybrids were developed by crossing in half-diallel fashion during rainy season 2019. These hybrides were evaluated along with two local hybrid checks [one OPV check (Arka Anamika) and one OPV cross check for YVMV susceptibility (Pusa Sawani) in a randomized complete block design with three replications during summer 2019-20 at the Research farm of SKUAST, Jammu for studying their yield potential, pod quality and resistance to YVMV. All of the 26 single cross hybrids were resistant to YVMV with 0% incidence as against 66.66% incidence in Arka Anamika and Pusa Sawani, while two developed crosses showed 10 percent YVMV symptoms. On the basis of mean performance, four crosses P1P2, P3P7, P4P2, and P5P1 were of significantly higher yield potential than the standard check Pusa Sawani, but of comparable yield potential with Arka Anamika. In addition, these three crosses also of superior in pod quality could be exploited for development of commercial hybrid okra. These hybrids would be advantageous for production and quality improvement, trade facilitation and environmental protection.

New guava varieties for subtropics of North East India

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Abstract

Guava (*Psidium guajava* L) is popularly known as***"****Apple of Tropics"* and is also referred as*"super fruits"* owing to its high vitamin C and antioxidants content.In NEH region,guava has acclimatized well from low (250 m) to high (1200 m) altitudes of with aproduction of 126.33 thousand MT from an area of 9.32 thousand ha (NHB, 2018). However, absence of suitable varieties and their standard production practices limits the future expansion of guava in the region. Looking towards this, four (04 nos.) new guava varieties *viz.,*Megha Supreme (creamy white pulp with soft seed; fruityield: 17-19 t ha^{-1}; vitamin C: 218-247 mg/100 g and pectin: 1.26-1.37%); Megha Magenta (red fleshed big size fruits: 180-200 g; fruit yield:11-14 t ha^{-1}; suitable for value addition and products prepared *viz.,* jam, jellies, juice and RTS using this variety retains the attractive colour); Megha Wonder (dwarf stratured plantsuitable for high density planting;fruit yield:12-15 t ha^{-1} and soft withless seeds :107-119 seeds/100g fruit weight) and Megha Seedless (white fleshed sweet fruits with few seeds :42-55 seeds/100 g pulp) were developed for table and processing purpose along with their package of practices. These varieties were recommended for release by State Seed Sub-Committee for Agricultural and Horticultural Crops, Meghalayain 2018. Further, ultra-high density planting system accommodating 3,333 plants ha^{-1} (spacing: 2.0 m x 1.5 m) was standardized for guava with afruit productivity of 20-24 tonnes ha^{-1} (BC ratio: 2.4 to 2.6) from 3rd year onwards as compared to 8-12 tonnes ha^{-1} (BC ratio: 1.5 to 1.7) in traditional system (300-400 plants ha^{-1}) from 5th year onwards.

Keywords*: Guava, varieties; HDP*

COVID- 19 Impacts on Agriculture

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Abstract

COVID-19 pandemic has adversely affected almost every sector around the world, especially agriculture, which is a central pillar of every nation's economy. It has been negatively affected by the pandemic. It has impacted the global food system, disrupting regional agricultural value gains, and posing risk to household food security. Agriculture is divided into sub-sectors such as livestock production, crop protection, agricultural economic forestry, apiculture, fisheries farming, etc. It serves as the main source of food, income, and employment and also affected different types of rural households in emerging markets, food security, and national security. Agriculture is a source of livelihood for 86 % of rural peoples (FAOSTAT). Agriculture is an input-intensive industry globally, among which, India is a farming-based country and largest producer of milk, pulses, sugarcane, jute and other important crops. It is one of the leading producers of fish, poultry and plantation crops. Both lives and livelihoods are at risk from this pandemic. According to the latest UN estimate, 132 million people approximately, may go hungry in 2020 as a result of the agricultural economic recession triggered by the pandemic. Amidst coronavirus outbreak, disrupts into input supply, production, marketing as well as consumptions of food grain crops caused in the reduction of economic value and food and nutrition, livelihoods, rural development and sustainable agriculture. Due to the lockdown period, crops are not harvested timely, demand and supply system of the agricultural product has been failed. To address this global economic crisis, the governments should frame policies to expand and improve emergency food assistance and social protection programmes, provide immediate assistance to protect smallholder farmers' and Address trade and tax policies to keep global trade open (FAO, 2020). threatening livelihoods, disrupting value chains, affecting international trade, and posing risks to fish supply chains the COVID-19 is a global health crisis and FAO is playing a role in assessing and responding to its potential impacts on people's lives and livelihoods, global food trade, markets, food supply chains and livestock.

***Keywords**: Agriculture, COVID- 19, livelihood, pandemic, FAOSTAT, crop production, small and medium agricultural enterprise (agri- SMEs)*

COVID- 19 PANDEMIC AND ITS IMPACT ON LIVESTOCK SECTOR

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Abstract

The severe acute respiratory syndrome corona virus 2 (SARS-CoV-2) is a new public health crisis that threatens the world with its emergence and spread. The virus originated in bats and transmitted to humans in Wuhan, Hubei province, China in December 2019. There have been around 25,298,875 reported cases of corona virus disease 2019 (COVID-2019) and 847,602 reported deaths to date (01/09/2020) globally. The disease is transmitted by inhalation or contact with infected droplets and the incubation period ranges from 2 to 14 d. The livestock sector has been largely impacted by the effect of corona virus. There has been a sharp fall in the demand for chicken and meat since the outbreak as there have been various rumors amongst the peoples that the virus can spread through the animal's meat and chicken. However, the Centers for Disease Control & Prevention declared that corona virus is known to be transmitted via direct contacts to humans, and not via livestock or aqua animals. The sector is segmented by type into dairy, meat, and poultry. Meat and poultry are expected to get affected significantly due to the COVID-19 pandemic. Based on the regional viewpoint, the most affected regions are the US, China, Italy, France, Germany, Spain, UK, and India. The regional demand for chicken and meat is decreased due to the increased rate of virus spread. Further, it has also been witnessed that the peoples are opting for the jackfruit as the replacement of chicken and mutton. Whereas, the continuous shutdowns has also affected the market growth by disturbing the food chain services like restaurants.

Keywords: *Corona virus, Wuhan, Livestock, Chicken, Diary*

IMPACT OF COVID-19 PANDEMIC ON FOOD AND AGRICULTURE

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Abstract

As the COVID-19 outbreak continues to spread across the world, it is essential to address its existing and potential impacts on the agri-food sector, from the perspective of both food supply and food demand. Ensuring the continued functioning of global and national food supply chains will be crucial in securing food supply, preventing a food crisis in countries that are already experiencing food and nutrition security challenges, and reducing the overall negative impact of the pandemic on the world economy especially in developing countries like India. India with its apt governance has tried its best to combat this crisis with a country wide lockdown to prevent the health implications. But agriculture being the backbone of the country and the GDP has been impacted in a negative way with huge disruptions in the supply chain and cropping decisions for upcoming agricultural seasons. All these have a negative implication on the farming community that is and will be undergoing heavy financial and mental losses. The non availability of migrant labors is affecting the harvesting and pre sowing activities especially on crops like wheat and pulses. Due to transportation issues and breaking the chain between the intermediaries, the supply chains have been in the losers' ends. The agri-food sector is highly connected internationally, Ports that shut down or reduce activity, vastly reduced freight capacity on commercial flights for agricultural goods, and other broad global supply chain disruptions due to the COVID-19 crisis. There is a huge gap between the prices received by the farmers and the prices paid by the consumers. Many of the farmer leaders believe that the relief packages announced by the government is hardly of any benefit to the farmers and once the lockdown is lifted, the prices of the agricultural commodities will crash rapidly leading to an excessive fall in the farmer's income. To avoid the adverse impact of Covid 19 outbreak and to keep the agriculture sector unaffected the government should issue particular guidelines for agriculture operation, the price structure should be taken into consideration and changed in a way that the farmers are not under any kind of financial losses, the farming community along with the laborers should be protected from Corona virus by maintaining social distancing along with assistance in dealing with the panic and mental losses during this time and of course giving the farmers a platform for direct marketing to meet the demand of the consumers of the agricultural produce and avoid any kind of wastages in the harvested products.

***Keywords**: COVID 19, Pandemic, Food and Agriculture.*

Value Chain Management in Oilseed Crops

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Abstract

Value chains are the full range of activities needed to carry the product from the original concept to the end consumer. A 'value chain' in agriculture describes the range of activities and set of actors that bring agricultural product from production in the field to final consumption, wherein at each stage value is added to the product. Value chain management refers to the power and ability to realize control along the chain. India imports 9.2 Mt of vegetable oils during 2010-11. Currently India is in the mid-way of self-sustaining in oilseeds production and thus, organization of agriculture along the value-chain framework has been conceived as one of the strategies to bring more efficiency in the Agricultural sector. The emergence of modern food value chains has improved linkages between buyers and poor farmers in the developing countries, which have turned out to be beneficial for the smallholders. Understanding the oilseed value chain is vital to the development of the Indian oilseed sector. Perpetual environment of high risk & vulnerability of oilseed production results in lowered farmers' confidence and suppressed their entrepreneurial instincts. However, proper management of value chain links its constituent parts in order to better understand its structure and functioning as well as identify strategies for improvement in the oilseed sector. Successful coordination in the value chain has a significant impact on cost reduction and farm-income enhancement. Since the concepts of value chains and value chain analysis have been evolving in India, the need of clarity on these issues was felt unanimously. Therefore, it is suggested that both professional societies like AERA (Agricultural Economics Research Association) and the national institutions like NAARM (National Academy of Agricultural Research and Management), NCAP (National Centre for Agricultural Economics and Policy Research), etc. should take lead in developing conceptual framework for value chain analysis and management and addressing the issues and concerns related to value chains for different agricultural commodities. Over and above, connecting farm and industry through value chain empowerment among small holder farmers is a major issue right now.

Keywords: *Value chain, oilseed, agriculture*

Agroclimatic indices for prediction of groundnut yield under the middle Gujarat agroclimatic zone

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Abstract

The field experiment to study the impact of agroclimatic indices on yield of groundnut under the middle Gujarat agroclimatic zone were conducted with three dates of sowing and three varieties during *kharif* season of the year 2019 at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand which is situated in middle Gujarat agro-climatic zone. The results revealed that groundnut accumulated about 2143.5 GDD, 171430.8 hydrothermal units (HYTU) and 9465.7 heliothermal units (HTU) for getting higher yield (2387.48 kg ha^{-1}) in first date of sowing D_{1-} onset of monsoon as compared with second date of sowing D_2-10 days after onset of monsoon (2253.68 kg ha^{-1}) and the late sowing i.e. third date of sowing D_3 - 20 days after onset of monsoon (1852.61 kg ha^{-1}). Out of which 7.8 %, 32.4 % and 65.6 % GDD, 7.3 %, 31.3% and 65.3 % HYTU and 3.8 %, 35 % and 60.4 % HTU were accumulated for the emergence, flowering and pod development stage, respectively were recorded in the first date of sowing. The Heat use efficiency (HUE) 1.11 kg ha^{-1} ^oC obtained for crop sown in D_1 – onset of monsoon. Among the varieties, V_1 - GG 20 accumulated about 2253.7 GDD, 17943.4 HYTU and 10593.5 HTU for getting higher yield (2275.73 kg ha^{-1}) in comparison with V_2-GJG 34 and V_3 – TAG 37 A. The Heat use efficiency (HUE) 1.01 kg ha^{-1} ^oC recorded for variety V_1 – GG 20. The resuts also showed that first date of sowing D_1 - onset of monsoon produced significantly higher pod yield than the D_2-10 days after onset of monsoon and the late sowing i.e. D_3 - 20 days after onset of monsoon.

Keywords: *Groundnut, Agroclimatic indices, Yield and Heat Use Efficiency*

SWOT Analysis of Organic Farming with Special Reference to Nagaland.

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Abstract

In India, the northeastern state of Sikkim achieved its goal of converting to 100% organic farming. Other states, including Nagaland, Mizoram, Goa, Kerala, and Meghalaya, have also declared their intentions to shift to fully organic cultivation. Nagaland farmers rely heavily on traditional knowledge which advocates the use of commonly available organic materials such as cattle manure, leaf litter, and crop residues for enrichment of soil. These attributes put the region in a rather comfortable position to convert to fully organic agricultural production without major shifts in the prevailing farming paradigm. Studies has shown that there are inherent advantages for adoption and conversion of farming in Nagaland as the state has very less and negligible use of chemical in farming as well as the traditional system of farming model suits the principle of organic farming. It is noteworthy to point out the long age traditional shifting cultivation without the use of chemical although has negative externalities but has a scope to reinvent this model in more sustainable mode of farming. Another farming practices adopted in Nagaland is the Alder based farming system and the Zabo farming system which has shown significantly self sustaining based on natural input management.

Keywords: *Organic Farming, Nagaland, traditional knowledge, shifting cultivation, Zabo farming, Alder based farming system*

Sustainable Agriculture Module for Livelihood Security

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Abstract

Today, concerns regarding environmental safety and sustainability of land productivity are increasing among scientists, administrators and environmentalists. It is doubted whether the strategy adopted during the green revolution era could be continued any longer under the challenging conditions of this new century. During the last two decades, there has also been a significant sensitization of the global community towards environmental preservation and assuring of food quality. Ardent promoters of organic farming consider that it can meet both these demands and become the means for complete development of rural areas. After almost a century of neglect, organic agriculture is now finding place in the mainstream of development and shows great promise commercially, socially and environmentally. Already, a section of people in the world is questioning the propriety of conventional agriculture, and a few of them are advocating alternative practices that are perceived to lay foundation for sustained production. On these lines, systems like alternative agriculture, natural farming, organic farming etc. were proposed at various conventions. However, the scientists harping on the success of green revolution continue to doubt whether such a system can really be functional, productive and meet the growing demands for agricultural products in this e-age. These emphasize the need to develop new strategy of living with the nature and nurturing it for sustainable production.

Keywords: *Sustainability, land productivity, natural farming and organic farming*

Alternative Sources of Soil amendments for reclamation and management of Salt affected soil

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Abstract

Salt affected soil exists in all the continents of the world. Based on the FAO soil map, about 952 million hectors of land in the world is varying degrees of deterioration due to excessive accumulation of salts in the soil profile. Some amounts of salts are always present in soil, when the concentration of these salts is low, they are not harmful for the plant growth, but with the increasing levels of salt affected the plant growth is adversely affected and production of agricultural crops decreases. The excessive accumulation of salts in soil also affects the germination of seeds. The presence of excess salts on the soil surface and in the root zone characterizes all saline soils. The main source of all salts the soil is the primary minerals in the exposed layer of the earth crust. During the process of chemical weathering which involves hydrolysis, hydration, solution, oxidation, carbonation and other processes the salt constituents are gradually released and made soluble. The reclamation of sodic and saline-sodic soils is more difficult, time consuming and expensive than those of saline soils. The reclamation of such soils involves not only the leaching of soluble salts and sodium replacement but also improvement of their soil physical conditions. It may also enhance the process of replacing Na+ by Ca++ on the exchange complex various amendments like gypsum, sulphur, acids, press mud and farm yard manure (FYM) may be used for reclamation of these soils. The higher rates of amendments significantly the increased the exchangeable Ca++, Mg++ and K+ ions and decreased the exchangeable Na+ in the soil. Maximum increase of exchangeable cations and reduction of exchangeable Na+ were recorded with highest rates of gypsum (100%), followed by pyrites (100%), press mud and farm yard manure (30 tonnes/ha). The favorable effect of gypsum on the increase of exchangeable cations and decrease of exchangeable sodium in the soil improved the soil properties after greater soluilization of the native calcium carbonate. Among different amendments that gypsum is a superior soil amendment for the improvement of salt affected soil.

Keywords: *Soil amendments, reclamation, excessive accumulation and Carbonation*

Impact of Covid-19 on Indian Agriculture

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Abstract

The COVID-19 pandemic is the first and foremost human disaster that has created an unprecedented situation all over the world. More than 200 countries and territories have confirmedmedical cases, caused by coronavirus. This natural disaster has poorly surprised the world financial system and has a huge unenthusiastic insinuation on the same. The most responsive agricultural sector which is the spine of our nation is also hit with the externalities of COVID-19 eruption. The potential negative impacts of Corona on agricultural production, market stability, food supply may be seen from the surface but it is still difficult to quantify the exact damage accurately. The nationwide lockdown was announced at the peak of rabi season when almost all the crops were at harvestable stage. A mass exodus of migrant labourers went back to their hometown creating a shortage of labourers. Consequently, the harvesting process was thrown completely off-balance. Furthermore, movement across state borders had been heavily restricted, which blocked the movement of crops and consequently their sale. However, in order to reinforce a zero-hurdle harvest season, the government exempted the movement of farm machinery from lockdown. Immediately after the lockdown, government declared an INR 1.7 trillion package to protect the vulnerable sections. Advance release of INR 2000 to bank accounts of farmers was also done under PM-KISAN scheme. The government also raised the wage rate for workers engaged under the NREGS. However, somewhere there has not been a uniform implementation of these legislations thereby creating a devastating impact on Indian Agriculture.

Keywords: *COVID-19, Agriculture, PM-KISAN, NREGS*

A Review Paper on Impact of Environmental Externalities in Agriculture and Allied Sector"

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Abstract

Externality prevents the attainment of Pareto-Optimality, whether it is positive or negative. In this review paper, positive and negative externalities and its impact on environment were documented as it differs across various production systems. The positive externalities associated with livestock production in India's mixed farming system includes saving of chemical fertilizers due to use of dung as manure and prevention of carbon dioxide emission (4.17 Mt) due to use of animal energy in agriculture. The study has found the saving of soil nutrients (0.54 Mt of N, 0.14 Mt of P and 0.54 Mt of K) and saving of chemical fertilizers (2.63 Mt of ammonium sulphate, 0.31 Mt of super phosphate and 0.82 Mt of Murate of potash) in Indian mixed farming system on account of use of dung as manure. Mangrove ecosystem and its impact was seen in the form of positive externalities like- shoreline protection, increased fish catch and enhanced income, utilization of non-timber forest products, control of soil erosion and water retention. Besides nitrogen fixation, the positive impact of pulses was seen in the form of reduction of farmer's expenses and burden of government subsidy on fertilizers and environment because of reduced production and use of synthetic urea. Pulses reduced the expenditure on transportation and urea application in field and 10 per cent application losses, farmers could save Rs 613 ha and also reduced the burden of Government subsidy by Rs 1221/ha. Further, it also reduced the potential damage to environment by 1137 Rs/ha in terms of greenhouse gases and health effects. The total positive externality of pulse farming was estimated as Rs 2971/ha. The negative externalities were seen in the form of effluents discharged by the industries as well as use of pesticides, had led to severe pollution, which had ultimately affected the livelihood of the poor. It can be seen in the form of human health hazards (occupational poisoning & pesticide residues through contamination) and reducing the value of land and agricultural production on affected farms. The value of a highly affected farm land was less than half of a farm land less affected by pollution. Losses of beneficial insects, loss of biodiversity and ecosystem as well as honey bee loss and pest resistance were also appeared as a part of negative externality in the environment.

***Keywords**: Biodiversity, effluents, externality, expenses, livelihood and subsidy*

Biorational approaches for the management of various diseases of Indian mustard

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Abstract

Indian mustard [*Brassica juncea* (L.) Czern & Coss.] is one of the major oilseed crops cultivated in India and around the world. Despite considerable increased in productivity and production, a wide gap exists between yield potential and yield realized at farmer's field, which is largely due to biotic and abiotic stresses. Among biotic stress, white rust, alternaria blight and stem rot have been reported to be most wide spread and destructive fungal diseases of rapeseed-mustard throughout the world. All these three diseases causes huge losses to the mustard crops. Control of these diseases by use of different fungicides with varying degree of success has been reported in the literature. Ideally a chemical compound should not only be safe to the human beings and other mammals, but also to the microbes. With the growing awareness of harmful effects of pesticides, use of disease tolerant cultivar, crop rotation or sanitation practices, bio- agents, plant extracts to integrate with less fungicidal spray is gaining importance in recent years. The concept of biorational approaches for disease management seeks to minimize the advantages in the use of fungicides. Therefore, keeping in view the importance of these diseases, the present study of field trials were carried out during 2017-18 and 2018-19 at CCSHAU, Regional Research Station, Bawal (Rewari), Haryana using different bio-agent, plant extract and fungicide with different concentrations as seed treatment and foliar spray against these diseases in Indian mustard to find out effective and economical control. In present study for the management of the *Sclerotinia* rot of mustard in particular and white rust and *Alternaria* blight in general comprised three treatments i.e control, (T_1); seed treatment with carbendazim 50WP @ 1 g ai/kg followed by two foliar spray of carbendazim 50WP @ 0.5 g a.i./l water at 45 and 60 DAS (T_2); soil incorporation of *Trichoderma viride (*NCIPM strain), seed treatment with *T. viride* and two foliar sprays of freshly prepared aqueous garlic bulb extract 2% w/v, (T_3). The treatments T_3 was found significantly superior over other treatments in reducing three major diseases of Indian mustard

Keywords: *Indian mustard, Alternaria blight, white rust, bio-agents and fungicides*

Foliar Nutrient Supplementation to Enhance Pulse Productivity

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Abstract

Pulses serves as a major source of dietary protein for majority of people in India. The nutritive value of pulses lies in its high and easily digestible protein. The yield potential of pulses is very low because of the fact that the crops are mainly grown under rainfed conditions with poor management practices. This is also due to various physiological, biochemical as well as lack of nutrients during critical stages of crop growth. Foliar application of nutrients, is gaining importance in many crops. Foliar applied nutrients usually penetrate the leaf cuticle or stomata and enter the cells facilitating easy and rapid utilization of nutrients. Foliar sprays are used for three main reasons. They are (i) to maintain optimum level of a particular nutrient, (ii) to give a crop nutritional boost at critical stages of different phenophases and (iii) to correct nutrient deficiency. Nutrient absorption mechanism by the above-ground parts is crucial to optimize foliar fertilization. There are three ways of absorption of foliar nutrients; they are (i) penetration through the epicuticular wax and the cuticular membrane (ii) penetration through the cell wall (iii) penetration through the plasma membrane. absorption of mineral nutrients are influenced by (i) environmental factors (light, temperature, air, humidity) (ii) factors related to spray solution (solution concentration, pH, surfactants, chelates) and (iii) biological factors such as species and variety, leaf surface and leaf age, nutritional status and plant development stages). Application of nutrient sprays may certainly be an environment friendly fertilization method since the nutrients are directly bring to the plant in limited amounts, thereby helping to reduce the environmental impact associated with soil fertilization.

Keywords: *Pulses, foliar supplements, crop growth, productivity*

Deciphering genetic inheritance and interallelic interactions for grain micronutrients concentration, yield and its component traits by generation mean analysis in pearl millet [*Pennisetum glaucum* (L.) R. Br.]

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Abstract

Pearl millet is a major staple cereal crop worldwide and genetic biofortification with enhanced grain iron (Fe) and zinc (Zn) concentrations are ongoing efforts to combat micronutrient malnutrition. There is limited information on the nature and magnitude of gene action for Fe and Zn densities, yield and its component traits in pearl millet. Therefore, generation mean analysis was carried out with six basic generation's *viz*., P_1, P_2, F_1, F_2, BC_1 and BC_2 derived from nine crosses using 18 parental lines of diverse pedigree. Analysis of variance revealed that genotypes were significant for days to flowering, days to maturity, panicle length, panicle girth, plant height, number of productive tillers per plant, grain yield per plant, 1000 grain weight, grain iron content and grain zinc content in all the crosses while, non significant for days to maturity and 1000 grain weight in crosses J 2340 x 30291 and ICMB 10444 x ICMB 97222, respectively. Generation mean analysis studies revealed that inheritance of grain yield per plant and contributing traits were governed by additive, dominance and varied types of nonallelic interactions. The additive and varied nonallelic interactions were observed in few crosses for days to maturity, plant height, panicle girth, 1000 grain weight and grain iron content. Similarly, dominance and varied types of nonallelic interactions were present in limited crosses for days to flowering, days to maturity, plant height, number of productive tillers per plant, panicle length and panicle girth. The dominance gene action was observed in cross J 2372 x 30610 for number of productive tillers per plant and J 2454 x 30348 for panicle length while, additive gene action was exhibited in cross 30727 x J 2523 for days to maturity and J 2340 x 30291 for panicle length in pearl millet. Presence of duplicate epistasis in most of the crosses for all the traits except number of productive tillers per plant indicated prevalence of greater genetic diversity. While, complementary epistasis was restricted to limited crosses for days to flowering, plant height, number of productive tillers per plant, panicle length and grain yield per plant. For grain Fe and Zn content varied nonallellic interactions in combination with additive and dominance gene actions played a major role in influencing the trait. However, nonallelic gene interactions with only additive (d) gene actions played a major role in genetic control of grain iron content in crosses J 2340 x 30291, 30127 x J 256, ICMB 10444 x ICMB 97222 and 30843 x ICMB 98222. Moreover, one cross 30725 x ICMB 05333 showed only additive gene effect and additive x dominance component of genic interaction for grain zinc content. This information can be utilized in developing pearl millet lines with high grain Fe and Zn content.

Heterosis, inbreeding depression, heritability and genetic advance for grain iron and zinc concentration, yield and related traits in pearl millet [*Pennisetum glaucum* (L.) R. Br.]

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Abstract

Pearl millet is a major staple crop globally and biofortifying with enhanced grain iron (Fe) and zinc (Zn) concentrations is ongoing efforts to combat micronutrient malnutrition. The present investigation was undertaken to study heterosis, inbreeding depression, heritability and genetic advance for grain micronutrients concentration, yield and related traits in pearl millet [*Pennisetum glaucum* (L.) R. Br.]. Most of the crosses for days to flowering, days to maturity and plant height exhibited considerable heterosis in desirable direction and low inbreeding depression that indicated additive and /or additive × additive variance. Yield and related traits showed high magnitude of relative heterosis and heterobeltiosis coupled with severe inbreeding depression that confirmed predominance of non-additive gene action including dominance and additive × dominance or dominance × dominance gene interactions. Presence of low level of relative and better parent heterosis in F_1s and absence of inbreeding depression in F_{2s} indicated the prevalence of additive gene action of grain iron and zinc content. Moderate to high heritability coupled with low to moderate genetic advance was the feature of most of the traits. Such traits showing low genetic advance cannot be expected to improve through selection and therefore, heterosis breeding might be better option. Crosses, 30127 x J 2556 for days to maturity; J 2454 x 30348, 30725 x ICMB 05333 and 30843 x ICMB 98222 for plant height; ICMB 99222 x ICMB 08222, 30127 x J 2556, 30727 x J 2523 and 30843 x ICMB 98222 for panicle girth; 30725 x ICMB 05333 and 30727 x J 2523 for grain yield per plant; ICMB 99222 x ICMB 08222, J 2372 x 30610 and 30843 x ICMB 98222 for 1000 grain weight; ICMB 99222 x ICMB 08222 and 30843 x ICMB 98222 for grain iron content; ICMB 99222 x ICMB 08222, J 2372 x 30610, 30127 x J 2556, J 2454 x 30348, 30727 x J 2523, ICMB 10444 x ICMB 97222 and 30843 x ICMB 98222 for grain zinc content exhibited high to moderate heritability coupled with medium to high genetic advance which can be handled through selection in pearl millet.

Identification of simple sequence repeat markers associated for grain micronutrients concentration in pearl millet [*Pennisetum glaucum* (L.) R. Br.]

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Abstract

Pearl millet is a major staple crop and biofortifying with grain iron (Fe) and zinc (Zn) is ongoing efforts to combat micronutrients malnutrition globally. In the present study, genotype J 2340 was used as low grain iron and zinc content parent, whereas genotype 30291 as a high grain iron and zinc content parent to develop the F_2 mapping population. Phenotyping of $F_{2:3}$ seeds/families to deduce grain iron and zinc contents of correspondent F_2 plants were done in the laboratory of Bio Science Research Centre, Sardarkrushinagar. Frequency distribution for grain iron and zinc content exhibited more or less normal distribution which indicated the quantitative inheritance of micronutrients. Parental polymorphism survey identified 99 polymorphic primers between the contrasting parents out of 275 primers used. Further, in bulk segregant analysis (BSA) two SSRs, *Xipes0027* and *Xpsmp2263* were found to be polymorphic between high and low grain iron and zinc content parents as well as bulks. The primer *Xipes0027* showed the specific band of 214 bp while, SSRs primer *Xpsmp2263* amplified 238 bp in the high grain iron and zinc content parents and bulks, same band was absent in contrasting parents and bulks. One of these markers, *Xipes0027* is located on linkage group 7 of pearl millet according to the published SSR consensus maps. Moreover, individual plants of each contrasting bulks were genotyped to validate the result of BSA. Markers *Xipes0027* and *Xpsmp2263* amplified a specific band size of 214 and 238 bps respectively, in high grain iron and zinc content parents, bulks and the ten high grain iron and zinc content F_2 individuals. However, the specific band produced by each primer was found to be absent in low grain iron and zinc content parents, bulks and individuals. So, these markers were reported to be putatively linked to high grain Fe and Zn. The identified SSRs markers *Xipes0027* and *Xpsmp2263* might be useful to screen higher grain iron and zinc content genotypes in pearl millet in future crop improvement program.

Delineating genotype-environment interactions and stability analysis for root yield, alkaloid content and other morphometric traits in ashwagandha [*Withania somnifera* (L.) Dunal]

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Abstract

The present study was undertaken to delineate genotype-environment interactions and stability status of sixteen genotypes of ashwagandha [*Withania somnifera* (L.) Dunal] genotypes in context to 12 characters *i.e.* plant height, number of primary branches, number of secondary branches, days to flowering, days to maturity, number of berries, number of seeds / berry, root length, root diameter, root branches, dry root yield and total alkaloid content (%). Experiment was carried out in randomized complete block design (RCBD) over three different locations (S. K. Nagar, Jagudan and Bhiloda) in North Gujarat for three years (2016-17, 2017-18 and 2018-19). Pooled analysis of variance revealed mean squares due to genotypes and genotype x environment interaction alongwith linear and non-linear components were highly significant for most of the traits under study. Stability parameters for component traits through Eberhart and Russell model revealed that genotypes that can be used directly for breeding programme are SKA-4 for flowering time, SKA-21 for maturity duration and SKA-1, SKA-4, SKA-6 and SKA-17 for plant height, SKA-21 for number of primary branches per plant, SKA-11 and SKA-17 for number of secondary branches per plant and SKA-19 for number of berries per plant, SKA-6, SKA-21, SKA-27 and AWS-1 for root branches and SKA-17 for root length as found most stable across the environments. The result revealed that some reliable predictions about G x E interaction and its unpredictable components involved significantly in determining the stability of genotypes.

Conclusion: Hence, present investigation can be exploited for identification of more productive genotypes in specific environments, leading to significant increase in root productivity in ashwagandha.

Impact of COVID-19 on Livelihood Security of Mountain Community

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Abstract

The unexpected outbreak of global pandemic COVID-19 has rapidly spread all over the world, challenging the livelihood security of millions. It severely impacted the Indian agriculture and its allied sectors, and farmers struggled to sustain the production-supply cycle amongst complete lockdown. COVID-19 directly impacted the economic system of India, but its indirect effect, particularly on the rural mountain communities - jeopardizing their lives and livelihood is often less addressed. There is little understanding and compassion towards the isolated mountain population of the Indian Himalayan Region, for whom the infectious disease played out differently. Can they seek social justice? The multifunctionality of the mountain landscape has made agriculture, animal husbandry and rural tourism, the most important sources of income generation. In order to study the impacts of COVID-19 on the mountain community, a comprehensive assessment of agro-based livelihood in 2020 was conducted in the villages around Govind Wildlife Sanctuary and National Park, Uttarakhand. The study adopted Participatory Rural Appraisal Tools, like, key informant interviews, focus group discussions, telephonic interviews and field visits to collect the primary information on current livelihood situations prevailing in the hills. The study highlights the reasons for income lossesrelated to agricultural production, livestock rearing and tourist inflow.The monetary damage faced by local people has been estimated, impacting the livelihood security this year, and which might endanger their capacity for next year as well. The study helped in scrutinizing the vulnerability of mountain community towards external stressors. This assessment draws attention towards the key issues related to policy and governance system and advocates for region-specific recommendations to guide national level policy making and implementation.

Keywords: *Agriculture, COVID-19, Livelihood Security, Mountain Community, Policy & Governance*

Resource Conservation Technologies in Rabi Pulses at Farmers Field and Their Impact on Crop Yield, Technological and Extension Yield Gaps

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Abstract

Pulses are generally grown under rainfed condition and on marginal soil. Increase in irrigated area has further pushed the pulse crops more under marginal soil. Therefore, there is a need to go towards Resource Conservation technology (RCT) for sustaining the production of pulses. RCT are the heart of sustainable agriculture, providing dynamic solutions to problems encountered in increasing agricultural production while avoiding damaging ecosystems or depleting natural resources for future generations. Conservation technologies incorporate into normal agriculture practice, natural regenerative processes, such as nitrogen fixation, nutrient recycling, maintenance of soil structure and fertility and protection of natural enemies of insect pests, weeds and diseases. The innovative approaches make better use of the practical knowledge of farmers and whenever needed appropriate technologies should be adopted for optimum results. Resource Conservation Technologies package includes Zero or minimum tillage, Improved varieties, Seed treatment, Sowing time, Seed rate, Method of sowing, Nutrient management, Weed Management, Plant protection measures etc. Keeping all in view a study was carried out in the farmer's field of Raebareli district in Rabi Pulses viz. Gram, Field Pea & Lentil in the year 2016-17and 2017-18 under CFLD programme. It was observed that there was a wide yield variation between potential and demonstration yields of pulses mainly due to technology and extension gaps. Extension yield gaps varied to the extent of 8.6-8.85q/ha in Gram, 4.35-6.0q/ha in Lentil and 7.25-8.2q/ha in Field Pea during the study period. Improved technology package has also improved the profitability of pulses in terms of gross and net returns besides enhanced benefit-cost ratio ranging from 1.79 to 5.40 in Gram, 1.05 to 4.46 in Lentil and 2.27 to 3.68 in Field Pea. Technology index in Gram (3.47-7.60%), Lentil (13.61-18.88%), and Field Pea (36.09-49.21) has revealed that demonstrated improved crop management technology is quite feasible under prevailing farming situations in Raebareli district of Uttar Pradesh, but there is urgent need to aware and educate the farmers to adopt the technologically feasible and economically viable farm technology for enhancing yields and profitability through intensification of productive inputs. Overall, it is inferred that improved Resource Conservation Technologies has great potential in enhancing the pulse productivity and profitability through Cluster Frontline Demonstration programme in Raebareli district of Uttar Pradesh.

Impact of Covid-19 on Indian Agriculture

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Abstract

Covid-19, a global pandemic, has impacted millions of lives across the globe and caused significant losses to global economies including that of India.As per Reserve Bank of India, Indian GDP grew at 4.2% during 2019-20.According to International Monetary Fund, Indian GDP in 2020-21 is estimated to contract by 4.5% due to Covid-19 impact. During first quarter of 2020 – 21, Indian GDP contracted by 23.9% as against 3.1% growth during previous quarter. While all the key sectors witnessed contraction in terms of percent change over previous year, agriculture showed a 3.4% growth.Increased net acreage of crops sown is a positive sign for kharif 2020 indicating possibly higher production, provided there won't be any significant losses due to various biotic and abiotic factors.These numbers indicate no or minimal effect of COVID-19 on Indian agricultural sector.However, pandemic had drastic effects on transportation of commodities to procurement centres and to wholesalers affecting immediate price realization to farmers especially small and marginal farmers. Agri supply chains were also hit badly due to various factors including non-availability of the migrant labour, procurement disruptions,lack of transportation facilities etc. One of the major indicators for impact assessment is the area under kharif crop, which during 2020 – 21 stood at 1082.22 Lakh ha compared to 1009.98 Lakh ha during 2019 – 20, an increase of 7.15% as on Aug 28, 2020. Normal acreages (average acreages during last 5 years) 389.81during Kharif season stands at 1066.5 lakh ha.All the major crops showed an increase in net sown area compared to previous kharif season. The three major kharif crops considered for this study – Paddy, Maize and Soybean also showed increase in net sown area compared to previous year. The increase is 9.99% for paddy, 1.49% for maize and 6.95% for soybean. Acreage of these crops not only increased compared to previous year but also showed an increase with respect to average net sown area of previous five years.Adequate and distributed rainfall during the crop sowing season might have played a crucial role in increasing the net sown area. During first three months of the southwest monsoon season 2020, the country's rainfall departure from long term average was +17.6% while during the same period of 2019, it was -32.8% resulting in favourable conditions for undertaking sowing operations on a large scale.Apart, migrant labours returning to their villages due to loss of opportunities in cities, have contributed to increased agricultural activity by returning to farming. Though supply chains were hit during initial lockdown periods primarily due to non-availability of transportation facilities, agri-related activities including transportation, warehouses etc were exempted at the earliest which resulted in very minimal disruption to agricultural operations. Compared to other sectors, pandemic had no or minimal impact on Indian agriculturein terms of field operations.Due to increased net sown area, favourable weather conditions, and supportive governmental policies agricultural production and productivity may see an increase this year. However, other supply chain links faced major disruptions during initial phases of lockdown.

Keywords: *Covid-19, Pandemic, Agricultural impact, Crop acreage, Agri supply chain.*

Resource capture and utilization through canopy stratification in homesteads: a blue print of sustainability

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Abstract

Homegardens or homesteads are farming systems in which a number of crops (including tree crops) are grown around the farmer's dwelling mainly for the purpose of satisfying the farmer's basic needs. The diversified farm satisfies the multiple requirements of the family in terms of food, fuel, fodder, and medicine. The distinct species richness and cropping pattern with the perennial components endorses a multi-storeyed canopy configuration which adds to the complementary interactions and synergism in the homegarden. Homesteads provide various regulatory services like nutrient cycling, water harvesting and recharge, carbon sequestration and prevention of soil erosion. The structural arrangement and selection of crops are intended for a long term maintenance rather than a maximum production in a short span of time. Resources like water, light and energy are effectively and efficiently used by keeping in mind a sustainable production for the future generation. Diversification of the system ensures livelihood and nutritional security. Various biological interactions among the different elements of the agricultural system are peculiar to the homegardens viz., association of climbing plants and supports, provision of shade, nitrogen fixation, mulching and biological control of weeds and diseases. It also ensures human health and environmental conservation. High intensity vertical and horizontal space utilisation results in increased cropping intensity along with continued supply of outputs. The multispecies production system contribute increased share to the ready, healthy, safe and nutritious daily dietary intake. The multiple productive and ecosystem services rendered by the homesteads undisputedly bestow sustainability to the multistrata homestead farming.

Keywords: *Homegardens, Interactions, Multi-storeyed crop configuration, Nutrient cycling, Resources, Sustainability,*

Integrated Farming System and their Impact on Productivity and Rural Livelihood

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Abstract

In India, agriculture production is a backbone of the Indian economy, but in recent past agriculture the gross domestic product is declining 14%, the average size of landholding is gradually decreasing less than 0.5 ha. It is essential to develop strategies that enable sufficient income and employment generation, particularly for small and marginal farmers who represent approximately greater than 85% of the farming community. It is thus essential to look at the present farming practices with an emphasis on the integrated concept of sustainable farming that enhances the quality of environmental and natural resources base while ensuring increased productivity. Sustainable development in agriculture must include integrated farming systems (IFS) with efficient soil, water, crop, and pest management practices which are environmentally friendly and cost-effective. The concept of sustainability is an important element in the development of integrated systems. Developing countries around the world are promoting sustainable development through sustainable agricultural practices which will help them addressing socio-economic as well as environmental issues simultaneously. Within the broad concept of sustainable agriculture integrated farming system holds the special position as in this system nothing is wasted, the byproduct of one system becomes the input of others. An integrated farming system is a reliable way of obtaining high productivity with the substantial nutrient economy in combination with maximum compatibility and replenishment of organic matter by way of effective recycling of organic residues or waste etc. obtained through the integration of various land-based enterprises. A judicious mix of one or more enterprises that complement the cropping activity can result in increased farm income and recycling of farm residues. The integrated farming system approach is not only a reliable way of obtaining fairly high productivity with substantial fertilizer economy but also a concept of ecological soundness leading to sustainable agriculture and also deriving maximum compatibility and replenishment of organic matter by way of proper recycling of organic residues or waste obtained through integration of enterprises like fishery, poultry, goat, milch animal, mushroom and sericulture activities. Integrating different components with the crop will increase the profitability through recycling of waste of one component into another. To avoid the uncertain income and high degree of risk through a single crop production enterprise, there is a need to develop an integrated farming system.

***Keywords**: integrated farming system, sustainability*

Impact of COVID-19 in Agriculture at Current Scenario

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Abstract

The ongoing COVID-19 pandemic causes a health and food security crisis, if persist prolong. This pandemic has devastating impact on the Indian economy and affects almost all the sector *like* industries, automobiles, manufacturing sector, agriculture as well as allied sectors and no sector has escaped its impact. Among these agriculture sector has badly affected either directly and indirectly. Various agricultural practices are affected during lockdown periods. There are some of the agricultural sectors *like* crops, dairy, fishery, poultry, and horticulture sector. In the initial phase, India declared a three- week nationwide lockdown from 25th march to till mid April and this was the peak time for *rabi* crop harvesting. Due to labour scarcity, *rabi* crops harvesting had not done at right time and the most of the losses of agricultural commodities took place in the field. The agriculture cultivation of Punjab and Haryana are drastically hit as they tend to more dependent on migrant labour. The sale of dairy products; fish; poultry, fruits and vegetables *etc.* has also been hit during the lockdown period due to the dissemination of misleading rumor that COVID-19 can transmit through the consumption of chicken. As a result the price of the chicken fallen significantly as well as more than two crore people involved in this sector was also affected. However, the organized industry players have been affected due to shortage of workforce and transport issues. Most of vegetable growers bear huge losses because they were unable to send their perishables vegetables *like* tomato, chilly, leafy vegetable in the Mandi, due to the restricted movement of transport between inter and intra state. The prize of several essential agricultural commodity become hike due to limited availability of produce. The maximum labor has lost their job that working in the non agri-sectors. On 17th April union agricultural minister announced a "KISAN RATH" app where 5.5 lakhs vehicles are registered, this app facilitate the farmers can easily send their agri produce in the Mandi during lockdown period. Farmers brought agriculture inputs like seeds, fertilizer, pesticide etc on higher prize. The Indian Finance Minister declared an INR 1.7 trillion package, mostly to protect the vulnerable sections (including farmers *i.e.* small and marginal) from any adverse impacts of the Corona pandemic.

***Keywords**: Agricultural commodities, Kisan rath, Lockdown, Mandi, Migrant labour*

Nutrient requirement of papaya (*Carica papaya* L.) in the homestead farming system of kerala for yield optimisation

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Abstract

Papaya has gained commercial importance over the years because of its varied uses, mainly for table purpose. It is usually grown as homestead crop in Kerala. In recent years, isolated attempts have been made by some progressive farmers for commercial cultivation. Major production constraint encountered in papaya is difficulty in maximizing yield with in unit time. Balanced nutrition plays a vital role on plant growth, yield and fruit quality. One of the reasons for low production in papaya is inadequate nourishment. As the export of papaya from India is rapidly increasing in the recent past, there is a pressing need to enhance its productivity and improve the fruit quality. Papaya is a heavy feeder and it demands nutrients continuously in large amounts. Papaya variety CO-2 was used for the experimental purpose. Soil samples were analysed for available nitrogen, phosphous and potassium before and after the experiment. Nitrogen, phosphous and potassium content in leaf petiole were also analysed. The petiole samples were collected from the recently matured petiole. The trial was undertaken to study the effect of nitrogen, phosphorus and potassium application on growth, yield and quality of papaya and also to find out the optimum dose of NPK for commercial cultivation of papaya under Kerala conditions. The trial was conducted in 3^3 confounded factorial RBD, confounding NPK in replication-1 and NP^2K^2 in replication-2. Three different levels of nitrogen [200 (n_0), 250 (n_1), 300 (n_2) gram per plant per year], phosphorus [200 (p_0), 250 (p_1), 300 (p_2) gram per plant per year] and potassium [300 (k_0), 400 (k_1), 500 (k_2) gram per plant per year] were applied to papaya plants in six equal split doses at two months interval. Two month old seedlings were used for transplanting. Fertilizer application started thirty days after transplantation of seedlings to the main field. Urea, Rock phosphate and Muriate of potash were used as sources of Nitrogen, Phosphorus and Potassium. The treatments involved 27 different combinations of Nitrogen, Phosphorus and Potassium at different levels , their interactions and control. Biometric characters like height of plants, girth of plants, number of leaves, time of first flowering, time of harvest were noted. Yield characters like number of fruits per plant, fruit weight, fruit length and girth, fruit volume, pulp percentage, total yield per plant and papain yield were recorded. Results revealed that application of nitrogen, phosphorus and potassium at the rate of 250:250:500 gram per plant per year in six equal splits, at two months interval was economically viable and improved the growth, yield and quality of papaya

Keywords: *Papaya, Nitrogen, Phosphorus, Potassium, Yield*

Strategies for Boosting Indian Agriculture in the Current Scenario

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Abstract

Agriculture and its allied sectors play an important and critical role in rural livelihood, employment and national food security as well as in national income. The sector provides the largest source of livelihoods in India. Proportion of Indian population depending directly or indirectly on agriculture for employment opportunities is more than that of any other sector in India. According to Economic Survey (2019-20), about 70 per cent of its rural households still depend primarily on agriculture for their livelihood, with 82 per cent of farmers being small and marginal (who own less than one acre of land each). Its contribution to national income has gradually declined from 18.2 per cent in 2014–15 to 16.5 per cent in 2019–20, reflecting the development process and the structural transformation taking place in the economy. For Doubling Farmers' Income, it has been identified seven sources of income growth: improvement in crop and livestock productivity; resource-use efficiency or savings in the cost of production; increase in the cropping intensity; diversification towards high-value crops; improvement in real prices received by farmers; and shift from farm to non-farm occupations; and establishing a national cold supply chain. A seamless national cold supply chain will set up a "Kisan Rail" with refrigerated coaches for perishables, inclusive of milk, meat and fish which would likely reduce the transport cost. There are 16 actions points for boosting agricultural incomes. 1. The central government enacted three model laws to implement in the states as: Model Agricultural Land Leasing Act, 2016; Model Agricultural Produce and Livestock Marketing (Promotion and Facilitation) Act, 2017; Model Agricultural Produce and Livestock Contract Farming and Services (Promotion and Facilitation) Act, 2018. 2. Water stress-related issues are now a serious concern across the country. The government is proposing comprehensive measures for one hundred water-stressed districts. 3. The PM KUSUM scheme removed farmers' dependence on diesel and kerosene and linked pump sets to solar energy. 4. Encouraging balanced use of all kinds of fertilizers. 5. Setting up of efficient agri-warehousing, cold storage, van facilities *etc.* at the block and taluk level. 6. The Budget has proposed a village storage scheme which would be run by the Self Help Groups (SHGs) which will provide farmers' ability to hold stocks of agricultural produce at the village level and reduce their logistics cost. 7. To expand mobilization of more SHGs. 8. The focus on cultivation of pulses and expansion of micro-irrigation through Krishi Sinchai Yojana, have raised the self-reliance of the country. The provision of any annual supplement of the income to the farmer is directly done through PM KISAN, connectivity through PMGSY, which have helped raise farm incomes. 9. Krishi Udaan' will immensely help to improve value realisation especially in North-East and tribal districts. 10. For better marketing and export, it has proposed supporting horticulture intensive states through cluster-based approach with a focus on 'one product, one district'. 11. Expansion of integrated farming systems in rainfed areas and also strengthen online national organic products market portal on 'jaivik kheti'. 12. Integration of Negotiable Warehousing Receipts (e-NWR) with the e-NAM (Currently 585 *mandis* have joined the e-NAM portal and another 400 *mandis* will be joining this portal soon). 13. Increase in agriculture credit disbursement. 14. Increasing the milk processing capacity from 53.5 million MT currently to 108 million MT by 2025. 15. To enhance the milk production use of artificial insemination techniques in the cattle (*i.e.* Blue Revolution). 16. Youth in coastal areas benefit through fish processing and marketing. The government would promote growing of algae, sea-weed and cage culture.

Keywords: *Krishi Udaan, Model laws, SHGs, Technology*

Yielding behaviour of chickpea varieties under varying plant rectangularities in late sown conditions of Pantnagar

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Abstract

Pulses hold prime position in Indian Agriculture. India is the largest producer (25% of the global production), consumer (27% of the world consumption), and importer (14%) of pulses in the world. Pulses account for around 20 % of the area under food grains and contribute around 7-10% of the total food grains production in the country. Among pulses, chickpea (*Cicer arietinum* L.), the premier pulse crop of Indian subcontinent, is predominantly consumed as a pulse. One of the major constraints of poor yield of chickpea is improper population. Too low plant population at harvest beyond a certain limit very often affects the crop yield adversely. Number of plants per unit area influences plant yield components and ultimately the seed yield. Plant spacing in the field is also very important to facilitate aeration and light penetration in to plant canopy for optimizing rate of photosynthesis. Row and plant spacing is also one of the important factors which ultimately affects nutrient uptake, growth and yield of plant. Increase in spacing decreases the total population, but with more nutrition to the individual plant grows better and yield more and vice-versa. This increase or decrease of plant population per unit area has definite pattern in relation to the yield. So the plant rectangularity, one of the important crop density characters, can be manipulated either by varying row or plant spacing or by both to attain the maximum production from unit land area. The space requirement to individual plant depends on variety, its growth habit and agro climatic condition. Thus, the present investigation "Yielding behaviour of chickpea varieties (PG186, PG4, PG5) under varying plant rectangularities (30×5 cm, 30×10 cm, 30×15 cm, 30×20 cm) in late sown conditions of Pantnagar" was undertaken and found that chickpea variety PG5 recorded more yield attributing characters like number of pods/plant, number of seeds/pod, 100-grain weight and ultimately higher seed yield than other varieties. While among all the plant rectangularities 30×5 cm performs better than other.

Baseline Survey and Identification of Problems in Hill Cattle Production System of Pauri Garhwal District of Uttarakhand

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Abstract

A baseline survey was conducted to review the cattle production system in the Bilkhet, Dhuroli and Bunga villages of Kaljikhal block of PauriGarhwal district. The data collected from 113 dairy farmers on various aspects of socio-economic structure and cattle management practices were tabulated and analysed to assess the problems commonly encountered by livestock owners. The results indicated that majority of dairy farmers were above 50 years of age and served as casuallabour along with dairyingas their main occupation. Most of them had educationupto junior high school and their land holding was upto two acres. Themost common herd sizewas upto 3 milch cattle withupto 4 kg/daymilk production.Natural service was the mainbreeding method andmucus discharge from vagina with frequent bellowingwas the common method of heat detection.Sixty per centdairy farmersperformed deworming of their cattle and87 per centwere vaccinating their cattlewith the help of GovernmentVeterinary Hospital however, they did not follow the complete protocol.Only 7 per cent and 5 per cent farmers followed proper deworming and vaccination schedule, respectively. Majorityof dairy farmers were feeding concentrates (86.73%)and salt (97.35%) and only 8.85 per cent farmers were feeding mineral mixtures to their animals.Themajor health problems of the cattlefaced by the villagerswerefoot and mouth disease (100%), ectoparasites (100%), endoparasites (72.57%), calf mortalityand some cases of mastitis, repeat breeding,anoestrus, metritis and abortion. The major problems identified in selected villages werewater andfodder scarcity,very low milk productivity of local Badri cattle,inadequate veterinary services, poor AI facilities and problems of stray & wild animals for agriculture and horticulture crops.

Key words: *Baseline, cattle, dairy farmers, productivity, vaccination*

Hi-Tech Agriculture and Scopes of Agri-Entrepreneurship

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Abstract

Food and water crisis is one of the supreme issues of the modern world. Sufficient technologies are available all over the world which can be used to enhance production and at the same time provide economic and social gains to the producer. An Agri-Entrepreneur is a person who makes use of the latest technologies to increase the agricultural production and its post-harvest operations. Creative problem solving skills with the help of these technologies are to be developed through innovative approaches. The major qualities for becoming an entrepreneur are the focus in the business and self-confidence. The demand is increasing in the urban areas with the improvement in the standard of living of the people and health consciousness. With Hi tech agricultural technologies like vertical farming, precision farming, hydroponics technology, aquaponics, soil less culture etc. the possibility of increasing production in the urban areas has also become possible. In Agriculture, the major constraint in increasing production is labour scarcity. In earlier days Agri- Entrepreneurship program was mainly involved in growing crops and rearing livestock. Agriculture by means of the earlier technologies cannot run profitably, whereas the use of modern technologies leads an Agri-Entrepreneur to success. In Agri- Entrepreneurship, major concern is the identification of market demand and developing the protocol to be followed in the production. The different aspects of Hi-Tech agriculture which helps in producing quality products though modern technologies can be adopted by the young agriculturists. The application of artificial intelligence, robotics, GPS technology, sensor based technologies etc. enhance the scope of agricultural based Entrepreneurship in high-tech agricultural field.

Keywords: *High-tech agriculture, Entrepreneurship, Vertical Farming, Hydroponics*

Interactive effect of green manure and zinc fertilization on the physical and nutritional quality of basmati rice under Indian rice-wheat system

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Abstract

Enhancing the physical quality and micronutrients content of basmati rice increases its preference among buyers in the market. When used in combination, the interactive effects of suitable plant sources and slow release micro-nutrient fertilizers can significantly improve the quality of basmati rice grains. In this regard, a field experiment was carried out using split plot design at ICAR-Indian Agricultural Research Institute, New Delhi, India during 2015-16 to determine the interactive effects of in-situ (*Sesbania aculeata* and *Vigna umbellate*) and ex-situ (*Leucaena leucocephala*) green manuring and summer fallow in main plots and zinc fertilization (control, soil application of 5 kg Zn through chelated Zn-EDTA, 2.5 kg Zn through chelated Zn-EDTA as soil application+1foliar spray at flowering, foliar spray of chelated Zn-EDTA at active tillering+ flowering+grain filling and foliar spray of chelated Zn-EDTA at 20, 40, 60 and 80 DAT in sub-plots on physical and nutritional quality of basmati rice under rice-wheat system. The results of two-year average data showed that *Sesbania aculeata*, *Vigna umbellata*, *Leucaena leucocephala* green manuring and summer fallow recorded the hulling (%)- 78.9, 78.0, 77.5 and 76.5, milling (%)- 69.0 68.5, 67.5 and 67.2 and head rice recovery (%)- 58.6, 57.4, 56.6 and 54.8 respectively, when each applied with foliar spray of chelated Zn-EDTA at 20, 40, 60 and 80 DAT. Similarly, the micronutrient content viz. Zn (ppm)- 30.5, 29.9, 29.8 and 25.6, Mn (ppm)- 31.2, 30.2, 29.7 and 26.0, Cu (ppm)-9.2, 8.1, 7.1 and 6.6 and Fe-30.0, 28.1, 27.0 and 26.3 was recorded with *Sesbania aculeata, Vigna umbellate, Leucaena leucocephala* and summer fallow respectively incorporated along with foliar spray of chelated Zn-EDTA at 20, 40, 60 and 80 DAT.Thus it was suggested that combined application of sesbania green manure and foliar spray of chelated Zn-EDTA at 20, 40, 60 and 80 DAT can produce best interaction effects in terms of enhancing the physical and nutritional quality of basmati rice under rice-wheat system.

Nitrification Regulation- A Mitigation Strategy for Nitrogen Pollution in Agriculture

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Abstract

The Green Revolution in India could make the country self - reliant in food grain production with the adoption of modern technologies such as the use of high yielding varieties, fertilizers, pesticides, irrigation etc. Over the years, there has been a rapid increase in the use of nitrogen fertilizers, to meet the nutrient demands of high yielding varieties of crops. Nearly 70 per cent of the applied N fertilizers in managed ecosystems is lost through nitrification leading to nitrogen pollution. The two major pathways of N loss during and following nitrification are i) gaseous emissions as dinitrogen and oxides of N and ii) leaching of nitrate. Gaseous losses can contribute to global warming whereas, leaching losses result in eutrophication of water bodies. The environmental impact of these losses is referred to as nitrogen pollution. Hence it becomes important to mitigate nitrogen pollution and improve Nitrogen Use Efficiency. Regulation of nitrification has been identified as a suitable strategy towards the development of low nitrifying agronomic systems, benefiting both agriculture and environment. Nitrification can be regulated indirectly by limiting the substrate i.e., ammonium ion availability to the nitrifiers by timing of fertilization so that it coincide with rapid plant uptake, avoiding fallows by continuous cropping or by using live mulches, using slow and controlled release N fertilizers, intensifying internal soil N cycling etc. Another option would be to inhibit nitrifiers directly either by using synthetic nitrification inhibitors such as allyl thio urea, 2-chloro-6-(trichloromethyl) pyridine, dicyandiamide, DMPP etc. or by exploiting biological nitrification inhibition. It is the ability of certain plant roots to impede soil nitrification through the production of biological inhibitors. The allelochemicals are present in the plant rhizosphere. It has been reported in pasture grasses, *Brachiaria* spp. and among field crops, in groundnut, sorghum, rice and wheat. The nitrification inhibitor, *brachialactone,* in the root exudates of *Brachiaria humidicola* is capable of blocking both AMO and hydroxylamine oxidoreductase enzymatic pathways in *Nitrosomonas.* The potential of nitrification inhibition can be utilised by incorporating these crops in rotations/ pasture systems or transferring the BNI traits to grain crops through breeding techniques. These approaches would help to retain N in soil systems thereby increasing soil N pools. Given the current environmental concerns, strategies have to be evolved to combat the rapid nitrification and to retain N in the system without allowing its movement into aquatic and atmospheric systems. Biological nitrification inhibition is a relatively new concept, but, has the potential to increase NUE and minimize N losses, benefitting both agricultural production and environment.

Keywords: *Nitrogen, Nitrification, Strategy, Agriculture*

Leaf surface inhabiting pigmented methylotrophic bacteria tapped for their plant growth promoting traits

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Abstract

Bacteria are among the most abundant inhabitants of the phyllosphere, which is highly influenced by changes in temperature, relative humidity and UV radiation. Leaf leachates comprising of sugars, amino acids, inorganic ions, etc. play a major role in the successful colonization of phyllosphere microflora. Among other groups of bacteria, methylotrophic bacteria are found as common colonists of the leaf surface which can utilize C_1 compounds such as methanol or formaldehyde along with several multi carbon compounds. The most common genera of this group being *Methylobacterium*, comprising mostly of pink pigmented facultative methylotroph (PPFM). The present investigation envisaged isolation, biochemical characterization and screening of phyllospheric methlyotrophic bacteria associated with various crops for their plant growth promoting characteristics. Leaf imprinting and serial dilution technique were used for isolation of the epiphytic bacteria. Enumeration of methylotrophic bacterial population carried out for both phyllosphere samples and rhizospheric soil in Ammonium mineral salt (AMS) media, resulted in a higher population in the phyllosphere (3.90-4.11 log cfug^{-1}). Eighteen prospective isolates, mostly exhibiting pink and yellow coloured pigmentation on AMS media, were screened for their plant growth promoting traits like indole acetic acid (IAA), siderophore production, antibiotic resistance, NH_3 production, etc. All the prospective isolates could produce IAA within a range of 0.69- 5.53 µgg^{-1}, with the highest in isolate from spinach (M16). Total nitrogen content of the isolates ranged between 1.4-2.6 mgg^{-1}. Siderophore production was shown by the isolates obtained from chilli (M1) and cauliflower (M10), and resistance to common antibiotics were exhibited by few isolates M4, M15, M16 and M17 obtained from ivy gourd, cowpea, spinach and french bean crops, respectively. Isolates M1, M10 and M12, retrieved from the phyllopshere of chilli and cauliflower crop possessed the ability to solubilize phosphorus, and isolate M7 from phyllosphere of tomato could solubilize insoluble zinc. After screening for plant growth promoting traits, twelve isolates were finally selected for a series of biochemical tests. The isolates responded differently to all the biochemical tests like casein hydrolysis, nitrate reduction, urease, citrate utilization, starch hydrolysis, etc. Soil samples of the study site were also analyzed for soil chemical (pH, available N, available P_2O_5, available K_2O, organic carbon) and biological parameters (microbial biomass carbon, fluorescein diacetate, and phosphomonoesterase). Correlation studies between the population of methylotroph in leaf and that of rhizospheric soil resulted in positive correlation (r=0.762*), and indicated that phyllospheric methylotrophic population was influenced by rhizospheric population. Phyllospheric population of the methylotrophic bacteria and soil pH of the study sites also resulted in a positive correlation(r=0.934**). From the research initiative, it could be inferred that a wide array of methylotrophic bacteria occur in the phyllosphere of different crops, and possess varied plant growth promoting traits. These phyllospheric methylotrophic bacteria could further be utilized for coinoculation with biofertilizers or used as bioinoculants in crop improvement.

Keywords: *Phyllosphere, methylotrophic bacteria, PPFM*

Lycopene: A Nutraceutical

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Abstract

Lycopene, a potent antioxidant and natural plant carotenoid pigment is responsible for the red color of the fruits and vegetables. It is mainly found in large amounts in tomatoes but is also presents in other fruits such as papayas, pink grapefruits and guavas, apricots and watermelon. An intermediate in the β–carotene synthetic pathway, lycopene is a higly unsaturated hydrocarbon, containing 11 conjugated and 2 unconjugated double bonds. The presence of a system of 11 conjugated double bonds confers on lycopene its ability to absorb light in the UV-visible region. It is lipophilic in nature and is considered one of the most efficient singlet oxygen quenchers, which suggests that it may have comparatively stronger antioxidant properties. As a major carotenoid in human blood, lycopene protects against oxidative damage to lipids, proteins, and DNA. Lycopene has also been found to be a potent and specific inhibitor of cancer cell proliferation. Pharmacological activity of lycopene includes antiatherosclerotic, antioxidant, anti-inflammatory, anti-hypertensive, antiplatelet, antiapoptotic and protective endothelial effects, the ability to improve the metabolic profile and reduce arterial stiffness.

Keywords*: Lycopene, nutraceutical, water-insoluble, antioxidant, anticarcinogenic*

Suggestions from Farmers to Overcome the Constraints in the Efficient use of Mobile Communication Technologies to Transfer Agricultural Information

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Abstract

The professionals of ICT have recognized that mobile is the most appropriate device for farmers for improving the knowledge, general awareness and speedy learning. A study was conducted to seek suggestions from farmers to overcome the constraints in the efficient use of mobile communication technologies to transfer agricultural information. Ex-post facto research design was followed. A total of 240 respondents were selected from twelve villages. One sample test of kurtosis &skewness, frequency and percentage wereused for statistical measures. The most important suggestions offered by the farmers to overcome the constraints in the efficient use of mobile communication technologies to transfer agricultural information were: Continuous accessible network services should be made available in rural areas (79.58 per cent) andInformation should be offered in understandable local language (77.92 per cent).Hence government should concentrate on our old age farmers for popularize smart phone among them so that their vast experience & indigenous knowledge in agriculture can be utilized by next generations.

Keywords: *Agriculture, Farmers, Mobile, Suggestions*.

Hydrolysis of urea by immobilized Urease: A integrated approach for Urease stabilization and its utilization in environmental and industrial applications

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Abstract

Urease a member of superfamily amidohydrolases and phosphotriesterases, catalyzes hydrolysis of urea into ammonia and carbon dioxide. It has attracted much attention as a catalyst in food industry, agriculture and medical industry. The stabilization of enzymes is of great importance in many applications and can be defined as storage stability and operational stability. When enzyme is stored as a dehydrated preparation, a solution or immobilised it is storage stability and is particularly concerned with retention of activity over time. The second generally relates to the retention of activity of an enzyme when in use. Nowadays, immobilization is a unique approach for enhancement of enzyme stability. In the present work, Urease purified from *Cajanus cajan* has been immobilized on cysteine functionalized gold nanoparticles (Cys-AuNPs). The prepared bioconjugates were subjected to Transmission electron microscopy (TEM), Fourier-transform infrared spectroscopy (FTIR) and biochemical assays. Results obtained after immobilization revealed that the stability of the enzyme with respect to changes in temperature and pH is improved. The immobilized *C. cajan* urease could be reused 10 times and stored up to 50 days with the retention of 50% residual activity. The immobilized enzyme showed a broader range of pH and temperature operability, better thermal stability, higher storage stability, reusability and improvement of these physiochemical properties compared to soluble counterparts makes immobilized Urease a better candidate for environmental and industrial applications.

Keywords: *Urease immobilization, Gold nanoparticles, Operational stability*

Response of bottle gourd fruit yield to organic and inorganic fertilizers

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Abstract

Bottle gourd belongs to the family cucurbitaceae and locally known as 'Lauki'.It is also called as white flower gourd and very important gourd among the cucurbitaceous family grown in India. It has wide range of uses and is largely cultivated in the tropics and subtropics. It is used in making vegetable, sweets, andraita. As a vegetable it is easily digestible and the pulp is good for overcoming constipation. Hence, a field experiment was conducted during kharif 2018 to evaluate the response of bottle gourd to organic and inorganic fertilizers on growth and yield of bottle gourd. The experiment was designed in randomized block design (RBD) with seven treatments. The growth and fruit yield of bottle gourd increased with application of inorganic and organic sources of nutrient. The fruit yield of bottle gourd varied from 105.07 to 188.85 q/ha with application of organic and inorganic sources of nutrient. The effect of inorganic sources alone and in combination with organic sources was found to be significant over control. Application of organic sources in conjoint with inorganic sources also increased fruit yield significantly but their effect when applied alone was non-significant. Maximum fruit yield 188.85q/ha was recorded in RDF, while minimum was 105.07 q/ha in control.

Keywords: *Bottle gourd, N:P:K, FYM and cowdung +urine base formulation*

Seed Invigouration: A Climate-Smart Crop Production Practice

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Abstract

Worldwide agricultural production is considerably affected by climate change and pressure induced by the ever-increasing human population and their food demand. The production in agriculture is also affected by the insufficient availability of quality seeds and affordable cost for farmers. There is an urgent need to enhance seed productivity and seed invigouration has played a vital role in increasing agricultural productivity. Seed invigouration is quite a new term and be used for both seed pelleting and priming. It has the potential not only to enhance the seed vigour and germinability of normal seeds but also has the excellent ability to enhance yield and improve the germination power over a wide range of environmental conditions.To cope with the challenges of climate change, crop production must adapt and become resilient to changes. Many seed invigouration treatments are being employed in a number of field crops, including rice, to improve seedling establishment under normal and stressful conditions. Seed pelleting is a pre-sowing physical seed management procedure. In seed pelleting the seed-soil interface at the rhizosphere region is improved by applying growth promoting substances or substances with protective, nutritive and invigourative function on the seed surface. Seed pelleting ensures easy planting, uniformity in size, uniform stress tolerance and nourishment to the seedlings. Seed priming is a pre-sowing approach for influencing the seedling development by modifying the pre-germination activity preceding the radicle emergence. Increased germination rate, uniformity in germination, faster emergence of seedlings, better allometric attributes, drought tolerance, earliness in flowering and increased yield are the beneficial effects of seed priming. Seed priming (soaking the seeds in micronutrient solutions of definite concentration for a specific period) or seed coating with micronutrients are the two easy cost-effective methods of micronutrient application. Seed biopriming is one of the vital technologies in the management of biotic as well as abiotic stresses and guarantees uniform stand establishment under a stressed environment.

Keywords: *Seed invigouration, Seed pelleting, Seed priming, Stress tolerance, yield enhancement*

Impact of COVID-19 Lockdown on Farming Community in Cold Desert Region-Ladakh

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Abstract

Leh Ladakh is situated between 32 to 36 degree North latitude and 75 to 80 degree east longitude and at an altitude ranging from 2900 M to 5900 M, and it is scattered on an area of 82665 Sq.Kms (includes 37555 Sq.Km under illegal occupation of China) makes it the largest district in the country is having 112 inhabited and one un inhabited villages with a population of 133487 souls as per 2011 census with Buddhist as the biggest ethnic group followed by Muslim. Agriculture is the main source of livelihood in this district as in the rest of the state. According to revenue department village papers, the district has a reporting area of 45167 hectares of which 10542 hectares has been brought under cultivation. The departments concerned have contributed a lot in increasing production especially the cash crops. Majority of this farming community are small and marginal farmers with an average land holding of 0.66 ha, as per agriculture census 2010-11, LAHDC, Leh. The area under different crops in this district are Barley (4390 ha), wheat (2713 ha), other millets (548 ha), Pulses (265 ha), oilseeds (97 ha), vegetables (360 ha), Fruits (79 ha), and fodder (2082 ha) as per statistical handbook 2016-17, LAHDC, Leh. India took early action to limit the spread of COVID-19 when the numbers of active cases are near about 500, ordering a 21-day nationwide lockdown for its population of 1.3 billion people starting March 25 and the district administration Leh also strictly followed the lockdown. Before the official lockdown, a one day "Janta Curfew" was observed on March 22nd and the inhabitants of this district also followed properly. Subsequently, the lockdown was extended three more times before May 31 and the active COVID 19 cases gradually declined and the district was declared COVID free. But unfortunately, it again rises due to the influx of migrant labourers from outside state and the graph abruptly increases and the recovery rate is more than the active cases in this newly formed union territory. The total no. of active cases is 850, cured cases of 2151 and 35 no. of total deaths as per Govt. of India, Ministry of Health and Family Welfare dated. 07th September 2020. The complete shutdown of all economic activities and construction except essential services has created an economic crisis for the poor, particularly daily wagers and rising food insecurity. Out of the national total of 465 million workers, around 91% (422 million) were informal workers in 2017-2018. Lacking regular salaries or incomes, these migrant and even local labourers would be hardest hit during the lockdown period. COVID-19 is disrupting some activities in agriculture and supply chains. After many interviews with the tribal farmers and survey, it is observed that the lack of available migrant and local labor interrupting some farming activities like land preparation, harvesting and post harvest management in agricultural crops and fruits in Leh Ladakh where wheat, Barley and Buckwheat were grown. These forced the family members to performed as labours and these family labours are taking their farming activities on rotation basis locally known as " Bais system" to make farm activities in a easy manner. As there is restriction on transportation, the supply chains are also disrupted. Prices for the local produce have rises very high as the vegetables as well as other animal based products from outside state can't be import resulting in consumers to pay more for the same products. Some measures which are taken by the UT government and local governing body, LAHDC Leh, to keep the agricultural sector and supply chains working smoothly are 1), the government has issued SOPs that exempt farm operations and supply chains in the extended lockdown period 2) as lockdown measures have increased, demand has risen for home delivery of groceries but under Ladakh, no any e-commerce sites or apps are available 3) the government has provided Rs.500 per month to the bank accounts of below poverty line families via the Jan Dhan financial inclusion program. But this too is insufficient to fulfil the requirements of a family 4) the UT government and LAHDC, Leh is providing rations including vegetables and pulses at the doorsteps of migrant labours and native households.

Keywords: *COVID-19, Lockdown, Bais System, e-commerce, Ladakh*

Nutritional Aspects of Seabuckthorn to Improve the Livelihood Condition in Gangotri Region

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Abstract

Uttarakhand is rich in cultural and biological diversity. Seabuckthorn is native to Europe and Asia. In uttarakhand, it is reported to exist in abundance in Garhwal Himalayas mainly in Gangotri national park, Badrinath, Yanunotri and Har ki dun etc. Three species, namely *H. rhamnoidesssp.turkestanica, H.salicifolia*and*H.tibetana* have been found in Indian Himalayas. Locally this plant is known as Ames, Chuk and Ameel. The genus name *Hippophae* is derived from Hippo which means, a horse and phao, which means to destroy. The German name of Seabuckthorn–'Sanddorn' may be translated as sand spine. Legends about Seabuckthorn tell that the ancient Greeks used it in the diet of race horses-Pegasus. The genus *Hippophae* is quite abundant in Uttarkashi district. Almost all parts of the plant, particularly fruits and leaves, are very rich in variety of vitamins like A, C, E, K and other bioactive substances like carotenoids, flavonoids and sterols which possess strong nutritional and medicinal properties. The present stydy is an attempt to assess biochemical composition of fruit berries and seeds of this plant species from Uttarkashi district. This kind of information will be helpful for local communities to improve their livelihood in an environmentally sustainable manner while harnessing the potential of this species.

A Study on Use of Banana Leaves for the Treatment of Burn Injuries in Cows

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Abstract

Burn injury is seldom noticed in animals. But it often occurs, when the animal is kept under thatched houses that catches fire accidently. The burns are classified into three groups depending upon depth and extent of injury as first, second and third degree burn injury. Prognosis of burns is favourable in first degree burns as against poor or doubtful in second degree burns, but grave in third degree burns. In this study, three cross-bred cows presented with third degree burn injury with more than 50% of the total body surface area getting involved. One animal died before initiation of treatment due to severe damage to vital parenchymatous organs. Remaining two animals were treated with the application of boil and cooled water to the burnt area. The eyes were flushed with normal saline solution. It was evident that these animals were in a state of shock and dehydration. Both the animals were infused with intravenous solution of Ringers Lactate and Dextrose (5%) for five successive days. To prevent infection and damage by insects and ectoparasites, the burnt skin was covered with clean, fresh banana leaves. Anti-inflammatory drugs, steroids and antibiotics were administered to prevent the inflammatory reactions and secondary bacterial infections respectively. Both the animals did not withstand the treatment and ultimately died within a week's duration. Upon post mortem examination presence of foul smelling fluid in the body cavities was noticed. The PM lesions included congestion of renal parenchyma, myocardium and brain propria. Duodenal ulcers, diffused peritonitis, shrunken brain, enlarged lymph nodes and spleenomegaly were also evidenced during autopsy findings. Cloudy swelling and necrosis of liver was apparently evident. The death could be to attributed to septicaemia and toxaemia. Though the animals succumbed due to internal organ damage, infection of the skin and secondary complications were minimized to considerable extent

Keywords: *Burn injury, Banana leaves, cross bred cows*

Impact of COVID-19 pandemic on food supply chain and food industry

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Abstract

The restrictions on mobility (lockdown) to check the spread of the disease COVID-19, caused by the novel coronavirus (SARS-CoV-2), is disrupting some activities in agriculture, food supply chains and food industries. The food processing industry in India is a sunrise sector that has serves as a vital link between the agricultural and industrial segments of a country's economy. COVID-19 is taking a hard toll on the food and agriculture sector and the largest employer of Agri and food sector is severely affected, because of disruptions in the food supply chain that was induced by the pandemic COVID-19. Before COVID-19, industries were working with their previously laid norms and had their inbuilt properly working supply chain from procurement of raw materials to their processing into finished food items in a smooth profitable manner. However as the pandemic started in the country, the agricultural and food sector experienced heavy disruptions due to the freezing up of the supply chain and the complete lockdown just made it worse before the harvesting season. COVID-19 has affected most of the processes starting from raw material to the consumption of the product because of the lack of available migrant labor is interrupting some harvesting activities, transportation problems and other issues, thus disruptions in supply chains. Perishable raw fruits and vegetables which were for distribution among different food processing industries got spoiled, increased food waste and vulnerable to food system disruption. Prices for wheat, vegetables, and other crops, have declined yet consumers are often paying more. Media reports show that the closure of restaurants, hotels, tea shops, and sweet shops during the lockdown is already depressing milk sales and the misinformation on social media about chickens carrier of COVID-19 have badly hit the poultry farmer and industry. The industry has seen a sudden change in consumption patterns away from the food service sector to meals prepared and consumed at home, a decline in foodservice demand for processed food, a slowdown in food processing activities because of labor and raw material inputs shortages, and a decline in export and import activity. The food processing firms which are more labor intensive are more vulnerable to labour disruptions and need to ensure a safe working environment for food plant workers, with appropriate physical distancing measures. A different supply chain has to be made with more stringent rules and regulations and keeping supply chains functioning well is also crucial to food security.

Keywords: *COVID-19, Perishable, Disruption, Supply chain, Food security*

Plant Breeding Techniques in the Era of Changes

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Abstract

New Plant-Breeding Techniques (NBTs) are methods allowing the development of new plant varieties with desired traits, by modifying the DNA of the seeds and plant cells.These techniques have been developed in the last decades only and have evolved rapidly in recent years. These practices are still continuously evolving .On assessments of the European Commission, the following plant-breeding techniques can currently be considered as the main NBTs viz. 1) Site-Directed Nucleases (SDN) (Viz.,zinc finger nucleases ZFN-1/2/3, Transcription activator-like effector (TALE) nucleases and Clustered Regularly Interspaced Short Palindromic Repeats CRISPR systems) 2) Oligonucleotide Directed Mutagenesis (ODM) 3) Cisgenesis 4) RNA-dependent DNA methylation (RdDM) 5) Grafting (non-GM scion on GM rootstock) 6) Reverse breeding 7) Agro-infiltration. The application of NBTs may lead to three types of plants such as a) containing new DNA, b) without new DNA but with specific mutation in their own DNA, and c) without any genome modification (no new DNA nor mutation). In the case of plants with specific mutations, various types of nucleotide changes may be induced by DNA deletions, DNA insertions or small mutations). NBTs have technical advantages and economic advantages, as the use of these techniques reduce the necessary time for plant breeding compared to conventional approaches. NBTs are a heterogeneous group of methods, the products of which may be treated differently from the point of view of provisions on the use of GMOs. The development of NBTs sparked controversies as to their status from European union (EU) GMO legislation. Since they are not a uniform group of methods, they may be differently classified. In addition, different risks may be connected with their application. In recent years, particular legal controversies have been connected with the application of techniques that utilize precision methods of mutagenesis, such as ODMs and SDNs, and the legal status of their products. Limitations as, it may limit access to innovative technologies for EU breeders and new varieties for farmers. Plant breeders may be enthusiastic about introducing innovative technologies into breeding programs but, it would only be possible if such technologies were not classified as leading to the production of GMOs. So, the developing nations also need to make appropriate policies to feed the increasing population.

Keywords: *New breeding techniques, GMO,ODM, CRISPR*

Isolation and Molecular Characterization of Zinc Solubilising Bacteria and Evaluation of Their Potential to Influence the Growth and Yield of Maize (*Zea mays*)

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Abstract

Plant associated rhizobacteria prevailing in different agro-ecosystems exhibit multiple traits which could be utilized in various aspect of sustainable agriculture. Seventy one zinc solubilising isolates were isolated from rhizospheric soil collected from different regions of Rajasthan, India. Out of 71 isolates, 18 strains were able to solubilise zinc sulphate ($ZnSO_4$), 21 strains were able to solubilise zinc phosphate $Zn_3(PO_4)_2$, 7 strains were able to solubilise zinc carbonate ($ZnCO_3$) and 25 strains were able to solubilise zinc oxide (ZnO). On the basis of best Zinc solubilization index 37 strains were selected for further study. Out of 37 strains, 26 strains were positive for P and 25 strains for K solubilisation. All of them were tested for various PGPR traits like IAA, HCN, ammonia, siderophores and extracellular enzymes like cellulases, proteases and amylases. Results showed that 31 strains showed IAA production, 29 isolates produced ammonia, 16 strains were positive for hydrogen cyanide, 6 isolates produced siderophores, 3 strains exhibited cellulases activity, 20 strains produce protease, 4 strains produce amylase. The strain ZSB-1 and ZSB-17 with maximum Zn solubilisation index 70.8 mm and 65.5 mm. They solubilize all three zinc ore and have best Zn, P, K solubilization efficacy, high IAA, ammonia, siderophore production and hydrolytic enzyme production. The strains enhanced Zn translocation toward grains and increased yield of Maize variety P3441 by 19.01% and 17.64% respectively. The Zn solubilising strains were identified as *Cupriavidus* sp. and *Enterobacter* sp. by 16SrRNA gene sequencing.

Awareness and Approach of People Towards Biomedical Waste and Household Waste Management During COVID-19

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Abstract

Wastes that are generated during diagnosis, treatment, or immunization of human beings or animals or in research activities are the Biomedical wastes (BMW). To regulate the proper disposal and management of biomedical wastes, the Ministry of Environment and Forests has published the Bio-Medical Waste Rules, 1998. The current spread of COVID-19 disease has resulted in the increase of biomedical waste generated per day. Bio Medical Wastes are hazardous very different from other house hold wastes or industrial wastes and can be injurious to humans or animals and deleterious to environment as it can transmit infections, particularly HIV, Hepatitis B and C and Tetanus, to the people who handle it or come in contact with. The management of biomedical waste as well as household waste scientifically is extremely important and this is the biggest challenge in present day times. The present study was conducted in Kashmir valley to obtain baseline information about awareness and attitude of people towards management of biomedical wastes and household waste during COVID-19. In this paper, a well designed and validated questionnaire was used to collect the information from a sample of 400 people chosen randomly from Kashmir valley of J&K region. The data collected was analyzed and tabulated using standard statistical techniques. The results of study revealed that people understudy are aware about biomedical and household waste management but lack in practice. In view of present COVID-19 threat daily waste generated is increasing, but authorities are unable to create facilities required for proper management of such waste. Biomedical waste is not properly managed as garbage is littered on roads and foot paths, thus becoming a source of threat to human life. The shortage of storage bins, absence of waste segregation, and lack of knowledge about disposal of biomedical wastes, inefficient collection and management are the issues. It is concluded that there is an urgent need of giving mass awareness of biomedical waste and household waste disposal practices to the people of Kashmir.

Keywords: *Biomedical waste, Environment, Household waste, Waste Management, Awareness, COVID-19, Kashmir.*

Effect of Surface Sterilants on Survival Rate of *Dalbergia sissoo* Roxb. Through Tissue Culture Technique

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Abstract

Shisham (*Dalbergia sissoo*) has been recognized as a high value timber species of North India. In few last years the heavy mortality of shisham has threatened the existence of this species. The present work was done to evaluate the effect of surface sterilization survival rate of *Dalbergia sissoo* Roxb through tissue culture techniques. Tissue culture is possible for mass production of genetically stable, superior, disease resistance and uniform trees identical to the elite parent trees. The findings of recent investigations have shown that by selecting the best treatment of surface sterilant on *Dalbergia sissoo* can enhance survival rate. By this study we also can gain maximum contamination free cultures. For surface sterilization of the explants different sterilants were tried in various concentrations. The sterilants tried were sodium hypochlorite (4% available chlorine) and mercuric chloride. Two sterilants were tried *viz.* sodium hypochlorite and mercuric chloride for sterilization of explants. Out of various concentrations 0.15% concentration of mercuric chloride helped in obtaining maximum (87%) contamination free cultures. However, maximum survival percentage (39.5) was observed with NaOCl with 20% concentration. 0.10% concentration of $HgCl_2$ showed 69.5% survival and minimum survival (64.2%) was observed in 0.05% $HgCl_2$.

Keywords: *Dalbergia sissoo, Sterilants, In-vitro, Shisham.*

Effect of Microclimate on the Performance of Salad Cucumber Under Naturally Ventilated Polyhouse

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Abstract

A study was conducted to determine the effect of microclimate on the plant growth characteristics and fruit yield of salad cucumber grown in a naturally ventilated polyhouse at PDFC, KCAFT, Tavanur, and Kerela. The crop water requirement of the salad cucumber was determined using the irrigation management and planning model CROPWAT. The calculated total evapotranspiration during the crop period was 264.6 mm. The daily crop water requirement of salad cucumber obtained was 2.84 mm. The microclimate change in a naturally ventilated polyhouse was also evaluated. The results were then discussed with respect to yield of salad cucumber. It was seen that the most suitable temperature range for the optimum crop production is 22 to 33°C and most suitable relative humidity range was 80 to 95%. The irrigation trial was carried out with four levels of irrigation viz. 50, 65, 80 and 95% of daily irrigation requirement. Under the same fertilizer amount, the highest yield was obtained for the treatment with 65% of daily irrigation requirement and the lowest yield was obtained with 50%. This may be due to the reason that plants suffer due to water deficit by limited application of water. Irrigation amount significantly affected irrigation water use efficiency (IWUE). It ranged from 150 kg,/ha-mm to 359 kg/ha-mm. In the fertigation trial, the treatment which applied 100% of fertilizer requirement increased the yield significantly compared to 80, 90 and 110% under the same amount of irrigation. The fruit characteristics and quality did not vary significantly with respect to irrigation and fertigation levels.

Keywords: *Salad Cucumber, CROPWAT, Evapotranspiration, IWUE, Fertigation*

Affect of Covid 19 Pandemic on Agri Start-ups

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Abstract

All over the world, incubators were receiving attention for developing new enterprises in the fields of technology, service, business ideas etc. in research institutions and universities. The Government of India has also attempted to rejuvenate the technology and business development ecosystem in various sectors through its rejuvenated flagship programmes. Before the outbreak of CoVID19 Pandemic, it was sure that the success rate of agri start-ups will rise and Government of India was very keen to support innovative agri start-ups with grant in aid under different categories and already GoI has funded many startups. Now two categories of agri start-ups are in dilemma because of CoVID-19 pandemic. Moreover we can say A virus has upset every aspect of business and agri start-ups are also one of them. First category, who established their start-ups newly and are penetrating their products in the market to acquire clients. Second category who are in a queue to receive grant in aid from GoI to establish their innovative start-ups or potential startups that have a minimum viable product (MVP) based on innovative solutions/ processes / products/ services/ business models in agriculture and allied sector which is ready for commercialization. Now to survive during and post COVID 19 pandemic; agri startups must have to work on main pillars and how to bring changes in the working of these pillars is a big challenge. Team work will play an important role during the situation and decision lies with the founder of the start-up. Revenue is often referred to as the top line because it sits at the top of the income statement and Profitability is the ability of a business to earn a profit. Start-ups needs policy of Cost-cutting which refers to measures implemented by a company to reduce its expenses and improve profitability. Purchase Order collections will play an important role in their survival. Research is needed about the product and new business opportunities as product manufactured by the start-ups needs to satisfy the demand of the customer in the market which is entirely changed due to pandemic. Start-ups need to change their business model and making changes in the existing environment to deliver better products or services for acquiring new clients. Mergers of two or more star-ups is the need of the hour for their survival. Currently start-ups are facing the problem of fund raising and in future it will rise because it is the process of seeking and gathering voluntary financial contributions by engaging individuals, businesses, charitable foundations, or governmental agencies to run start-ups. Grants at this time of juncture are very limited and whatever Govt. is giving is for the start-ups working in the field of PPE (Personal Protective Equipments). Therefore, venture capital funding is the option in startup and small- to medium-sized enterprises. As far as the economy is concerned, The global economy is looking at recession worse than 2008-09 financial crisis. CoVID 19 has already caused a loss of USD 2.7 trillion and still more loss is expected in coming days. Some of the worst affected sectors due to CoVID 19 pandemic includes travel, transportation, airlines, tourism, automobile, luxury goods, retail manufacturing and agriculture as well. Inspite of relaxation for supply of essential commodities, still it may reduce resulting in severe price increase and inflation. To conclude, I must say that during this lockdown the agri startups will not be able to escalate the services and the need of the customer will change. Only one with essential items will be able to start in case they have already setup the network. Post Lockdown and Covid 19 Pandemic will take more time to stable as customer will be more focused on conversation of resources than experimenting with something new.

Mentha Intercropping with Wheat- A Boon for the Farmer's

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Abstract

Wheat (*Triticum aestivum*) belongs to the family of Gramineae. It is grown as a major crop in *rabi* season in district Sambhal. District Sambhal comes under Western U.P. and is the leading agricultural district. Sugarcane, Paddy, wheat, mustard and Urdbean are the main crops of the district. Mentha plays a very significant role in the agricultural economy. The crop is economically significant not only for its contribution to the livelihood of thousands of farmers but also for its highly diversified industrial use in confectionery, cosmetics and pharmaceutical sectors. All category of farmers are growing this crop for eating and selling purposes. Wheat straw also plays a key role as fodder for animals round the year. It is sufficient to state that wheat crop is the lifeline for the farmers of both rural and urban areas. But, due to the increase in the labours and input cost, the declining agriculture land holdings, the wheat-growers are not getting attractive returns. Keeping this in view, agriculture experts provided the production technology through training, field and exposure visits and diagnosed the problems and giving their solutions for promoting the mentha inter cropping with wheat. Study on mentha intercropping with wheat was carried out at farmer's field in the district Sambhal during the year of 2018-19& 2019-20. The study revealed that mentha intercropping with wheat is increasing the income of the farmers. Besides this benefit of mentha intercropping system, it also resulted in increased organic matter in the soil and employment in the rural areas. Due to this increased organic matter in the soil, water holding capacity and sustainability of the soil also improved. The mentha intercropping with wheat may be adopted for most effective profitable than the sole wheat crop.

Repercussion of Covid 19 on Indian Agriculture

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Abstract

India has always been an agricultural hub, characterized by small resources, where bulk of its farmers are small and marginal, depending on subsistence farming, yet they feed 1.3 billion people. Agriculture employs about 55 per cent of the population and contributes roughly 17 per cent to the GDP. India is second in agricultural production, next to China. Now with COVID-19 spreading in India, massive consequences to health and livelihoods are feared, and the government has imposed a national lockdown to limit virus transmission. As of now because of this pandemic each sector of economy has been effected very badly including agriculture, the problems in agriculture at the moment are primarily related to (a) labour availability and, (b) inability to access markets for produce due to issues in transportation as well operation of markets. Agricultural producers are particularly hard hit with returns on produce varying from one-third the usual or a complete loss. In a number of districts, inter-state trade in commercial crops or proximity to urban areas provides market access and better prices. These are often due to initiatives of individual farmers rather than direct state support. The rise in labour costs and lack of access means that farmers are staring at huge losses and hence allowing crops to rot in the fields. India, being trade-surplus on commodities like rice, meat, milk products, tea, honey, horticultural products, etc. may seize the opportunities by exporting such products with a stable agri-exports policy. India's agricultural exports are valued at 38 billion US Dollars in 2018-19 and can rise up further with conducive policies. Development of export-supportive infrastructure and logistics would need investments and support of the private sector that will be in the long term interests of farmers in boosting their income. Many climate models predict a favorable monsoon in the 2020 season (the India Meteorological Department has also since officially announced) as the El-Nino weather phenomenon, that disrupts rainfall in India, is not evident. This is indeed a good news in the COVID scenario, assuming agriculture can practice largely unscathed. Good news is that Government of India has now increased its focus on nutrition (besides food) security and raising farmers' income (rather than enhancing farm productivity). Changing the consumer behavior with suitable programs and incentives is already in the agenda. For all these to happen, the existing landscape of policy incentives that favor the two big staples of wheat and rice has to change. Designing agricultural policies, post-COVID19 scenario, must include these imperatives for a food systems transformation in India.

***Keywords**: GDP, Subsistence farming, Agri- export policy, Pandemic, Nutrition*

To study the effect of iron and manganese on yield, nutrient content and their uptake at various cutting in spinach

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Abstract

In order to boost up crop production per unit area per unit time, increasing emphasis is being laid on cultivation of high yielding varieties of crops, intensive cropping, heavly fertilization and modern techniques of cultivation. In this context, importance of micronutrients can hardly be over emphasized as in many areas their supply in soil, may become a limiting factor in obtaining maximum level of crop yields. A pot experiment was conducted at pot culture yard in department of agriculture chemistry and soil science of RBS College Bichpuri Agra U.P. To study the effect of iron and manganese on yield, nutrients content and their uptake at various cutting in spinach four levels (0, 5, 10, 20 ppm) of each iron and managanes were evaluated in factorial design with three replications. The results revealed that the consistent and significant increase in green foliage and dry matter yield was noted with increasing level of Fe and Mn at various cuttings. The highest green foliage (18.63g/pot) and dry matter yield (2.08g/pot) was recorded with 10 ppm iron and Mn treatments. Higher yield of green foliage and dry matter was noted with the advancement of growth. Highest dose (20ppm) of iron and manganese caused reduction in yield of green foliage, dry matter in both the cutting. Nutrient composition of Spinach plants at both cutting in respect of N.P, Fe. Mn, content was consistently and significantly increased up to (10ppm) dose of iron and manganese level. Thereafter, decrement was noted. Similar trend was noted in nutrient uptake by spinach plants at various cutting. Investigation was also revealed that Fe and Mn has antagonistic relation in respect of their content and uptake in both the cuttings of Spinach plants.

Keywords: *yield, nutrients content uptake spinach crop.*

Agricultural Diversification in India

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Abstract

Agricultural diversification can be described in terms of the shift from the regional dominance of one crop towards the production of a large number of crops to meet the increasing demand of those crops. Diversification reflects a change in business activities based on the flexible and differentiated response to changing opportunities created by new production technology or market signals. Change over from mono crop or a few crops to more crops in a year or more years can also be defined as crop diversification. Agricultural diversification is used as a strategy to reduce risks associated with traditional agriculture and improve returns to investment in it. Better technology, quality seeds, fertilizers, implements, market information and higher level of farm management through intensive crop specific farmer training are some of the critical inputs used for crop diversification. Agricultural diversification is viewed mainly as a measure of enhancing agricultural income of farming households. India is a country of over 1.24 billion people. Nearly 70 percent of India's population lives in rural areas where the main occupation is agriculture. Indian agriculture is characterized by small farm holdings. The average farm size is only 1.57 hectares. Around 93 percent of farmers have land holdings smaller than 4 hectares and they cultivate nearly 55 percent of the arable land. On the other hand, only 1.6 percent of the farmers have operational land holdings above 10 hectares and they utilize 17.4 percent of the total cultivated land. Due to diverse agro climatic conditions in the country, instead of cultivating a few crops varieties of agricultural items are produced. Broadly, these can be classified into two groups - food grains crops and commercial crops. India has tremendous potential to unleash large scale process based farm activities in order to exploit the emerging global agricultural market opportunities. Diversification of agriculture will boost farm income growth. Agricultural diversification plays a vital role in commercializing agriculture and adding value to agricultural produce. The diversity of crops and livestock is neither accidental nor is purely natural. It is more the outcome of thousands of years of deliberate selection, planned exposure to a range of natural conditions, field-level cross-breeding, and other manipulations which farmers have tried out. The Indian farmers did this for one obvious reason: different crop varieties and livestock breeds were adapted to diverse local conditions of growth and survival, which were available in the country. The agricultural production basket consists of food grains, commercial crops, high value commodities and marine products. Among the various items in the food basket, high value commodities such as horticulture (fruits and vegetables) and livestock items (milk, meat, poultry and eggs) find a greater share in the consumption basket of an average Indian. Hence the high value segments hold an important place in the future sources of agricultural growth.

Keywords: *Agriculture, diversification, farmers, products, resources*

Plants Used in Traditional Health Care of Livestocks of Uttarkashi, Garhwal Himalaya

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Abstract

Health and economy are the key features of our life. Livestock are the important part of our economy and therefore their health perspectives are equally important. Majority of farmer community deals with their traditional procedure for healing and treatment for their livestock. Such traditional procedures include ethnoveterinary knowledge. This paper deals some commonly used ethno veterinary medicinal plants used by the farmer community to cure animal disease in Uttarkashi District of Garhwal Himalaya. Four villages, Gewanla, Ganeshpur, Daang and Netala were randomly selected for study. Ethno veterinary information was gathered through individual interviews and personal observations among the farmer community. A total of 45 species ofethno veterinary belongs to 28 families and 40 genera were recorded in the study with the help of ethno veterinary traditional healers. During the survey, it was noted that these ethno veterinary plants used to treat various veterinary diseases such as basic first aid for food poison, indigestion, snake bite, bone fracture, anti bacterial, antifungal activity over cuts and wounds, insect repellent, deworming in cattle, diarrhea, reproduction and increase cattle lactation. The information provided in this study would bring new insights on the development of environment friendly, effective medicines to control veterinary diseases in the future. In addition, this study may be highly useful to protect and conserve medicinal plants as well as traditional knowledge of farmers of Uttarkashi District of Garhwal Himalaya.

Keywords: *Ethno veterinary, Livestock,*

Shelf Life Study of Fruits and Vegetables using Chemical and Natural Preservatives

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Abstract

Fruits and vegetables are rich source of minerals and vitamins and thus, are necessary for nutritionally balanced meal. Fruits and vegetables contain important plant chemicals, calcium and magnesium. The storage life of fruits and vegetables can be greatly increased by different Physical and chemical methods. In view of this an experiment was carried out for increasing the shelf life of Bananas, tomatoes and cucumbers by treating with chemical preservative Calcium chloride, natural preservatives Sodium chloride and lime juice with different steeping time. It was observed that due to pre-treatment increase in pH, TSS and weight loss was lower in bananas, tomatoes and cucumbers treated with Calcium chloride and Sodium chloride as compared to control, there was no significant difference between fruits and vegetables treated with lime juice and control. Shelf life of the Calcium chloride (3%) treated fruits and vegetables with a steeping time of 5 minutes, 10 minutes and Sodium chloride (3%) treated fruits and vegetables with a steeping time of 10 minutes is more compared to control and lime juice treated fruits and vegetables.

Keywords: *Chemical preservative, Calcium chloride, Sodium chloride, pH, TSS*

Performance of different chemical herbicides on weed dynamics, yield and economics in spring planted sugarcane (*Saccharum officinarum* L.)

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Abstract

Sugarcane (*Saccharum officinarum* L.), a principal sugar crop, has significant contribution in Indian agriculture. India is the second largest sugarcane growing country after Brazil. Though Uttar Pradesh is the leading state both in terms of acreage and production, Tamil Nadu has the highest productivity due to the presence of tropical climate which is favorable for its growth. Among all management practices weed control is one of the most important components to achieve higher productivity in sugarcane. Weeds reduce cane yields by competing with crop for light, moisture and nutrients during the growing season. Since sugarcane is a slow growing long duration crop, the initial 120 days is considered as critical for crop-weed competition. Reduction in cane yield due to weeds ranges between 40–67%. Therefore, weed control is most critical early in the season prior to sugarcane canopy closure. The herbicides are the most potent tools to manage weeds but due to deliberate and indiscriminate use it results in resistance weed evolution and environmental pollution causing great threat to human health. A field study was conducted during the year 2017-2018 at Agriculture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (Uttar Pradesh) to study the effect of Diuron applied at 2, 4 leaf of weed in comparison to other herbicides on weed dynamics, yield and economics in sugarcane (*Saccharum officinarum* L.) with an objective of reducing dependency on herbicide by changing the time of application. The experiment was laid out in randomized complete block design with nine treatments and three replications. The treatment consisted of; T_1- Diuron @ 2.4 kg/ha PE(pre-emergence), T_2- Diuron @ 3.2 kg/ha PE, T_3- Diuron @ 2.4 kg/ha 2-4 leaf stage of weed, T_4- Diuron @ 3.2 kg/ha 2-4 leaf stage of weed, T_5Paraquat @ 0.5 kg/ha EPo(Early post-emergence), T_6-2,4-D Na+ salt @ 2.6 kg/ha 2-4 leaf stage of weed, T_7- Metribuzin @ 1.5 kg/ha, T_8 – Hand weeding (60, 90 and 120 DAP) and Untreated control (T_9). The major weed flora such as grassy weeds (*Cynodon dactylon*, *Dactyloctenium aegyptium, Eleusine indica, Digitaria sanguinalis*), broad leaf weeds (*Trianthema monogyna, Phyllanthus niruri*and *Commelina benghalensis* were recorded in the field. *Cyperus rotundus* was the only sedge found in the experimental plot. The results showed distinct superiority of all weed control treatments over the weedy check. Hand weeding was found significantly superior over the rest of the treatments. Application of diuron @ 3.2 kg/ha at 2-4 leaf stage of weed recorded lowest weed density, weed dry matter, weed index, and maximum weed control efficiency amongst the herbicidal treatments. The presence of weed reduces cane yield upto 49.98% in comparison to hand weeding. The highest cane yield (88.81 t/ha) and net return (Rs.194550.60) was obtained with hand weeding, however the highest B: C (2.03) was recorded with the application of diuron 3.2 kg/ha at 2-4 leaf stage of weed.

Keywords: *Diuron, Hand weeding, Herbicide, Sugarcane, Weed Control Efficiency, Weed Index.*

Characterization and Classification of Soils under Different Land Uses in Golaghat District of Assam

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Abstract

A study was conducted in 2018 in the soils of Golaghat district of Assam in order to characterize the soils as influenced by different land uses. Five pedons were selected representing five land uses viz., Forest cover (P1), Paddy cultivation (P2), Tea plantation (P3), Bamboo plantation (P4) & Vegetable cultivation (P5), and analyzed for morphological and physicochemical properties. The soils were dark greyish brown to light grey in colour with dominant hue of 10YR, value ranging from 4 to 7 and chroma ranging from 1 to 6. The soil texture ranged from sandy loam to clayey, and the structure of the soils showed progression of development with depth. Thin patchy clay cutans was observed in the sub-surface horizons of paddy soils (P2). Paddy soil (P2) recorded the highest clay content (weighted mean 41.7%). The silt/silt+clay ratio varied narrowly from 0.36 to 0.76 and the difference in the ratio between any two adjacent horizons within a profile was less than 0.1. The soils were acidic (pH 4.1 to 5.7) with appreciable amount of exchangeable H^+[0.05 to 1.6 cmol(p^+) kg^{-1}] and Al^{3+}[0.05 to 0.87 cmol(p^+) kg^{-1}]. Exchangeable Ca^{2+} was dominant followed by Mg^{2+}, Na^+ and K^+. The CEC was highest in forest soil, P1 [weighted mean 13.7cmol (p^+)kg^{-1}] and the percent base saturation was highest in vegetable soil,P5 (weighted mean 60.86%). Dithionite extractable Fe (Fe_d) varied from 2.54 to 4.45 % and paddy soil recorded the highest Fe_d (weighted mean 3.64%). The co-migration of Fe with clay as evidenced by (clay/Fe_d) ratios followed an increasing trend with few exceptions in case of P1, P2 and P3 pedons. In P4 and P5 pedons the ratios did not follow any consistent pattern with relevance to the different horizons at different depths. Soils were classified as Typic Dystrudepts (P1, P3 and P4), Oxyaquic Hapludalfs (P2) and Aquic Udifluvents (P5) at subgroup level.

Keywords: *Characterization, Classification, cutans, landuses*

Vegetable grafting for environmental sustainability

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Abstract

Grafting is the fusion of plant parts so that vascular continuity is established between them resulting in genetically composite organism which functions as a single plant. Grafting is exclusively done in fruit crops but recently grafting in herbaceous vegetable crops have gained importance. Vegetable grafting is trending in solanaceous and cucurbitaceous crops only, and there is a scope to extend in all other vegetable crops. There are different methods of grafting like cleft grafting, one-cotyledon method, approach grafting, hole insertion method *etc*, which are yet to be standardized for different crops.Commercial grafting of vegetables has started in the early 20th century only, with the aim of managing soil borne pathogens but now, grafting is successfully done to manage many biotic and abiotic factors by using various wild relatives as rootstocks. This sustainable method avoids extensive use of pesticides and chemicals to treat pest and diseases in vegetable crops.*Capsicum annuum* rootstocks with nematode resistance offered effectivecontrol of *Melodogyne incognita* when grafted to a popular commercial bell pepper (Kokalis *et al.,* 2009). It has high adaptability compared to conventional crops due to wild sources of rootstocks. Grafting of a cucumber scion onto a squash rootstock (*Cucurbita moschata*) could tolerate suboptimal temperatures compared with a self-grafted cucumber (Shibuya *et al*., 2007). It also enhances biodiversity by conserving the wild sources of resistance.*Solanum torvum,* wild relative of brinjal was the most effective rootstock for tomato and eggplant against bacterial wilt disease. Increased labour cost, low labour efficiency, spread of seed borne diseases, lack of scion-rootstock compatibility are some of the problems in commercialization of vegetable grafting.Identification of appropriate rootstocks are still a matter of trial and error and the use of specific physiological parameters and molecular techniques to select rootstocks and early detection of incompatible grafts are necessary.Considering the diverse applications of vegetable grafting worldwide, this technique has the potential to boost farmers' income by improving yield and quality of vegetables and by reducing cost incurred through inducing resistance to different biotic and abiotic stresses. Grafting is an sustainable approach which promotes organic vegetable production, mechanization and a good option to earn foreign exchange.

Keywords: *Rootstock, Scion, Grafting, Sustainable*

Bt Cotton in India: An Overview

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Abstract

Cotton is one of the most important fiber crop in India and it is referred as white gold. After China, India is the largest producer and consumer of cotton. Cotton is a long duration crop and is attacked by large number of insect pests throughout its growth and development and the major problem in cotton cultivation is bollworms *i.e* American bollworm (*Helicoverpa armigera*), Pink bollworm (*Pectionphora gossypiella*) and spotted bollworm (*Earias vitella*). Amongst them, Helicoverpa emerged as a key pest all over the country causing as high as 80% losses in cotton and Cotton bolls are highly vulnerable to hidden insects To overcome this problem bt cotton was developed. Bt was first discovered in by Shigetane Ishiwatarias. Earlier Bt has been applied to crops in spray form as an insecticide, containing a mixture of spores and the associated protein crystals. Genetic engineering involves in the production of transgenic cotton. Bt- Cotton was produced by using different gene transfer technologies. There are several regulatory authorities are there to control the bio safety issues regarding transgenic cotton. In India Mahyco, in collaboration with Monsanto, introduced Bt cotton technology into India. Bt cotton, the first genetically modified (GM) crop in India, was initially approved in India on March 26th 2002 for commercial cultivation in six states belonging to southern and central cotton cultivation zones of the country. The first approval for commercial cultivation of Bt cotton in India was granted to three cotton hybrids, MECH-12 Bt, MECH-162 Bt and MECH-184 Bt

Keywords: *Bt-Cotton, Genetic engineering, Cotton Bollworms*

Sahiwal cattle, the Pride of India: An Overview

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Abstract

Livestock is an important and integral part of agriculture sector in India. It plays an important role in the national economy and in the socio-economic development of the country. India mainly as an agriculture based nation where a large portion of population practice farming as a main profession, livestock gives a major contribution in sustaining rural economy of the country. India possesses the largest number of livestock population (20th Census, 2019) in the world as well as its milk production is the highest around the globe. Total cattle population in India is 192.49 million (35.94 % of total livestock population) and India contributed approximately 22% of the total milk production of the world total production. As per the National Bureau of Animal Genetic Resources India have 50 well defined breeds of indigenous cattle. Among them Sahiwal is considered as the best milch dairy breed of the country and is well adapted to the tropical and sub tropical conditions of Indian sub continent. It is recognized by various names as Lola, Montgomery, Lambi-Bar and Multani. It reared by many farmers and dairy owners in India. The original breeding tract of this breed is in the central and southern area of Punjab particularly in Montgomery district in Pakistan. Small herd of Sahiwal cattle are found along the Indo-Pak borders of Ferozpur and Amritsar districts of Punjab and Sri Ganganagar district in Rajasthan. It is also found in some areas of UP and Chattisgarh. Sahiwal is known for low maintenance cost, high milk constituents, disease resistance and endurance to hot climatic conditions of tropics. Average lactation yield of Sahiwal cows is 2325 kilo grams. The lactation yield ranges from 1600 to 2750 Kg. However, selected herds may have higher productivity. Milk yield as high as 6000 lit has been recorded under organized farm conditions. The Age at first calving, first calving interval, service period, first lactation length, first lactation milk yield, 305 days first lactation milk yield and dry period of Sahiwal cattle were ranged 1101.07±8.53 days to 1390.00±3.90 days, 388.4±17.4 to 525.84±7.81 days, 119±3.31 days to 123.73±3.64, 205.98±5.32 days, 1941.59±58.76 kg, 1365.93±81.46 to 2030.19±19.96 and 75.3 days to 272.97±27.82days, respectively. Hence, this dairy breed has higher demand among the indigenous breeds. It is being widely used for the improvement of local stock through upgrading in some state of India. Sahiwal germ-plasm has been imported by more than 17 countries for improvement of their local stocks from India. It has been used for the production of different strains all over the world such as Jamaica hope, Australian milking Zebu, Australian Friesian Sahiwal (AFS) and Patina crosses. In India, Karan Swiss and Frieswal have been developed by crossing Sahiwal with Brown Swiss and Holstein Friesian, respectively. The Sahiwal cattle has an immense production potential with special reference to milk production however, their maximum potential has not been realized due to subsistence production system. The maximum production potential can be achieved by following the cattle improved husbandry practices, which will not only improve the productive and reproductive performance of Sahiwal cattle but also increase the socio-economic conditions of the dairy farmers.

Role of GA_3 and BA in floriculture

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Abstract

Plant growth regulators have quicker impact on vegetative as well as flower yield of flowering crops. As it have various advantages like less time consuming to treat the plant and environment friendly. There are various factors contributing to the efficacy of plant growth regulators among them the method of application plays a key role in determining the effectiveness of plant growth regulators, as PGRs can be effective if properly absorbed by plants. Use of growth regulators in flowering crops must be specific their action and toxicologically and environmentally safe. *Gibberellic acid* (GA_3) and *benzyladenine* (BA) play an important role in growth and developmental processes in floriculture. Combinational treatments of these two hormones have been used in floriculture to improve flower quality. We assessed the effects of combined GA_3 and BA, as well as the individual effects of each hormone, on growth characteristics using soil drench Our results showed positive growth effects, including plant height, days to flowering, first flower height, number of flowers from the application of individual and combined hormones to *R. asiaticus* cultivars and demonstrate a role for these hormones in future bulbous floriculture.

***Keywords**: Plant growth regulators, GA_3, BA, flower quality*

Constraints Perceived by the Farmers in Adoption of IPM Practices in Cauliflower Cultivation in Jaipur District of Rajasthan

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Abstact

Integrated Pest Management is one of such systematic approach which emphasizes not only the reduction in the use of pesticides and keeping below the level of pest causing economic injury but also it facilitates the use of cultural, mechanical, botanical, biological and chemical methods of control in an integrated manner and restores ecological balance for sustainable agriculture. The present study was conducted in the selected Chomu and Bassi tehsils of Jaipur district of Rajasthan. Four villages from each selected tehsil were taken on the basis of maximum area under cauliflower cultivation. Thus, total eight villages were selected for the study. For selection of respondents, comprehensive list of cauliflower growers was prepared and 15 respondents were selected on the basis of maximum area from each selected village. Thus, in all 120 farmers were included in the sample of the study. The major constraints perceived by cauliflower growers was lack of knowledge about pest's life cycle and their infestation on cauliflower followed by Non-availability of Trichoderma at local markets, Lack of proper knowledge about insect- pests damaging stages" and Lack of knowledge about botanical pesticide.

Impact of Climate Change on Crop Production& Food Security

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Abstract

Climate change and agriculture are interrelated processes, both of which take place on a global scale. Climate change affects agriculture in many ways, including through changes in average temperature, rainfall, and climate extremes (e.g., heat waves); changes in pests and diseases; changes in atmospheric carbon dioxide and ground-level ozone concentrations; changes in the nutritional quality of some foods; and changes in sea levels. Climate change is already affecting agriculture, with effects unevenly distributed across the world. Future climate change will likely negatively affect crop productivity in low-latitude countries, while effects in northern latitudes may be positive or negative. Climate change will probably increase the risk of food security for some vulnerable groups, such as the poor. Methods which can be adopted to mitigate the impact of climate change are the implementation of sustainable agricultural practices like Zero Budget Natural Farming (ZBNF), mixed farming etc. The global food system must operate within boundaries for human health and food production to ensure healthy diets from sustainable food systems for nearly 10 billion people by 2050, for this a concept of planetary healthy plate by EAT-Lancet Commission is introduced. A planetary healthy plate should consist by volume of approximately half a plate of vegetables and fruits; the other half, displayed by contribution to calories, should consist of primarily whole grains, plant protein sources, unsaturated plant oils, and (optionally) modest amounts of animal sources of protein.

Keywords: *Climate Change, Food security, Sustainable Agriculture, Crop Productivity*

Measures to Overcome the Effect of Covid-19 on Agriculture

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Abstract

The poor sections of society are always the hardest hit in any disaster or pandemic situation. With about 85 percent of Indian farm households being small and marginal farmers and a significant part of the population being landless farm laborers, welfare measures to contain any damage from COVID-19 are definitely going to help them with sincere implementation However, people living on agriculture and allied activities, mostly those losing their income from informal employment at this lockdown period, have to be provided with cash transfers till the economy bounces back. To sustain the demand for agricultural commodities, small and medium enterprises, running with raw materials from the agriculture and allied sector or otherwise, also need special attention so that the rural economy doesn't collapse. To obviate the immediate concerns of scarcity of farm labor, policies must facilitate easy availability of machinery through state entities, Farmer Producer Organizations (FPOs) or custom hiring centers (CHCs) with suitable incentives. It is also suggested to explore leveraging MNREGA funds to pay part of the farm labor (with farmers paying the balance wage amount) to lessen the monetary burden on the farmer, while ensuring wage employment to the landless laborers and workers. Relaxation of the norms by Agricultural Produce Market Committees (APMCs) allowing farmers to sell their produce beyond the designated mandis will certainly ease the burdens of farmers. State Governments must gear up their machineries for smooth procurement operations of farmers' marketable surpluses at MSP (minimum support price) or through other price support schemes. Agriculture in India is a State subject, and as has been observed in past years, policies and programs vary from one State to the other. However, agricultural activities being interconnected in neighboring regions, agri-sops or benefits must not distort the market scenario. Waiver of farm loans, evidences suggest, have not fully benefitted the majority of small and marginal farmers. Rather, it affects the future credit behavior of the borrowers and thus negatively impacts the agricultural credit culture altogether.

Keywords: *COVID-19, Agriculture, Marketable surpluses, Farmer Producer Organizations, Pandemic.*

Invasion Success and Management Strategies for *Vespula* Wasps

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Abstract

Three species of *Vespula* have become invasive in Australia, New Zealand, and North and South America and continue to spread. These social wasp species can achieve high nest densities, and their behavioral plasticity has led to substantial impacts on recipient communities. Ecologically, they affect all trophic levels, restructuring communities and altering resource flows economically, their main negative effect is associated with pollination and the apicultural industry. Social wasps (Hymenoptera: *Vespidae*) forage for water, pulp, carbohydrates, and animal protein. When hunting, social wasps are opportunistic generalists and use a variety of mechanisms to locate and choose prey. Individual foragers are influenced by past foraging experience and by the presence of other foragers on resources. A forager's ability to learn odors and landmarks, which direct its return to foraging sites. Insect species associated with human goods continue to be accidentally introduced into new locations. A small proportion of these introduced species become invasive, causing a range of impacts in the receiving community. Traps are effective in the spring to catch queens and, later in the season, to catch workers. Each queen caught in spring may dramatically reduce wasp populations in late summer and fall. Attractants for these traps may include heptyl butyrate, meat, pet food, fish, or rotting fruit.

Keywords: *Social wasp, Foraging behavior, Invasive species, Management*.

Recent Advances of Nitrogen Management in Rice

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Abstract

Rice is one of the major cereal crops next to wheat contributing the highest area and second in production by our country. Out of various limiting factors that affect the yield of the crop, nitrogen is an important one. To feed the ever burgeoning population we need to produce more. The production of nitrogenous fertilizer is costly, high energy requiring and subjected to various losses. Nitrogen is the key nutrient that most frequently limits the rice production (Singh *et al.* 2015). So to increase the B:C ratio of the production practices, successful N management strategy is required which can optimize crop yields and increase profitability and minimize N leakage to the environment. It is a sensitive indicator for the dynamic changes in plant nitrogen, so monitoring of nitrogen status during the crop growing period is essential to achieve efficient N fertilizer management and higher grain yield in rice (Singh *et al.* 2015). Since, most rice farmers do not generally use the method of direct measurement of leaf N concentration due to its time consuming procedures (10-14 days), so a simple, rapid, and reliable field scale method is necessary to detect the leaf N status and predict the precise time and rate of nitrogen fertilizer for top dressing to increase the nitrogen use efficiency in rice field and increase the yield. Ali (2005) reported that the requirement of N fertilizer based on SPAD reading was found 15 and 40 kg N/ha lower compared to conventional N management during wet and dry seasons, respectively. Also, the SPAD meter- based N management appeared to be more efficient and would save 20-30 kg N/ha than the conventional N management practices to produce similar grain yield (Miah and Ahmed, 2002). Recent advancements in nutrient management strategies such as use of LCC, SPAD, Green Seeker, etc. are required to be used for increasing the efficiency of the N applied to the rice crop which will ultimately boost the yield and increase the production. A good source with an efficient technique of application is required to meet the demand of the rice crop to feed at the right time to boost the production of rice.

Keywords: *LCC, SPAD, Green Seeker*

COVID-19 impacts on agriculture, food security and mitigation measures

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Abstract

The lockdown has choked off almost all economic activity. The complete shutdown of all economic activities is created an economic crisis and misery for the poor, with massive job losses and rising food insecurity. The economic shock will likely be much more severe for India, for the two reasons *viz.,* firstly, pre-COVID-19, the economy was already slowing down, compounding existing problems of unemployment, low incomes, rural distress, malnutrition, and widespread inequality and secondly, India's large informal sector is particularly vulnerable. Under such circumstances, the critical challenge is making the food grains, fruits and vegetables and other essential items available to consumers, both in rural and urban areas by Government machinery. For the mitigation measures, smooth functioning of the supply chain, with adequate safety measures for the people involved, is of paramount importance. Transportation of public distribution system (PDS) items to the last mile delivery agents has to be ensured by respective Government agencies. Distribution of the commodities to vulnerable population, while maintaining prescribed guidelines and protocol, particularly of social distancing, must be effectively monitored. For the sustaining demand of agricultural commodities, investments in key logistics must be enhanced. Moreover, e-commerce and delivery companies and start-ups need to be encouraged with suitable policies and incentives. The small and medium enterprises, running with raw materials from the agriculture and allied sector or otherwise, also need special attention so that the rural economy doesn't collapse. Furthermore, to obviate the immediate concerns of scarcity of farm labour, policies must facilitate easy availability of machinery through state entities, Farmer Producer Organizations (FPOs) or custom hiring centres (CHCs) with suitable incentives and given the precarious livelihoods of many Indians, agriculture, food security, and safety net policy and program responses are also urgently required.

Keywords: *COVID-19, agriculture, food, security.*

Resource management through foliar feeding for increasing the pulse production – A review

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Abstract

Pulses, an amazing gift of nature belonging to Fabaceae family also known as 'poor man's vegetable' is rich in proteins, complex carbohydrates, micronutrients, minerals, vitamins and bioactive compounds. Of the diverse sources of protein available, pulses play an irreplaceable role in the day to day food chart of Indians. In general, pulses are having low productivity compared to cereals thus retaining a gap between the demand and supply of this protein rich food. For increasing the pulse productivity and to provide balanced nutrition, additional nutrition through foliar feeding has vital role by stimulating root development, nodulation, energy transformation, various metabolic processes and increasing pod setting and thereby increasing the productivity. It is the practice of spraying fertilizers or plant growth regulators directly onto the foliage in the form of aqueous solutions raising the pulse productivity that is constrained by both biotic and abiotic stresses. Soil fertilization supplemented with foliar feeding helps in realizing quality yield of pulses by increasing the number of seeds per pod, pod length and number of pods per plant which can be attributed to improved photosynthate translocation from source to sink (Thakur et al., 2017). The efficacy of foliar nutrition is due to rapid and nearly complete absorption of nutrients through stomatal openings and cuticles, eliminating leaching losses and fixation, resulting in fast remediation of prompt plant nutrient deficiency (Manonmani and Srimathi, 2009). It is more promising in situations where, roots are incapable of absorbing required amount of nutrients from soil due to lack of available soil moisture, excess losses from leaching, low soil temperature and high degree of fixation. An yield increase from 12 to 25 per cent has been obtained in waterlogged and water deficit areas through foliar nutrition (Deol et al., 2018). Apart from the benefits enjoyed by the plant, foliar feeding lowers environmental pollution due to reduced amounts of fertilizers added to soil (Abou El-Nour, 2002).Foliar nutrition becomes more fruitful if the crop growth stage, soil and crop health and meteorological conditions are taken into consideration. Rainfall, humidity, temperature, time of day and wind speed influence the physical and biological aspects of foliar feeding by affecting plant tissue permeability. Spraying should be done before 9.00 am or after 6.00 pm with a temperature optimum of 21^{o}C, humidity not more than 70 per cent and wind velocity of less than 7.5 kmph. For achieving self-sufficiency in pulses by 2050, there is a need to increase its production to 30.5 million tonnes. To reach the target of narrowing the yield gap, foliar feeding is a viable option. It has the potential to deal with physiological limitations of pulses and enhance their productivity. Foliar feeding shall prove a blessing for Indian farming and may pave way for another pulse revolution and provide support to boost agricultural production and export.

Keywords: *Balanced nutrition, demand supply gap, foliar feeding, plant growth regulators, pulses, yield*

Covid-19 Probable Impacts on Post Harvest Management: Agriculture

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Abstract

The world population is increasing faster than the growth in the food supply, and the resources used for creating food are all becoming increasingly scarce. Reducing postharvest food losses must be an essential component in any strategy to make more food available without increasing the burden on the natural environment. In both developed countries and less developed countries (LDCs), incentives are needed to encourage the reduction of 'postharvest loss' (PHLs) and food waste. In developed countries, losses close to the farm are considered to be relatively low and any further reduction is subject to commercial priorities. Losses by food processors and retailers are constrained by the financial costs of disposing waste via land-fills or incineration. There are ideas to reduce PHLs and food waste that are worth exploring include, Consumer education campaigns to increase knowledge and awareness of appropriate portion sizes, food purchasing skills, meal planning, using left- over, what is safe to eat, food discard behavior and interpreting sell-by or use-by dates, Tax foods with the highest waste to increase their income elasticity, Increase cost of and tax on waste disposal, particularly food by-products and food waste, Develop private (e.g. retail, community groups and waste industry) and public sector (local, state and Federal governments) partnerships to jointly reduce food waste and share responsibility. In LDCs, the incentives to reduce PHLs are much greater as loss reductions can directly improve the livelihoods and food security of the poor, and, potentially, food safety and quality with associated health benefits. Further, adopting improved methods, especially mechanization, can liberate time to spend on more profitable off-farm activities. Looking forward, it would be beneficial for developed countries to provide national estimates of food waste and information on where to target re-sources to decrease food waste efficiently. For LDCs, there is a wide range of priority areas for further research effort but key among these must be studies on the implications of climate change for on-farm PHLs and options for smallholder adaptation, and the development of an authoritative approach to cost–benefit analysis for postharvest interventions, in order to guide policy making and the efficient use of resources.

Keywords: *Postharvest Loss, Less Developed Countries, Food Safety*

Covid-19 Impact: Rise of Reforms in Indian Agriculture for Sustainibility

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Abstract

The COVID-19 is not just global health crisis but has led to cataclysmic economic failure in the world directly and also because of requisite preventive measures taken to avoid widespread contamination. Agriculture and Food Security of the world are no exceptions to devastating impacts of the pandemic. India has experienced decrease in GDP from Agriculture to 4546.58 INR Billion in the second quarter of 2020 from 5306.26 INR Billion in the first quarter of 2020. India's retail price inflation climbed to 6.93 percent yeariy in July 2020 as food prices continued to increase (9.62 percent vs 2.36 percent in July 2019) due to disrupted supply chains of agro-food products to markets and consumers, both within and across borders and also a substantial shift in the composition of the demand. Along with that COVID-19 has caused crack in the economic backbone of India i.e. agriculture due to loss of labour, lack of income to get resources, reduced availibility of resources (due to restricted access to Kisan mela, Seed banks, mandi, lack of literacy to get virtual aid), post harvest loss due to lack of demand of certain commodities due to lifestyle changes out of unawareness like poultry and meat, increased prices due to hoarding, decreased production of processed food due to closed factories during lockdown.Which led to farmer's suicide due to losses and increment poverty due to lack of food or lack of affordability of food. Government policies subsidies, loans, concession during lockdown (transport and market) and subsidized health care have succoured the farmers. Government has aided an extention in crop loan repayment period and also a working capital limit of Rs 6,700 crore for the procurement of agriculture produce of state government entities has been sanctioned since March 2020. Need of the hour to mitigate the crisis among financial aid awareness is to take preventive measure during handling of goods, mechanization of farms and factories and training of farmers to use machines and technology. Along with preventing spread of virus during different activities, prevention from ill practices like hoarding and selling at increased price (by introducing maximum price for commodities to prevent unreasonable prices), more testing in rural regions and providing subsidized treatment, strict rules for human, resource and waste management, compensation for losses, introducing new and efficient practices to prevent farm and post harvest losses. Although the COVID-19 pandemic gave rise to some onerous challenges for the existing food and agriculture system, but it acts an opportunity to expedite reforms in the agriculture and allied sector to augment its resilience and sustainibility in the face of a range of future challenges.

Keywords: *COVID-19, agriculture, food security, sustainable development*

Soil Acidity Tolerance in Crop Plants

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Abstract

Acid soils occur primarily in hilly areas with high rainfall and low pH range (pH 4.0–5.5). Soil acidity leads to reduce in plant growth and its productivity due to several micronutrient deficiency and toxicity. Phosphorus deficiency and aluminium toxicity are the important micronutrients co-exist in acid soil. The toxic effects of acids soils are due to the interaction between low pH and elements present in the soil Addition of lime neutralizes soil acidity, increases microbial activity and nutrient availability and improves the physical condition of soil. In North East region of India, about 21 million ha of soils are acidic in nature. To harness the genetic mechanisms involved in acidity tolerance in crop plants, several molecular breeding approaches have been employed. For developing acid soil tolerant crop plant, it is important to collect the land races from the region with known low pH. So, for acidity tolerance it is require to acquaint a thorough knowledge of the key genes involved in root development and nutrient transport in crop plants. Such approaches will lead to provide new resource for further improvement of crop plants in soil acidity tolerance through molecular breeding.

Keywords: *Soil, Acidity, Tolerance, Crop plants, low pH*

Impact of Covid-19 on Agriculture and Livelihood Security

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Abstract

In India and all over the world, COVID-19 has major issues that affect the life of human being. In India, there are total 4.2 million people get affected till date (7 March 2020). The COVID-19 specially effect the Agricultural sector as well as Farmer's income in India. Indian government's order to lock down the country to rein in the pandemic has already had major economic and social impacts, particularly for informal sector workers whose livelihoods, health, safety, and food security have been compromised. Agriculture is also facing the similar problems due to Lockdown like crop management, labour intensive work, including marketing of crop produced etc. The situation is very crucial for smallholder farmers, who account approximately 86% of the population in India and contribute significantly to the nation's food security and productivity. Due to present restrictions, not only have they lost their farm income, but also their daily wage incomes. The migration of farm labour, lack of access to farm machinery due to transport restrictions and the lack of access to markets, especially in a situation where most wholesale markets are shut down, means that farmers are unable to sell even the products that they're able to harvest. This is a particularly tough situation for farmers growing perishable commodities such as horticulture crops, many of whom are having to dump their bounty due to the lack of buyers and post-harvest storage facilities. Governments, private sectors, and development institutions must develop a new framework of collaboration and come together in innovative ways to engage in reconstruction efforts, mitigate the economic disruption and formulate a post-COVID world while ensuring our farmer livelihoods and food systems are preserved.

Keywords: *covid-19, agriculture, lovelihood security*

Impact of COVID-19 on agricultural sector and socio-economic conditions of the farming community of district Poonch (J&K)

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Abstract

Agriculture is the mainstay in district Poonch where more than 85 *per cent of its rural households still depend primarily on agriculture for their livelihood*. Lockdown had a serious impact on Agriculture related activities. KrishiVigyan Kendra – Poonchundertook a rapid phone-based survey during the month of August 2020to study the impact of COVID-19 on agricultural sector and socio economic conditions of the farming community. 40 farmers from fourblocks of district viz. Haveli, Loran, Mendhar and Surankot were surveyed as per a questionnaire framed for the purpose of study.The farmers were examined based on questions regarding i) labour and harvesting equipment's availability during lockdown ii) transportation of produce iii) marketing of produce fresh vegetables, fresh fruits, dairy products, rabi crop produce iv) input availability (seed and fertilizer ii) Extension services. Out of 40 farmers, 32 farmers i.e 80 per cent faced labour and harvesting equipment's issues during lockdown. The survey revealed that around 50 percent farmers faced problems in transportation of produce. Farmers also reported of major disruptions in marketing and sale of their farm produce as around 65 percent vegetable growers and 36 percent dairy farmers were among the worst sufferer as they failed to reach the market during lockdown period**.**Only 10 per cent farmers reported problem in sale of rabi crop produce.The Government took timely steps before the start of kharif season and seed availability was ensured in each block of the district. Only 15 per cent farmers reported difficulty in availability of seed whereas 30 per cent farmers complained of inadequate fertilizer availability. The Extension services were also badly affected as 40 per cent farmers could not get timely access to Extension services.

Key words: *COVID-19, Lockdown, Agriculture, input availability, Economic Impact*

Mango Fruit an Agricultural Commodity in Northern India Supply Chain Merchandise

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Abstract

Mango is the most important commercially grown fruit crop of the country. It is called the king of fruits and accounts for 40.48% share in world total production. Northern India has the richest collection of mango cultivars. In India mangoes are available in various shapes, sizes and colors with a wide variety of flavor, aroma and taste. This mango is the special product that substantiates the high standards of quality and bountiful of nutrients packed in it. Mangoes of this region accounts for approximately half of all tropical fruits produced and is considered as the main wholesale market for mangoes. This paper attempts to study post harvest measures adopted for fresh and raw fruit with market in the existing supply chain and suggestions to generate better income to farmers and traders.

Keywords*:* Mango, Supply Chain, Post Harvest, Northern India, Farmer, Market

Efficient management of sugarcane based intercropping practices for crop diversification, sustainable productivity, improving soil health and environmental quality

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Abstract

Crop diversification has witnessed paradigm shift which encompasses several concepts to accommodate the intercrops with sugarcane in space and time for vertical land productivity. The present study was pursuedat ICAR-IISR, Lucknow with objective to identify the most) compatible, efficient and remunerative pulses for intercropping with sugarcane. There is very slow growth of sugarcane in the initial months of planting, as it takes approximately30-35 days to germinate in spring and even more time during autumn season. The crop takes further 100 days to develop full canopy to cover entire inter-row spaces. Thus, it offers a good opportunity for the cultivation of pulse crops as intercrops in this space without affecting the growth of sugarcane. Pulse crops, having shorter maturity period, short and erect statured nature of the crop and no competition between component crops for natural and applied resources at any point of time are the most suitable crops for intercropping with sugarcane. Intercropping of pulse crops in sugarcane ensures efficient utilization of inter-row spaces and vertical increase in land productivity.Sugarcane as well as pulse crops meet the multiple needs of the farmers through mixed farming enterprises.Pulse crops generate mid-season income from intercrops for better management of sugarcane, *per se*.Intercropping of pulses in sugarcane ensures regular on-farm employment and income generating opportunities especially for women and children.This system also ensures savings in market purchased inputs through integrated nutrient management.This system also ensures proofing against risk due to aberrant weather conditions, disease and insect pests.This system has also been found helpful in controlling weeds through sufficient canopy developed by intercrops during germination phase or later.Intercropping of pulses in sugarcane provides high yielding environment to pulses which otherwise are grown under sub-marginal conditions.Growing legumes in rotation and incorporation of legume residues after picking of pods also significantly improve the yield of main crop, sugarcane. Incorporation of spring mungbean residues after picking pods economized 60 kg N/ha.The association of pulse roots with Vesicular-arbuscular mycorrhiza (use as bio-fertilizer) fungi helps to increase the availability of water and nutrients to plants.Pulse crops also contribute significantly in reducing the Greenhouse gases*i.e.,* water vapour, carbon dioxide, methane, ozone, nitrous oxide and chlorofluorocarbons, *etc.*Intercropping of pulses in the prevailing cropping systems is must for sustaining and improving the productivity, soil health, environment and quality of produce. Pulses with sugarcane intercropping uses and availability to short duration/short stature photo-insensitive crop with resistance to biotic and abiotic stresses has very high potential for diversification of cropping systems and enhancing the productivity andCrop residue recycling *vis-à-vis* maintenance of soil health. Thus, intercropping of pulses with sugarcane will play pro-active and decisive role in developing sustainable production system and food, nutritional and environmental security, It would facilitate in raising the land utilization efficiency, declining the cost of production, economizing the use of market purchased costly inputs and making plant-ratoon system sustainable which ultimately helps in raising the socio-economic status of small and marginal resource constrained farmers and generates plenty of employment opportunities especially for rural women and youth.

Keywords: *Crop diversification, Resource use efficiency, Soil health, Greenhouse gases, Food and nutritional security*

Cadmium tolerant PGPR as agricultural diversifier: An innovative strategy for maintaining soil's health and environmental sustainability.

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Abstract

The plant root colonizing bacteria which enhance its growth and yield are known as Plant Growth Promoting Rhizobacteria (PGPR). They stimulate plant's overall growth by ammonia production, siderophore production, IAA secretion, phosphate solubilization etc. In this study 25 PGPR strains were isolated from Paper mill effluent infested soil and thencadmium tolerance level was examined. The rhizospheric soil's chemical analysis was also done by conventional methods. After that on the basis of best PGPR performance and definitely heavy metal tolerance, 2 PGPRs were selected and were applied on Capsicum annuum L. plants under cadmium stress. The results obtained from the experiment indicates that those 2 PGPRs increased the overall plant growth under cadmium stress condition to a higher extent. So, it can be concluded that both the PGPRs might be safely used as biofertilizer on chilli plants under cadmium stressed condition and this can cause agricultural diversification and it will definitely open an innovative way for betterment of soil heath and sustainable environment.

Keywords: *Cadmium, PGPR, IAA, biofertilizer, sustainable, agriculture*

Aftermath of COVID-19 Pandemic on Indian Agriculture: Unprecedented Challenges and Its Mitigating Strategies

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Abstract

The unending health crisis of COVID-19 has affected every spheres of life, starting from health, education, economy to employment. In this series, agriculture sector is not an exception. Indian farmers persistently battle against skewed monsoon and irregular rainfall, risky natural events, interrupted supply chains and rising inflation. These plights now are supplemented by the COVID induced lockdowns. Worse affected sections are majority of small and marginal farmers. Disruption in the supply chain, labour shortage due to reverse migration, fall in the crop prices, restriction in export and import, peak rabi harvest with very little or no procurement, financial problems etc. are some of the immediate challenges before Indian agriculture posed by this pandemic that need immediate attention. These have directly or indirectly affected the food and nutritional security of the farming families. In order to mitigate these unprecedented challenges, government has introduced a number of measures including crop insurance to farmers, free flow of agricultural credit, unemployment allowance to rural landless/migrant workers under MANREGA, etc. Reforming e-NAM, virtual trade platform with foreign countries, boosting contract farming, allocation of direct transfers, popularizing direct marketing, technological support in the form of development of Kisan Sabha App are some of the worth mentioning strategies. Sustaining in this new normal situation needs out of box thinking and there is a biggerprerequisite for government support in the form of provision for other agricultural inputs. Maximising the possibilities of agriculture is the pressing priority, which has demonstrated its utility and resilience in trying times.

Keywords: *COVID Pandemic, Agriculture, Farmers' Challenges, Government strategies*

Rural Environmental Planning - An Approach to Environmental Sustainability

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Abstract

India is the second most populated and seventh largest country in the world, India faces an entirely different scale of environmental challenges than its neighbouring countries. Sustainability defined as the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, WCED, 1988). Environmental sustainability can be achieved only through proper Rural Environmental Planning (REP), It includes subthemes: technological innovation, tools and public policies, value added and regional development. Public management and policy instruments guided the farmer in the new environmental compliance processes of the farm such as the Rural Environmental Registry or provided assistance to the legal framework of recently implemented policies and laws. Some kind of technological innovation investigated the production systems already developed in the Farm and researched technical improvement measures and better process efficiency opportunities, such as improvement in irrigation systems and implementation of rainwater catchment systems. The thematic of added value was addressed in the projects to couple economic development with environmental conservation, focusing on the generation of by-products from the agricultural production units. The regional development subtheme assembled proposals that presented a landscape-scale analysis and promote Eco tourism, through these sub themes developed under Rural Environmental Planning encompassed integrated environmental conservation, social responsibility and economic returns, each one with its own specificity.

Keywords: *Sustainability, Rural Environmental Planning, Rural Development*

Impact of Polyethylene Mulch on Growth and Yield of Tomato (*Solanum lycopersicum* L.) in Sub tropical condition

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Abstract

Now-a-days there is need to get more yield and reducing the cost of cultivation by intervention of novel agri-technologies. Tomato is the most important vegetable crop in India. Growing tomato on raised bed with stakingproduced qualitative/ marketable morefruit yield by reducing infestation of insects and diseasesthan conventional practices. Mulching is the process or practice of covering the soil/ground to make more favourable conditions for plant growth, development and efficient crop production. The use of black polyethylene mulch in vegetable production has been reported to control the weed incidence, reduces infestation of insects and diseases, reduces nutrient losses and improves the hydro thermal regimes of soil. However, there is a need to study more regardingthe effect of polyethylene mulch ongrowth and yield of tomato. Therefore, the present investigation was undertaken to study the effect of polyethylene mulch on growthandyield of tomato.Keeping in view, an experiment was carried out rabi season 2016-17 at farmer's field of Lucknow district using black polyethylene mulch against afarmer practice(uncovered control) on growthand yield of tomato. The results revealed that application of black polyethylene significantly increased the growth parameters like plant height, number of branches and stem diameter, etc. as compared to farmer practice. It's indicatedthat27.5% increasing in marketable yieldas compared to control (farmer practice).

Keywords: *Polyethylene mulch, growth, yield, tomato Mulching.*

Roof Top Gardening: Viable option for Nutritional Security in Urban areas

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Abstract

As the rate of urbanisation increases over time, food production sites should be increasingly located near main consumption centres. Cities have effectively driven out agriculture from their boundaries. . Food arrives in the city from hundreds of miles away. It is often neither fresh nor good. Pesticides and preservatives may also diminish the health and value of produce. A roof top gardening is a practice of developing garden on the roof of building besides decorative benefits and which may roof plantings may provide food, temperature control, hydrological benefits, architectural enhancement habitat or corridors for wild life, recreational opportunities and in large scale, it may even have ecological benefits too. With these two distinct phenomena it may shape our planet however more than half of the world's urbanized human population besides addressing global warming induced climate change. An available gardening area in cities around houses is seriously lacking which give us scope to promote or develop roof gardens. Modern cities, in ecological terms, have become parasitic energy and resource 'sinks,' consuming 75% of the world's resources on only 2% of the global land area. In this way, roof top farming is one such solution to meet growing demand of safe and healthy food, improving air quality, heat influx, etc. Rooftops are places of fantasy and imagination – places that sit above the pollution free area of the city, engaged with and yet apart from the city's motion. Urban agriculture is gaining relevance all over the world due to its ability to provide direct benefits (food), but also provides some indirect ecosystem services at a macro level (conservation of biodiversity). The majority of the population, nearly 66% (about 30.4 lakh) lives in urban area of Lucknow district and 34% (about 15.5 lakh) population live in the rural area. This study presents a survey and introduction of roof top gardening in Lucknow district of Uttar Pradesh, India and exhibits its importance pertaining to ecosystem services and nutritional security perspectives. The present study was conducted during 2016-17, 2017-18, 2018-19, 2019-20 in urban areas of the Lucknow district to popularise roof top farming in cities through outreach programmes, capacity building and policy interventions. In this study, a total of 150 household families were surveyed, and out of which 125 household families were selected randomly in five groups of 25-25 households. Accordingly, organized training programmes for creating awareness & capacity building on roof top gardening in urban areas for home consumption.Provided seed & planting materials of suitable vegetables, advisory services and method demonstration at every household level. Out of 125 household, 63 urban women's were motivated who later on adopted the technology of roof top kitchen gardening to produce fresh vegetable for home consumption.

***Keywords**: Roof Top Gardening, nutritional security, Urban areas, Adoption of technology.*

Thermal response of potato under different sowing dates and organic mulches in North East India

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Abstract

An experiment was conducted at upland agronomy farm, CPGSAS, Central Agricultural University, Umiam under rice fallows on potato crop. There was 15 number of treatments with 3 replications under split plot design with 3 straw mulch (M1- Rice straw mulch, M2- Weed straw mulch and M3- No mulch) and 5 dates of sowing (S1- 5th -November, S2- 20th November, S3- 5th December, S4- 20th December and S5- 4th January). The experimental results shown that application of diverse organic mulches and dates of sowing has significant impacts on different growth and developmentparameters of potato crop. The application of organic straw mulch has increased in the rate of potato emergences as well as on other parameters.

Keywords: *Rice, Potato, Mulch, Thermal response, Growth and Development.*

Mineralization pattern of organic mulches in potato undervalley lands of North East India

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Abstract

An experiment was conducted at upland agronomy farm, CPGSAS, Central Agricultural University, Umiam under rice fallows on potato crop. There was 15 number of treatments with 3 replications under split plot design with 3 straw mulch (M1- Rice straw mulch, M2- Weed straw mulch and M3- No mulch) and 5 dates of sowing (S1- 5th -November, S2- 20th November, S3- 5th December, S4- 20th December and S5- 4th January). The experimental results on mineralization patterns of soil incubated organic straw mulches have been shown variability in nutrient release at different time interval. The application of organic straw mulches shows a slow nutrient release pattern at initial stages and increased at later stages of potato crop growth.

Keywords: *Rice fallows, Potato crop, Rice straw, Weed straw, Mineralization.*

Integrated Farming Systems: An approach for livelihood Security of small and marginal farmers

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Abstract

Indian agriculture has been shouldering the responsibility of providing food and nutrition to its teeming millions. Ensuring food security for a fast growing global population estimated at 9.1 billion in 2050 and over 10 billion by the end of the twenty first century is a mammoth challenge for the present agricultural production system. India has around 18% of the world population, 15% of the world livestock with only 2.3% of the total geographical area and 0.5% of pasture and grazing lands. Nearly 65% of the Indian population is dependent upon agriculture and 80% of the farmers cultivate less than one ha land holding (Singh, 2009). In the past, farmers were concentrated mainly on crop production which was subjected to a high degree of uncertainty in income and employment of the farmers. The current scenario in the country indicates that area under cultivation may further dwindle and more than 20% of current cultivable area will be converted for non-agricultural purposes by 2030 (Gill *et al.,* 2005). Apart from this, 39% of the area has soil loss rates more than the permissible levels and 11% of the area falls in the very severe category where soil loss has more than 40 t/ha/yr, resulting in reduced productivity (Venkateswarlu and Prasad, 2012). It may also be noted that climatic is changing and its variations are recognized as one of the major factors contributing to land degradation. These statistics emphasize that pressure on the land is increasing rapidly and land degradation is also on the rise. Widespread occurrence of ill-effects of green revolution technologies in all intensively cultivated areas like Punjab and Haryana are threatening the sustainability of agricultural production systems and national food security. The gradual declining trend in size of land holding poses a serious challenge to the sustainability and profitability of the farming. The average size of the land holding has declined to 1.16 ha during 2010-11 from 2.28 ha in 1970-71. If this trend continues, the average size of holding in India would be mere 0.68 ha in 2020 and would be further reduced to 0.32 ha in 2030 (Agriculture Census, 2010-11).This situation in India calls for an integrated effort to address the emerging livelihood issues. It is imperative to develop strategies and agricultural technologies that enable adequate income and employment generation, especially for small and marginal farmers who constitute more than 85 per cent of the farming community. The integrated farming system approach is considered to be the most powerful tool for enhancing the profitability of small and marginal farmers. These integrated farming systems required to be planned, designed, analyzed and implemented for increasing productivity, profitability and sustainability of the farm. These systems also need to be socially acceptable, economically viable and eco-friendly. Integration of enterprises lead to greater dividends than single enterprise based farming, especially for small and marginal farmers. It also leads to improvement in nutritional quality of daily diet of farmers.There are 115 million operational holdings in the country and about 80 % are marginal and small farmers. To fulfill the basic needs of house hold including food (cereal, pulses, oilseeds, milk, fruit, honey, meat, etc.), feed, fodder, fiber, etc., an attention about Integrated Farming System (IFS) is very important. Undoubtedly, majority of the farmers are doing farming since long back but their main focus based on individual component basis, not in an integrated manner of those components.

Keywords: *Integrated Farming System, Small and marginal farmers.*

Studies on variability, heritability and genectic advance of brinjal (*Solanum melongena* L.) for different yield attributing characters

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Abstract

The mean, range, phenotypic coefficient of variation (PCV), Genotypic coefficient of variation (GCV), heritability, genetic advance and genetic advance as per cent of mean were worked for the selection superior crosses in the F_2 generation. The phenotypic and genotypic coefficient of variation were high for the characters like number of fruits per plant, fruit yield per plant, little leaf incidence (%) and shoot and fruit borer infestation (%). The heritability (broad sense) were found high for the characters studied *i.e.,* plant height (96.82%), days to 50% flowering(99.81%), fruit length (99.81%), number of fruits per plant(66.20%), fruit yield per plant (96.81%), days to final harvesting(74.80%), little leaf incidence (74.59%) and shoot and fruit borer infestation(91.32%). The genetic advance was high for days to final harvesting (21.42%) and the genetic advance as per cent of mean were high for the characters like days to 50% flowering(25.50%), fruit length(23.71%), number of fruits per plant (23.66%), fruit yield per plant(59.67%), little leaf incidence (32.20%) and shoot and fruit borer infestation (45.08%).

Keywords: *Brinjal, PCV, GCV, heritability, genetic advance and GAM.*

Strategies to up-scaling fodder production to sustain livestock demand: A need of hours

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Abstract

Livestock production and profitability largely depends on quality feeds. It can only meet through availability of good quality fodder in balanced ratio. Indian accounts for >530 million animal population which is the world's largest. Being the leader there is increasing livestock population at a rate of 1.23 % per year current fodder production in our country is not able to meet the requirement. Thus there is large demand on one hand deficit on other hand. According to an estimate the shortages in dry fodder, green fodder and concentrates are 40.4 per cent, 24.7 per cent and 47.1 per cent against the requirements of 650.7, 761.5 and 79.4 million tones for the current livestock population, respectively. The pattern of deficit varies in different parts of the country. Though, India cultivated 8.3 million ha of fodder on individual crop basis approximately 5 per cent of the gross cropped area in the country. Sorghum amongst the *kharif* crops (2.6 million ha) and berseem (Egyptian clover) amongst the *rabi* crops (1.9 million ha) occupy about 54% of the total cultivated fodder cropped area. The area under fodder crops has almost remained static for the last 3-4 decades. Crop residue meets more than 50% of the livestock sector demand in the country on other hand. Wherever there are opportunities to produce fodder on arable lands, intensive forage production system may be practiced, aiming at achieving maximum sustainable harvest of nutritive herbage per unit area and time. The system assures regular supply of green forage when staggered sowing and harvesting schedules are followed. Under assured irrigation multiple crop sequences like MP Chari - turnip, Berseem + mustard - maize + cowpea - MP Chari + cowpea and Berseem + mustard - MP Chari + cowpea has been found better. These systems are better suited to well-managed mechanized farms. The concept of overlapping cropping systems may also be practiced. In this sowing of succeeding crop in done while the preceding crop is still in the field. Integrated use of organic, inorganic and bio-fertilizer sources of nitrogen in sorghum + cowpea–berseem cropping system led to over 25 per cent saving in N through use of Rhizobium and/or Azotobacter. However, a reliable system of quality control and efficient system of storage, transportation and management of bio-fertilizers is required for its wider applicability. Besides, improving productivity in areas already under fodder cultivation, improving productivity of grazing and pasture lands, raising perennial fodder crops on field bunds and boundaries, peri-urban areas and exploiting unutilized and underutilized fodder crops are also some of the promising options to enhance fodder availability. To overcome the area constraints in fodder production, hydroponics is now emerging as an alternative technology to grow fodder for farm animals. Grains of oats, barley, wheat, sorghum and corn could be grown in hydroponics methods in a short time span.

Keywords: *Fodder crops, livestock production, hydroponics, system approach*

Rearing performance and cocoon characters of muga silk worm on primary food plantsin different crop

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Abstract

Two primary host plants of Muga silkworm (*Antheraea assamensis* Helfer*), viz*. Som (*Persea bombycina*), Soalu (*Litsea monopetela*) were evaluated for rearing performance and cocoon characters during four different seasons under the agro climatic conditions of Resubelpara, NorthGaro Hills, Meghalaya. Mature larval weight was recorded significantly the highest from Soalu fed larvae, while it was the lowest from Soalu. Significantly heavier male cocoon and female cocoon weight was from Soalu. Biochemical constituents, viz. carbohydrates, crude fat and proteins etc. of the leaves were determined and correlated with the rearing performance. Among the rearing season Kotia crop recorded significantly highest rearing performance as well as biochemical constituent as compare to the rest of treatments.

Keywords: *Antheraea assamensis*, Som, Soalu, Rearing performance, Biochemical constituents

Impact of COVID-19 on Indian Agriculture

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Abstract

The outbreak of the Covid-19 pandemic is an unprecedented shock to the Indian economy. Agriculture is one of the most important sectors in human development and is related to food security. Covid-19 is affecting agriculture in two significant aspects: the supply and demand for food. These two aspects are directly related to food security; thus, it is also at risk.The lockdown and associated disruptions are affecting agricultural activities and the necessary supply chains through several channels: input distribution, harvesting, procurement, transport hurdles, marketing and processing. Restrictions of movement and labour scarcity may impede farming and food processing (FAO, 2020). March-April was the peak season for the sale of the rabi produce but harvesting will get hampered due to the departure of thousands of migrant workers. Shortages of fertilizers, and other inputs could also affect agricultural production.farmers are stuck with harvest as APMC (agricultural product market committee) mandis are closed in several states thereby disrupting food supply disruption from the production to the consumption centres. the supply chain impacts using a popular flowchart of the advertising and marketing channels of food grains/vegetables in rural areas. The bottlenecks due to the lockdown are marked as crosses at the appropriate locations. Since supply chains are not working properly, vast amounts of food are already getting wasted leading to massive losses for Indian farmers. Unable to export their produce across the country. The farm sector will grow by 3 per cent this year despite adverse conditions and it would add at least 0.5 per cent to India's GDP growth in 2020-21. This 0.5 per cent additional contribution by agriculture may actually prevent Indian economy from contracting fiscal. This includes production of non-food crops such as oilseeds.So, the government should focus on postharvest activities, wholesale and retail marketing and initiate procurement operations.We check the immediately challenges that covid19 has posed to the farm area and advise mitigation measures to make sure a sustainable food.Concerns had been raised regarding negative implications of Covid-19 pandemic on the farm economy.

Keywords: *Covid, GDP, food security, demand, supply,*

COVID-19 Impacts on Agriculture, Policy responses and Livelihood Security

Mayank

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Abstract

The on-going health crisis around COVID19 has affected all walks of life. Protecting lives of people suffering from the disease as well as frontline health responders have been the priority of nations. *Also,* the central pillar of the Indian economy *has been adversely affected by the pandemic and resulted in lockdown*. Agriculture sector serves the food consumption needs of the whole country, while also placing among the top exporters of agricultural produce in the world. The major challenges are: Labour scarcity and exports. Northern Indian states of Punjab and Haryana are among India's agricultural powerhouses, although farming work in these states is mostly carried out by migrant labour from East India. When India's nationwide lockdown was announced in March, the knee-jerk reaction was a mass exodus of migrant labour back to rural hometowns. The harvesting process, which usually starts in mid-April, was thrown completely off balance, resulting in major liquidity issues. The June crop is among those that has been hit hard. The researchers also point out that the labour scarcity has also affected the supporting infrastructure around India's agriculture sector. Then there is the transportation sector. Movement across state borders has been heavily restricted, which has blocked the movement of crops and consequently their sale. Add to this a lack of machine repairs mechanics and other such support staff, and one gets the picture of a sector in trouble. The economic shock will likely be much more severe for India because of two reasons: pre COVID-19, the economy was already slowing down, compounding existing problems of unemployment, low incomes, rural distress and malnutrition secondly India's large informal sector is particularly vulnerable. Out of nation 465 million workers, around 91% (422 million) were informal workers in 2017-18. Lacking regular salaries or incomes, these agriculture, migrant, and other informal workers were hardest-hit during the lockdown period. Government is trying its best to support the farmers through various schemes under mentioned, immediately after the nation-wide lockdown was announced, the Indian Finance Minister declared an INR 1.7 trillion package, mostly to protect the vulnerable sections (including farmers) from any adverse impacts of the Corona pandemic. The announcement, among a slew of benefits, contained advance release of INR 2000 to bank accounts of farmers as income support under PM-KISAN scheme. The Government also raised the wage rate for workers engaged under the MGNREGA, under the special scheme to take care of the vulnerable population, *Pradhan Mantri Garib Kalyan Yojana* has been announced. Additional grain allotments to registered beneficiaries were also announced for the next three months. Cash and food assistance to persons engaged in the informal sector (mostly migrant labourers), a separate PM-CARES (Prime Minister Citizen Assistance and Relief in Emergency Situations) fund has been created.Though, everyone is trying hard through these rough times, we must have patience and hope for the best to overcome these health and economic crisisas soon as possible so that everything must return to their original working conditions.

***Keywords**: Covid-19, Economy, Agriculture Policies*

Elucidating genotype × environment interactions by AMMI and GGE biplot methods for dry root yield and total alkaloid content in ashwagandha [*Withania somnifera* (L.) Dunal]

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Abstract

In the present study, additive main effects and multiplicative interactions (AMMI) and genotype (G) main effects and genotype (G) × environment (E) interaction (GGE) biplot analyses were used to identify location specific and widely adapted genotypes for dry root yield and total root alkaloid content to dissect GEI in ashwagandha [*Withania somnifera* (L.) Dunal]. Trials were conducted in randomized complete block design (RCBD) over three consecutive years, 2016-17, 2017-18 and 2018-19 at three different locations (S.K.Nagar, Jagudan and Bhiloda). ANOVA analysis of AMMI of dry root yield showed that significant sum of squares of 35.31%, 24.89 % and 32.96 % was explained by the environment, genotype and G×E interaction, respectively. For total root alkaloid content, significance of 27.59% of total sum of squares was justified by environment, 17.72% by genotype and 43.13% by GEI. In total, nine experimental trials were considered as environments to analyze GEI in sixteen genotypes including one check. Present AMMI analysis revealed that SKA-11, SKA-27, SKA-23 and SKA-10 were the superior genotypes for mean dry root yield and SKA-11, SKA-27 and SKA-21 had the better performance for total root alkaloid content across environments. The GGE biplot showed that genotypes SKA-11, SKA-27, SKA-10 for dry root yield and SKA-26, SKA-27, SKA-11 for total root alkaloid content were most desirable genotypes. SSI statistics revealed SKA-10, SKA-27, SKA-6, SKA-11 and AWS-1 best for dry root yield, whilst SKA-25, SKA-6, SKA-12, AWS-1 and SKA-11 best for total root alkaloid content. Based on trait variation, GGE biplot analysis identified two mega-environments for dry root yield and four for total root alkaloid content. Two discriminating and representative environments were identified one each for dry root yield and total root alkaloid content. Location-specific and breeding for wider adaptation could be advocated for varietal release and improvement of Indian ginseng.

Covid 19 Impact on Agriculture

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Abstract

Since late 2019, an outbreak of the coronavirus disease 2019 (COVID-19) has rapidly spread all over the world, challenging the sustainability of global agri-food markets. No sector has escaped its impact. Its impact on agriculture is complex and varied across diverse segments that form the agricultural value chain. Although its full impact on agricultural and food markets is not yet evident, we have some early evidence on the different impacts. The aim of this article is to summarize the early evidence by screening global newspaper articles and sites written on the topic until 10 April 2020. Agriculture-related pandemic effects can be grouped into supply, demand, labour, food security, food safety, trade and other effects. It is also evident that the first impacts are not one-sided: what helped some hurt others. This article can serve as a basis for future research on the topic by identifying and highlighting the key topics as well as summarizing the earliest evidence available.

Keywords: *corona, virus, COVID, agriculture*

Evaluation of genotypes and non-conventional chemicals against sheath rot of rice caused by *Sarocladium oryzae* (Sawada) Gams and Hawksworth in Haryana

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Abstract

Sheath rot of rice caused by Sarocladium oryzae (Sawada) Gams and Hawksworth earlier considered being a minor disease has become destructive and widely damaging in recent years in Haryana. Since the use of host resistance is only feasible means of controlling the disease in plants. Hence as much as 123 genotypes were screened against this pathogen. In resistant screening 9 genotypes/cultivars showed highly resistant reaction against S.oryzaeviz., HKR98-476 (IET1704); HKR02-430 (IET18995); HKR03-428 (IET19443); HKR04-409; HKR04-479; HKR04-493; HKR05-476; HKR05-497 and HKR05-499. The genotype HKR05-495 was resistant and genotypes HKR03-408 (IET19411); HKR04-487; HKR04-487; HKR04-523; HKR04-524 and HKR05-417 were moderately resistant to the pathogen. Six non-conventional chemicals were also tried as an alternative disease management option against this pathogen to cope with the threat to the environment, crop ecology, soil biology and human health. Among six non conventional chemicals viz., zinc sulphate (0.1%), calcium chloride (0.1%), gibberelic acid (0.02%), salicylic acid (0.1%), benzoic acid (0.1%) and maleic acid (0.1%), zinc sulphate proved to be the most effective in reducing disease incidence and increasing grain yield.

Keywords: *Sheath rot, genotype, pathogen and salicylic acid*

Impact of COVID-19 on Agriculture and it reconstruction with special reference to North-East India

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Abstract

On 5th January, 2020 WHO (World Health Organisation) issued its first Outbreak news for a disease, whichwas later known as COVID-19. Since then almost all the countries of the world had been facing the brute of the pandemic. COVID-19 had a great impact on all human activities including agriculture. The impact of the pandemic on agricultural production, transportation, labour availability, economic condition and health of farmers is drastically affected.Therefore it's a need of the hour to give more emphasize on improving the agricultural supply channels as agricultural activities are the backbone of any country in their development and it's also supported by the facts that during this pandemic as our country's GDP is all time low with -29.3 percent with negative growth in almost all the sectors only agricultural sector is the ray of hope for reviving the economy by producing positive growth rate as there is increase in agricultural GDP by 3.4 percent. For this reviving, agriculture in the post pandemic era would need some major reconstruction and there would be huge scope due to the migration of labours from cities to the villages. In India out of 465 million workers, around 91 percent were in informal sector in 2017-18 and are most vulnerable during this lockdown period.The consumption and buying habits of the people may also change due to the economic situation. People being free during the lockdown has started to grow vegetables in their kitchen garden and are unwilling to go to vegetable market due to fear of infection. Therefore there is need to strategize future of farmers and innovative ideas like bio flock fish culture, mushroom cultivation, e-marketing of fresh fruits and vegetables should be adopted. Due to the disruptions in transportation facilities the availability of agro inputs have been significantly affected. In the first few weeks of lockdown, vegetable and fruit producers were unable to get fertilizers and pesticides for their crops. The availability of cattle and poultry feed was also affected.Therefore the farmers need to take steps to be self-sufficient. The need to take up integrated farming or organic farming practices would be inevitable in the near future. And clearly the North-East Indian region has an edge in such situation due to being relatively untouched by Green Revolution.

Keywords: *COVID-19, pandemic, Bioflock fish culture, mushroom, e-marketing, integrated farming, organic farming.*

Major Constraints in Mango Production and Productivity in some villages of Lucknow District, Uttar Pradesh

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Abstract

India ranks first in production of Mango in the world. During 2018-19, India had an area of 2.1 million hectares with a production of 12.7 million tonnes and productivity of 5.5 tonnes under the fruit crop. But due to certain known/unknown limitations, the productivity is reducing in the country. The present investigation was undertaken to study the problems faced by mango growers of Lucknow district, Uttar Pradesh, India and develop a database for management of pest-diseases. The Malihabad, Mal and Kakori blocks have been purposively selected for the research work, being the major producers of the fruit crop. The total of 9 villages namely Wallinagar, Dasdohi, Khalispur from Malihabad block, Firozpur, Kasmandi Kalan, Mehmoodnagar from Mal block and Shahmau Naubasta, Ram Nagar, Shahpur Godawa were selected. From the selected village's 40 respondents each was selected randomly, thus a total number of Mango growers constituted the sample size of 360 farmers for the study and data was collected by the means of a personal interview with the help of a pre-structured schedule. It was depicted that the majority of the farmers reported the huge losses from the severe incidence of pests and are totally dependent on the pesticide dealers for the management of Pests. Mango leaf hopper, Thrips, Mealybugs, leaf Webber, Stem borer and shoot borer etc. are main limiting factors but Thripsis one of the most prevalent pest in last years which is pronounced as Ruzzi in the local language has caused great damage and severe losses to the production and productivity of the fruit crop. The prices have declined to almost half the price earlier due to Ruzzi. The practice of chemical washing is most common in the study area but the pest occurs again immediately after 15-20 days of spray. Majority of the farmers (approx. 70-80 %) reported about the lack of knowledge of right dosage and time of the spray of pesticides and the farmers were having no knowledge of Integrated Pest management practices. The farmers also are unaware of the bio-formulations such as Neem oil. The major constraints can be improved with the new scientific technologies or facilities of modern agricultural practices and farmer's awareness through training and workshops.

Keywords: *IPM, Mango, Pest-diseases, Pesticides, Thrips*

Strengthening linkage between researchers and farming community through various web based and android applications in Indian Agriculture

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Abstract

The digitalization of agriculture is causing a significant shift in farming and food production over the few years. The use of technology bring many economic and social benefits but there are also associated challenges. Disparities in access to digital technologies and services mean there is a risk of a digital divide. Simply introducing technologies is not sufficient to generate results but the basic conditions and enablers for digital transformation needs to be provided by the system. The first and foremost requirement of the farmers is to get the timely information in response to their specific needs. Nowadays android apps and web pages that provide latest agricultural information about trends, equipment, technologies and methods being used to help identify pests and diseases, provide real-time data about weather, early warnings about storms, local markets offering best prices, seeds, fertilizers etc. that are being developed by various research institutes and organizations though which a farmer can also interact and get guidance from agriculture experts across the country.Government of India has launched a number of web and mobile based applications for dissemination of information on agriculture related activities, free of cost, for the benefit of farmers and other stakeholders. There are apps also developed by agricultural institutions such as ICAR system, private sector, NGOs for disseminating information from agricultural research and extension to farmer fields and facilitating exchange of information.

Keywords: *web, android, technologies, pests and diseases, agricultural research*

Impact of growing environment on phenological development, growth and yield of Barley (*Hordeum vulgare*) cultivars under semi-arid regions of Haryana

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Abstract

Field experiment was conducted during rabi season of 2016-17 and 2017-18 at research farm, Department of Agricultural Meteorology, CCS HAU, Hisar located at 29° 10´ N latitude, 75° 46´ E longitude and 215.2 m altitude. The experiment was put in a split plot design and comprised of four sowing dates (main plot treatments) viz. D_1- 3rd November; D_2- 18th November; D_3- 3rd December and D_4- 19th December; four sub plot treatments comprising four different varieties viz. V_1 (BH 393), V_2 (BH 902), V_3 (BH 946) and V_4 (BH 885) during crop season 2016-17 and 2017-18, respectively with three replications. The experimental results revealed that delayed sowing reduced the length of phenophases in all varieties during growing period. The crop duration was shortest, especially the reproductive phase get synchronized to alter the daily assimilation rate in 19th December sown crop as followed by3rd December, 18th November and 3rd November. The impact varieties to complete the life cycle in prevailed environments and total crop duration was found longest in BH 885 as followed by BH 946, BH 902 and BH 393 respectively. Growth and yield observations i.e. plant height, no. of tillers, LAI, dry matter accumulation and its partitioning, grain and biological yields are also higher in first sown crop as compared to delayed sown and quantified at various growth intervals and similarly in varieties, BH 885 performed better as compared to BH 946, BH 902 and BH 393 during both the crop season.

Keywords: *Growth intervals, Phenophases variation, Growing environment, Yield.*

Long term effect of fertilizer and herbicides on soil properties and productivity of rice-rice system in rainfed lowland ecosystem under subtropical region of eastern Himalayas, India

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Abstract

Appropriate fertilizer and weed management is important for improving soil health, enhancing crop productivity and ultimately the sustainability of the system vital for food and nutritional security. A 14 year long-term field trial was initiated during 2001 to investigate the effect of fertilizer and herbicides on soil properties and productivity of rice-rice system under rainfed lowland ecosystem. In the present study, the effects of long term use of herbicides and fertilizer on soil organic carbon (SOC), carbon stock (CS), soil physical properties, available nutrients (N, P, K, Fe, Mn & Cu) and rice productivity were assessed. Treatments consisted of T1-Farmers practice (FP) with one hand weeding, T2- Butachlor +2,4-D with 100 % recommended dose of fertilizer (RDF), T3-Butachlor +2,4-D with 75 % RDF + 25 %N (FYM), T4-Butachlor +2,4-D rotated with pretilachlor (100 % RDF), T5-Butachlor +2,4-D rotated with pretilachlor (75 % RDF + 25 % N (FYM) and were arranged in a randomized block design with three replications. The SOC content was increased significantly after 14 years of continuous application of herbicides and fertilizer. Long term use of butachlor (pre emergence)+ 2,4-D (post emergence) with 75 % RDF + 25 % N (FYM)resulted in highest build up of SOC (8.8 g ha^{-1}), carbon stock (16.63 Mg ha^{-1}), soil porosity and mean weight diameter (MWD). The lowest SOC and carbon stock was with farmer's practice (FP) involving one hand weeding (HW). Soil bulk density (BD) was reduced from the initial value of 1.41 g $cc^{-1}$and ranged from 1.38-1.23 and 1.67-1.50 g cc^{-1} respectively at 0-15 and 15- 30 cm soil depth. The lowest BD was with application of 75 % RDF+ 25 % N (FYM) and rotational use of butachlor and pretilachlor + 2, 4-D. The available N, P_20_5 and K_20 in soil increased significantly after 14 years of continuous use of herbicides and fertilizers. Integrated use of 75 % RDF+ 25 % N (FYM) along with sequential application of herbicides significantly increased the availability of Fe and Mn in soil and the highest nutrient uptake (NPK).Continuous use of herbicides for 14 years significantly reduced the weed density and dry matter accumulation compared to FP. Application of 100 % RDF or 75 % RDF + 25 % N (FYM) and sequential application of butachlor/pretilachlor + 2,4-D produced significantly higher grain yield over FP. Pearson correlation matrix developed among soil properties and rice productivity showed significant and positive correlation among SOC, soil porosity, MWD, WHC, N, P, K with rice productivity. Therefore, it can be concluded that sequential application of butachlor/pretilachlor+2,4-D at recommended rate along with balanced use of 100 % RDF or 75 % RDF + 25 % N (FYM) is required for sustaining soil health and productivity of rice-rice system.

Keywords: *Fertilizer, herbicides, Soil organic carbon, carbon stock, rice–rice system*

Screening of Traditional Rice Cultivars Due to Rice Root-Knot Nematode *Meloidogyne graminicola*

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Abstract

A pot experiment was carried out in the net house during *Kharif* season of 2017 in the Department of Nematology, Assam Agricultural University, Jorhat. A total of thirty five rice cultivars were screened against rice root-knot nematode *Meloidogyne graminicola*. Luit (local cultivar) was included as susceptible check. All the cultivars show varying degree of responses. Out of these thirty five screened rice cultivars, eight cultivars *viz*., Bongal ahu, Malbhog ahu, Naga ahu, Bahadur sub-1, Shraboni, Disang, Kolong and Jaymati were found to be resistant, five cultivars *viz*., Ahu joha, Bhogali bora, Aghoni bora, Ranjit sub-1 and Kanaklata were found to be moderately resistant, two cultivars *viz*., Sambha mashuri and Kanaklata were found to be susceptible and remaining twenty were found highly susceptible against *M. graminicola*.

Resource management and sustainability through organic recycling in homestead agroforestry systems

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Abstract

Tree leaf litters are often considered a menace in homesteads as the disposal options is mostly limited to mechanical removal, use as mulch and burning. Events of air pollution that occurred in recent months in north India have been an eye opener and has immense implications on human health and ecosystem. Explorations to evolve a suitable technology for the biowaste management led to the evaluation of bioconversion of the litter to compost that could be used as manure for crop production. Studies were conducted at the College of Agriculture, Vellayani during 2016-17 and 2018-19 to assess the efficacy of different organisms and materials for the biodegradation of commonly occurring leaf litters in homesteads. Coconut (*Cocos nucifera*), Mango (*Mangiferaindica*), Jack (*Artocarpusheterophyllus*) and cashew (*Anacardium occidentale*) are multipurpose trees commonly found in homesteads with high litter production potential. The selected tree leaves were subjected to decomposition with additives in the form of decomposers/ materials *viz*., poultry manure, earthworms, microbial inoculum and N rich glyricidia leaves for organicreycling. Augmented composting was compared with natural decomposition. The results revealed accelerated decay of the leaf litters when supplemented with decomposers, but the most suited technology varied with the species litter quality. The technology found to be superior for the bioconversion were as follows: jack, and coconut leaves (with midribs removed) - co-composting with poultry manure (105 and 121 days); mango and cashew leaves - microbial composting inoculum + earthworms (110 and 144 days respectively). The time taken for the complete degradation were 40 to 50 per cent less than that taken for natural decomposition. Nutrient content in the final composts were dependent on the initial content in the litter material, nevertheless could be enhanced by mixing them with the PGPR Mix 1 (Plant Growth Promoting Rhizobacteria), the consortium biofertilizer and rock phosphate. The experiments thus bring to light the potential of composting technology for the bioconversion of the biowaste leaf litter found in abundance in almost all homesteads into quality nutrient inputs. Further, the enrichment of soil with microflora with the use of these inputs in the vegetables tried revealed the potential for sustaining soil health. The resource management strategy would also reduce the dependence on external chemical inputs thus contributing to ecological restoration as the adverse effects on other organisms and environment are minimized.

Keywords: *compost, decomposition, leaf litter, organic recycling*

Studies on the collection and evaluation of bael cultivars

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Abstract

The present investigation was carried out at Research Orchard of Department of Horticulture, Chaudhary Charan Singh Haryana Agricultural University, Hisar during the year 2018-19. The experiment was laid out in Factorial Randomized Block Design with three replications and three cultivars. The plant height (5.82 m), stem girth (63.7 cm) and spread of plants (6.24 x 5.92 m) were found maximum in NB-7. The flowering started from 1st week of June to third week of June in cultivar NB-5 and Ist week to 2nd week of June in NB-7 and NB-9. The maximum fruit weight (2.50 kg) was observed in NB-7. Whereas minimum fruit weight (1.32 kg) was recorded in NB-5. Maximum TSS (30.2 %) was recorded in NB-9 followed by NB-5 (29.7 %). However, maximum yield (52 kg) was recorded in NB-7 and minimum (23 kg) in the NB-5.

Keywords: *Bael cultivars, Plant height, Fruit weight and Yield.*

Conversion of point source field dripper method to line source field dripper method for in-situ measurement of unsaturated hydraulic conductivity function

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Abstract

Exponential form of Gardener's unsaturated hydraulic conductivity function (K_h) has been used for the design of drip irrigation systems. Point Source Field Dripper Method (PSFDM) of Wooding (1968) had been used to measure in-situ K_h but it covers small soil volume. Approximate line-source field dripper steady-state solution of Warrick (1985) was used by Ojha et al. (2020) for in-situ measurement of K_h of the soil. Line source covers large volume of soil hence more appropriate for K_h measurement. The PSFDM was transformed to Line Source Field Dripper Method (LSFDM) for in-situ measurement of K_h as given below.

$$q_l = K_s + C_\alpha \frac{4\,K_s}{\pi\alpha}.\frac{1}{x_s} \qquad (1)$$

Where q_l is line source field dripper discharge rate, K_s is saturated hydraulic conductivity of the soil, x_s is the half width of saturated front C_α is correction factor for α and α is relative measurement of capillarity over gravity. An experiment was conducted to measure K_h of recently tilled normal soil using LSFDM. The half saturated widths were measured to be 34.4, 56.0, 43.5 and 16.0 cm against 27.5, 41.5, 36.2 and 15.0 liter per second. Water flux densities for line source discharges were calculated as 7.994, 7.411, 8.321 and 9.375 cm/hr. Water flux density was plotted against inverse of saturated front widths. The slope and intercepts of the lines were worked out. The saturated hydraulic conductivity (K_s) and relative measurement of capillarity over gravity (α) were worked out using slopes and intercepts of lines. The correction factor C_α was considered as 0.243. The value of K_s was calculated as 7.017 cm/hr and α as 0.114 cm^{-1}. A LSFDM (Ojha, 2020) also known as OLSFDM resulted the value of K_s as 8.146 cm/hr and α as 0.219 cm^{-1}. The value of K_s was obtained as 4.453 cm/hr and α as 0.104 cm^{-1}. The K_s value measured from proposed LSFDM was 36.52% higher and α 8.77% higher than the value obtained from PSFDM. Similarly the K_s value obtained by proposed LSFDM was 16.09% lower than the value obtained by OLSFDM. The value of α obtained by proposed LSFDM was 92.10% lower than the value obtained by OLSFDM. The K_s and α values obtained by proposed LSFDM and OLSFDM are fairly close to each other. The proposed LSFDM is derived from PSFDM while OLSFDM is an approximate solution of line source. The proposed method seems better over PSFDM and OLSFDM hence may be used for wider field applications.

Keywords: *Liner source, unsaturated hydraulic conductivity, field dripper & saturated front*

Integrated Farming Systems for Ensuring Food, Nutritional and Livelihood Security of Tribal Farmers in North-Eastern Hill Region of India

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Abstract

North-East Hill Region (NEHR) accounted 8.0 per cent of the total area and 3.4 per cent of total cultivable area of India. However, the region contributes only 2.8 per cent to the total food grain production of the nation. Majority of the fields in the region are situated across the hilly slopes. Nearly 0.88 m ha area in NEHR is under *Jhum* cultivation. The region, by and large, is characterized by fragility, marginality, inaccessibility, culturally heterogeneity, ethnicity, however it is endowed with a rich repository of biological diversity, valuable genetic resources of agricultural crops and a plethora of natural resources. The production system is characterized by low cropping intensity, subsistence level and mono cropping. As a result, the stamp of backwardness has been attached to this region suffering food and nutritional security. Integrated farming system approach is not only a reliable way of obtaining fairly high productivity with considerable scope for resource recycling, but also a concept of ecological soundness leading to enhance livelihood. Central Agricultural University, Imphal has developed several farming system models for each fragile hill agro-ecosystem based on different monitorable variables involving fish culture, livestock, crops and agro-forestry to meet the food, nutritional and livelihood security challenges of the region. These models are assessed on the basis of capability to sustain the farm family needs, food and nutritional requirement of one family having 5 adult members. The packages of practices for different location specific farming systems have been developed and verified extensively for economic viability and feasibility at the farmers' level. It can be concluded that the location specific farming components are required to be intelligently identified to harness complementarities between enterprises to achieve optimum productivity from unit area, ensuring food and nutritional security and getting higher returns and bio-resource flow within the system.

Keywords: *North Eastern hill region, IFS, location specific, food and nutritional security.*

Frontier Technological Management of Intensive Rice-Wheat Systems of South-Asia for Food and Environmental Security

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Abstract

The ‘‘rice-wheat cropping system’’ (RWCS) of South Asia (SA) are amongst the maximum productive cropping systems in the world and it is most vital for the food security of the growing population. More recently, a makeable reduction in productivity of the RWCs system is showing due to the changing climate. Therefore, the declining tendencies of cereal production in RWCs of SA creates great concern for the growing population. One of the main difficulties of this system is soils of rice and wheat are managed totally different way. For example, rice seedlings are transplanting into puddled soils is the traditional way (soils ploughed with repeated tillage with wet basis). Repeated ploughing for puddling of transplanted rice deteriorating soil physical and chemical properties, creation of a hard plough-pan layer at a surface-depth which creates poor infiltration and water-logging lead to poor-rooting for wheat, declining water tables as a result of less recharge as compared to uptake, same crops (rice and wheat) in the same land and season increase the infestation of pests and imbalance use of synthetic fertilizers and pesticides increase the greenhouse gas emission (GHGs). Although RWCS systems have numerous adverse effects on the environment, while the systems are a major source of cereal food production for the growing population in the region. Farmers find very few substitutes for rice and wheat that provide similar low risk and profit. So, it will be not a wise-think for suggesting to replace the system. Research has to find ways of sustaining this system and making it more efficient and profitable. In the meantime, scientists suggested several climate-smart and next-generation sequential technologies for resolving these difficulties, among them zero-tillage (ZT) system is one of the best one. In the chapter, we highlight the major consequences in the RWCS of SA under the changing climates. We also suggested several next-generation sequential technologies to meet the food and nutritional safety of increasing population who are depending on RWCS.

Keywords: *Rice-wheat systems, Agroecology, climate-smart technology, South Asia, Sequential technology*

Effect of Weed Management Practices on Yield, Economics and Weed Dynamics of Spring Maize at Dhading Besi, Nepal

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Abstract

Weeds have been a major constraint in maize cultivation resulting in huge economic loss to farmers and thus becoming burden to the farmers. Hence, a field experiment entitled "Effect of Weed Management Practices on Yield, Economics and Weed Dynamics of Spring Maize atDhadingBesi, Nepal"was carried out at the command area of PMAMP, Maize zone, Dhading during the spring season of 2020. The experiment was conducted to evaluate the effect of weed management practices on yield, economics and weed dynamics of spring maize. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications comprising of 8 treatments viz. weedy check, weed free, atrazine only as PE @1.0 kg a.i./ha, pendimethalin only as PE @1.0 kg a.i./ha, atrazine @ 1.0 kg a.i./ha as PE fb 2,4- D EE @0.5 kg a.i./ha as PoE, pendimethalin @ 1.0 kg a.i./ha as PE fb 2,4-D EE @ 0.5 kg a.i./ha as PoE, 2 hand weeding @ 20 and 40 DAS and Farmer's practice. The research result revealed that sequential application of atrazine @ 1.0 kg a.i./ha as PE fb 2,4-D EE @ 0.5 kg a.i./ha as PoE resulted maximum grain yield (11.37 t ha^{-1}) which was statistically similar with weed free (11.24 t ha^{-1}) and followed by atrazine only @1.0 kg a.i./ha (10.36 t ha^{-1}). 16 weed species belonging to 6 different families were identified in the experimental field. The broad leaf weeds were prominent than grass and sedge weeds in the field during earlier crop growth period. As compared to weed free, weed caused grain yield loss up to 50.99 % in weedy check which was followed by farmer's practice (43.17%). After weed free, the total density and dry weight of weeds were found significantly minimum in sequential application of atrazine fb 2,4- D EE than other treatments. Similarly, application of atrazine fb 2,4-D EE resulted maximum weed control efficiency of 87.59 %, 95.91 % and 92.17% at 30, 45 and 60 DAS respectively and also lowest weed index (-1.27%) was obtained in the same treatment. The sequential application of atrazine fb 2,4-D EE was found most economical with maximum value of net return and B:C ratio.

Keywords: *Spring maize, weed dynamics, weed management, atrazine, 2,4-D EE*

Interplay between Forest dependency, Ecosystem Services and Biodiversity Conservation in Kalsa-Gola sub-watershed, Nainital, Uttarakhand

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Abstract

Forest managed through Van Panchayats in Uttarakhand is a success story of forest management in India. However, in recent times high forest dependency in Uttarakhand region has led to forest cover loss impacting biodiversity and ecosystem services. Therefore, the study attempts to investigate different socio-economic characteristics influencing forest dependency, phytosociology and ecosystem service particularly carbon sequestration in Kalsa-Gola sub-watershed of Nainital district, Uttarakhand. The study also assessed the relationship between components of biodiversity, ecosystem service and extraction of forest products. A total of 406 households in the study area were surveyed using semi-structured questionnaire. Similarly, phytosociology and carbon stocks were measured in 119 sample plots across 9 different forest types of the study area. Binary logistics model, Spearman correlation and Whittaker pair wise comparison method was used for analysis of data. The results found majority of the households were dependent on provisioning ecosystem services such as fuelwood, fodder and leaf litter. The dependency was attributed to lower education level, lesser income and inadequate alternate livelihood opportunities. Among nine different forest types of the study area, species richness was found highest in Banj Oak forest and lowest in Khair-Sissoo forest type. The value of Shannon-Weiner index of diversity ranged between 1.72 to 0.60, and the Whittaker value of β-diversity is 2.64, indicating high diversity in the study area. The high value for β-diversity indices was found due to the variation in forest type, altitude, aspect and other geographical and climatic variables across the study area. The Whittaker Pair wise comparison for different forest communities showed that Khair-Sissoo forest community (5/1S2) is one of the most distinct community of the study area with least similarity with any of the sites, while the moist Shivalik Sal forest have elements/species of all the forest types in the study area. The study revealed a significant correlation between diversity index (H˙) and tree carbon stock ($r=0.381$, $p \leq 0.01$), herb carbon stock ($r=-0.293$, $p \leq 0.05$) and litter carbon stock ($r=-0.398$, $p \leq 0.01$). Also, it was found that diversity index has a significant positive/negative correlation with the different carbon pools and extraction of fuelwood, fodder and leaf litter. The leaf litter collection from the forest increases with increase in land holdings and number of cattles, as apparent by the significantly high positive correlation of leaf litter collection with land holding ($r=-0.445$ $p \leq 0.01$) and livestock ($r=-0.477$, $p \leq 0.01$). The study found that even with high dependency of communities with extraction of different forest products, the forests does not seem to be degraded in terms of diversity and carbon stock. Overall, it can be concluded that village forest communities through experience has evolved an inherent mechanism of sustainable forest management.

Keywords: *Socio-economic characteristics, Phytosociology, Kalsa-Gola sub-watershed, Spearman correlation, diversity index.*

Exploitation of zinc solubilising bacteria for zinc nutrition in rice

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Abstract

Zn deficiency is a key factor in determining the rice production in several parts of India. 48% soil in India is afflicted with Zn deficiency with a significant potent deficiency of 25.5% in Assam. The excretion of low molecular weight organic acids and siderophores in rice rhizosphere by PGPRs thereby increasing the bioavailability of Zn is a potential mechanism of reducing Zn deficiency in lowland rice. In this context, the present study aims to isolate few potent strains that have the ability to enhance Zn availability in rice. A total of 139 geo-referenced rhizosphere soil samples (0-15cm) of Zn deficient (<0.6ppm) spots were collected from 5 districts of Assam *viz*, Golaghat, Jorhat, Sibsagar, Nagaon and Lakhimpur after the harvest of *sali* rice for isolation of PGPR. On analysis, the DTPA-Zn of the collected samples ranged from 0.21ppm to a maximum of 1.46ppm. 38.84 % (54 samples) resulted the sufficiency of DTPA-Zn (>0.6ppm) and 61.15% of the samples exhibited deficiency (<0.6ppm DTPA-Zn). Following classical serial dilution technique, isolation of PGPR having the potentiality of Zn solubilization was done and the fast-growing colonies with clear zones around them in plates were considered as putative ZSB. The colonies with clear zone in the media containing insoluble ZnO were 0-27.27 %, 0-33.78%, 0-32.83%, 0-25.00% and 0-31.70 % in Golaghat, Jorhat, Sibsagar, Nagaon and Lakhimpur districts respectively. As such, total 61 isolates were selected based on preliminary zone of clearance in the modified Pikovskaya's solid media and further subjected to secondary screening based on the Khandeparkar's ratio. Based on Khandeparkar's selection ratio, out of these total 61 isolates, 20 were selected having the ratio >1.0 as prospective PGPR having the potentiality of Zn solubilisation. The Khandeparkar's ratio ranged between1.25-6.44 and among the isolates, most apparent Zn solubilizing zone was shown by the isolate SS93 (58.00mm in diameter and corresponding solubilisation index of 6.44). The isolate SS91 had the least solubilisation zone of 10.00 mm in diameter as compared to other isolates and the corresponding solubilisation index is 1.25. On assessment of the isolates for production of plant growth promoting substances like indole acetic acid (IAA) and gibberellins, it was observed that IAA varied in them from a minimum of 4.4 µg/ml (SS20) to maximum of 33 µg/ml (SS1220). On the other hand gibberellin content ranged from 11.64 µg/ml (SS22) to 43.85 µg/ml (SS130). Quantative estimation of the ability of bacteria to solubilize the Zn from ZnO when examined exhibited gradual increase of Zn in the solution during the incubation period for 45 days compared to 15 & 30 DAI. At 45 DAI, the maximum concentration (130ppm) of Zn in the broth solution was observed for the isolate SS129 followed by SS94 (94 ppm) and SS122 (91ppm).

Keywords: *Siderophores, Khandeparker ratio, Solubilisation index.*

Improving the farm biodiversity and sustainability through agroforestry

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Abstract

The increasing human and live stock population increases pressure on the natural resources and causes their degradation and biodiversity loss as well. As rates of deforestation continue to rise in many parts of the tropics, the agrian community of these regions is faced with the challenge of finding plausible approaches which can reduce deforestation and provide rural livelihoods in addition to conserving biodiversity. The role of biodiversity in agroecosystem function is one of the keystones of sustainability. So, the mitigation of these challenges lead to recognition of the contribution of agroforestry to improve ecosystem services and livelihoods especially in rural areas. Agroforestry – intentional management of shade trees with agricultural crops – has the potential for providing habitats outside formally protected land, connecting nature reserves and alleviating resource-use pressure on conservation areas. Improved agroforestry systems (AFS) such as improved fallows that mimic shifting cultivation and other AFS provide benefits that contribute to rural livelihoods, improved socioeconomic status and ecosystem functioning of land use systems. The vision of agroforestry under recognition is as an integrated landuse that, through the capture of intraspecific diversity and the diversification of species on farm, combines increases in productivity and income generation with environmental rehabilitation and the creation of biodiverse agroecosystems. Agroforestry systems also provide favourable environmental conditions for arbuscular mycorrhizae fungi (AMF), bacteria, and enzyme activities which helps to improves and enhances the soil micro flora and funa conclusively enhancing the sustainability of farm areas. However, little is known ecologically about how best to integrate agroforestry into the landscape, or to what extent agroforestry can be used to link forest patches and expand biogeographical islands. A wise domestication strategy for indigenous trees will involve the capture and maximization of intra-specific genetic diversity and so benefit both production and the environment.

Keywords: *Agroforestry, agroecosystem, biodiversity, sustainability, genetic diversity, flora and funa*

Biodiversity Conservation

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Abstract

Biodiversity means the variability among living organisms from all sources including terrestrial, marine and aquatic ecosystems and the complexes of which they are part: this includes diversity within species, between species and of ecosystems. It includes diversity of forms right from the molecular unit to the individual organism and up to the biosphere level. Biodiversity is the sum total of species richness. Biodiversity includes genetic diversity, species diversity, ecosystem diversity and habitat diversity. Biodiversity conservation includes in situ and Ex situ conservation. In situ conservation is "On-site conservation" or the conservation of genetic resources in natural habitat. Eg: Biosphere reserves, natural parks, wildlife sanctuaries, sacred groove and lakes. Ex situ conservation is "Off-site conservation" or the process of protecting an endangered species of plant or animal outside its natural habitat. Eg: Zoo, botanical gardens, seed banks, sacred plants and home gardens etc.

Keywords: *Biodiversity, Conservation, Ex-situ, In-situ, Habitat*

Impact of resource conservation techniques on chemical properties of soil in lower shivaliks of Jammu

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Abstract

In India land degradation is a common problem in the lower *Shivaliks* of Jammu, extending from district Kathua in the southeast to Rajouri in the northwest. It is a dry semi-hilly belt, locally known as kandi. The soils of submontane *Shivaliks* are under tremendous stress because of high soil erosivity and poor soil management practices. So in this regard an experiment was laid out in district Kathua, to observe how resource conservation techniques helps in improving the various chemical properties of soils. The study was conducted in two different catchment areas (one with sandy loam texture and other with clay loam texture) with slope varies from 3-6% and the different resource conservation techniques used in these areas include cover crop, agrostological measures, terrace farming, contour plowing, perimeter runoff control and overgrazing prevention. From the studies it was concluded that besides controlling runoff and trapping sediments, the resource conservation techniques were also effective in improving the various chemical properties of the soils. The value of pH in sandy loam and clay loam was highest in cover crop (*i.e.* 7.84 in sandy loam and7.73 in clay loam) and lowest (7.33 in sandy loam and 6.64 in clay loam) in overgrazing prevention. The organic carbon content was also highest in cover crop in both sandy and clay loam soils (8.14g kg^{-1} and 8.25g kg^{-1}) and lowest in overgrazing prevention (2.11g kg^{-1} and 2.37 g kg^{-1}), respectively. The highest value of available nitrogen, phosphorus and potassium were recorded in cover crop *i.e.* (426.22 kg ha^{-1} and 440.10 kg ha^{-1}), (28.52 kg ha^{-1} and 30.29 kg ha^{-1}) & (292.04 kg $ha^{-1}$and 309.70 kg ha^{-1}) in both sandy loam and clay loam, respectively where as the lowest value was recorded in overgrazing prevention. From the study therefore, it can be concluded that resource conservation techniques should be adopted in submontane *Shivaliks*. As these practices not only reduces runoff and sediment yield but are also effective in maintaining the nutrient status and various physical and chemical properties of soil. The carbon content also increased with the use of these resource conservation techniques which is very good indicator of soil health, as carbon act as bridge between nutrient, water and soil. These techniques contributes to more accumulation of nutrients and soil organic carbon, better physical condition of the soil along with good soil aggregation.

Keywords*: resource conservation techniques, runoff, sediment yield, organic matter, available nutrients*

5-HMF possesses activity against colon cancer cells: Isolation and characterization from the fruit part of *Grewia asiatica*

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Abstract

Biodiversity of plants ensures a resource for new food crops and bioactive compounds, while plant diversity is well represented in rural areas, development pressures have reduced the amount of greenspace in urban areas, resulting in a poorer diversity of plant communities. In the present research work, our aim was to investigate the *in vitro* cytotoxic potential of methanolic extract of *Grewia asiatica* (phalsa) fruit and further isolation of active compound. The methanolic extract was prepared and further fractionated with n-hexane, chloroform and butanol in the order of increasing polarity. The inhibitory effect of 5-HMF on different human cancer cell lines was investigated by SRB assay. The extract and fractions were evaluated against eight human cancer cell lines (A-549, HCT-116, HT-29, SW-620, PC-3, MCF-7, MDAMB-231 and MIA PaCa-2) from five different tissues (lung, colon, prostate, breast and pancreatic) respectively at the conc. of 100 µg/ml. The results revealed that chloroform fraction of *G. asiatica* exhibited *in vitro* cytotoxicity against colon cancer cell line (SW-620) with growth inhibition of 70% whereas n-hexane fraction also inhibited the growth of same cell line by 76%. Moreover, a compound named 5-hydroxy methyl furfural (5-HMF) was isolated from chloroform fraction through column chromatography and characterized *via* NMR (^{1}H and ^{13}C) and mass spectroscopy (HRMS). It was tested against SW-620 cell line and the IC_{50} value calculated was >50±0.77 µM. Taken together, these findings suggest that bioactivity guided fractionation resulted in the isolation of 5-hydroxymethyl furfural (5-HMF) with the potential to treat specifically colon cancer.

Key words: *Grewia asiatica*, *in vitro* cytotoxicity, 5-HMF, phalsa, SRB assay, cancer cell lines

Resource Conservation Management for Sustainable Development

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Abstract

Farmers today prepare for planting in ways that disturb the soil to varying degrees. Tillage with a moldboard plough completely turns over the first six to 10 inches of soil, burying most of the residue. A chisel plough, meanwhile, only fractures the topsoil and preserves more surface residue. In contrast, no-till methods merely create in each planted row a groove just half an inch to three inches across into which seeds can be dropped, resulting in minimal overall soil disturbance. Conservation Agriculture aims to produce high crop yields while reducing production costs, maintaining the soil fertility and conserving water. It is a way to achieve sustainable agriculture and improve livelihoods. The three principles of conservation agriculture are- disturb the soil as little as possible (adopt conservation tillage) keep the soil covered as much as possible (keep permanent soil cover, especially by crop residues and cover crops) and mix and rotate crops (diversify crop rotations). In conservation agriculture, crop residues left on the field, mulch and special cover crops protect the soil from erosion and limit weed growth throughout the year. Conservation agriculture enable us to improve yield, reduce production cost and overcome shortages of labour and farm power. Biodiversity and healthy ecosystems are a foundation for sustainable development, and thus play a key role in supporting the achievement of all 17 SDGs, including and beyond SDGs 14 and 15 which address life below water and life on land.

Keywords: *Resource, biodiversity, sustainable development*

Role of Plant Genetic Diversity in Sustainable Agriculture

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Abstract

The importance of plant genetic diversity is now being recognized as a specific area since exploding population with urbanization and decreasing cultivable lands are the critical factors contributing to food insecurity in developing world. Crop plant evolution either natural or human-directed, is primarily based on existing genetic diversity in the population. Diversity can be described as the degree of differentiation between or within species. Existing intra- and inter-specific differences are at the base of all crop improvement programmes. If all the individuals within the species would have been similar, then possibly there could not have been any scope for improvement in plant performances for different traits. Since the beginning of systematic plant breeding, natural variability and divergence between crops have been extensively identified and used in improvement of crop species. Agricultural scientists realized that genetic diversity can be captured and stored in the form of plant genetic resources (PGR) such as gene bank, DNA library, and in the biorepository which preserve genetic material for long period. However, conserved PGR must be utilized for crop improvement in order to meet future global challenges in relation to food and nutritional security. Since plant breeding research and cultivar development are integral components of improving food production, therefore, availability of and access to diverse genetic sources will ensure that the global food production network becomes more sustainable. Genetic diversity becomes more important in context of climatic change and associated unforeseen events as it may serve as the reservoir of many novel traits conferring tolerance to different biotic and abiotic stresses.

Keywords: *Biotic-abiotic stress, Climate change, Food production, Genetic diversity, Sustainable*

Exploring biodiversity of foothill Himalyas for production and anticancer efficiency of L-asparaginase

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Abstract

L-asparaginase is an outstandingly viable therapy worldwide for those peculiar cases where blood cells become malignant, as in acute lymphoblastic leukemia (ALL). *E. coli* L-asparaginase preparations were introduced into cancer chemotherapy over 50 years ago and remain of significant use as a chemotherapeutic agent for the treatment of ALL, non-Hodgkin's Lymphoma, acute myeloid leukemia and other lymphosarcomas. Asparaginase is broadly found in plants, animals and microbes but not in humans. Varied microorganism sources such as yeast, fungi and bacteria are generally used to produce L-asparaginase as it is trivial to extract the enzyme from plants and animals. In this study rhizospheric soil sample of Black gram was collected from Rajouri region of J&K followed by isolation and screening of pure culture showing noteworthy enzyme activity. Enzyme purification was done by anion exchange chromatography using a mono-Q column attached to Biologic-Duoflow FPLC system. In-vitro evaluation of cytotoxic potential of purified protein was carried out against four different human cancer cell lines, MDA-MB-231(breast), MIAPACA (pancreas), MDA-MB-435(melanoma) and A-498(renal). The enzyme showed significant results from medicinal point of view as 55% growth inhibition was observed against breast cancer cells and 50 % growth inhibition was observed against pancreatic human cancer cells. The enzyme can be modified through chemical means for the preparation of anti cancer drug that will serve as a great service and promise to cancer patients especially with breast and pancreatic carcinoma.

Keywords: *L-Asparaginase, Biodiversity, Purification, Cytotoxicity, Human Cancer Cells*

THEME- III
Biodiversity Conservation, Resource Management and Ecological Restoration for Sustainable Development

Underutilized citrus fruits of Arunachal Pradesh

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Abstract

Arunachal Pradesh situated between latitude of 26^0 30' to 29^0 28' North and longitude of 91^0 25' to 97^0 24' East stretching over 83,730 sq.km is the largest state area wise in North Eastern Region and blessed by nature with one of the richest flora and fauna on the earth. Arunachal Pradesh is endowed with diverse agro-climatic conditions suitable for growing an array of horticultural crops including citrus. The state has been growing numerous forms of citrus from a hoary past and it also abounds in its wild forms. The wild adoptability of citrus fruit of Arunachal Pradesh is reflected in their general distribution. The khasi mandarin has already attained commercial importance in the state. The limes, lemons, and pummelos are predominant in the plains and sub-mountain tracts. There are some other species which more or less, grow exclusively in high altitudes. In a naturally cross-pollinated genus like the citrus, nature has eventually created different forms of citrus and the state has the conducive environment, suitable soil and topography for perpetuation of these various forms. Other than the commercial species, some of other species of citrus namely Rough lemon, Kamala Australia, Samphola, Citron, Singkin, various forms of Limes and Lemons, Pummelos, Grapefruit etc. are available either in homestead or in forests. A study was conducted to characterise some underutilised citrus species of Arunachal Pradesh. The details of some underexploited endangered citrus species will be presented in this paper.

Keywords: *Citrus, Arunachal Pradesh, Diversity, Physico-Chemical Properties*

Organic Farming –A Key to Sustainable Agricultiure

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Abstract

Agriculture is the backbone of Indian economy. The advancement of technology and development in agriculture has enabled our country to provide food security. As every technology has pros and cons; this advancement in agriculture has directed to imbalance our ecosystem by unsystematic application of an enormous quantity of chemical fertilizers, pesticides in terms of their negative impact on the human health and the environment. So Organic Agriculture' is the only solution to nurture the land and to regenerate the soil by going back to our traditional method of farming i.e., free from chemicals, pesticides and fertilizers. Adaptation and mitigation based on organic agriculture can build on the well-established practice because organic agriculture avoids nutrient exploitation and increases soil organic matter content. Consequently, soils under organic farming capture and store more water than soils under conventional cultivation. Furthermore, organic farming reduces the vulnerability of the farmers to climate change and variability by comprising highly diverse farming systems and thus, increases the diversity of income sources and the flexibility to cope with adverse effects of climate change and variability, such as changed rainfall patterns. So this chapter provides a brief outlook about Organic Agriculture, its major components, its present scenario in India, Govt. policies, the main principles of organic agriculture and limitations in practicing organic agriculture.

Keywords: *Organic Agriculture, Sustainable Agriculture, Food Security, Modern Agriculture*

Crop Intensification for Enhanced Production under Organic Farming in Nendran Banana

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Abstract

Nendran banana was planted at a wider spacing of 2.5 m x 2.5 m and it usually takes three to four months to establish and cover the ground area. Hence, with an objective to utilize the interrow spaces between the banana in the early stages of crop growth for enhancing the production per unit area, field experiments were carried out in RBD with nine treatments in an organically maintained area at Coconut Research Station, Balaramapuram replicated thrice. Four Nendran banana plants were taken as one unit and the area of 6.25 m^2 available between the four Nendran banana was intercropped with different crops *viz*., bush type vegetable cowpea, tomato, upland rice, cassava, elephant foot yam, hybrid napier, palisade grass, turmeric and ginger and was compared with sole crop of Nendran banana. The intercrops were planted at the recommended spacings. Nendran banana as well as intercrops were fertilized as per the package of practice recommendations on N equivalent basis, 85 per cent of N was given in the form of FYM and remaining 15 per cent was given in the form of poultry manure, vermicompost and goat manure. The pooled results of two years data revealed that intercrops did not cause any significant reduction in the yield of Nendran banana. Results also revealed that, except Nendran banana intercropped with cowpea, all other combinations recorded higher or statistically comparable yield with the sole crop of Nendran banana. The yield of banana was the highest, when banana intercropped with upland rice and it was statistically at par with banana intercropped with turmeric and amorphophallus. The net returns and B:C ratio were also found to be the highest in Nendran banana intercropped with turmeric. Results on the soil dehydrogenase activity revealed that, it was highest in Nendran banana intercropped with bush type vegetable cowpea and the lowest in sole crop of Nendran banana. The post-harvest nutrient status also revealed that compared to sole crop of Nendran banana, Nendran banana with intercrops recorded higher soil organic carbon, soil available N and P. Compared to sole crop of Nendran banana, K availability was found to be higher in all treatments, except Nendran banana intercropped with fodder crops. The system productivity also worked out to compare the treatments on banana equivalent basis, the highest system productivity was observed in Nendran banana intercropped with turmeric. Hence, it can be concluded that interrow spaces available between the organically grown Nendran banana can be successfully utilized for growing compatible crops and among the intercrops tested, turmeric was found to be the best one. Nendran banana + turmeric recorded the highest net returns, B:C ratio and system productivity by maintaining a better soil health and soil nutrient status.

Keywords: Intercrops, *Nendran banana, Net returns, System productivity*

Effects of Herbicides on Soil Microbial Count under Mungbean Cultivation

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Abstract

The soil micro-organism (collectively called soil microbial biomass) are the agents of transformation of soil organic matter, nutrients and most key soil process. The microbial activity has a direct impact on the nutrient availability as other properties related to soil productivity. The microbial activity much influenced by Physico-chemical interaction. The population of microbe's viz., bacteria, actinomycetes and fungi is increase with the crop advances with decreasing rate this might be due to adverse effects of herbicides. Herbicides show reduction in the total microbial population within 7 to 30 days after application depending on the type of herbicide molecules. The adverse effects of herbicides appear instantly after the application when their concentration in soil is maximum. Later on, microbial count take part in degradation process and chemical concentration decreases. The recommended dose did not affect the microbial counts significantly but the application of excessive and higher doses of herbicides has also been reported to result in the death of many sensitive microbes. A low concentration of Imezathyper in soil is compensated for high microbial activity due to high persistency in soil up to 5 to 24 months. For marinating sustainability herbicides should be used at recommended rate.

***Keywords**: Soil microbial biomass, soil productivity, herbicides*

An Overview: Entomopathogenic Fungi-Biological Control of Locust

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Abstract

Locusts are a group of several short-horned grasshoppers with a swarming mechanism in the Acrididae family. India has in the past encountered several plagues of locust, upsurge, and incursion. Nevertheless, desert locust is a solitary process, *Schistocera gregaria* F. In or around Rajasthan and Gujarat, India, has been reported from time to time. Locusts are a group of several species of short-horned grasshoppers in the family Acrididae that have a swarming process. Usually these insects are solitary, but they become more abundant under certain circumstances, and change their behavior and habits, becoming gregarious. Since the beginning of civilization, locusts and grasshoppers have been among the most devastating threats to agriculture. This group of insects contains hundreds of pest species and affects the livelihoods of one in every ten people worldwide. To the food security and livelihoods of rural communities, the effects of the invasions in the affected areas may be disastrous. Ultimately, control camps commonly cost $1 million, with the vast amounts of chemical insecticides used having significant environmental side effects. Entomopathogenic fungi are typically present within natural insect populations and are often solely considered as effective microbial control agents in integrated pest management. The use of fungal insect pathogens may have certain advantages over the use of parasitoids and insecticides such as efficiency and environmental safety. Several fungal agents have been used to control pests, such as the rice planthopper *Nilaparvata lugens*, *Haemaphysalis longicornis*, and the oriental migratory locust *Locusta migratoria manilensis* Meyen, and have achieved good results

Climate Change: Impact on Horticultural Crops

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Abstract

The horticultural productions and productivity are extremely affected by climatic variability. Rainfall pattern and high temperature are the major parameters of climate change that has severe impacts on agriculture and horticulture. Agriculture and horticulture are the most susceptible to climate change and global warming. Climate change affects horticultural production in various ways. Rise in temperature, changed the production timing and hasten maturity in photosensitive crops. Extreme temperature affects pollination because of floral abortions; flower and fruit drop occurs frequently. Tuber initiation process in potato, quality in tomatoes and pollination in many crops reduced due to extreme temperatures. In crucifers, high temperature leads to bolting; anthocyanin production also affected in apples and capsicum. Most of the varieties of cauliflower under high humidity perform well in the temperature range of 15- 25°C and some varieties have adapted to temperatures over 30°C while, most varieties are sensitive to higher temperatures and delayed curd initiation. Increase in temperature resulted to have influences on the flowering phenology of perennial crops like mango and guava. Some physiological disorder like spongy tissue of mango, fruit cracking of litchi, flower and fruit abscission in solanaceous vegetables are caused due to high temperature and air pollutions. Banana cultivation also suffers from high temperature, soil moisture stress and flooding/ water logging. Sunburn and cracking in apples, apricot and cherries also resultant effect of raised temperature. Poor rain, rise in temperature and violent winds, reduced the productivity of cashew nut owing to abortion or drying of the flowers, falling of the leaves and the immature fruits. The occurrence of pests and diseases due to untimely rains and heavy precipitation during flowering and fruiting period caused yields reduction up to 50% to 65%. By minimizing the effect of climate changes and greater use of greenhouse technology are some of the solutions to sustain the productivity. Developing horticultural crops tolerant to high temperature, resistant to pests and diseases, short duration and producing good yields under stress conditions will be the main strategies to meets these challenges.

Keywords*: Climate change, Temperature, Rainfall, Horticultural crops, productivity*

Climate Transform Variation Strategies for Resource Management

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Abstract

Recent quick changes among the Earth's climate have altered ecological systems around the globe. Global warming has been connected to changes in physiology, phenology, species distributions, interspecies interactions, and disturbance regimes. Projected future climate change will on the far side any doubt result in even heaps of dramatic shifts among the states of the various ecosystems. These shifts can give one of the most important challenges to natural resources managers and conservation planners. However, with the quick can increase in world population and manufacture, to boot as accumulated demands on natural resources like water provides, the planet isn't any further able to sustain a healthy and balanced system. Managing natural resources and ecosystems among the face of unsure climate would like new approaches. Most of the recommended approaches are general principles and much of our tools that managers are already victimization. The most target of restoration will get to shift from historic species assemblages to potential future ecosystem services. Active accommodative management supported potential future climate impact eventualities ought to be a vicinity of everyday operations. And sorting will likely become a vital selection. Though' many ideas and tools for addressing climate change are projected, key things of information are still missing. To with success manage for climate change, a far better understanding is required of that species and systems can doubtless be most tormented by climate change. The marks show that the most effective attainable approach for managing resources with declining growth is capable of managing resources with unsteady or rising growth at an insignificant value, making during a management strategy that's each capable and sturdy towards future unknown changes. To get the strategy, adaptive management ought to try for: high learning rates to new information, high valuation of future outcomes and modest exploration around what's perceived because the best action.

Keywords: *Climate change, Resource management, adaptation, ecosystem services*

Pollution Status and Conservation of Monomictic Lake of Kashmir Himalaya, India

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Abstract

In freshwater ecosystems, water quality plays an important role in determining the status and condition of that fresh water ecosystem. During the present study, an attempt was made to assess the water quality and conservation status of Manasbal Lake of Kashmir Himalaya. The Manasbal Lake, a marl lake, is located district Ganderbal in the UT of Jammu and Kashmir, India. The actual location of the Manasbal catchment is defined by latitudes $34^0 14'$ - $34^0 16'$ N and longitude $74^0 40'$ - $74^0 43'$ E, and has altitude position of about 1551m a.s.l. The lake catchment covers an area of about 22 km^2located in district Ganderbal at a distance of 30 km north from the Srinagar city of Jammu and Kashmir. The Manasbal Lake a semi urban lake is getting modified as a result of cultural eutrophication due to anthropogenic pressure, siltation and the wastewater released from the nearby kilns and residential areas. From the present study, It can be concluded that the higher values of Phosphates (PO4), Alkalinity, Hardness, Electric Conductivity, Free carbon dioxide and lower values of dissolved oxygen and transparency clearly depicted higher trophic status of Manasbal Lake. It can also be concluded that climatic factors, untreated sewage and solid garbage from surrounding population, fertilizers containing Nitrates and Phosphates and slit load were the main causes for degradation of water quality of the studied lake. Hence, periodic monitoring of Manasbal Lake is necessary for assessing the quality of water for human and animal consumption as well as for aquatic life. Besides, immediate remedial measures should be taken up for protection and conservation of this monomictic lake in order to save it from further pollution and deterioration.

Keywords: *Monomictic, Physico-chemical, Cultural eutrophication, Conservation.*

Impact of Climate Change on Weed Menace

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Abstract

Climate change is perhaps the most serious environmental threat to fight against hunger, malnutrition, disease and poverty. Climate change is a significant variation in weather patterns occurring over periods. Climatic change could affect agriculture in several ways: productivity, in terms of quantity and quality of crops; agricultural practices, agricultural inputs such as herbicides, insecticides and fertilizers; environmental effects, soil erosion, reduction of crop diversity. Agriculture is the most vulnerable and sensitive sector affected by climate change because of its dependency on local climate parameters like rainfall, temperature, etc. Climate change engrosses increasing temperatures and changed precipitation patterns. Weeds are influenced by these altered abiotic conditions. Weeds tend to show better survival mechanisms under changing climate. This might be due to their greater inter-specific genetic variation, ease to adoptability and physiological plasticity. Under changing climate aggressive growth of C3 or C4 weeds may need more energy and labour intensive management. Control of weeds is likely to be more difficult and more expensive under climate change. Some well known invasive species are likely increase their bio-geographical ranges, and other, comparatively placid species may become violent invaders. Climate change caused further alterations in the weed species composition. As a result, climate change may become one of the most important determinants for the distribution of weeds. Climate change also influences weeds indirectly by imposing adaptations of farming methods such as crop choice, sowing time, harvesting method, and other agronomical practices to these alterations.

Keywords: *Climate change, weed menace, weeds*

Effect of jute caddies on physico-chemical properties of soil under chilli production

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Abstract

The processing waste or by-products of jute industry, commonly known as Jute Caddies can be used as a mulching material for crop production which is eco friendly and bio degradable. Chilli productivity in Inceptisols remains unstable due to oscillating weather and soil related constraints. Application of a suitable ameliorative thus necessitates for improving the soil conditions towards increasing the chilli productivity. In order to explore a new tool of mulching which is both bio-degradable and cost-effective, the present study has been undertaken to assess the effectiveness of various quantities of jute caddies on the improvement of soil quality and enhancement of chilli productivity at the Instruction farm of Soil and Water Conservation Department, Bidhan Chandra Krishi Viswavidyalaya in Nadia representing New Alluvial Zone of West Bengal, during winter seasons of 2019-2020. The experiment was conducted with six treatment combinations viz. T_1- 2 tonnes jute caddies/ha, T_2- 4 tonnes jute caddies/ha, T_3- 6 tonnes jute caddies/ha, T_4- 8 tonnes jute caddies/ha, T_5- 10 tonnes jute caddies/ha and T_6 - farmers practice (i.e. control). All jute caddies materials were spread on the soil after final land preparation and before transplanting of chilli seedlings. The plots were designed in randomized block design in having 21 sq. m plot size with 4 replications. The results reveals that all the treatments of jute caddies showed much better performance than control (farmers practice) in respect of yields, yield attributes, growth parameters, and water use efficiencies of chilli crop. The difference in percentage increase between 4 and 6 tonnes/ha is greater than the percentage difference between 8 and 10 tonnes/ha. That is, the percentage increase in yield shows a declining trend with the increase in quantity of jute caddies. The benefit-cost ratio estimated for each treatment is observed to be the highest in case of 6 tonnes/ha. So, 6 tonnes/ha jute caddies was much cost effective in comparison to any other treatment of jute caddies. Each treatment increases organic carbon and availability of nitrogen, phosphorous and potassium. Sharp increase of porosity, moisture use efficiency and reduction of bulk density of soil as well as better aggregation and well stabilization of soil aggregates have been observed thus favoring better growth and yield of chilli. Among the various quantity jute caddies treatments, the 6 ton/ha jute caddies proves much superior for growth, yield and yield attributes of chilli as well as water use efficiencies and various soil properties in comparison to other treatments of jute caddies. Since, this is a by-product of jute industry, recycling jute caddies as soil ameliorative also solves the problem of handling, disposal of this waste serving as a viable tool to keep the surrounding environment clean.

Keywords: *chilli productivity, jute caddies, organic carbon, moisture use efficiency*

Brown Manuring for effective weed management and sustainable yield in rice.

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Abstract

To achieve crop yield sustainability, an efficient nutrient management is essential. In India, modifying the farming practices and increasing attention towards the development of resource conservation practices is desirable. In the current scenario of agriculture, evolving eco-friendly approach of weed control is more advisable so as to protect the natural resources such as soil flora and fauna including human being and animals in a holistic manner. Traditionally, farmers grow green manure crops before rice cultivation and incorporate it by ploughing before transplanting rice seedlings and this requires more number of tillage operations for green manuring which leads to loss of soil moisture, also it needs additional irrigation water and fuel costs for incorporation. In addition to it, green manuring practice requires a period of about 45-60 days from seeding to decomposition with proper temperature and optimum moisture conditions after incorporation. So, the practicable option left behind is brown manuring as a tool for integrated nutrient management and is also becoming a popular technique in agriculture. Brown manuring is simply a 'no-till' version of green manuring, using a post emergence and non-selective herbicide to desiccate the green manuring crops before flowering instead of using cultivation. After spraying, the colour of green crops becomes brown due to loss of chlorophyll, hence the process is called as brown manuring. The practice led to reduction of weed population by nearly half without any adverse effect on rice yield. It aims at suppressing the weeds by shading. Like green manuring, brown manuring also impacts positively on soil organic matter, improving the soil physio-chemical properties and its associated microbes. Brown manuring can replace 25 per cent of nitrogenous fertilizer with the overall improvement of soil health. Thus, it can concluded that brown manuring is capable of supplying all nutrients to the crops which is also considered beneficial for weed management as well as improving soil properties.

Keywords: *Rice, resource conservation practices, herbicide and brown manuring*

Sustainable Farming and Its Future Needs

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Abstract

The population of India, >65% is dependent directly or indirectly on agricultural activities. Indian agriculture is facing with an array of problems such as shallow to black alluvial soils with poor fertility levels and low moisture retention capacity, poor crop stand, erratic weather, inadequate crop inputs and farming infrastructure, uncertain and low rainfall coupled with late onset and early cessation of rains or prolonged dry spells during crop season, conventional farming, lack of improved technology, soil salinity or alkalinity, water and soil erosion, low productivity of cattle, water scarcity, reduction in cultivable land/capita, high cost of crop inputs, lack of marketing network and avenues for value addition of farm produce and fluctuating market prices. These situations result in socio economic constraints such as, poverty, illiteracy and poor standard of living. In reality, concerted efforts for maintaining sustainability in these areas are urgently needed. Sustainable agriculture is defined by three interactive components: economic profitability, environmental stewardship and social responsibility. It is important that sustainability is embraced at all levels of the supply chain. Farm practices can have compound effects across the entire supply chain in very complex ways, both positive and negative. Sustainable agriculture techniques enable higher resource efficiency – they help produce greater agricultural output while using lesser land, water and energy, ensuring profitability for the farmer. These essentially include methods that, among other things, protect and enhance the crops and the soil, improve water absorption and use efficient seed treatments. For example, for soil enhancement certified biodegradable mulch films are now available. An independently certified biodegradable mulch film, on the other hand, is directly absorbed by the microorganisms in the soil. It conserves the soil properties, eliminates soil contamination, and saves the labor cost that comes with PE mulch films. The other perpetual challenge for India's farms is the availability of water. Many food crops like rice and sugarcane have a high-water requirement. In a country like India, where majority of the agricultural land is rain-fed, low rainfall years can wreak havoc for crops and cause a slew of other problems - a surge in crop prices and a reduction in access to essential food items. Again, Indian farmers have long experience in water conservation that can now be enhanced through technology. Seeds can now be treated with enhancements that help them improve their root systems. This leads to more efficient water absorption. In addition to soil and water management, the third big factor, better seed treatment, can also significantly improve crop health and boost productivity. These solutions include application of fungicides and insecticides that protect the seed from unwanted fungi and parasites that can damage crops or hinder growth, and increase productivity. While sustainable agriculture through soil, water and seed management can increase crop yields, an efficient warehousing and distribution system is also necessary to ensure that the output reaches the consumers.

Keywords: *Sustainable agriculture, Soil erosion, Low productivity.*

Impact of Climatic Conditions on Horticultural Crop Production

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Abstract

Global warming and climate change is one of the greatest concerns of mankind in 21st century. The established commercial varieties of Horticultural crops will perform poorly in an unpredictable manner due to aberration of climate. The best responses for every plant either for vegetative growth or for its reproductive potentials are obtained in the cardinal temperature ranges, which includes minimum, maximum and optimum. The adverse effect of temperature on fruit plants occurs when it crosses its limits. These effects are either due to direct injuries or due the reduced activity of enzymes and disturbed metabolic processes. Due to high temperature, physiological disorder of horticultural crops will be more pronounced, for instance, spongy tissue of mango, fruit cracking of litchi, flower and fruit abscission in solanaceous fruit vegetables, melting of ice cap in the Himalayan regions will reduce chilling effect required for the flowering in apple, saffron, rhododendron, orchid, etc. Air pollution also significantly decreased the yield of several horticultural crops and increases the intensity of certain physiological disorders like black tip of mango. Hence there is a need to protect these valuable crops for sustainability against the climate change scenario. Minimizing the effect of climate changes and greater use of greenhouse technology are some of the solutions to sustain the productivity and modification of present horticultural practices. Developing horticultural crops tolerant to high temperature, resistant to pests and diseases, short duration and producing good yields under stress conditions, as well as adoption of hi–tech horticulture and judicious management of natural resources will be the main strategies to meet this challenge.

Keywords: *Climate, disorder, horticultural crop, resistance, tolerant*

Sustainable Agriculture Technologies: Approaching Natural Resource Management

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Abstract

The rise in temperature of the earth is responsible for global warming which leads to a change in the climate. Climate change has become a global phenomenon affecting the whole environment. Its impacts are ice melting, sea-level rise, species extinction, changes in the ecosystems, the occurrence of extreme weather events like flooding, drought, and cyclone, etc. Agriculture is dependent on weather and it is also affected by climate change. Globally, agricultural ecosystems have been reduced due to increased temperatures. It has become vulnerable to agricultural pests and diseases. Rising temperatures decrease crop productivity too. The world population is increasing day by day which would demand more food for survival. Hence, food security has to be ensured for human sustainability. Actions need to be taken to combat the impacts of climate change on agriculture and achieving food security such as adopting clean-green-organic practices and efficient irrigation management, increasing soil health, reducing methane emissions from livestock, supporting farmers' markets and local foods to reduce carbon footprint and strictly implementing climate-friendly policies.

Keywords: *Sustainable Agriculture, Agricultural Technologies, Natural Resource Management.*

Studies on cytology, phenology and breeding system of *Viola pilosa* blume: A medicinally important herb

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Abstract

Viola pilosa blume. (Violaceae), widely distributed in Jammu Province of Jammu and Kashmir (India), is an important medicinal herb. Locals collect its leaves and flowers for personal use to cure fever, cough, cold and chest infection as well as for selling to pharmaceutical companies associated with preparing commercial "Banafsha". To meet the increasing demands of locals and drug houses and avoiding pressure on naturally occurring populations, plants of this species need to be cultivated. In view of this, information regarding cytological and phonological aspects as well as breeding strategy adopted by the species is of paramount importance. Present meiotic studies in this species revealed its having 20 chromosomes, showing regular behavior at meta- and anaphase I and exhibiting high pollen stainabilty. This species bears chasmogamous and cleistogamous flowers, with the former appearing during March-May and later differentiating during late summers. While chasmogamous flowers form seed through cross-pollination, cleistogamous ones develop into seeds on selfing. As such, these observations pointed towards mixed-mating system operative in this species

Indigenous Technical Knowledge (ITK) – A Means to Climate Smart Agriculture (CSA)

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Abstract

Green revolution in India converted Indian agriculture into an industrial system due to the adoption of modern methods and technology though these technologies partly solved food problems but had several impacts on the environment and several living beings too. Modern farming methods demands anything that comes in the way of crop production needs to be uprooted and destroyed which to the loss of many wild species from their natural habitats. The chemicals used in the farm are becoming a greatest threat to environment and becoming responsible for climate change. Under these situations ITK's are the possible solutions to the problem at hand. Indigenous technical knowledge is a cumulative body of knowledge and practices maintained and developed by people with expanded histories of interaction with the natural environment. Climate smart agriculture (CSA) is an approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. Sustainably increasing agricultural production, adapting to climate change and reducing emissions are the main points of climate-smart agriculture. Therefore, reverting back to indigenous knowledge and practices can help us in achieving our objective of climate smart agriculture and also preserves and mobilizes local knowledge.

Keywords: *Green revolution, Climate change, Indigenous Technical Knowledge (ITK), Climate Smart Agriculture.*

Role of Biodiversity conservation to natural environment and nutritious food security

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Abstract

Biodiversity conservation and food security are two sides of the same coin. Biodiversity conservation is the protection and management of biodiversity to obtain resources for sustainable development Ecologists and conservation biologists focus primarily on biodiversity conservation in non-agricultural lands it has been recognized that a strictly conservation focus is limited in scope, particularly in terms of fulfilling production requirements. This is pertinent given that the majority of the world's biodiversity remains outside of protected areas, often in complex, multi-functional landscapes occupied by people and their associated farming systems. Biodiversity is essential for achieving nutritional diversity in diets a diverse food basket which is important for human health and development. However, biodiversity, and in particular genetic diversity, is being lost at an alarming rate. **The threats to biodiversity:** The focus on the development and use of only a few commercial crop varieties and breeds of livestock, neglecting locally adapted varieties and breeds and their important characteristics. Effects of increasing population pressure affect the biodiversity. The loss of natural habitats and environmental degradation, including deforestation, desertification and river basin modification. Due to Climate change loss of biodiversity.

Keywords: *Biodiversity, Challenges, food security, conservation*

Genetic Variability of Morphological Traits among Indian mustard (*Brassica juncea* L.Czern & Coss) Genotypes under non- irrigated and irrigated condition

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Abstract

Water calamity results in the screening of drought tolerant genotypes which were suitable for both non-irrigated as well as in irrigated condition. Keeping consideration over this experiment was designed to study genetic variability and heritability under non- irrigated and irrigated condition on some morphological and quality traits an experiment on Indian mustard (Brassica juncea L.Czern & Coss), was conducted by accommodating 20 genotypes, from various Rapeseed & Mustard centres located across country, randomly in three replications during Rabi 2016-17 in Randomized Complete Block Design (RBCD), one subjected to a drought regime inside the Rainout shelter under non-irrigated condition which was also devoid of rainfall and another one provided with normal irrigated field condition in Dr. Rajendra Prasad Central Agricultural University , Pusa, Samastipur. Analysis of variance for the studied traits revealed considerably exploitable variability. Out of 20 genotypes under both non-irrigated as well as irrigated condition, Rajendra Suphalam showed tolerance towards water stressed condition and performed well in terms of productivity in an irrigated situation for all the traits. PKRS-28 identified as tolerant genotype under non- irrigated, and Pusa Mahak as well suited under an irrigated condition in terms of flowering – maturity, siliqua characteristics and yield contributing traits. Under both conditions, high heritability coupled with high GAM for traits namely, HFPB and SBP-1 which were indicative of preponderance of additive gene action for expression of these traits hence are acquiescent for simple selection. The height of first primary branch and secondary branches per plant due to wide variability, meagre environmental influence along with high heritability and genetic advance suggested the exploitation of these traits for the further breeding programme as these traits are fixable in nature can be utilized in further segregating generations.The initiation of primary branches from the lowest position of the plant can accommodate number of branches and also provides a way to utilize the non- usable portion of the mustard plant from the base up to 55-60 cm.

Keywords: *Brassica juncea L., Heritability, Genetic Advance, Non- Irrigated, Quality Traits*

Effect of *Urocystis Agropyri* and Different Inoculum Levels of *Heterodera Avenae* on Chlorophyll Content and Growth of Wheat

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Abstract

A pot experiment was done for studying the effect U. agropyri and different inoculum levels of H. avenae on wheat cultivar HD 2967. The experiment was conducted under screen house conditions in Department of Nematology, CCS HAU, Hisar during Nov. 2018 – April 2019. SPAD chlorophyll content was measured 30, 40, 50 and 60 days after sowing, while plant height and plant weight at crop maturity. Maximum reduction in plant height and plant weight was observed at highest inoculum level (15 eggs and juveniles/ g soil) of nematode. SPAD chlorophyll content increased from 30-60 days after sowing and was maximum at 60 days after sowing. Per cent reduction in chlorophyll increased from 30-60 days after sowing and maximum reduction was observed at 60 days after sowing in 15 eggs and juveniles/ g soil of Heterodera avenae and Urocystis agropyri.

***Keywords**: SPAD, U. agropyri, Chlorophyll, H. avenae, wheat*

Trichoderma potential biocontrol agent for management of plant parasitic nematodes

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Abstract

Plant parasitic nematodes are important plant pathogen affecting crop production throughout the world. Since, indiscriminate use of nematicides is hazardous for soil as well as soil micro-flora and fauna. Biological control of plant parasitic nematodes through microorganisms offers an alternative management tool to replace chemical methods and their uses is considered to be economically feasible. Several fungal and bacterial bio-agents have been tested for management of nematodes. The main criteria for successful deployment of these biocontrol agents in fields are their ability to suppress nematode populations, restrain their multiplication and enhance yields profitably. As fungi coexist with nematodes in the rhizosphere, so there is possibility that their toxic metabolites may suppress or repel nematode populations. Toxic effects of fungal culture filtrates had showed different levels of efficacy due to the differences of soil ecological types and climate, a broad range of fungi remains far unexplored. *Trichoderma spp.*, is parasites of fungus as well as nematodes and suppress nematode growth by releasing metabolite "Trichodermin" which is toxic for nematodes, it also parasitize egg of nematodes by enzymatic activity. *Trichoderma spp.* as biological control agent is one of the eco-friendly method for management of PPNs.

Keywords: *Trichoderma, Nematicide, Bio-Control, Rhizosphere*

Biodiversity: Need of the current situation for sustainable crop production

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Abstract

Biodiversity, an amalgamation of two vital words "bio and diversity" about the variation of life. Biodiversity typically measures variation in the genetic, the species, and the ecosystem level. Biodiversity provides goods and services such as food, fiber, medicine, air, water purification, climate regulation, erosion control, and nutrient cycling. Biodiversity also plays an imperative role in economic sectors that drive development, including agriculture, forestry, fisheries, and tourism. More than 3 billion people rely on marine and coastal biodiversity while 1.6 billion people rely on forests and non-timber forest products for their livelihoods. Sustainable development is improving the quality of human life while living within the carrying capacity of sustaining ecosystems. Biodiversity conservation and sustainable development are two interrelated branches focusing on social progress, economic growth and environmental protection on one side, and ecosystem conservation on the other. Participatory approach policies with locals involved at every stage must be framed as they have experience and rich knowledge of traditional flora and fauna. Policies should support access of indigenous tribes over sustainable use of natural resources to conserve, alleviate poverty, and ensure adaptation to climate change. The diversity in life forms suffers greater threat from degradation, habitat fragmentation; spreading of invasive species; indiscriminate use of natural resources; climate change; pollution within the aquatic environment, and water flows. The natural system has its setting involving land water, atmospheres, ecological cycles, hydrological cycles, climate, animals, and plants, etc. It provides greater opportunities in the field of medical, research, education, and economic development. Preserving species in their habitats is the in-situ conservation and includes identification of biological hot spots to protect them as Natural Park/sanctuary/biosphere reserve etc. The ex-situ conservation includes developing gene banks, zoos, and botanical gardens, cryopreservation, artificial propagation of plants, biotechnological approaches. Genetic manipulation of the endangered and threatened species can be an effective tool for maintaining biodiversity. The utilization of resources is an intrinsic component of the process of development yet, overexploitation of natural resources has led to environmental degradation. The management of natural resources seems to be the only way forward to sustain the ecosystem and livelihood. Natural resources management is considered the most appropriate act of availing the resources for a long period without abandoning it for the present. NRM broadly focuses groups such as i) abiotic resources like land, water and air ii) biotic resources like forest and animals, iii) transformed biotic and abiotic resources like coal, petroleum, ores, and minerals. Land, water, air resources are though renewable, their quality, availability, and performances are to be addressed in NRM. Future-aimed restoration should acknowledge the changing and unpredictable environment of the future, assume the dynamic nature of ecological communities with multiple trajectories, and connect landscape elements for improving ecosystem functions and structures. Restoration of degraded lands improves water supplies (Bossio et al. 2009). Land restoration efforts indicate it is possible to reverse trends in forest and wetland loss and improve water quality and quantity at both the local and regional scales. Now a days government is also focusing on traditional crops to be incorporate in present cropping systems like small millets pulses like lathyrus as these crops are considered to survive successfully in harsh weather. As climate changing is the burning issue in current situation. Biodiversity also helps in maintain the physical, chemical and biological quality of soil also.

***Keywords**: Biodiversity, Conservation, Sustainable Development, natural resource, Ecosystems*

Assessment of drought tolerant *Pseudomonas* sp. on Zn and Fe biofortification and drought tolerance conferring efficacy on wheat

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Abstract

Drought is key abiotic stress, it brutally affects plant growth and nutrient content in crops. But PGPR posses the ability to confer drought resistance to plants to mitigate impacts of drought. In current investigation we recorded bio-protective traits of *Pseudomonas* sp to reorganize the consequence of drought in wheat. During the investigation we chosen drought tolerant PGPRs on account of growth in nutrient broth supplemented with 10% poly-ethylene-glycol (PEG). All drought tolerant isolates possess superior *in vitro* plant growth promoting property. Among all *Pseudomonas* sp demonstrated superior outcomes such as higher production of ACC deaminase activity i.e. 4.71±0.001 µM/mg/hr α-ketobutyrate, IAA i.e. 94.5±0.04 µg/ml and exopolysaccharide i.e. 14.93±0.040 mg/mg protein as well. Drought diminishes various agronomical parameters, chlorophyll, water status and osmolyte accumulation, carotenoids content and scavenging ability. Furthermore, *In situ* pot experiment confirmed the drought tolerance conferring the efficiency of *Pseudomonas* sp into plants. Among all treatments, *Pseudomonas* sp primed plants demonstrated premier percent harvest index 31.06% and retained higher biomass over non-inoculated plants. Moreover, *Pseudomonas* sp priming extensively enhanced the zinc and iron content in grains as well. In addition, *acd* S gene, involved in the biosynthesis of ACC deaminase enzyme, which reduces the elevated level of ethylene, was also detected in *Pseudomonas* sp. Above results concludes that *Pseudomonas sp* is a potential drought tolerant PGPR that could be used as bio-inoculant to improve Zn and iron biofortification and crop productivity under drought stress.

Impact assessment of zooplankton diversity and pollution status of River Alaknanda, Uttarakhand

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Abstract

Zooplankton plays an important role in food chain of a fresh water ecosystem. Anthropogenic activities are increasing the deterioration of biota of an aquatic ecosystem. The present study was carried out to monitoring the zooplanktonic community of head stream river of the holy Ganga i.e. Alaknanda river at Uttarakhand. The river supports a rich biodiversity in upper Gangetic region. Examined density, diversity and distribution pattern of zooplanktons in the river, along with evaluation of the relationships among different zooplankton groups and abiotic factors during the period September 2016 to August 2018. Water samples were collected from four different sampling stations viz. ZA, ZB, ZC and ZD at river Alaknanda. The study revealed that the presence of 19 species of zooplankton including 6 species of Rotifers, 6 species of Cladocera, 3 species of Copepoda and 4 species of Protozoa. Cladocera group was the most dominant among all three groups followed by Rotifera and Copepoda. The positive co-relation was calculated between dissolved oxygen and different groups of zooplankton. The dominant species as Bosmina, Mesocyclops and Filnia sp. were noted during the whole study period of two years. These species were indicating that the river water is present under some environmental pollution stressed condition. The dominant Cladocera family of zooplankton was represented the pollution tolerant species and can tolerate wide range of fluctuations in environmental changes. Due to changes in ecological habitat parameters, the zooplanktonic community shows a variation in species density and diversity.

Keywords: *Zooplankton; Diversity; Shannon Weiner index; Co-relation; Alaknanda River*

Molecular Markers Approaches and Role of Bioinformatics in Assessing Diversity of Germplasm Resources

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Abstract

Information on genetic diversity is essential in optimizing both conservation and utilization strategies for germplasm resources as resources for conservation are limited, prioritization is often necessary. The main benefit of using molecular markers is that they are good indicators of genetic distances among accessions because of their selective neutrality. DNA polymorphisms have become the markers of choice for molecular-based surveys of genetic variation and thus molecular markers have been used to identify putative centers of domestication identifying those wild populations that are most closely related to the domesticated gene pools. Molecular markers have also been used to identify ecogeographic races such as ecotones within the domesticated or wild gene pools of crop species. molecular markers are being used to assist in gene bank management. Molecular markers assist in direct germplasm explorations toward missing landraces based on DNA sequence data, allozyme, isozyme and protein electrophoretic studies. Currently, microsatellites are the most popular markers in genetic characterization studies due to their high mutation rate and codominant nature which permits the estimation of genetic diversity. SNPs (single nucleotide polymorphism) are used as an alternative to microsatellites in genetic diversity studies. Mitochondrial DNA (mt-DNA) polymorphisms have been extensively used in phylogenetic and genetic diversity analyses. Mitochondrial DNA has a maternal mode of inheritance and a high mutation rate thus enables biologists to reconstruct evolutionary relationships between and within species by assessing the patterns of mutations in mt-DNA. Developing high-throughput technologies would be useless without the capacity to analyses the exponentially large amount of biological data generated in diversity analysis studies. This needs to be stored in electronic databases associated with specific softwares designed to permit data update, integration and retrieval. Information must be easily accessible and interrogation-flexible, to allow the retrieval of information, that can be analysed to unravel metabolic pathways and the role of the proteins and genes involved. Bioinformatics is crucial to combine information from different sources and generate new knowledge from existing data. It also has the potential to simulate the structure, function and dynamics of molecular systems, and is therefore helpful in driving conclusions.

Keywords: *Molecular Markers, Bioinformatics, Diversity, Germplasm Resources.*

Role of microbes in bioremediation of polluted environment

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Abstract

Bioremediation is an emerging and innovative technology because of its economic feasibility, enhanced competence, and natural environment friendliness. The technology uses various eco-friendly microbial processes to handle the ever-rising environmental pollution problem. It is the process that uses microorganisms, fungi, green plants or their enzymes to return the natural environment altered by contaminants to its original condition. Contaminant compounds are transformed by microorganisms through reactions that take place as a part of their metabolic processes. Bioremediation technologies can be generally classified as in situ or ex situ. In situ bioremediation involves treating the contaminated material at the site while ex situ involves the removal of the contaminated material to be treated elsewhere. There are various microbial processes and mechanisms involved in the decontamination of pollutants from the environment which includes, biosorption, bioaccumulation, bioleaching, detoxification, co-metabolism and primary metabolism. The major factors which influence the bioremediation includes carbon bioavailability, nutritional availability, and temperature, pH and oxygen availability.

Keywords: *Bioremediation, biosorption, detoxification*

Diversity studies in Himalayan ginger (*Zingiber officinale* Rosc.) using phenotypic and molecular markers

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Abstract

Ginger (Zingiber officinale Rosc.), (2n=22), a monocotyledon belonging to family Zingiberaceae, is an important spice and medicinal plant originated in South-East Asia. Ginger finds inseparable and highest place among other spices grown in Shivalik Hills of Jammu and Kashmir and Himachal Pradesh. The local resources are facing the threat of depletion for many reasons and needs to be conserved. The present work deals with the morphological and molecular characterization of 62 genotypes of ginger collected from different agro climatic regions of J&K, H.P, north east and southern regions of India. Field trials were done during the kharif season of 2015-16 and 2016-17 at SKUAST-Jammu. The data on different morphological traits viz., plant height (cm), number of shoots, yield per plant (g), dry recovery per 100 grams, rhizome length (cm), rhizome breath (cm), leaf area, leaf attachment etc. were recorded for both the years. Maximum yield to the tune of 135.38 g per plant was recorded in a local accession Aghar Ballian (G57) which was at par with Gagret (G46), Kanachak (G1), Bindla (G9) and Thangar (G7). These collections outperformed some of the well known adapted varieties viz., Bainsa, Rio de Janerio, Lakshmi, Himgiri and HP Collection and other South Indian varieties Varda, Mahima and Rejatha. For molecular characterization, 28 ISSRs and 34 SSRs were used. All the SSRs generated 97 scorable bands of which 98.9% were polymorphic whereas, ISSRs produced 253 scorable bands out of which 248 were polymorphic (98%). As expected, the diversity analysis indicated the existence of narrow genetic diversity among the 62 accessions. This study puts forward an extensive report on the genetic diversity of ginger accessions collected from different regions of India especially northern Himalayan region (J&K and H.P). The genetic variability as deciphered using phenotypic and molecular markers could serve as the major resource available to breeders and can play a crucial role in their conservation.

***Keywords**: Conservation, Crop improvement, Genetic variability, Germplasm, Molecular characterization, Zingiber officinale Rosc.*

Biodiversity and Conservation of Indian Goat Genetic Resources for Sustainable Development - an Overview

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Abstract

Goats are the backbone of rural economy of arid, semi-arid and hilly regions of the country and popularly known as "ATM" in two ways; any time money and any time milk. Goat biodiversity in India is characterized by high degree of endemism and variations in agro-climatic conditions of different regions and are well adapted to specific set of environmental conditions. Goat breeds have generally been named after their place of origin and some based on their prominent characteristics. Indigenous goats contribute greatly to the agrarian economy, especially in areas where crop and dairy farming are not economical, and play an important role in the livelihood of a large proportion of small and marginal farmers and landless laborers. World's current population of goats is around 1034 million; Asian region possesses about 53.29 % and India 14.40 % of the total world population (BAHF, 2019). India's current goat population is 148.88 million with an increase of 10.14% over the previous census (Livestock Census, 2019). India possesses 34 recognized breeds of goats, which constitute 38.74 % of the total goat population and remaining (61.26%) are non-descript. Goats share about 27.78 % of livestock population of India with an overall growth rate of 3.10% during 1951-2019, the highest among all ruminants and ranked 2st in the world. India is endowed with large and biologically diverse population of goats. They are widely distributed throughout the country. Eastern region has the highest goat population followed by Northern plain region, southern peninsula, North temperate region and North-eastern hill region of total India's population. Major leading states in goat population are Rajasthan, West Bengal, Uttar Pradesh, Bihar, Madhya Pradesh, Maharashtra, Tamil Naidu, Jharkhand, Odisha and Karnataka contributing 13.99, 10.93, 9.73, 8.61, 7.73, 7.12, 6.64, 6.13, 4.29 and 4.14%, respectively (GOI, 2019). The average birth weight, weaning weights, 6 months and 12 months weight of Indian goats ranged from 0.98±0.01 kg in Black Bengal goats to 3.64±0.26 kg in Sojat goats, 4.64±0.58 kg in Assam local to 22.00±0.79 kg in Sojat, 6.99±0.40 kg in Assam local goats to 36.00±2.83 in Sojat breed and 10.54±0.64 kg in Assam local to 53.28±3.38 kg in Sojat goats, respectively. The average age at first kidding, gestation period, service period, and kidding interval of Indian goats were found to be 450- 750 days, 145-156 days, 151-210 days and 200-350 days, respectively. Based on the facts revealed, it may be concluded that the indigenous goat breeds have an immense production potential however, their optimum potential has not expressed due to subsistence production system and low inputs. Goat rearing provides opportunities of regular income and employment to the poor goat keepers. The socio-economic conditions of goat rearers can be improved through scientific goat rearing, which will not only generate income for their livelihood but also contribute much to the nutritional and health security. While framing breeding strategy for goat improvement traits of local importance like adaptability to climate, disease resistance and irregular and scarce feeds availability, etc. should not be ignored. Breeding objectives of the breed in different region should be well defined along with breed based improved package of practices. Management interventions for different farming systems in different regions should be popularized among stakeholders. Critical inputs for goat farming such as breeding bucks, vaccines, medicines, credit, etc. should be essentially made available with easy access particularly in the home tracts of goat breeds. Formation of goat breeder's cooperative/ societies/ Buck Mother Farm/ Multiplier Flocks should be encouraged. Up gradation of non-descript goats through improved breeds should be implemented in a big way.

Role of coffee on biodiversity conservation, restoration of ecological balance & sustainable development in agency areas of Andhra Pradesh

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Abstract

Coffee is one of the most commercialised food products and widely consumed beverages. All over the world, more than 400 billion cups of coffee are consumed every year. Coffee cultivation is confined to more than 80 countries in between the Tropic of Cancer and the Tropic of Capricorn. The coffee industry is a source of employment for over 500 million world population involved in cultivation, processing and trade sectors. In India, coffee is emerging as the most popular beverage among the youths and urban population. Coffee industry contributes nearly Rs. 5,600 crores of foreign exchange to the national exchequer annually. Coffee was introduced as a plantation crop in agency areas of Andhra Pradesh during 1960s to wean away the tribal farmers from Podu/ shifting cultivation. Since then, the planted area under coffee in Andhra Pradesh has steadily increased and presently more than 80000 ha is under coffee providing employment to more than 1,40,000 families. Coffee cultivation helps in conservation of forest and native bio diversity. The diversified shade trees in coffee estates provide shelter and food for different species of epiphytes, birds, honey bee, various beneficial insects and wild animals. The leaf litter from the shade trees retains the carbon in soil and helps in recycling of nutrients. The coffee ecosystem helps to reduce soil erosion up to 37% in hilly terrain. Once established, a coffee plantation can give income up to 50-60 years. The additional income generated by various intercrops in coffee is an added advantage for the prosperity of coffee growers. The organically grown arabica coffee from Andhra Pradesh has high demand both in national and international market. So, there is tremendous scope for sustainable development in the agency areas of Andhra Pradesh through production of high value speciality coffee like shade grown coffee, high altitude coffee and organic coffee and through coffee trade. Owing to these positive aspects, the coffee cultivation in these areas will certainly conserve the bio diversity, restore the ecological balance and will pave the path for sustainable development in terms of livelihood of the tribal's and also various stakeholders involved in coffee.

Keywords: *Shade grown Coffee, Conservation of forests, Bio diversity, and Sustainable development*

Rhizosphere - an unexplored vista for sustainable agriculture

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Abstract

Improved grain production to meet the increasing food demand of the population is highly dependent on chemical fertilizers. Nevertheless, the indiscriminate use of chemicals has led to the deterioration of soil health and quality. Modern intensive agricultural practices could increase the production, but by compromising on the environment health. This lightened the dawn of the concept of sustainable agriculture and practices promoting conservation of resources. Encouraging the beneficial services provided by the soil microorganisms and managing the rhizosphere, which is a hub of beneficial microbes, is an effective approach for sustainable crop production. Rhizosphere is the area adjacent or in close proximity to the roots which provides a favorable environment to the growth of plants through microbial activity. The plant roots, microorganisms and soil constitue the rhizosphere. Rhizosphere management involves a strategic management of plant, soil and microbiota and harbours huge potentials to increase nutrient use efficiency, soil health and crop productivity. It includes different methods. Crop diversification modifies the soil biodiversity spatially (intercropping and mixed cropping) and temporally (cover cropping and crop rotation) through selection of crops and varieties which have positive effect on the agro ecosystem. Conservation tillage enhances the soil organic carbon and microbial biomass carbon. It promotes maintenance of a permanent soil cover, minimum soil disturbance and overcomes sustainability weakness. The accurate method of planting and optimum spacing reduces the competition for the inputs and thus provide a better above ground and below ground interactions. Mulches provide an ecological niche for soil microorganisms. It helps to improvethe organic carbon status of the soil, facilitates rhizopriming, release allelo chemicals and other leachates that suppress harmful micro-organisms Addition of soil amendments like lime, gypsum and biochar alters the soil pH, increased population of beneficial microbial biomass and amount of dehydrogenase in the soil. Addition of organic manures improves the physico-chemical properties of rhizosphere, root growth, soil biological activity, nutrient mobilization, soil water retention and buffering capacity of soil against alkalinity and acidity. Application of biofertilizers like Nitrogen fixers, P solubilizers and mobilizers, K solubilizers, and consortium biofertilizers like PGPR Mix I, auguments the microbiome in rhizosphere and enhances nutrient availability. Site specific and precise application of nutrients based on soil test data and crop demand helps to improve the root growth and rhizosphere efficiency. Water management practices that ensures adequate moisture at the right time in right quantity should be emphasised. Rhizopshere engineering, the approach of engineering organisms that can complement the naturally occurring plant- soil- microbe interaction near the roots is the recent upcomimg strategy for the exploitation of rhizosphere. Rhizosphere being the core of all the physiochemical and biological activities essential for plant growth and development, research explorations on the root microbe interactions will help to improve productivity of food crops under stress conditions and allows for the increased drawdown of atmospheric carbon dioxide to stabilize carbon pools in soil.

Keywords: *Rhizosphere, Rhizosphere Management, Sustainable Agriculture*

Diversity of insect fauna associated with cowpea [*Vigna Unguiculata* (L.) Walp.] In southern Rajasthan

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Abstract

The present investigation, "Diversity of insect fauna associated with cowpea [*Vigna Unguiculata* (L.) Walp.] in southern Rajasthan" was carried during 2019 and 2020 at different locations of southern Rajasthan viz. Udaipur, Bhilwara and Banswara during summer. The insect pest complex of cowpea categorized into 5 orders viz., Hemiptera, Thysanoptera, Coleoptera, Diptera and Lepidoptera comprising 14 families. The pestiferous fauna includes population of flea beetle, jassids, whiteflies, sap sucking bugs, leaf miner, thrips, aphids, spotted borer, and blue butterfly caterpillar. The aphid had the maximum relative diversity in all the districts. The Simpson and Shanon diversity indices for Udaipur was the maximum (3.35 & 1.67, respectively), followed by that for Bhilwara (2.79 & 1.54) and Banswara (2.44 & 1.43) during 2019; whereas, it was found to be 2.48 and 1.52 for Udaipur, 3.91 and 1.82 for Bhilwara and 4.59 and 1.68 for Banswara during 2020. It was evident that Udaipur region had more species richness during 2019, while it was more in Bhilwara during 2020.

Keywords: *Simpson's diversity, Shanon diversity, insect pest, and summer season*

Rhizosphere mediated nutrient management using phosphate solubilising rhizobacteria in inceptisols of Jammu, J&K

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Abstract

Rhizosphere is the narrow zone of soil highly influenced by root system and is scrutinized as zone of rich bacterial diversity compared to bulk soil Root colonizing bacteria are efficacious to stimulate plant growth by fixation of atmospheric nitrogen, solubilisation of minerals such as phosphorus, production of siderophores that solubilize and sequester iron and production of plant growth regulators. Phosphorus solubilization ability of PGPR's is an important aspect associated with plant P nutrition which attracts the attention of agriculturalist for the use of PGPR's as environment friendly biofertilizers which can also reduce the use of expensive and non renewable phosphatic fertilizers.PGPR's comprise of diverse genera among which Pseudomonas and Bacillus are found to be abundant in the rhizosphere and are known for increasing the concentration of available nutrients and phosphate solubilization. Although several PGPR occur in soil a target microorganism at a much higher concentration than normally found in soil is an advantage for phosphate solubilisation and crop yield enhancement. Combined inoculation of effective PGPR and available phosphorus sources under controlled conditions is also found to be a better strategy for increase in nutrient availability and plant growth.Soil microbial biomass and soil enzymes are an important indicator of soil quality and have an important relation with the activity of microbes in the soil. Increase in the biological properties of soil by PGPR's is also an important trait for improving soil quality. Thus microbial mediated nutrient management with balanced input supply is an ecofriendly approach for maintining soil fertility.

Keywords: *Rhizosphere, Phosphate Solubilising Rhizobacteria, Phosphate Solubilisation, Biofertilizers*

Maintaining the soil health by soil biodiversity conservation: an ecological approach towards the sustainable crop production

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Abstract

Agriculture in the advanced time faces genuine ecological difficulties, for example, climate change, deficiency of water, and reduced *soil and water quality*. These elements compel proceeding with endeavors to take care of expanding populaces, particularly in developing nations. To fulfill this need, high-yielding varieties are being created, which require broad use of synthetic fertilizers, for example, nitrogen (N) and phosphorus (P). The disturbing increment in manufactured chemical compounds has prompted *degradation in soil health*, reduced air and water quality, which compromises the natural manageability. Unmistakably, there is an earnest need to create effective, practical and green harvest creation frameworks for future. *Soil microorganisms* are pivotal for nutrient cycling, soil productivity and crop productivity. To understand the rationale for sustainable agriculture, one must appreciate the critical importance of soil. Soil is not just another component of crop production, like pesticides or fertilizers. Rather it is a complex, living, fragile medium that must be protected and nurtured to ensure its long-term productivity and stability. A healthy soil is a hospitable world for growth. Considering the role of soil microbes that contribute directly and indirectly to plant growth include (1) the maintenance of soil structure; (2) their role in nutrient recycling; and (3) their beneficial and detrimental interactions with plants. Hence, consideration will be given to prospects for the management of soil micro-organisms in *sustainable agricultural* systems and the potential of using microbial activities and/or populations of soil micro-organisms as indicators of sustainability.

Keywords: *Soil and water quality, Degradation in soil health, Soil microorganisms, Sustainable agricultural etc.*

Effect of plantation on soil carbon stock and heavy metals in mined out forest area of Talcher, Odisha

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Abstract

A detail soil study was conducted at Talcher, Angul district of Odisha to know the effect of some dominant forest species like Eucalyptus, Teak and Sal on soil carbon stock and quantity of heavy and toxic elements in soil. Soil samples from genetic horizons were collected, processed and analyzed for soil organic carbon, other soil properties including heavy and toxic elements. From the above study, it was revealed that, the colour of soil varied from light olive brown to red with angular blocky to blocky structure. The bulk density varied from 1.47-1.72Mg/m^3 and pore space from 34-43%. The soils were light textured dominated by sand ranging 63.4-80.4% followed by silt ranging 11.4-22.4% whereas clay varied from 5.2% to 16.2%. Sand content decreased along the depth whereas silt and clay showed reverse trend. The soils were acidic to neutral and pH ranging 5.58-8.01 and increases with increasing depth. The soil organic carbon content varied from 1.8-9.5g/kg and showed a decreasing trend in below horizons. Similarly the cation exchange capacity value increased with low to medium with increasing depth ranging from 4.6 to 8.6 cmol (p$^+$)/kg. The available nutrient status of soils of Talcher for nitrogen was low varied from 36.5-256 kg/ha. The available phosphorus for different soils were from medium to low, available potassium was high to medium. The heavy metals like chromium, cadmium and lead ranged 0.028-0.074mg/kg, 0.036-0.0929 mg/kg and 1.924-3.438 mg/kg respectively. Toxic elements like Nickel, Zinc and copper ranged 0.38-2.35mg/kg, 1.278-1.886mg/kg and 1.286-1.976mg/kg respectively. It can be concluded that plantation helped in increasing the soil organic carbon, improve the physical, chemical and morphological properties of soil, upgraded the fertility status and reduced the heavy metal hazards. Eucalyptus was found most suitable plantation species followed by Sal and Teak in the Talcher area.

Keywords: *Soil organic carbon, plantation, cation exchange capacity, soil texture, heavy metals.*

Dynamics of Microbial Population in Sodic Soil as Influenced by Enriched Municipal Solid Waste Compost and Other Amendments

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Abstract

Salt induced soil degradation is major concern throughout the world because it often results in the dramatic decline of the agricultural production. The prevailing gypsum technology for reclamation of sodic soil is very costly and beyond the reach of small farmers. Moreover, this approach fails to improve the biological properties salt affected soil. Organic amendments, like FYM and municipal solid waste compost alone and in combination with reduced dose of gypsum found effective approach to improve soil physico -chemical and biological properties and sustaining crop yields. The enrichment of municipal solid waste compost with agriculturally important microbes enhances microbial activities and availability of the nutrients to the plants. To prove this hypothesis, an experiment with six treatments consisted of T_1-control, T_2- Mineral gypsum@50%GR,T_3- Municipal solid waste compost @10t/ha,T_4- Microbial enriched municipal solid waste compost@10tha, T_5- Mineral Gypsum@ 25%GR+MSWC@10/ha, T_6- Mineral Gypsum @25%GR+Microbial enriched MSWC@ 10t/ha was conducting during 2019-2020 under highly sodic soil. After harvesting of rice-wheat cropping system, fresh soil samples collected and the dynamics of bacteria, fungi and actinomycetes population was enumerated using selective standard media. From the analysis, it was revealed that the maximum bacterial, fungal and actinomycetes population were observed in treatments where microbial enriched MSW compost was used @ 10t/ha applied in conjunction with reduced dose of gypsum. The improvement in soil microbial activity resulted from substantial availability of substrate with the combined application of organic and inorganic amendments. The grain yield of rice and wheat with combined use of enriched MSW compost with gypsum was also higher over the only use of inorganic amendment. Thus, it can be concluded that enrichment of MSWC with agriculturally important microbes can be an alternate source of amendment for reclamation of salt affected soils.

Keywords: *MSW, Sodic soil, Gypsum, Microorganisms (bacteria, fungi and actinomycetes), FYM*

Phosphate Solubilizing Microorganisms (PSMs): A Promising Approach as Bio-fertilizers

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Abstract

Phosphorus (P) is a vital plant nutrient, available to plant roots only in soluble forms that are often in short supply in the soil. In fact, P can be tightly bound with soil cations, particularly calcium, iron, or aluminum, leading to precipitation of P in the soil. It has a critical role in plant metabolism and other activities such as cell division, development, photosynthesis, breakdown of sugar, nutrient uptake, and nuclear transport within the cell, plant disease resistance and regulation of metabolic pathways. Therefore, despite P being widely and abundantly distributed in the soil in both its inorganic and organic forms, it is not easily accessible for plant growth. Microorganisms present in soil plays a major role in enhancing the plant growth. Thus, phosphate solubilizing bacteria (PSB) play an important role in reducing P deficiency in soil through transforming insoluble phosphate to available, soluble phosphate. Phosphate solubilizing microorganisms (PSMs) are group of beneficial microorganisms capable of hydrolyzing organic and inorganic phosphorus compounds from insoluble compounds. Among these PSMs, strains from bacterial genera (Bacillus, Pseudomonas, and Rhizobium), fungal genera (Penicillium and Aspergillus), actinomycetes, and arbuscular mycorrhizal (AM). Soil is a natural basal media for microbial growth. Mostly, one gram of fertile soil contains 10^1 to 10^{10} bacteria, and their live weight may exceed 2,000 kg ha^{-1}. Among the whole microbial population in soil P, solubilizing bacteria comprise 1–50% and P solubilizing fungi 0.1 to 0.5% of the total respective population. PSMs are ubiquitous, and their figures differ from soil to soil. Most PSMs were isolated from the rhizosphere of various plants, where they are known to be metabolically more active. Apart from those species, symbiotic nitrogenous rhizobia, and nematofungus *Arthrobotrys oligospora* have also shown phosphate solubilizing activity. Although several mechanisms may be involved, the main one is through the production of organic acids. Many PSMs are proved to be effective biofertilizers or biocontrolling agents.

Plant Growth Promoting Rhizobacteria (PGPR) for Sustainable Agriculture

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Abstract

The continuous increase in the human population is creating too much stress on existing resources of food, fuel, and raw materials. To meet the demand, agriculture practices are using intensive amounts of chemical-based fertilizers and pesticides, which ultimately leads to land degradation and biodiversity loss. Microbes associated with plants can be used to overcome problems related to soil salinity, fertility, degradation, and habitat loss. The application of several microbes—like the plant growth-promoting microorganism cyanobacteria and the mycorrhizal fungus—in agricultural practices has shown to be beneficial for plant growth and development. These microorganisms are also useful for land reclamation. Soil is a living entity and it is not only a valuable natural resource in agricultural and food security but it is also towards maintenance of all life process. Agricultural productivity rests on the foundation of microbial diversity in the soil, and in recent years, PGPR have emerged as an important tool for sustainable agriculture. PGPR are the soil bacteria inhabiting around/on the root surface and are directly or indirectly involved in promoting plant growth and development directly or indirectly, either by releasing plant growth phytohormones or other biologically active substances, altering endogenous levels of phytohormones, enhancing the availability and uptake of nutrients through fixation and mobilization, or reducing the harmful effects of pathogenic microorganisms on plants and/or by employing multiple mechanisms of action. Besides offering an economically attractive and ecologically sound route for augmenting the nutrient supply and protecting against soil borne pathogens, PGPR play an important roles to increase in soil fertility, bioremediation and stress management for development of eco-friendly sustainable agriculture.

Bio Fertilizers: A Promising Tool for Sustainable Farming

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Abstract

Fertilizers are compounds added directly into the soil to increase the fertility. There is another alternative to help the soil to naturally gain productivity by the introduction of microbes that can help in solubilizing phosphorus or fixing atmospheric nitrogen or help in the synthesis of growth promoting substances etc. Microorganisms having the potential to oxidize Sulphur, solubilize phosphorus, fix nitrogen and decompose matter, when creatively incorporated into farming in order to contribute to the fertility of the soil are collectively termed as biofertilizers. These are introduced into the soil or applied to the seed or the plant surfaces enabling it to form colonies in the rhizosphere or seep into the plant to help the plant grow faster or to increase the availability and absorption of primary nutrients to the plant. This is an eco-friendly and inexpensive method to aid in farming. The past couple of decades have seen an increased reliance on carrier based biofertilizers, where carriers like rice bran, lignite powder, talc, rock phosphate, paddy straw compost, vermiculite, fly ash, peat may be used individually or mixed to productive proportions. But this system does not guarantee the survival of the microbe for more than a few months, in order to remedy the major hurdles associated with the shelf life of the average carrier based biofertilizers, liquid biofertilizers have been developed to function as a cost effective sustainable agricultural bypass. The liquid Biofertilizer technology giving authentic causes for their necessity, specificity and emphasizes that the use of agriculturally relevant microorganisms, is an effective tool for Sustainable farming.

Keywords: *Fertilizers, Carrier based biofertilizer, Liquid Biofertilizer, Sustainable farming and Shelf life*

Soil Microbes in the Service of Humanity

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Abstract

Microbes were the first forms of life, originating almost four billion years ago, and in future, they will continue to inhabit planet Earth long even after the disappearance of humans and other life forms. They are the supreme waste recyclers and regenerators of the planet. Collectively and to a significant extent in partnership with the sun, they are the life support system of the biosphere. Although we humans consider ourselves to be the stewards of planetary health, microbes are much more powerful agents of influence, regulation and change of planetary activities. Microbes are central actors and key stakeholders in planetary and biological evolution. Tomorrow's agriculture, challenged by increasing global demand for food, scarcity of arable lands, and resources alongside multiple environment pressures, needs to be managed smartly through sustainable and eco-efficient approaches. Modern agriculture has to be more productive, sustainable, and environmentally friendly. While macronutrients such as nitrogen, phosphorus, potassium, and sulphur supplied by mineral fertilizers are vital to crop production, agriculturally beneficial microorganisms may also contribute directly (Biological N_2 fixation, P solubilisation, phytohormone production) or indirectly to crop improvement and fertilizer use efficiency. Microbial based bio-formulations that increase plant performance are greatly needed, and in particular bio-formulations that exhibit complementary and synergistic effects with mineral fertilization. Such an integrated soil fertility management strategy has been demonstrated through several controlled and non-controlled experiments, but more efforts have to be made in order to thoroughly understand the multiple functions of beneficial microorganisms within the soil microbial community itself and in interaction with plants and mineral resources. The role of diversity is critical to maintaining a well-functioning and stable agriculture. Where many different types of organisms coexist, there are fewer disease, insect, and nematode problems. There is more competition for food and a greater possibility that many types of predators will be found. This means that no single pest organism will be able to reach a population high enough to cause a major decrease in crop yield. We can promote a diversity of plant species growing on the land by using cover crops, intercropping, and crop rotations. However, diversity below the soil surface is as important as diversity above ground. Growing cover crops and using crop rotations help to maintain the diversity below ground, but adding manures and composts and making sure that crop residues are returned to the soil are also critical for promoting soil organism diversity. The actions taken to improve soil health should contribute to growing healthy plants, stressing pests, and increasing beneficial organisms. Improving use of biological diversity of soil is must to secure higher productivity in a sustainable manner, therefore continuously designing, developing and testing innovative integrated plant management systems based on relevant biological resources is highly required. The ability to recognize new opportunities of microbial activities in a timely manner, to accurately assess benefits and possible risks, and take evidence based decisions on actions needed to facilitate their exploitation, is essential for knowledge based, bio-centric economies to be competitive and to progress significantly towards sustainable practices.

Keywords: *Agriculture, Biological, Diversity, Microbes, Organisms, Productivity, Soil*

Harnessing productivity potential and rehabilitation of degraded sodic lands through Jatropha based intercropping systems

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Abstract

This paper evaluates an intercropping model with *Jatropha curcas* L. (JCL) as an alternative crop on degraded sodic land in north India. Monoculture of JCL has not proven economically viable in India in view of its poor yield; therefore, intercrops in between JCL plantations were tried to optimize land use efficiency. The results revealed that the planting of JCL at 3x 3 m spacing with inter-cultivation of sweet basil–matricaria (SB-M) cropping system for four years was more economically viable than planting at 3 x 2 m spacing and the other rotations tested in the study. Improvements in soil properties in terms of soil pH, EC and organic carbon were found with the SB-M cropping system with JCL as the main crop. Maximum soil microbial biomass carbon was recorded with the SB-M cropping system followed by sorghum-wheat (S-W) and maize-linseed (M-L), and the lowest values were found in the control plot where no intercrop was planted in between JCL plants. This study shows that intercropping with JCL on sodic soils stimulated the soil microbial population, which in turn led to high biological activity in the rhizosphere soil. Growing of medicinal and aromatic crops as intercrops between JCL plantations for four years appears to be a more suitable land use system than JCL mono-cropping to obtain maximum income. Simultaneously a soil improvement due to intercropping provides a new opportunity for even more competitive land use systems in the future.

Keywords: *Sodic soil, Jatropha carcus, Plant density, Intercrops, Soil amelioration*

Precision Agriculture and Climate Smart Approaches for Sustainable Management of Resources

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Abstract

According to the United Nations report, the world's population is expected to increase to 9.7 billion in 2050. FAO estimates that feeding the world population will require a 60 percentage increase in total agricultural production with many of the resources needed for sustainable food security already stretched, the food security challenges are huge. At the same time climate change is already negatively impacting agricultural production globally and locally. Climate risks to cropping, livestock and fisheries are expected to increase in coming decades. Impacts on agriculture threaten both food security and agriculture's pivotal role in rural livelihoods and broad-based development. Keeping above mentioned challenges in mind, Precision Agriculture is important, in fact, I see it as the one of the best sustainable way in agriculture. The economic and health crisis, which the whole world is going through, Covid-19, will make it necessary for all of us to use all the resources sustainably as once it all will be over, these resources will not be feasible and economically available to all of us. Our resources are limited: water is a critical and limited resource, arable land is a finite resource and energy prices are rising. This type of farming is an approach where inputs are utilized in precise amounts to get increased average yields compared to traditional cultivation techniques. It uses IT to collect valuable data from multiple sources which factors into the decision-making process. It relies on technologies like GPS, GIS, yield monitors, remote mapping sensors and guidance systems for application with variable rate which enables in-depth monitoring of field variations. It is quite clear that the only way to grow more food is to increase the yield while saving the environment from further degradation. It is not just food, it is the four F's – Food, Feed, Fiber and Fuel. Climate-smart agriculture (CSA) is also an integrative approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate, with its objectives: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing greenhouse gas emissions where possible. It is one of the 11 Corporate Areas for Resource Mobilization under the FAO's Strategic Objectives. It is in line with FAO's vision for Sustainable Food and Agriculture and supports FAO's goal to make agriculture, forestry and fisheries more productive and sustainable. Its approaches include four major types of actions: Expanding the evidence base and assessment tools to identify agricultural growth strategies for food security that integrate necessary adaptation and potential mitigation ;Building policy frameworks and consensus to support implementation at scale ;Strengthening national and local institutions to enable farmer management of climate risks and adoption of context-suitable agricultural practices, technologies and systems ;Enhancing options to support implementation, linking climate and agriculture. The only way to get higher yield from limited resources is by changing agriculture into what we call Precision Agriculture, Climate Smart Agriculture.

Keywords: *Sustainability, precision farming, climate smart agriculture, resources*

Efficacy of Various Insecticides against Major Insect Pests of Smmer Squash (*Cucurbita pepo*) in Dhading District, Nepal

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Abstract

Red pumpkin beetle, fruit fly, flea beetle, whitefly, squash bug, melon aphid, etc. are the major insect pests of summer squash resulting in a huge loss in quality and quantity to farmers A field trial was conducted to find out the comparative efficacy of various insecticides against the major insect pests of summer squash from January to June 2020 in Dhading district, Nepal. The experiment was laid in Randomized Complete Block Design (RCBD) with four different insecticides i.e. imidachloropid 17.8 SL @1.5ml/l, spinosad 45SC @1ml/L, Azadiractin (Nimbecidine) 500ppm @ 5 ml/L, jholmol @ 1:5 concentration and normal water spray as control as five treatments. The treatments were replicated four times and 'Anna 303' variety of summer squash was used under study. The results revealed that, among all the insecticides evaluated at all the four sprays, Imidachloropid recorded the maximum reduction in the population of red pumpkin beetle (RPB) (about 90%), other insects (about 88%) and also showed minimum leaf infestation % (28.5%), and leaf damage % per plant (15.63%) and Spinosad being at par with Imidachloropid followed by Azadirachtin and Jholmol respectively. Imidachloropid and Spinosad also showed comparatively lower fruit infestation by fruit fly i.e. 18.5% and 20.5 % respectively than other insecticides. Both Imidachloropid and Spinosad treated plots were statistically ($p<0.05$) similar and significantly superior over other treatments for yield (52.11 and 50.31Mt ha^{-1} respectively), for fruit length (37.62 and 37.12cm respectively) and fruit diameter (26.78 and 26.51cm respectively). A negative and strong correlation was found between yield and mean population of RPB and other insects, leaf infestation % per plant, leaf damage % per plant, and fruit infestation % per plant whereas fruit length and diameter showed a positive correlation with yield. The benefit-cost ratio was highest for plot treated with Imidachloropid (4.21) followed by Spinosad, Azadiractin, Jholmol, and Control. Thus, Imidachloropid was the most effective and economic in controlling the major insect pests of summer squash.

Keywords: *Jholmol, Insecticides, Red Pumpkin beetle, Pest*

Nutrient indexing in soils of *Gloriosa superba* crop to forecast Emerging nutrient disorders

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Abstract

After green revolution, agriculture has transformed in to high input system. However, the increase in crop yield with the addition of fertilizers started declining which was the consequence of imbalanced fertilization. Nutrient deficiencies in soil not only reduce the crop productivity but also reduce the efficiency of other inputs in crop production. A balance is to be maintained between the crop removal and addition of fertilizers for maintaining the soil health. *Gloriosa superba* Linn. is an important medicinal plant belonging to the family Liliaceae. Seeds and tubers contain valuable alkaloids viz., colchine and colchicoside as the major constituents, which are used an antidote for snake bites, gout and rheumatism. Tamil Nadu holds a monopoly in production of glory lily with an annual production of about 600 tonnes of seeds in an area of about 6000 acres. This study was aimed to monitor the changes in nutrient status in soils growing *Gloriosa superba* crop to forecast emerging nutrient disorders. Twenty farm sites with Glory Lily crop were fixed in Thoppampatti and Oddanchatram blocks of Dindigul district in Tamil Nadu for monitoring the changes in soil fertility due to intensive cropping of Glory Lily. Details of fertilizers and manures applied by the farmers were collected. The average quantity of N, P, K, S, Zn, Fe, Mn, Cu and B applied by the farmers were 63.8, 28.4, 94.3, 46.6, 2.40, 1.39, 0.66, 0.30 and 1.07 kg ha^{-1} respectively. The initial soil analysis revealed that all the farm soils were having slightly acidic to alkaline soil reaction (6.20 to 8.60) with an electrical conductivity of 0.17 to 0.75 dSm^{-1}. The initial fertility of the fields were low to medium in N, P, medium to high in K and S. Moderate to sufficient in Zn and Cu status, deficient to sufficient in Fe and sufficient in Mn status was observed in all the farm sites. Soil and plant samples collected at the harvest stage of Gloriosa crop were analysed for macro and micro nutrients. Fertility rating of the initial soil and soils collected at the end of Gloriosa crop were worked out using the nutrient index values and the fertility classes were assessed. The nutrient balance was worked out by considering the nutrients applied and nutrients taken up by the crop. The seed yield of all the 20 locations varied from 536 to 935 kg ha^{-1} with a mean yield of 802 kg ha^{-1}. The results showed reduction in soil available N status from low to very low level. All other nutrients were maintained in the same status. Nutrient balance was negative for N which indicated that the removal of N from the soil was more than the addition through manures and fertilizers. Positive balance was noticed for all other primary, secondary and micronutrients. Negative balance of nutrients if not corrected leads to depletion of soil nutrient reserves. Hence, balanced addition of manures and fertilizers based on soil fertility status and crop requirement is crucial for sustaining the soil health as well as crop productivity.

Effect of planting dates and sources of nitrogen on growth and yield of Cauliflower (var-Snow mystic) at Rampur, Chitwan, Nepal

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Abstract

Appropriate time of planting and use of suitable sources of nitrogen are highly conducive for better growth and yield of cauliflower. A field experiment was conducted to study the effect of planting dates and sources of nitrogen on growth & yield of cauliflower at horticulture research block of Agriculture and Forestry University, Rampur, Chitwan , Nepal from 1st Nov 2019 to 4th March using 'Snow mystic', a late season variety. The study was laid out in split-plot design with two dates of planting (Dec 1st & Dec 16th) as main plot factors & four sources of nitrogen viz.100% biochar (BCH), 100% Urea(U), 50% urea+ 50%Poultry manure (U+PM) & 50% Biochar+50% poultry manure (BCH+PM) against a control as sub-plot factors and were replicated thrice with 30 experimental units each of 9 m^2 size containing 5 rows with 5 plants per row. The recommended dose of fertilizer used for the research was 108:92:60 kg N, P_2O_5, K_2O ha^{-1} and K and P were supplied through SSP and MOP for each treatment. The soil of experimental plot was sandy loam with slightly acidic with pH (5.6). The data regarding days to 90% curding, canopy area (cm^2), leaf number per plant, above ground dry mater (g m^{-2})(AGDM), curd size (cm^2) and curd weight per plant(g) were recorded and analysed using MS Excel and R studio. Significantly higher number of leaves per plant (16.03), bigger average canopy area (5089.93 cm^2), higher AGDM (217.91 g m^{-2}), bigger (1563.03 cm^2) and heavier curds (1412.44 g) were recorded in 1st Dec. transplanted cauliflower with significantly higher harvest index (68.20). Regarding the sources of nitrogen, all the above parameters were seen better under BCH+ PM but were statistically at par with other nitrogen sources except control. The 1st Dec. planted crop had 4 more days of curding to harvesting interval than 16th Dec. planted one but the difference was not significant. December 1st planted cauliflower yielded 110% more yield and net returns than 16th Dec. planted crop whereas BCH incurred maximum cost (NRs.322145 ha^{-1}) and U and U+PM were the most profitable in terms of B:C ratio (12.77 and 12.96 respectively).Hence, better crop yield and benefit could be obtained by planting the late season cauliflower (var. Snow mystic) at 1st Dec with the use of 100% urea or U+ Pm as nitrogen source in plains of Nepal having Chitwan like climate.

Keywords: *Cauliflower, Biochar, planting dates, Nitrogen source*

Field validation of soil test crop response based fertilizer recommendations for targeted yields of onion in red soils

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Abstract

A field experiment was conducted to validate the Soil test crop response equation developed for prescribing fertilizer doses of onion in red soils of ARS, Utukur Kadapa district of Andhra Pradesh state. It comprised of four treatments namely farmers practice (FP), General or Recommended dose of fertilizers (RDF), STCR recommendations for 200 qha^{-1} with fertilizers alone and STCR recommendations for target yield of 200 qha^{-1} + vermicompost 2tha^{-1}(IPNS). The fertilizer doses applied in different treatments are about 250-100-40 kg NPK/ha - Farmers practice, 200-80-60 kg NPK/ha - General or Recommended dose of fertilizers, 140-50-40 kg NPK /ha- STCR only chemical fertilizer dose, 135-47-36 kg NPK /ha - STCR IPNS treatment. The experimental results indicated that, the highest bulb yield of 187 q ha^{-1} was obtained at target yield of 200 q ha^{-1} was under STCR-IPNS treatment followed by STCR chemical fertilizers alone (176 q ha^{-1}). The achievement of yield was 93 percent at 200 q ha^{-1} yield target with IPNS and 88 percent with chemical fertilizers alone. The saving of fertilizer was about 60-30-20 kg NPK/ha with only chemical fertilizers and 65-33-24 kg NPK/ha under IPNS with STCR approach in comparison with recommended dose of fertilizers (RDF). The amount fertilizer saved with STCR approach over Farmers practice was 110-50-0 kg NPK/ha with only Chemical Fertilizers and 115-53-4 kg NPK/ha with IPNS respectively.

Keywords: *Field validation, Target yield, onion*

Soil Carbon Sequestration - Good for Soil Health, Potential Contribution to Climate Change mitigation

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Abstract

The prospect of global warming is a matter of genuine public concern. Currently, the world is on a path to be about 3ºC warmer than pre-Industrial times. Atmospheric concentrations of carbon dioxide have crossed limits and oceans are already turning acidic.In present era there is a need to develop a technology to reduce the rate of increase of atmospheric concentration of carbon dioxide (CO2) from annual emissios of 8.6PgC/yr. The greatest contributor to global warming over the past century has been carbon dioxide. Of all the greenhouse gases present in the atmosphere CO2 holds 82%. It is the major greenhouse gas vented to the atmosphere due to human activities which include agricultural activities. To mitigate climatic changes it is necessary that carbon dioxide should be removed from the atmosphere. One of the methods for the removal of carbon dioxide from atmosphere is carbon dioxide sequestration also known as carbon capture and storage. Soil carbon sequestration is the process of transferring carbon dioxide from the atmosphere into the soil of a land unit through plants, plant residues, and other organic solids, which are stored or retained in the unit as part of the soil organic matter (humus).The soil capacity to increase the concentration of CO2 in the atmosphere through mineralization of organic matter is also a source of concern.A mere 2% increase in the carbon content of the planet's soils could offset 100% of all greenhouse gas emissions into the atmosphere. This biotic techniques are natural and cost-effective processes, have numerous ancillary benefits, are immediately applicable but have finite sink capacity. carbon sequestration in soils has the potential to offset GHG emissions from fossil fuels by up to 15% annually.Utilising this option would thus offer the breathing time before other technologies can help transiting to a zero-carbon lifestyle.We need to create incentves for our ranchers and farmers to manage heir lands to maximize carbon sequestration which provide the potential contribution to Climate Change mitigation.

Keywords: *Soil carbon sequestration, Global warming*

Implementation of Integrated pest management of vegetables in and around ncr of Delhi through electronic media : A new thought

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Abstract

The Bulandshahr district administration urge the farmers to grow pesticide-free vegetables and grow multiple crops in their fields. Among the vegetables one of the common is cabbage. Cabbage being the fourth most widely grown vegetable crop of the country, the IPM experts planned to carry out a study in the Bulandshahr district of Uttar Pradesh. India, having the natural advantage of diverse agro-climatic conditions that enables the production of a wide range of horticultural crops and is bestowed with rich bio-diversity, also the second largest producer of vegetables accounts for about 15% of the total world's production. The total area under vegetable cultivation is around 10.1 million hectares in 2019 which is about 3% of the total area in the country. An electronic package and android based mobile application on the crop would be developed for the vegetable crop for the study area for management and awareness of IPM implementation for strengthening the linkage development between the lab to the field hence can be implemented as a model and can be developed for other crops. The farmers of the region face tremendous pain to arrive at the decision for their crop right from the selection and raising to the final disposal and managing the crop throughout the cropping season. They get the scattered information in piecemeal mode and the more on an unscientific basis. This approach can help the community to get the information in a better way as lack of proper and timely information as an authentic input is really lacking and missing from the ground reality and therefore they are forced to adopt and use whatever is provided by the seller or the sources.

Keywords: *Farmers, Bulandshahr, electronic package, cabbage, vegetables*

Impact of in situ green manuring through Dhaincha on yield and optimization of Nitrogen in Rice variety CSR-36 under sodic condition at Kaushambi

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Abstract

The Field demonstrations were conducted to study the impact of in situ green manuring through Dhaincha on yield and optimization of Nitrogen in Rice variety CSR-36 under sodic condition at Kaushambi during Kharif season, 2016-17 and 2017-18 in NICRA village -Umarchha and other adjoining having venerability sodicity. Total Salt affected area under Rice-Wheat Cultivation -18500 ha in the district and a sodic field having pH range 8.9 to 9.2. KVK Kaushambi conducted a farmer field demonstration in 6 .0 ha area at 15 farmer fields. During Demonstrations, treatments consists of Green manuring (Dhaincha)+100% recommended dose of nitrogen, Green manuring (Dhaincha)+75% recommended dose of nitrogen and farmer practice (Rice variety-NDR-359) as control. The result revealed that the Green manuring(Dhaincha)+100% recommended dose of nitrogen gave significantly higher growth in terms of plant height , yield related parameters and grain yield (46.5 q/ha.), net returns over Green manuring (Dhaincha)+75% recommended dose of nitrogen(45.45 q/ha.) and farmer practice (39.6 q/ha.). Since the maximum yield was recorded in treatments Green manuring (Dhaincha)+100% recommended dose of nitrogen but 25% of nitrogen could be saved through Green manuring (Dhaincha)+75% recommended dose of nitrogen with 45.45 q/ha. Yield and economically viable to the farmers under sodic condition as compared to farmer practice.

Precision agriculture and climate smart approaches for sustainable management of resources

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Abstract

Precision agriculture is a technology that can be used to improve profitability while reducing the impact of agriculture on environment. It is based on use of information and science based decision tools to improve productivity and profitability. The core ideas behind precision agriculture consist of improved decisions, higher yields, and reduced agricultural impacts. Precision agriculture requires technologies like GPS (Global positioning system) GIS (Geographic information systems), auto steer, yield monitors and variable rate fertilizer. Climate-Smart Agriculture (CSA) is Agriculture that sustainably increases productivity, resilience (to climate change), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals. Persistent food insecurity, a growing world population, accelerating global warming, and its impacts on agriculture make the climate-smart agriculture (CSA) approach ever more relevant. Leading international organizations presently argue that a transition to 'climate-smart agriculture' (CSA) is an obligatory task to ensure food supply for an anticipated nine billion people by 2050. Thus, there is an urgent need to evaluate current knowledge on the effectiveness of CSA to achieve its intended benefits and inform discourse on food, agriculture, and climate change. Assessing the status of soil and land resources helps decision makers understand the extent and effectiveness of existing or potential sustainable soil conservation and land recovery measures ; soil conversion trends and alternatives for optimal land use; and the type , extent and severity of different soil degradation processes. Thus combining the technologies of precision agriculture in management of crops, livestock, and agroforestry will be a wonderful approach for sustainable agriculture.

Keywords: *Agricultural impact, land resources, sustainability*

Mapping District Level Emission of Greenhouse Gases from the Livestock Sector of Uttar Pradesh, India

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Abstract

Climate change is a global challenge. Emission of greenhouse gases (GHGs) is the reason for climate change and global warming. The agriculture sector is significantly responsible for climate change and global warming through emission of GHGs; simultaneously, vulnerable to climate change. Various sub-sectors of agriculture, namely, livestock, rice cultivation, nitrogenous fertiliser application, manure application, and crop residue and burning, are releasing GHGs in decreasing order. The most challenging task to agricultural policy and implementation process is maximum productivity and production to address the food and nutrition security of the growing population with less or limited emission of GHGs. Climate-smart agriculture (CSA) is an approach to address the trade-off, that is maximum agricultural productivity from per unit area with less or reduce the emission of GHGs. This paper is an attempt to provide a guideline for database creation; and mapping of district-level emission of GHGs from the livestock sector of Uttar Pradesh, India which pave the way to better policy on CSA implementation. In this study, secondary data and descriptive statistics are used to measure and map the district level emission of GHGs from the livestock sector. All the districts of Uttar Pradesh are categorised into 'extremely alarming', 'Highly alarming', 'Alarming', and 'Moderate' based on the degree of emission of GHGs. The result shows that some districts of Uttar Pradesh, India are under 'Extremely alarming' category and remaining are under 'Highly alarming', 'Alarming' and under 'Moderate' category.

Keywords: *Mapping of emission, mapping district level emission, emission from livestock, extremely alarming category, Emission value and CSA.*

Precision agriculture and climate smart approaches for sustainable management of resources

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Abstract

Precision Agriculture is a environmentally friendly way can help in managing crop production inputs in an sustainable way. Precision Agriculture is all about using site-specific knowledge can target rates of fertilizer, seed and chemicals for soil and other conditions. Precision substitute's information and knowledge for physical inputs. Precision Agriculture can contribute in many ways to long-term sustainability of production agriculture, confirming the intuitive idea that Precision Agriculture helps in reducing environmental loading by applying fertilizers and pesticides only where they are needed, and when they are needed. Precision agriculture benefits to the environment come from more targeted use of inputs that reduce losses from excess applications and from reduction of losses due to nutrient imbalances, weed escapes, insect damage etc. An information and technology-based farm management system identifies, analyses and manages variability in fields by conducting crop production practices at the right place and time and in the right way, for optimum profitability, sustainability and protection of the land resource. Sustainable intensification approach and climate-smart agriculture are highly complementary. Sustainable Intensification is an essential means of adapting to climate change, also resulting in lower emissions per unit of output. With its emphasis on improving risk management, information flows and local institutions to support adaptive capacity, climate smart agriculture provides the foundations for incentivizing and enabling intensification. But adaptation requires going beyond a narrow intensification lens to include diversified farming systems, local adaptation planning, building responsive governance systems, enhancing leadership skills, and building asset diversity. While precision agriculture and Climate smart agriculture are crucial for global food and nutritional security, they are only part of a multi-pronged approach that includes reducing consumption and waste, building social safety nets, facilitating trade, and enhancing diets. Precision farming and climate smart agriculture is an approach where inputs are utilised in precise amounts to get increased average yields, compared to traditional cultivation techniques. Sustainable precision agriculture and climate smart agriculture is this century's most valuable innovation in farm management that is based on using Information and Communication Technologies (ICTs). This is the most recent innovation technology based on sustainable agriculture and healthy food production and it consists of profitability and increasing production, economic efficiency and the reduction of side effects on the environment. We need to transit to a more sustainable food system and mitigate climate change while at the same time adapt to climate change. Communities that are highly food-insecure or particularly vulnerable to climate change will necessarily prioritise adaptation, but many of the changes they might make to enhance resilience will also increase productivity and efficiency of inputs.

Keywords: *Precision Agriculture, Climate smart agriculture, Sustainable Intensification*

Precision agriculture and climate smart agriculture-Towards superior and sustainable future of the sector.

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Astract

Climate change, being a major threat to the agricultural sector, intensifies the environmental impact of fertilizer and pollution in agriculture. With the increasing food demand with ever increasing population has been exerting tremendous pressure on the global agricultural system results in adopting major changes in the agricultural production system. Climate change impacts such as increasing global temperature, changing rainfall pattern, changing in extreme weather events, reducing water availability, increasing new pathogens, insect-pests and weeds, etc. result in decreased quality, quantity as well as stability of the crops. Therefore, to mitigate the impact of climate change the environment friendly innovations like conservation agriculture, rainwater harvesting and adoption of seed varieties that are drought tolerant and early maturing can be followed for the betterment and stability of agricultural sector. Conserving resources and sustainable agriculture management practices is one of the techniques which potentially benefit today's climate change scenario by reducing GHG emissions and increased carbon sequestration which in turn, provides global food and national security. Precision agriculture is also one of the most welcomed technology-driven approach considering spatial and temporal variations in soils and climate which adopts management techniques to reduce cost, efficient use of inputs and reduce environmental pollution. In this, due to the regional or local in-field variabilities, plant protection measures, conservation and efficient use measures which when taken up according to the local circumstances with changing climatic variations of the region, help in marching towards better yield statistics. With the problems such as high initial investment costs, additional labour requirements and management intensity associated with conservation agriculture and rainwater harvesting, besides providing response to climate change by enhancing livelihood of the farmers, also responsible for food security at smallholder level. In precision agriculture, timely and precise collection of data in coordination with new emerging technologies such as GPS, GIS, remote sensing, help in tracking the changing climatic impacts and adopting efficient management measures for economic, social and ecological benefits. Rate of application of fertilizers and seeds are altered according to the changing environment thereby contributing to reduced wastage. 'Spatially variable crop production' or 'Site specific management' which includes application of site-specific inputs such as seed, fertilizers, crop protection chemicals, potentially reduce the input costs, maximize crop yields and sustains the environment by lowering the greenhouse gas emissions with proper efficiency of crop, field and animal management. Hence, precision agriculture helps farmers with the decision as when to apply the required inputs and in how much quantity of inputs to be applied according to the climatic needs of the region keeping in mind the soil and other resources conservation factor for sustainable food production.

Keywords: *Climate change, Precision agriculture, Site specific management, Sustainability*

Conservation Agriculture for Soil Health and Environmental Sustainability

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Abstract

As the population is increasing day by day, so to achieve higher and sustainable production level in order to maintain food security, it is important to maintain soil health along with environmental sustainability. Conservation agriculture is an viable technology to achieve this as it improve soil properties, controls soil erosion and reduces overall production cost. It is a resource saving agricultural technology that strives to achieve acceptable profits along with high and sustained production level while conserving the environment. It is based on minimum tillage, crop residue retention and crop rotation. Conservation agriculture enhances biodiversity and natural biological processes above and below the ground surface which contribute to increase water and nutrient use efficiency and to foster crop production. Technologies like conservation agriculture are important to adopt to deal with problems like increased carbon dioxide emission in the atmosphere, land degradation, reduction in soil organic matter content, soil compaction, less storage of water in soil, decline in soil biodiversity. Conservation tillage is defined as any tillage or planting system in which at least 30% of soil surface is covered by plant residues. Types of conservation tillage are zero tillage, strip tillage, reduced tillage, and mulch tillage. It improves soil physical quality like it increases soil structure aggregation, hydraulic conductivity, reduces soil bulk density, and increases soil moisture content due to reduced evaporation rates because of residues. Soil chemical properties like organic carbon content as well as biological soil properties like microbial biomass carbon, soil enzymatic activity etc are enhanced due to conservation agriculture. In the long term conservation agriculture has been found to render several benefits including soil conservation with improved soil health, high rainwater use efficiency, climate change mitigation and adaptation. Conservation agriculture has the potential to maintain sustainability, enhanced biodiversity and to increase the carbon sequestration in the soil along with labour saving and reduction in cost of cultivation with increased yields. Components of conservation agriculture can be in situ management of crop residue, engineering measures like contour bunding, graded bunding, terracing adoption of micro irrigation system, mulching, reduced tillage, and integrated nutrient management in soil. Principles of conservation agriculture are universally applicable to all agricultural landscape and land use with locally adapted practices. Soil interventions such as mechanical soil disturbance reduced to an absolute minimum or avoided, and external inputs such as agrochemicals and plant nutrients of mineral or organic origin are applied optimally and in ways and quantities that do not interfere with or disrupt the biological processes. Therefore, conservation agriculture provides the best opportunity for optimum use of resources and for restoring and improving soil productivity.

Keywords: *Conservation agriculture, integrated nutrient management, Nutrient use efficiency, Soil fertility, Soil productivity*

Application of nanoscience in rhizosphere studies and smart delivery systems

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Abstract

Agriculture is the backbone of most developing countries, with more than 60 percent of the population reliant on it for their livelihood. Agricultural scientists are facing a wide spectrum of challenges such as stagnation in crop yields, low nutrient use efficiency, declining soil organic matter, multi- nutrient deficiencies, climate change, shrinking arable land and water availability and shortage of labour besides exodus of people from farming. In spite of immense constraints faced, we need to attain a sustainable growth in agriculture at the rate of 4 percent to meet the food security challenges. To address these problems, there is a need to explore one of the frontier technologies such as 'Nanotechnology' to precisely detect and deliver the correct quantity of nutrients and pesticides that promote productivity while ensuring environmental safety and higher use efficiency. The nanotechnology can be exploited in the value chain of entire agriculture production system. Nanotechnology is emerging as the sixth revolutionary technology in the current era after the Industrial Revolution of Mid 1700s, Nuclear Energy Revolution of the 1940s, The Green Revolution of 1960s, Information Technology Revolution of 1980s and Biotechnology Revolution of the 1990s. It is now emerging and fast growing field of science which is being exploited over a wide range of disciplines such as physics, chemistry, biology, material science, electronics, medicine, energy, environment and health sectors. Nanoscience has brought revolution in different fields by helping develop processes and products that are hardly possible to evolve through conventional methods. The nanotechnology aided applications have the potential to change agricultural production by allowing better management and conservation of inputs of plant and animal production. Nanomaterials hold great promise regarding their application in agriculture in terms of plant protection and nutrition due to their size-dependent qualities, high surface-to-volume ratio and unique optical properties. Agriculture nanotechnology used under the entire field to enhancing the productivity with using smart delivery system of fertilizer, insecticide, herbicide and growth regulator. The related fields are as under food technology, crop improvement, seed technology, precision farming, plant disease diagnoses, weed management, water management, biosensors and pest management. The world demand for fertilizer is increasing day by day. Therefore, there is an urgent need to tackle the excessive usage of pesticides and fertilizers. Nanotechnology provides solutions to a complex set of engineering and scientific challenges in the vital food industry manufacturing safe food of high quality. Nanoscience principles can apply in the field of soil science as nano-fertilizer, biosensors and in rhizosphere studies for improving the fertilizer capacity and its management. However, this technology may also be associated with several risks in the environmental and health fields and all safety issues and the negative impacts of micro-particles must be studied before their release into the environment. So, it's very important to know the importance of nanotechnology for present and future use.

Keywords*: Nanotechnology, biosensors, rhizosphere studies, nano-fertilizers*

Soil test based fertilizer recommendations for targeted yield of soybean in Inceptisols of Telangana

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Abstract

A field experiment was conducted in Inceptisols with an objective of developing soil test based fertilizer recommendations for attaining yield targets under IPNS for three years at RARS Jagtial, Jagtial district. With the help of nutrient uptake, soil test values and average basic data (*i.e* nutrient requirement of N,P and K, percent contribution of N,P & K from soil, fertilizer and vermicompost) required for making fertilizer recommendations for different soybean production levels (22q/ha and 28 q/ha) were calibrated. The basic data was transformed into simple workable fertilizer prescription equations for calculating fertilizer doses based on initial soil test values by the procedures laid by Ramamoorthy *et al*. (1967) and Velayudham and Rani Perumal (1976). Based on the study, the estimates of nutrient requirement (kg) for obtaining 1 quintal seed yield of soybean were found to be 4.99 for N, 0.56 for P and 1.05 for K. The nutrient contribution from soil, fertilizer and vermicompost were found to be 66.15, 31.37 and 19.72 for N, 32.55, 7.46 and 2.00 for P and 7.32, 8.63 and 9.70 for K respectively. The response yard stick (kg output/kg input) was found to be 2.81 based on target yield coefficients. Using the fertilizer prescription equations, a fertilizer ready reckoner was developed for interpolating soil test based optimal fertilizer doses for attaining desired soybean yield targets in Inceptisol soils of Telangana.

Fertilizer prescription equations

$FN = 15.91\ T - 2.11\ SN - 0.63\ VC\ N$

$FP_2O_5 = 7.54\ T - 4.37\ SP - 0.27\ VC\ P$

$FK_2O = 12.16\ T - 0.85\ SK - 1.12\ VC\ K$

Keywords: *STCR equation, Target yield, Soybean*

Climate smart Approaches with Precision agriculture for managing resources sustainably

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Abstract

Precising agriculture is the idea of hopefully managing farm to make agricultural products safer by using sustainably agriculture friendly approaches .Itt leads to introduction of GPS, GIS, Remote Sensing helping in recording latitude, longitude and elevation, monitoring crop growth, weed insect and disease control, precise use of manures and irrigation and as a whole monitoring the yield. This alongwith climate smart approaches leads to management of resources sustainably.This include resource use efficiency, diversify production system reducing risk to crop ,,improving soil health, increasing buffering capacity and resilience to climate change impacts.Main goal of these two are to optimise returns on inputs in field and also at the same time preserving resources.climate smart approaches leads to resilience of food production to the impacts of climate change and thus enabling adaptation to long term changes in climate.Precision Agriculture and climate smart approaches can be taken as modern revolutions for feeding increasing population. It's way of working is to use resources precisely alongwith climate change by collecting data,interpretation and then application of resources in sustainable manner.Climate smart approaches leads leads to healthy well managed soil and environment as process of carbon sequestration to store carbon in soil. This two as a whole leading to use of resources in sustainable manner.

Keywords: Precision Agriculture, GIS, GPS, Climate Smart approaches, Remote sensing

Climate Smart Breeding – Need or Greed?

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Abstract

Impeding climate change, global warming and increased events of the weeds, pathogens and pests, is significantly affecting the agriculture sector, which yields the reduction in food grain production. The Intergovernmental Panel on Climate Change (IPCC) reported that climate change might reduce yields per hectare of wheat, rice, and maize by up to 2 percent per decade starting 2030 compared with projected yields without climate change. We are in need to enhance their cultivated crop area additional to 120 million ha to feed their over whelmed population. Climate smart breeding approaches such as Marker assisted selection (MAS), Genomic selection, Shuttle breeding and Speed breeding approach has been emerged and practiced to maximize the production by developing superior high yielding varieties by accumulation of beneficial alleles from vast plant genetic resources existing worldwide to meet the growing demand. Innovative approach such as Haplotype based breeding enabled breeders to develop tailored varieties by utilizing Omics technology along with the modern breeding techniques. Plant breeders have shifted their targets from one particular trait to the multiple traits, which a crop plant needs to combat the upcoming climate changes. In this context, Climate smart breeding approaches are in need of breeders to achieve their goals to mitigate the climate change and make an agriculture as a sustainable.

Keywords: *Climate Change, Speed breeding, Haplotype, Omics*

THEME- IV
Agriculture Diversification, Nutrient Management, Soil Health and Options for Environmental Sustainability

Nitrogen Transformation in Paddy Soil Fertilized with urea and Organic Manures

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Abstract

Nitrogen (N) is one of the most important plant nutrient required by plants for growth and metabolic activities. Its presence in soil mostly comes from natural sources and applied fertilizers. Nitrogen transformation in submerged soils are markedly different from those in drained, aerated soils. These differences affect the prevalent soil microorganisms and microbial activities and turnover, availability and losses of nitrogen.A field experiment was conducted to investigate transformation of different inorganic and organic forms of nitrogen in paddy soil fertilized with different organic manures (vermicompost, poultry manure and FYM) and urea at different growth stages of rice.Treatments consisted of addition of different organic manures *viz*., vermicompost, poultry manure and FYM applied at 100% RDN and combination of above organic manures @75% and 50% RDN along with urea @25% and 50% RDN, respectively, 100% RDN as urea and control. Results revealed that inorganic N ($NH_4^+$and NO_3^-) in soil was higher at the start of the growing season and decreased with crop growth. Higher values of NH_4^+ and NO_3^-in soil were observed in plots which received both organic manures and urea compared to their individual application. Irrespective of different treatments, different organic forms of N *viz*., amino acid N and hexosamine N increased with crop growth. Whereas, total N and total hydrolysable N including hydrolysable ammonium N and unidentified hydrolysable N gradually decreased with crop growth indicating that these fractions mainly contribute to mineralization. Greater amount of different inorganic and organic forms of nitrogen in soil were recorded in singly or combined treated plots of organic manures and urea over control. Organic manures amended soil also resulted in higher build up of different fractions of N over urea alone. The different forms of N were more under vermicompost amended soil followed by poultry manure and FYM. Results further revealed that the addition of organic manures and urea either singly or in combination significantly improved rice yield over control. Moreover, higher rice grain yield (5.55 t ha^{-1}) and straw yield (7.23 t ha^{-1}) were recorded in 50% RDNvermicompost + 50% RDN urea treatment which was at par with soil treated with 50% RDN poultry manure + 50% RDN urea and 100% RDN urea but superior to rest of the treatments. Application of urea N in combination with organic manures could be considered more effective in rice production for reducing N-losses, conserving-N and increasing the efficiency of applied nitrogen.

Keywords: *Exchangeable NH_4^+ -N, Soluble NO_3^- -N, organic forms of N, yield*

Impact of INM on soil fertility and yield in *Abelmoschus esculentus* – *Allium cepa* cropping system in semi arid zone of southern Haryana

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Abstract

A field experiment was conducted during *Kharif* 2014 to *Rabi* 2015 at Regional Research Station, CCS HAU, Bawal, Haryana to study the effect of integrated nutrient management on yield and soil fertility in *Abelmoschus esculentus* – *Allium cepa* cropping system. Results concluded that highest yield and B: C ratio of okra (37.65 qha^{-1}and 1.19) and onion (173.95 qha^{-1} and 6.19) were recorded with application of 75% RDF + 6t vermi-compost ha^{-1}+ bio-fertilizer. Application of 75% RDF alone significantly reduced the fruit yield of okra by 12.3 and bulb yield of onion by 4.1% over 100% RDF. Application of 75 % RDF +15 t FYM ha^{-1} increased the fruit yields okra by 25.6% and onion bulb yield by 8.0%, whereas the application of 75 % RDF + 6t vermi-compost ha^{-1} significantly increased the okra fruit yield by 29.6 % and onion bulb yield by 11.9 % over 75 % RDF. Bio-fertilizers application increased the yield of both crops significantly over control and but increase in yield were non-significant over 75 % RDF in both the crops. The integrated use of inorganic and organic fertilizer increased the crops yield by 25.9 and 8.4 % with 75% RDF+15t FYM ha^{-1}+ bio-fertilizer and by 27.8 and 11.9 % with 75% RDF + 6t vermi-compost ha^{-1}+ bio-fertilizer over 75% RDF + bio-fertilizer. The treatment comprising of 75% RDF+ 6t vermi-compost ha^{-1} +bio-fertilizers also maintained the highest available NPK (124.85, 15.85 & 176.05 kg ha^{-1}) after the harvest of okra-onion cropping system. The maximum B:C ratio of 1.19 & 6.19 was recorded under the treatment receiving 75% RDF+ 6t vermi-compost ha^{-1} + bio-fertilizers in okra and onion crops, respectively

Keywords: *Chemical fertilizer, FYM, vermi-compost, bio-fertilizer, yield, nutrients*

Soil Health Management through Enrichment of Beneficial Microbes

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Abstract

Now a days the scientific and farming community moving towards the era of organic and natural farming. Several researchers were proven the efficiency of both the concepts as it helps in the reduction of hazardous usage of pesticides. In our soil ecosystem basically two groups of micro organisms (Mos) one is beneficial and second is harmful. Beneficial micro organisms helpful to increase the crop production and also in reduction of disease severity, while harmful are able to cause the crop diseases and also destructed the soil health environment. In our soil uncountable beneficial microbes are present, among them nitrogen fixers like Azotobacter, Acetobactcter, Rhizobium and Azospirillum, Phosphate Solubilizers like Bacillus/Pseudomonas and potash mobilizers are most important as it has been proved as successful biofertilizers which gave higher crop yield and saving fifty per cent of chemical fertilizers. Biopesticides *viz*., Trichoderma, Pseudomonas and Bacillus also plays an important role for the improvement in soil health as all are proved as successful bio-control agents and useful for the plant growth promoting activities in different experiments conducted by the scientists of agriculture fraternity. In our soil all these beneficial microbes are present, but the population is low and that is why there is need to increase the numbers through enrichment. For the enrichment of beneficial microbes, lots of efforts were lead by many of the scientists worldwide. The present paper shows importance of microbes for the management of soil health by enrichment of these beneficial microbes.

Effect of Foliar Application of Nutrients and Growth Regulator on Fruit Cracking and Yield of Pomegranate Cv. Bhagwa

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Abstract

The experiment comprising of eleven treatments of nutrients and growth regulator was conducted on seven years old plants at Experimental Orchard of the Department of Horticulture, CCS Haryana Agricultural University, Hisar during the year 2019-20 to study the effect of urea, $ZnSO_4$ and NAA on fruit cracking and yield of pomegranate. The data were recorded onfruit cracking, number of fruits per plant, fruit yield, average fruit weight, fruit length, fruit breadth, fruit volume, and specific gravity. The recorded data were subjected to statistical analysis using RBD. The result of the experiment indicates that the foliar application of urea, $ZnSO_4$, and NAA had a significantly positive effect on most of the recorded parameters. The maximum potential of pomegranate plants in respect number of fruits per plant (122.3), fruit length (8.10 cm), fruit breadth (7.20 cm), average fruit weight (252.3 g), fruit yield (30.8 kg/plant) and fruit volume (305 ml) was exploited to a maximum level and specific gravity (0.82 kg/m^3) to a minimum level with foliar application of urea 1.0% + $ZnSO_4$ 0.5%. The lowest fruit cracking of pomegranate was recorded within the foliar application of $ZnSO_4$ at 0.5% concentration.

Keywords: *Pomegranate, nutrients, growth regulator, fruit cracking, yield.*

Sulphur Desorption with Different Physico-Chemical Properties of Cultivated Soils of Himachal Pradesh, India

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Abstract

Sulphur (S) desorption was investigated in the present study entitled "Sulphur Desorption with Different Physico-Chemical Properties of Cultivated Soils of Himachal Pradesh, India" to assess the S desorption behaviour of the soils of different textures. Eighty soil samples (0-0.15 m depth) were collected from different districts of Himachal Pradesh lying in North-West Himalayasvarying in soil pH, organic carbon (OC), cation exchange capacity (CEC) and clay content and their S desorption behaviour was studied. The results emanated from the present study revealed that soil pH, OC and CEC in soil samples ranged from 5.45 to 7.18, 7.8 to 15.2 g kg^{-1} and 6.1 to 17.5 cmol (p^+) kg^{-1}. The textural classes varied from sandy loam to clay. S desorption was calculated using Langmuir desorption isotherm. The Langmuir desorption parameters such as desorption maxima (Dm) and constant related to mobility of the solid phase (Kd) were worked out for different textured soils. Desorption of S was observedlowest in coarse textured soils; while fine textured soils resulted in the highest desorption values. Dm values for fine, medium and coarse textured soils varied between 218 to 826, 227 to 901 and 222 to 885 µg g^{-1} and values of Kd, in case of course, medium and fine textured soils ranged between 0.001 to 0.025, 0.003 to 0.021 and 0.004 to 0.0l6 ml g^{-1}, respectively. Dm value was negatively and non-significantly correlated with sand (r=-0.08), OC (r=-0.20), CEC (r=-0.02) but correlated positively and non-significantly with silt (r=0.07) and clay content (r=0.01). The mobility constant (Kd) had negative and significant correlation with clay (r=-0.22*), negative and non-significant relationship with CEC (r=-0.16) and pH (r = -0.05) but correlated positively and non-significantly with sand (r=0.13), silt (r=0.08) and OC (r=0.08).It can be concludedthat the availability of S in soils strongly dependent upon soil characteristics especially pH, OC and CEC; while during S desorption, desorbed amounts increased in proportion to amounts of sulphate adsorbed.

Keywords: *Sulphur desorption, physical and chemical properties, different textured soils, Langmuir desorption isotherm, desorption parameters*

Role of Micronutrient for Crop Production and Future Challenges

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Abstract

With E.Grish establishing the role for iron (Fe) in plant nitrition in 1843, heralded the era of micronutrients in crop nutrition. List includes iron, manganese, bron, zinc, copper, molybdenum, chlorine and nickel. In India, stress during the pre- green revolution (GR) period was on creating databases for micronutrient content and distribution; understanding the chemical behaviour and refining the methods for determination of micronutrients constituted the basic research. Advent of green Revolutionwitnessed the emergence of zinc deficiency in rice and wheat; Y.L. Nene had identified the zinc – deficiencies as the cause of khaira disease of rice. Subsequently, emergence of deficiency of Fe, Mn, B either singly or together provided impetus to the micronutrient Research. Compliationvividly demonstrates that magnitudes of Zn and B deficiencies in India more or less conforn to those reported on the global basis by Sillanpaa (96). Micronutrient nutrition in relation to crops; optimisation of rates, sources and methods of application; intraction behaviour in cropping systems; identification of hot- spots of micronutrient disorders vis –a-vis planning for the development and distribution of micronutrient fertilisers have been researched extensively during last sixty years. With human health issuses centering arount micronutrient nutrition, there is a clear paradigm shift in research from soil – plant nutrition to soil – plant – human nutrition. Bio- technological interventions for enhancing micronutrient content of the edible seeds 9 biofortification) and meeting the dietary micronutrirnt requirements through the food ought to be the priority area of research.

EPILOGUE:- Declaration for the twenty – first century micronutrient research should be to fight mirconutrient malnutrition in humans employing agricultural approaches of fortifying the stple food with micronutrients involving integrated strategy of growing micronutrient – efficient crop on soils fertilised with micronutrient – fertilisers. While in Green Revolution era of the twentieth century the stress was on maximising the crop productivity by need – based inclusion of the micronutrient fertilisers for overcoming the limitations imposed by their deficiencies, this century has to witness a paradigm shift in terms of producing the micronutrient – rich food capable of alleviating micronutrient – deficiency syndrome in human – beings. Fortunately for the micronutrients viz. Zn, cu, Mn and Fe limits of phytotoxicity are much less than that of zoo – toxicity. As a corollary it could be extrapolated that if crop yieldsare not going to be depressed by the application of these nutrients, even doses higher than those needed for overcoming phyto- deficiency could be applied as such a strategy will help in producing micronutrient – rich foods.Occurrence of more anemic – population in the northern India vis –a-vis southern and eastern parts is clearly because of low Fe – food produced in the farmer part.

Optimization of NPK fertilizer doses through STCR target yield approach for oat (*Avena sativa* L.) grown in inceptisols of Uttar Pradesh

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Abstract

To study the effect of N,P,K fertilizer on oat a gradient experiment was conducted at Agriculture Research Farm , Institute of Agricultural Sciences,Banaras Hindu University,Varanasi,Uttar Pradesh ,India,during rabi 2018-19. India for oat through Soil Test Crop Response (STCR) to recommend desired fertilizer nutrients. The aim study was to developed fertilizer recommendation equation for cultivation of oat. $N_0P_0K_0$, $N_1P_1K_1$ and $N_2P_2K_2$, fertilizer level were applied to I, II, and III, respectively. NPK were applied through Urea single super phosphate and muriate of potash fertilizer respectively. Oat var. Kent was grown as a gradient crop. At harvest plant samples were collected and analysed for NPK content and calculated total uptake of nutrients.Grain and straw yield of oat were recorded. The result revealed that an application of graded levels of NPK fertilizer significantly influenced NPK uptake, grain and straw yield of oat.

Keywords: *Oat, Available Nutrient, Nutrient uptake, fertilizer*

Manganese transformation and availability in soils under different wheat based cropping systems in north-western India

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Abstract

Assessment of rice-wheat (RWCS), maize-wheat (MWCS) and cotton-wheat (CWCS) are three predominant cropping systems, being practiced by majority of farmers in Punjab (North-western India). The adoption of these three cropping systems depletes a huge amount of manganese (Mn) causing deficiency of this nutrient mainly in light textured soils. The present research study has been conducted with a prime objective to investigate the transformation (chemical pools) of Mn under different cropping systems. To meet this objective, a total of 150 surface soil (0-15 cm, 50 samples per cropping system) samples were collected from three different districts viz. Ludhiana (for RWCS), Rupnagar (MWCS) and Mansa (CWCS) in Punjab (India). Soils of MWCS had significantly higher mean DTPA-Mn and other fractions of variable solubility, compared with the soils of other two investigated cropping systems. On the other hand, DTPA-Mn and the concentration of different chemical fractions in soils under RWCS were significantly lower which might be due to leaching of Mn from upper layers to lower layers of soil. The soils under CWCS had significantly (p<0.05) higher soil pH, E.C. and $CaCO_3$ as compared to other cropping systems. Highest soil organic carbon (SOC) content (mean, 0.60%) was observed in RWCS over other cropping systems due to the soils being flooded conditions for 3-4 months under rice crops, which retarded the rate of carbon oxidation in soils. Among various Mn fractions, maximum was found associated in residual (RES) form and minimum in organic matter bound (OM) form in all the cropping systems. The different fractions of variable solubility viz. WSEX-Mn, SpAD-Mn, OX-Mn,AFeOx-Mn, CFeOX-Mn, OM-Mn and residual-Mn showed significant linear relationship(p<0.05) with soil organic C (SOC) and soils' fine fraction (silt and clay).

Keywords: *Cropping systems, DTPA-Mn, Mn fractions, soil properties*

Impact of residual crop establishment methods and organic manures under zero tillage pea cultivation technique after harvest of black aromatic rice

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Abstract

Zero tillage approach started from 1960s by farmers in India. Generally most of the farmer practices single cropping system instead of taking up second crop, farmers leave field as fallow land in such situation no tillage crop production technique can be practices for raising crop to increase farmer income. Continuous use of heavy plough create hard pan in the subsoil, results in poor infiltration. Zero tillage reduces water requirement of crop and the loss of organic carbon by oxidation. Also, helps the land retain adequate surface residues to prevent soil erosion.An experiment was conducted during rabi season of 2018-19 and comprises of three crop establishment methods viz. direct seeding, normal transplanting and SRI in main plots and four nutrient management in sub plots viz. RDF, 100% RD of FYM, 100% RD of LoktakPhumdi compost and 50% RD of FYM + 50% RD of LoktakPhumdi compost which were replicated thrice in split plot design. The present finding indicates that among the four nutrient management, 50% FYM+50%Loktak phumdi compost (N4) showed significantly higher residual nutrients of available nitrogen (kg/ha), available phosphorus (kg/ha) and available potassium (kg/ha) in soil after the harvest of succeeding pea which was followed by 100% RD of Loktakphumdi compost (N3) and 100% RD of FYM (N2). Lowest NPK was recorded in the treatment RDF (60:40:30 kg/ha) i.e. N1 only chemical fertilizers were applied.This was due to in recent year there has been serious concern about long term adverse effect of continuous and indiscriminate use of inorganic fertilizers on deterioration of soil structure, soil health and environmental pollution. On the other hand, organic manures improved soil physical, chemical and biological properties and thus, resulting in enhanced crop productivity along with maintaining soil health.Though, regarding the crop establishment methods and interaction effect found to be non-significant.

Keywords: *Crop establishment, nutrient management and zero tillage*

Integrated Nutrient Management for Agricultural Production and Environmental Sustainability

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Abstract

The increasing use of chemical fertilizers to enhance the production of food and fibre is causing concern while soils which receive plant nutrients only through chemical fertilizers are showing decline in productivity despite being supplied with sufficient nutrients. The decrease in productivity can be ascribed to the presence of of deficiency in secondary and micronutrients. The physical conditions of the soil is deteriorated as a result of long term use of chemical fertilizers especially the nitrogenous ones. One of the potential solution to this problem is integrated nutrient management. Integrated nutrient management in the maintenance or adjustment of soil fertility and plant nutrition at an optimum level to sustain the desired crop productivity. This is done through optimisation of the benefit from all possible sources of plant nutrients in an integrated manner. In other words, it is the utilisation of different sources of plant nutrients integrated to check nutrient depletion and maintain soil health and crop productivity. It is a practice where all sources of nutrients namely organic, inorganic (chemical fertilizers), biofertilizer can be combined and applied to the soil so that the crop growth is enhanced to get desired yield with quality product. It also helps in keeping the soil in healthy condition by combining or integrating objective of production with ecology and environment that is optimum crop nutrition, optimum functioning of the soil health and minimum nutrient loss or other adverse effect on the environment. Components of integrated nutrient management are chemical fertilizers in conjugation with animal sources compost, green manure, legumes in cropping system, biofertilizer, crop residue, recyclable waste and other locally available nutrient sources for ensuring food security and sustaining soil fertility, health and productivity. The recent year energy crisis, high fertliser cost and purchasing power of the farming community had made it necessary to re-think alternative. Unlike chemical fertilizers, organic manure and biofertilizers available locally. They boost up crop yield per unit of applied nutrients by providing a better physical, chemical and microbial environment. The available quantity of animal excreta and crop residue cannot meet the country's requirement for crop production. Therefore, maximizing the usage of organic wastes and combining it with chemical fertilizers and bio fertilizer in the form of integrated manure appears to be the best alternative to improve physical conditions of soil, increased efficiency of plant nutrients and maintainance of environmental sustainability.

Keywords: *Biofertilizer, Cropping system, Environmental sustainability, Green manure, Integrated Nutrient Management.*

Spatial distribution of Available Micronutrient Status under different Land Use systems of district Doda, J&K

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Abstract

A survey was conducted to assess the micronutrient status of Zn, Cu, Fe and Mn. Composite surface soil samples were collected using stratified random sampling method at a depth of 0-15 cm from Agriculture, Barren lands and at a depth of 1 meter from Forest, Horticulture of district Doda of Jammu division. The exact sample location was recorded using a handheld GPS receiver. Soil maps of micronutrients have been developed using GPS and GIS which will improve our understanding regarding nature and extent of micronutrient deficiencies and their response to crop growth and development. The content of micronutrients and their availability to crops vary widely depending upon soil types, land uses, ecology and agroclimatic variability. Zinc was sufficient in major areas of Gandoh, Thathri and in small portions of Ghat blocks towards north-western sides. Available Iron was sufficient in major portions of district (90 percent area).Iron was sufficient in central and north-western areas of Ghat block. Available copper was sufficient in major portions of district. Copper was sufficient in upper Thathri and lower areas of Bhaderwah. Manganese was sufficient in all major portion of the district. These maps and frequency distribution of available micronutrient status in soils will be highly useful in assessing fields scale variability for developing site-specific nutrients management to maintain soil health of district Doda.

Keywords: *GPS, Barren land, GIS, Composite, Doda, land use, site specific*

Effect of micronutrients on growth, yield and economics of linseed (*Linum usitatissimum L.)* under limited irrigation

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Abstract

An experiment was conducted during Rabi 2018-19 at Oilseed Research Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpurto study the effect of micronutrient on growth, yield and economics of linseed under limited irrigation.The experiment was laid out in randomised block design with three replications. The soil of experimental site was sandy loam in texture, low in organic carbon, available nitrogen and medium in available phosphorus and potash with slightly alkaline in reaction. The experiment comprised of nine treatments viz. soil application of $ZnSO_4$ @ 25 kg ha^{-1}, foliar application of $ZnSO_4$ @ 0.5% at 45 DAS, soil application of $ZnSO_4$ @ 25 kg ha^{-1} + foliar application of $ZnSO_4$@0.5% at 45 DAS, soil application of Borax @ 1.5 kg ha^{-1}, foliar application of Borax @ 0.3% at 45 DAS, soil application of Borax @ 1.5 kg ha^{-1} + foliar application of Borax @ 0.3 at 45 DAS, foliar application of $ZnSO_4$ @ 0.5% + Borax @ 0.3% at 45DAS, soil application of $ZnSO_4$@25 kg ha^{-1} + Borax @ 1.5 kgha^{-1}and control. The experimental crop received total rainfall of 35.2 mm during flowering stage to capsule formation stage. The single irrigation was applied at branching stage. There significant effect of the treatments on growth, yield attributes, seed yield and economics of linseed was observed. The treatment foliar application of $ZnSO_4$ @0.5% + Borax @ 0.3% at DAS significantly increased the plant height, number of branches plant^{-1}, number of seeds capsule^{-1}, test weight and seed yield of linseed in comparison to other treatment and was followed by soil application of $ZnSO_4$ @ 25 kg ha^{-1} + Borax @ 1.5 kg ha^{-1}. Thefoliar application of $ZnSO_4$ @ 0.5% + Borax @ 0.3% at DAS recorded significantly higher plant height(57.97 cm, number of branches plant^{-1}(4.01),number of capsules plant^{-1}(53.89), number of seeds capsule^{-1}(8.72) , test weight (8.30g) and seed yield(2047 kg ha^{-1}) and the increased in seed yield of linseed was 49% over control. The treatment soil application of $ZnSO_4$ @ 25 kg ha^{-1} + Borax @ 1.5 kg ha^{-1} was next in highest order with respect to plant height(55.19 cm), number of branches plant^{-1}(3.84),number of capsules plant^{-1}(51.60), number of seeds capsule^{-}(8.35),test weight(8.09 g) and seed yield (1676 kg ha^{-1}) and the increase in seed yield was 22% over control.The control treatment recorded lowest plant height(45.65 cm), number of branches plant^{-1}(3.15),number of capsules plant^{-1}(42.33), number of seeds capsule^{-1}(6.85),test weight(7.65g) and seed yield (1365 kg ha^{-1}).The foliar application of $ZnSO_4$ @ 0.5% + Borax @ 0.3% at 45 DAS achieved highest net monetary return of Rs.65508 ha^{-1}and B:C ratio of 3.46 .

Keywords: *Micronutrient, linseed, Zinc Sulphate, Borax, Growth, Yield*

Release pattern of boron as influenced by applied calcium and boron in acidic soils under different soil orders

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Abstract

Boron (B) deficiency is the most common and widespread micronutrient deficiency problem in acid soil, which covering about 30% of the total cultivable area of India. Liming is the major package of practices for acid soils to ameliorate the soil acidity, which raises the pH of soil, decreases the Al and Fe toxicity and increases calcium (Ca) and magnesium (Mg) concentration in soils. Liming practices also increases B requirement of plant due to its resemblance in function and reduces availability of B in soil due to the formation of Ca-metaborate complex. Also, it leads to significant changes in physio-chemical properties of soil *viz.,* soil pH, oxides and hydroxides of Fe and Al and concentration of Ca in soil solution, these may influence the adsorption-desorption behaviour of B in soil and subsequently its availability to the crops. Therefore, release pattern of B in different acid soils of Alfisol and Mollisol as influenced by applied Ca and B was studied. For the study, the bulk acid surface soils from two different soil order *i.e.* Alfisol from Jharkhand (Ranchi) and Mollisol from Uttarakhand (Dehradun) were collected. Incubation study was conducted under laboratory conditions using these different acid soils, where eight treatment combinations of Ca based on lime requirement (0, 1/3, 2/3 and 1.0 LR) and B (0 and 2 mg kg^{-1}) were added into soils. Salycilic acid extractable-B (SAE-B) was determined in treated soils at 0, 15, 30 and 60 days after incubation. Results revealed that application of Ca reduced the SAE-B in soils collected from Mollisol (Dehradun) due to the effect of soil pH and high organic carbon content (1.44%) present in this soil. Whereas in Alfisol (Ranchi), SAE-B in soils increased up to 1/3 LR which was similar to 2/3 LR thereafter it was reduced at 1 LR. This was due to increase the pH of soil with addition of lime thereafter formation Ca-metaborate complex reduces B availability in soil at higher lime rate. Salicylic acid extractable-B increased significantly and consistently with the application of B @ 2 mg kg^{-1} in all the acid soils collected from Jharkhand and Uttarakhand. In all acid soils, SAE-B content was gradually decreased with the progression of incubation periods with significant differences.

Keywords: *Acid soil, Boron, Calcium, Mollisol, Alfisol*

Synergistic effect of Vesicular Arbuscular Mycorrhiza (VAM) with different amendments on soil pH and Phosphatase activity

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Abstract

Soil health is the continued capacity of *soil* to function as a vital living ecosystem that sustains plants, animals, and humans. Soil health includes the good soil properties, which is affected by the different nutrient management practices. In order to study the effect of VAM on improving the soil pH and enzyme activity the following study was undertaken. The experiment was carried out in a factorial completely randomized block design with five treatment combinations viz., Control (no P), P alone, P with FYM, EFYM and P with Humic acid and all the five treatments were tried with and without VAM and the experiment was replicated four times. The soil pH showed the decreasing trend along the crop growth stages, it followed the steady decline towards the neutral in humic acid and FYM applied treatment, both in the presence of VAM. The acid and alkaline phosphatase enzyme activity were analysed and the results showed the varying trend along the crop growth stages showing the significant effect of treatments on enzyme activity. The treatments P with FYM and EFYM recorded the highest enzyme activity, both in the presence of VAM. All the results showed that the application of VAM have promoted the good soil conditions. It have also facilitated the increased Phosphorus availability to plants in the alkaline soil. Therefore, the continuous and integrated application of inorganic fertilizer (SSP) as per the soil test recommendation along with a organic amendment (FYM) and a biofertilizer (VAM) can enhance the soil quality and health for the sustainable crop production.

Keywords: *Phosphorus, VAM, FYM, P availability.*

Development of multifunctional microbial consortia for sustaining soil health and improving nutrient use efficiency in High Mountain Himalayan agro-ecosystem

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Abstract

The geographical regions of Jammu and Kashmir are mountainous, where agriculture contributes to about 65% of the state revenue. The agro-ecosystems in these regions are the most neglected crop lands due to several geographical and climatic constraints, considering soil infertility and land degradation. In present scenario, soil and crop management strategies are mainly dependent on inorganic chemical-based fertilizers and pesticides respectively. However, these agricultural practices cannot be recommended for these agro-ecosystems for their environmental concerns and nevertheless, they are primary sources of freshwater supply to low lying areas and, thus, any anthropogenic contamination on them can disperse throughout the riverfront. In this perspective, exploration and development of the naturally available microbial inoculants for high altitude agro-ecosystems could be a promising approach to optimize soil productivity in such a way that soil capacity to function as a healthy medium is preserved. Thus prospecting the cold habitats has led to the isolation of a great diversity of cold active microorganisms that has plant growth promoting ability through the fixation of atmospheric nitrogen, solubilization and mobilization of minerals such as phosphorus, potassium, zinc, and iron by the frequent secretion of assorted organic acids and low molecular weight metal chelators, i.e., siderophore, thus facilitating and improving the uptake of nutrients from the environment. These microorganisms are also known to produce cold-adapted enzymes such as amylase, protease, lipase, pectinase, xylanase, cellulases and chitinase and thus could be used for biodegradation of lignocellulosic agro wastes at low temperature, producing value added product like compost for enhancing soil fertility and decreasing environmental pollution caused by burning of agro-wastes. Thus the cold microbes could be used as biofertilizers, biocontrol agent and bioremediators would be of great use in agriculture under cold climatic conditions. Some of the beneficial microbes reported so far include Pseudomonas sp, Bacillus sp, Azotobacter chroococcum, and Azospirillum brasilense, Rhizobium and fungi like Pencillium sp and Trichoderma sp and some algal species. Hence, a need is raised to identify, characterize, and conserve the compatible beneficial microbes to maintain their functional properties under cold temperature condition followed by their development into a multi functional microbial consortia and large scale production. Further they are environmental friendly and could replace chemical fertilizers and pesticides thus contributing to the goal of sustainable development.

Keywords: *Soil health; Himalayan; Psychrotrophic microbes; PGPR; Biofertilizer; Compost*

Response of plant nutrients on productivity, economics and nutrient uptake of Maize (*Zea mays* L.) - Chickpea (*Cicer arietinum*) cropping system

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Abstract

Multiplicity of cropping system has been one of the main features of Indian agricultural and it is attributed to rainfed agriculture and prevailing socio-economic situations of farming community. It has been estimated that more than 250 double cropping system are followed throughout the country and based on rationale of spread of crops in each district in the country, 30 important cropping system have been identified. By considering above the fact, the field experiments were carried out during the rainy (kharif) and winter (rabi) seasons of 2019-20 on farmers' fields in Dahod and Dhanpur taluka of Dahod district on the basis of productivity situated in Gujarat Plains and Hills, using maize-chickpea cropping pattern to see that effect of crop response to plant nutrients on soil properties and crop yields. Randomized Block Design (RBD) was used for statistical comparisons. The experiment was conducted with seven different treatments of NPK (T_1 : Control, T_2 : N (100 kg/ha), T_3 : NP (100:50 kg/ha), T_4: NK (100:50 kg/ha), T_5 : NPK (100:50:50 kg/ha), T_6 : NPK + $ZnSO_4$ (100:50:50 + 20 kg/ha) along with farmer's practices (T7) of NP (95:40 kg/ha) in kharif maize followed by rabi chickpea cultivation.T_1 : Control, T_2 : N (20 kg/ha), T_3 : NP (20:40 kg/ha), T_4 : NK (20:20 kg/ha), T_5 : NPK (20:40:20 kg/ha), T_6 : NPK + $ZnSO_4$ (20:40:20 + 20 kg/ha) along with farmer's practices (T_7) of NP (20:30 kg/ha). At each site/village, 4 farmers were selected thus making 6 replications. Maize cultivar ' GM 6' and chickpea cultivar 'JG 14' were sown. Result revealed that significantly the highest System Equivalent Yield (SEY) was obtained from treatment T_6 i.e. Recommended dose of NPK (100:50:50 kg/ha) + 20 kg $ZnSO_4$ (4855 kg/ha) with net return of Rs. 39358. The nutrient response was 8.40 kg grain per kg nutrient was achieved from the treatment T_6 (NPK + $ZnSO_4$ - 100:50:50 + 20 kg/ha) in Maize and (NPK-20:40:20 + $ZnSO_4$ - 20 kg/ha) in chickpea. While, in case of NPK concentration, it was slightly increased in grain as well as straw in chickpea. Therefore, cropping patter of maize in kharif after chickpea in rabi season with recommended dose of fertilizer along with $ZnSO_4$ increase the production as well as nutrient.

Keywords: *Productivity, Economics, Maize–chickpea cropping system, Nutrient uptake, Nutrient response*

Effect of Biochar in improving the soil health for environmental sustainability

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Abstract

Intensification of cultivation practices and indiscrimateuses of chemical fertilisers have led to the deterioration of soil health and also adversely affect environmental sustainability. Application of biochar for amending soil is a promising approach to improve soil health and also to increase crop productivity. Biochar is a fine grained or granular charcoal produced by pyrolysis and gasification of diverse biomass in oxygen limited or oxygen free environment at relatively low temperature (300-700°C). It is porous and environmentally stable material due to its polycyclic aromatic carbon structure. Because of high surface area and high surface charge density, it increases the ability of soils to retain nutrients hence increasing nutrient use efficiency.Leaching of essential nutrients from soil can deplete soil fertility, hasten soil acidification and reduce yield of crop thereby causing threat to environmental health. An option to reduce leaching is by application of biochar.Biochar can improve soil health by altering soil physical properties; viz., improving the water holding capacity of soils, increasing soil aeration and also increasing soil aggregate stability. A recent study has shown an increase in maize yield by 98-150% and water use efficiency by 91-139% as a result of biochar addition.Biochar also acts as a safe habitat for soil micro-organisms.It has been found to increase plant available nutrients by stimulating beneficial soil microbes such as mycorrhizal fungi.Conversion of biomass carbon to biochar leads to sequestration of about 50% of the initial carbon, thereby yielding more stable soil carbon than burning or direct incorporation of biomass in soil.Therefore, production of biochar along with its incorporation into soils is novel approach for improving soil health. Biochar has considerable potential in improving soil nutrient availability and promotion of soil quality as it utilises the wastes source and avoids environmental contamination.

***Keywords**: Biochar, nutrients, soil quality, environmental sustainability.*

Influence of lime and organic manures on growth and yield performance of baby corn (*Zea mays* L.) under rainfed condition

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Abstract

A field experiment was conducted at the Assam Agricultural University, Jorhat during the *summer* season of 2018 to study the effect of lime and manures on growth of baby corn under rainfed condition. The treatment consisted of seven different sources of nutrients viz., Control, Enriched compost(EC) @ 2.5 t/ha , FYM @2.5 t/ha , Lime (50% LR) + FYM @2.5 t/ha + ash (2.5 kg/ha)**,** Lime (50% LR) + EC @2.5 t/ha + ash (2.5 kg/ha) **,** EC @2.5 t/ha + Lime (25kg/ha) + ash (2.5 kg/ha) mixture at sowing and 30 days after sowing (DAS) and FYM @2.5 t/ha + Lime (25kg/ha) + ash (2.5 kg/ha) mixture at sowing and 30 DAS . The experiment was laid out in RBD with four replications and soil of the experimental field was medium in available nitrogen, potassium and low in available $P_2O_5$with pH value of 5.2 and O.C. value of 0.62%. G-5414was used as the test variety of baby corn. Among the treatments, application of enriched compost (2.5 t ha^{-1}) +lime (25 kg ha^{-1}) +ash (2.5 kgha^{-1}) mixture at sowing and 30 DAShas shown the significantly better results with respect to growth attributes (viz., plant height, number of leaves, dry matter accumulation, leaf area index, leaf area duration) and finally highest cob yield(42.88 q ha^{-1}) followed by FYM (2.5 t ha^{-1}) +lime (25 kg ha^{-1}) +ash (2.5 kgha^{-1}) mixture at sowing and 30 DAS (36.63 q ha^{-1}**).**

Keywords: *Baby corn, organic, lime, enriched compost, growth, dry matter accumulation.*

Nutrient dynamics as influenced by organic and inorganic inputs in rice grown in inceptisols

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Abstract

A research trial was carried at research farm of SKUAST-Jammu at Chatha during the year 2018-2019 to study the nutrient dynamics as influenced by organic and inorganic inputs in rice. The experiment was laid out with eight treatments replicated thrice on rice cultivar Basmati-370. The treatment comprised of different organic and inorganic treatments alone as well as in combination. Application of different treatments was given after field preparation while urea was applied in split doses at different crop growth stages. Data was recorded on various parameters *viz.* physico-chemical and biological properties of soil at various crop growth stages such as before tillering, tillering, panicle initiation and harvest. Results from our investigation revealed that plots which received application of FYM 25% nitrogen + VC 25% nitrogen + 50% N through inorganic fertilizer resulted in maximum yield (25.21 kg/ha) and minimum (12.04 kg/ha) was recorded under T_1 (Control). Application of organic and inorganic had a significance influence on nutrient uptake. Maximum nitrogen uptake (39.14 mg/kg) was recorded in treatment T_8 (FYM 25% nitrogen + VC 25% nitrogen + 50% N through inorganic fertilizer), maximum phosphorous uptake (5.37 mg/kg) was recorded in treatment T_2 (NPK) and maximum potassium uptake (9.45 mg/kg) was recorded with NPK in treatment T_2.The data pertaining to the effect of different organic and inorganic inputs showed that they had a significant influence on available nitrogen, phosphorous and potassium as well at various crop growth stages viz. before tillering, tillering, panicle initiation and harvest. Maximum pH (6.58, 6.97, 7.35 & 6.68) and EC (0.25, 0.25, 0.24 & 0.22) was recorded at before tillering, tillering and harvesting stage. Values of OC recorded remained same for all the treatments i.e. 0.39 at before tillering, tillering and harvesting stage and did not change with change in treatments. But at panicle initiation stage maximum organic carbon (0.41) was obtained under T_8.

Keywords: *Grain yield, nutrient uptake, available nutrient, physico-chemical properties*

Comparative evaluation of soil acidity in organic and conventional system of tea cultivation for long term sustainability

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Abstract

Tea (Cammelia sinensis) is a major cash crop and plays a very important role in the economic development of the state of Assam. Public concerns over environment, health, quality and safety have led to an increasing interest in organic farming practice in tea cultivation. Tea is an unusual crop because soil becomes strongly acidified following planting of tea and soil pH continues to decrease with the age of plantation. Many tea gardens including small scale tea growers are slowly converting from conventional to organic due to sustainability in production and maintenance of soil quality. Therefore, an attempt was made to compare soil acidity components under organic and conventional tea cultivation of two tea gardens of Golaghat district of Assam taking samples from five age group (<15, 15-30, 30-45, 45-60 and >60 years) and three depths (0-20) cm, (20-40) cm and (40-60) cm. Altogether 60 number of composite soil samples were collected from each management systems. Soil sample were analysed for important soil physico-chemical properties and different forms of acidity components using standard procedures. Conventional system was found to be more acidic than organic system although the pH was maintained at a favourable range for tea production. The Organic system was found to maintain higher levels of organic carbon than conventional system. The pH of the soil increased with depth and organic carbon decreased with depth in both the management systems. The Total potential acidity was higher in both the management system. The value of total acidity was lower as compared to total potential acidity. Irrespective of depth all the acidity component was higher in conventional management system as compared to organic management, except pH dependent acidity which was higher in organic management. All the acidity components were found to decrease with depth and increase with age of plantations. pH was negatively correlated with exchange acidity (r=-0.502**) under organic system and (r=0.301**) under conventional system indicating that most of the exchange acidity is responsible for lowering the soil pH. Exchangeable Al was positively correlated with organic carbon (r=0.340**) under organic and (r=0.283*) under conventional. Exchangeable acidity showed highly significant positive correlation with exchangeable Al both in organic (r=0.983**) and conventional (r=0.990. Highly significant positive correlation was found in between total potential acidity and pH dependant acidity under organic (r= 0.856**) and conventional (r=0.730**) management. The study showed that variation of acidity components were significantly higher under conventional management which may be due to the dominant role of Al in these soils.

Keywords: *Organic tea cultivation, Conventional tea cultivation, Total acidit, Soil health, Soil sustainability*

Effect of organic manures and phosphorus levels on growth, yield and economics of cowpea

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Abstract

Cowpea [*Vigna unguiculata* (L.) Walp] is of immense importance, as it is a multipurpose grain legume extensively cultivated in arid and semiarid tropics. The cowpea is used as grain, green pods and fodder. Cowpea is grown as a catch crop, weed smothering crop, intercrop, mixed crop and green manure crop. It has ability to fix atmospheric nitrogen in soil at the rate of 56 kg per hectare in association with symbiotic bacteria under favourable conditions. Organic manures although, not useful as sole sources of nutrients, are however, good complementary sources with inorganic fertilizers. Organic manures play a vital role in maintenance of physical, chemical and biological environment of soil and supply macro and micronutrients to crops, besides maintaining humic substances in soil). The judicious combination of organic manures and fertilizers should be used for improving crop productivity and maintaining soil fertility.Phosphorus is the second most critical plant nutrient over all, but for pulses it assumes primary importance owing to its important role in root proliferation and there by atmospheric nitrogen fixation. Phosphorus (P) is one of the most needed elements for pulse production. Phosphorus, although not required in large quantities, is critical to cowpea yield because of its multiple effects on nutrition. All growing plants require P for growth and development in significantly large quantity. Role of phosphorus is well documented that it increases root formation, number of nodules and in turn yield. The present study was taken up to study the influence of organic manures and phosphorus at different levels on yield and economics of cowpea crop in Southern Zone of Andhra Pradesh. Field experiment were conducted during kharif season of 2017 and 2018 at Tirupati (AP) to evaluate the effect of organic and inorganic sources of nutrients on growth, yield and economics of cowpea. Three levels of organic manures (no organic manure, FYM @ 5 tonnes ha^{-1} and poultry manure @2 tonnesha^{-1}) and 3 phosphorus levels (0, 40 and 60 kg P_2O_5 ha^{-1}) applied to cowpea. Yield attributes and yield of cowpea varied with manures and phosphorus levels. Poultry manure application @ 2 tonnes ha^{-1} resulted in higher number of pods per plant, seeds per pod, pod, haulm yield and economics which was statistically on par with application of FYM @ 5 tonnes ha^{-1}. Among the phosphorus levels, application of 60 kg P_2O_5 ha^{-1} resulted in higher pod yield and economics which was on par with that of 40 kg P_2O_5 ha^{-1}.

Keywords: *Cowpea, FYM, Poultry manure and Phosphorus levels*

Response of boron application on yield and economics of Maize (*Zea mays* L.)

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Abstract

A field experiment was conducted in participatory mode on farmers' field in Sankumari village of Nabarangpur district under Eastern Ghat High Land Zone (EGHLZ) of Odisha to assess the response of boron application on yield and economics of maize. The experiment was laid out in Randomized Block Design with four treatments replicated five times. The experimental soils were slightly acidic, non-saline, loamy sand, medium in organic carbon, available K, and low in available N, P, B and Zn contents. The detail treatments were, T_1: no boron application, T_2: 0.5 kg B ha^{-1} soil application, T_3:1.0 kg B ha^{-1} soil application and T_4: 0.5 kg B ha^{-1} soil application + 0.2 % borax as foliar spray at 30 & 45 DAS. Soil Test Based NPKZn @ 150:75:60:6.25 kg ha^{-1} (T_4) was made basing upon the normal Recommended Dose of Fertilizer (i.e. NPKZn @ 120:60:60:5 kg ha^{-1}) in which 25% more N, P and Zn were added to all the treatments. The maximum yield and yield attributes was recorded with the T_4 (Soil Test Based NPKZn @ 150:75:60:6.25 kg ha^{-1}) + 0.5 kg B ha^{-1} soil application + 0.2 % borax as foliar spray at 30 & 45 DAS) i.e. grain yield per cob (210.21 g), 100 grain weight (38.16 g), stover yield (8.10 t ha^{-1}), grain yield (6.52 t ha^{-1}) and B:C ratio (1.90). Hence, in EGHLZ of Odisha, soil deficient in boron, under continuous maize growing area, soil test based fertilizer application with boron is to be followed for remunerative maize production by farmers.

Keywords: *Maize, Boron, Yield, Economics*

Effect of integration of organic and inorganic sources of nitrogen in rice crop on soil fertility status at harvest

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Abstract

A field experiment was conducted during kharif-2016 at ICAR-Krishi Vigyan Kendra (KVK), Mangaluru of Karnataka state to study the effect of to study the effect of integration of organic and inorganic source of Nitrogen on soil fertility status at harvest of rice crop grown under submerged condition. The soil of the experimental field was lateritic with acidic pH, medium in available nitrogen, high in phosphorus and low in potassium content. The experiment was laid out in randomized block design (RBD) replicated thrice with eleven treatments comprising of vermicompost (VC), Poultry manure (PM) and Fish manure (FM) as nitrogen source of organic manure integrated with mineral fertilizer of nitrogen source namely urea in various combinations along with one treatment as control and one treatment comprising application of recommended package of practices. Soil samples were collected at harvest and analyzed for parameters of soil fertility. The results indicated that soil pH, Electrical Conductivity (EC) were not significantly influenced by integration of organic sources of nitrogen with urea. However the nutrient status of the soil was significantly influenced by various combinations of organic and inorganic sources of nitrogen. The available nitrogen was significantly higher in the treatment of receiving 50 per cent VC integrated with 50 per cent recommended dose of nitrogen (RDN) (382.36 kg ha^{-1}) compared to control (294.05 kg ha^{-1}) followed by the treatment receiving 25 per cent VC integrated with 50 per cent RDN (374.80 kg ha^{-1}). The available phosphorus in soil was significantly higher in treatment receiving 50 per cent PM integrated with 50 per cent RDN (78.83 kg ha^{-1}) compared to control (43.93 kg ha^{-1}) followed by treatment 25 per cent PM integrated with 75 per cent RDN (70.23 kg ha^{-1}). The available Potassium was significantly higher in the treatment receiving 50 per cent VC integrated with 50 per cent RDN (143.7 kg ha^{-1}) compared to control (92.31 kg ha^{-1}) followed by treatment receiving 50 per cent PM integrated with 50 per cent RDN (141.8 kg ha^{-1}).

Keywords: *Rice, soil fertility, submerged condition, vermicompost, poultry manure, fish manure*

Crop and environmental sustainability through integrated nutrient management (inm)

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Abstract

The increasing food demands of a growing human population and the need for an environmentally friendly strategy for sustainable agricultural development require significant attention when addressing the issue of enhancing crop productivity. Alleviation of poverty and achievement of zero-hunger target and food security are significant challenges faced by agricultural planners worldwide. Improving many agronomic approaches, which have drastic effects on crop growth and yield, is urgently needed to report this aim. Replacement of a part of chemical fertilizers by organic manure through a simple technique of using minimum effective dose of sufficient and balanced quantities of organic and inorganic fertilizers in combination with specific microorganisms, called INM, has a bright solution in this area. INM has potential in resolving these concerns, which has been proposed as a promising strategy for addressing such challenges. INM has multifaceted potential for the improvement of plant performance and resource efficiency while also enabling the protection of the environment and resource quality. A comprehensive literature search revealed that INM enhances crop yields by 8-150% compared with conventional practices, increases water-use efficiency, and the economic returns to farmers, while improving grain quality and soil health and sustainability. Model simulation and fate assessment further reveal that reactive nitrogen (N) losses and GHG (greenhouse gas) emissions are reduced substantially under advanced INM practices. Lower inputs of chemical fertilizer and therefore lower human and environmental costs (such as intensity of land use, N use, reactive N losses and GHG emissions) were achieved under advanced INM practices without compromising crop yields. INM is a tool that can offer good options and economic choices to supply plants with a sufficient amount of nutrients in need and can also reduce total costs, create favourable soil physiochemical conditions and healthy environment, eliminate the constraints, safeguard the soil nutrient balance, and find safety methods to get rid of agriculture wastes. Strong and convincing evidence indicates that INM practice could be an innovative and environmentally friendly strategy for sustainable agriculture worldwide.

Keywords: *Integrated Nutrient Management, Sustainable agriculture*

Effect of vermicompost and fym to enhance soil nutrient availability and nutrient uptake of paddy

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Abstract

The broad category of organic-based fertilizers includes diverse formulations of products that provide plants with nutrients and/or improve organic matter in the soil. They are applied to plants and/or soils to improve soil fertility and yield. Among that vermicompost and FYM are the well known and nutrient rich organic fertilizers which can increase the soil fertility, increases the microbial populations and reduce the environmental pollution. In India rice is grown in 43.86 million ha, the production level is 104.80 million tones and the productivity is about 2390 kg/ha (Agricultural Statistics at a glance- 2015). Field experiments was conducted during 2019-20 in the farmers field of sethiathoope, cuddalore, Tamilnadu, where six different treatments were implied to evaluate the residual effect of vermicompost and FYM on nutrient availability and uptake of rice in coastal saline soil. The treatments were T_1 – control, T_2 – RDF, T_3 – RDF + vermicompost, T_4 – RDF + enriched vermicompost, T_5 – RDF + FYM, T_6 – RDF + enriched FYM. Among the treatments T_4 (RDF + Enriched vermicompost) recorded highest grain yield and nutrient uptake, followed by T_6 (RDF + Enriched FYM). Vermicompost contain 30 to 50 percent microbial organisms which help in the stimulation of nitrogen fixation particularly that of roots. Robinson et al., (1992) reported that the nutrients present in vermicompost are readily available. Lenin et al. (2004) and Rajkhowa (2008) also reported similar results in rice, and they attributed the increased growth and yield to the increased availability and uptake of nutrients. The leaf chlorophyll content was increased by 11.9 and 5.5% due to application of enriched vermicompost. Ranva & Singh (2006) reported the application of vermicompost at 7.5 or 10 t ha^{-1} gave higher yields than 10 t ha^{-1} FYM. In the present study an attempt was made to study the effect of vermicompost and FYM in paddy crop to enhance the soil nutrient availability and nutrient uptake.

Keywords: *vermicompost, FYM, grain yield, organic matter, Agriculture Diversification, Nutrient Management, Soil Health and Innovative Options for Environmental Sustainability*

Role of Applications of Various Organic Sources in Nutrient Management on the Basis of Soil Testing Along with Diversified Agriculture to Maintain Ecological Restoration and Natural Resources Management

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Abstract

Natural resource management (NRM) are related issues have attractedattention of researchers and other policymakers in recent decades, particularly in developing countries like India, Nepal and Pakistan, in relation tocrises in energy, food, water and other resources.Due to use of chemically pure high analysis fertilizers and adoption of modern improved agriculture technology, depletion of nutrients is becoming faster and deficiencies of micronutrients are also used commonly. Natural resource management is a modern approach, which refers to the sustainable utilization of major natural resources, which includes terrestrial resources like land, water, air, minerals and forests.Diversified Agricultureis a scientific modern technique, which includes crop diversifications *viz*.use of high yielding varieties, crops having low water requirements, legumes intervention, short durationpulses and oilseed crops along with horticultural, medicinal, ornamental and aromatic crops, dairy, fishery, poultry, duck rearing with national and international demands, whereas, horizontal diversification are covers crop intensification and substitution, while, vertical diversification covers marketable access of agricultural productslike processing, packaging, regional branding, merchandising, and other efforts. Nutrient management in agricultural crops also plays an important role in crop production as well as improve of soil health.Applications of organic farm wastes through re-cycling solve the problem of disposal of these wastages, however, the most important constituents in soil is organic matter, an appreciable amount of organic matter in soil tremendously increases soil fertility, which leads to soil conservations and ecological sustainability.Nutrient management on the basis of soil testing values favours crop production, in present day soil health card is playingancrucial role in fertility management as well as conservation of soil. As, with the modernization of agriculture, required balanced use of organic manures and chemically fertilizer in agriculture system, on the basis of soil testing values are needed for conservation of natural resourcesand ecological development restoration.

Keywords: *SustainableAgriculture, Pesticides, Fertilization, diversification, Nutrient management, Soil Health Card, Intensive Cultivation, Natural Resource.*

Yield and soil fertility as effected by manures and fertilizers in rice

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Abstract

A field experiment was conducted during 2015-16 to study the effect of organic manures and inorganic fertilizers on yield of rice and soil fertility status after harvest at Agricultural Research Station, Perumallapalle, ANGRAU. The experiment consisted of two treatments i.e. organic and inorganic treatments. FYM and vermi compost were applied to organic treated plot based on N equivalent and recommended dose of fertilizers (80:60:40 kg NPK ha^{-1}) were applied to inorganic treated plot. Grain yield and yield attributing characters were recorded at harvest. Soil samples were collected to determine available nutrient status at harvest. Results revealed that inorganic treated plot recorded highest grain yield (4.102 t ha^{-1}), effective bearing tillers (42.3 lakhs), plant height (82.06 cm), panicle length (17.01 cm) and N content in grain (1.03%) than organic treated plot (3.665 t ha^{-1} of grain yield, 40.2 lakhs of effective bearing tillers, 78.10 cm of plant height, 15.24 cm of panicle length 0.92% of N content in grain). The available potassium (281 kg ha^{-1}) and organic carbon (0.48%) were higher in organic treated plot than inorganic plot (260 kg ha^{-1} of available potassium and 0.44% of organic carbon).

Impact of integrated nitrogen management on productivity of pearl millet under rainfed conditions of Jammu region

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Abstract

Pearl millet (*Pennisetum glaucum*) is the fifth most important food crop of India next to rice, wheat, maize and sorghum grown predominantly with rainfall moisture. In Jammu and Kashmir UT, pearl millet crop is grown on an area of 20 thousand hectares with a production of about 10 tonnes and an average productivity of 597 kg/ha. About 12 per cent of the geographical total area of Jammu region constituting dry semi-hilly belt is locally known as *kandi* area. The area purely rainfed in nature and the most moisture stressed ecosystem of the region. The field experiments were conducted at Research farm, Advanced Centre for Rainfed Agriculture (ACRA), SKUAST-J, Rakh Dhiansar, J&K UT during *kharif* (June-September) seasons of 2015 and 2016. The soil of the experimental site was sandy loam in texture with low available nitrogen, potash and OC and medium in phosphorus. The climate of the region represents sub-tropical conditions characterized by hot and dry summer. The experiment comprised of eight treatments *viz.* T_1: Control; T_2: 100% recommended fertilizer dose-RFD (50:30:15 NPK kg/ha); T_3:75% N Inorganic + 25% N through FYM, T_4: 50% N Inorganic + 50% N through T_5: FYM, 100% N through FYM, T_6: 75% N Inorganic + 25% N through vermicompost, T_7: 50% N Inorganic + 50% N through Vermicompost and T_8: 100% N through Vermicompost with 3 replications. The Urea, diammonium phosphate and muriate of potash were used as a source of nitrogen, phosphorus and potassium, respectively for inorganic source. Whereas the sources of organic nitrogen was as per the treatment combinations. Integrated nutrient management with Vermicompost/FYM and their combinations with inorganic fertilizers partially or alone significantly influenced the grain and stover yields of pearl millet crop. The application of 100% NPK (inorganic) recorded statistically higher grain (2867 kg/ha) and stover (5925 kg/ha) yields of pearl millet and was 79.6 and 53.9% higher over control, respectively. However, among integrated nutrient management treatments; 75% N inorganic + 25% N through VC recorded significantly higher grain (2775 kg/ha) and stover (5818 kg/ha) yields, respectively which was followed by statistically similar treatments 50% N inorganic + 50% N through VC with the grain yield values to the tune of 2674 and stover 5724 kg/ha, respectively. The grain and stover yield values of pearl millet crop in the treatments where 100% N was supplied through Vermicompost and FYM were statistically significant.

Keywords: *Pearl millet, INM, Rainfed, Vermicompost, FYM*

Validation of Soil Test and Yield Target Based Balanced Fertilizer Prescription Model for Glory lily on Alfisol

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Abstract

Soil Test Crop Response based fertilizer prescription equations for desired seed yield target of glory lily were developed under Integrated Plant Nutrition System (STCR-IPNS) on TypicRhodustalf (Palaviduthi soil series) of Tamil Nadu. On farm testing of STCR-IPNS equations are essential to demonstrate the effectiveness of technology to the clients. The present study was undertaken to evaluate the targeted yield model through field experiments at six locations in Dindigul district, western zone of Tamil Nadu. The treatments include control, blanket recommendation (RDF alone), soil test crop response (STCR) based fertilizer dose for the seed yield targets of 5.5, 6.5 and 7.5 q ha^{-1}, STCR-IPNS based fertilizer dose for the seed yield targets of 5.5, 6.5 and 7.5 q ha^{-1} and farmer's practice. Results elucidated that in all the six locations, the per cent achievement of the targeted yield was within $\pm$ 10 per cent variation proving the validity of the equations for prescribing integrated fertilizer doses for glory lily. The highest mean seed yield was recorded in STCR-IPNS – 7.5 q ha^{-1} (725 kg ha^{-1}) recording an increase of 43.19 per cent over blanket recommendation. The highest response ratio and B:C ratio of 0.78 and 1.72 respectively were recorded in the yield target of 7.5 q ha^{-1} under STCR-IPNS. The post-harvest soil available NPK indicated the build up and maintenance of soil fertility due to soil test based fertilizer recommendation under IPNS. The fertilizer prescription equations developed for glory lily under IPNS can be recommended for red non calcareous soils of Tamil Nadu for achieving the yield target of 7.5 q ha^{-1} with sustained soil fertility and it can be extrapolated to other agro-climatic zones of Tamil Nadu on similar and allied soil types.

Keywords: *Alfisols, Fertilizer prescription, Glory lily, STCR-IPNS, Validation*

Agriculture diversification for food, nutrition, livelihood & environmental security

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Abstract

Diversification is an integral part of the process of structural transformation of an economy. Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a particular farm taking into account the different returns from value-added crops with complementary marketing opportunities. Diversification become necessary for developing countries only growing of basic staples such as cereals cannot alone support economic development notwithstanding the need to ensure the food security to the people. Diversification to commercial crop and commodities becomes an essential strategy that can increase income in agriculture, minimize risk due to crop failures and above all earn foreign exchange. Horizontal Diversification- Diversification takes place through crop intensification by adding new high-value crops to existing cropping systems as a way to improve the overall productivity of a farm or region's farming economy. Vertical diversification- Farmers and others add value to products through processing, regional branding, packaging, merchandising, or other efforts to enhance the product. Diversification may be broadly defined as a shift of resources from low value agriculture to high value agriculture as indicated by Hayami and Otsuka (1992) or Vyas (1996). Government policies and strategies for crop diversification- Implementing National Agriculture Insurance Scheme, Technology Mission on Cotton, and Provision of Capital Subsidy of 25 percent for Construction / Modernization / Expansion of Cold Storages and Storages for Horticultural Produce, Creation of Watershed Development Fund, Strengthening Agricultural Marketing, Seed Crop Insurance, Seed Bank Scheme and Cooperative Sector Reforms. Diversification of agriculture is considered as an essential to take the advantage of complementary and supplementary relationships so as to reap the maximum returns. Need to synthesize high potential cropping systems and evaluate both on station and on farm in farmers participatory approach. The crop varieties short in duration with high potential yield and most suited for the synthesized systems needs to be identified. The location specific approaches and full packages need to be prepared. For arid and semi arid areas the crops and cropping systems for long term sustainability should be preferred.

Keywords: *Diversification, Subsidy, Horizontal, Vertical*

Soil Health and Environment

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Abstract

Soil health refers to a balance condition of soil physical, chemical and biological process conductive to high productivity and environmental quality. The major reason to decrease in soil health unbalanced and excessive use of chemical fertilizers, insecticide and pesticides which deteriorate soil ecosystem because these chemicals persists in the soil long time and affect the population of beneficial micro- macro organism present in soil system, so need maintain soil quality and improvement soil health by using natural resources and efficient technology like reduce soil disturbance, crop rotation, integrated live stock into cropping system, green manuring, use of vermicompost, farm residues management, biofertilizers, organic farming, balanced and minimum use of chemical fertilizers, pesticides, insecticides etc. Natural farming or organic farming has many benefits as it discourage environmental exposure to pesticides and chemicals, builds healthy soil. It fight the effect of global warming, support water conservation and water health. These natural resources are not only improve soil health it also sustainable and eco- friendly.

Impact of Soil Health Cards on Soil Fertility in India

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Abstract

"Earth needs to be nurtured with mother's care because earth gives us everything for sustaining life". So any kind of torture on it is a sin. To protect soil health and for sustainable agriculture, the Government of India launched Soil Health Cards (SHC) Scheme in February 2015. A SHC is meant to give each farmer soil nutrient status of his holding and advise him on the dosage of fertilizers and micronutrient and also the needed soil amendments that he should apply to maintain soil health in the long run. Farmers will be able to know how much nutrients are already available in the soil and how much will have to be provided additionally for a particular crop through soil testing. A SHC carries crop wise recommendation of nutrients and fertilizer required for the individual farms to help farmers to improve productivity through judicious use of inputs. In the guidelines, there is also an instruction to devise a mechanism to issue soil health cards every 3 years in respect of all holdings in order to capture the soil fertility changes occurring due to plant uptake or other natural causes. A project on generation of soil health cards for kuppam assembly. Field demonstrations in paddy indicated that fertilizer savings were observed for farmers who followed recommendations based on soil health cards apart from increase in crop yields. The extent of over utilization of nitrogenous fertilizer was less by the farmers having soil health card as compared to farmers without soil health cards with regards to sugarcane and *kharif* paddy crops. The extent of under utilization of phosphatic and potasic fertilizers was less for farmers having soil health card as compared to farmers without soil health cards. Land use was intensified, cropping patterns changed in favour of more remunerative crops and crop yields increased with the use of soil health cards. Mean yield of all crops grown significantly increased to the extent of 186%. Increase in net income was largely related to the increase in crop yield due to soil improvements. NPK consumption ratio of farmers with soil health cards was 2.68:1.30:1 as against 4.63:3.08:1 for the farmers without soil health cards. The mean yield per hectare of kharif paddy for the farmers with soil health cards was marginally higher than the control group. The net change in gross income between the two groups due to soil health cards was valued at Rs. 2178 per hectare.

Keywords: *Soil Health Card, Soil Health, Fertilizers.*

Impact of FYM, Zinc Fertilization and Different RSC Waters on Zinc Fractions, Response Studies, Productivity and Profitability of Barley in *Typic Ustipsamment* Soils of III-A Agroclimatic Zone of Rajasthan

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Abstract

During the *rabi*seasons of 2013-14 and 2014-15, a Field experiment was conducted at SKN Agriculture Collage to work out the effect of different residual sodium carbonate (RSC) waters, FYM and zinc fertilization on yield attributes, zinc fractions, response studies and economics of Barley in loamy sand soil under semi-arid climatic condition of eastern plain. The three levels of RSC waters (control, 5 and 10 mmol L^{-1}), two levels of FYM (control and 15 t ha^{-1}) in main plot and four levels of zinc (control, 15, 30 and 45 kg $ZnSO_4$ ha^{-1}) in sub-plot were tested. Based on the analysis of variance and F-test it was found that application of high sodic irrigation water (10 mmol L^{-1} RSC), the different fractions of soil Zn (except Occ-Zn), Plant height, total tillers, effective tillers and test weight got significantly adversely affected during both the years. Application of FYM positively and significantly increased the proportions of different zinc fractions in soil (except Occ-Zn) as well as yield attributes (Plant height, total tillers, effective tillers, test weight) of barley. The increasing level of zinc application (0.0, 15, 30 and 45 kg $ZnSO_4$ ha^{-1}), significantly increased the content of different chemical fractions of soil Zn (except Occ-Zn), available soil Znand yield attributes of barley. It was observed that the grain yield of barley revealed positive and significant correlation with different fractions of Zn *viz.* DTPA-Zn (r=0.888), Ads-Zn (r=0.525), Occ-Zn (r= 0.670), OC-Zn (r=0.948) and Res-Zn (r=0.923). The optimum dose of zinc for barley computed as 37.59 kg $ZnSO_4$ ha^{-1} with corresponding optimum yield of 4365.61 kg ha^{-1}. It was found that application of FYM and zinc significantly and economically (Rr. 44180/- ha^{-1}) increases barley yield in comparison to their costs.

Minimum soil disturbances for attaining good soil health

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Abstract

Soil degradation, characterized by a decline in quality and reduction in ecosystem goods and services. Soil degradation is a major constraint to achieve the specified increase in agricultural production. The major soil degradation processes are accelerated erosion, depletion of the soil organic carbon (SOC) pool and loss in biodiversity, and loss of soil fertility. Soil degradation trends are often reversed by conversion to restorative land use and the adoption of recommended management practices. Maintaining soil health is one of the major strategies for reducing soil degradation. The strategies for improving your soil's health are 1.Practice No-Tillage/Strip-Tillage: Reducing tillage to either no-till or strip-till minimizes disruptions to soil aggregates by not breaking them up continuously and forcing the system. Minimal tillage maintains natural aggregates and helps prevent loose soil particles from washing or blowing away easily. Residue decomposes more slowly under a reduced tillage and soil temperatures slightly cooler. Lower temperatures help organic matter accumulate, which helps in organism diversity and activity. By continuously applying minimum tillage for 4 years in a crop rotation(corn-soybean – wheat – potato/rape) shown an improvement in physical, hydro-physical, and biological properties of soil was observed, together with the rebuilt of structure and increase of water permeability of the soil. 2. Cover crop roots improve soil aggregation capacity and reduce erosion. Cover crop residue also reduces the impact of raindrops on the soil surface and is a habitat and food source for soil microbes. As organisms decompose the residue, nutrients are released back into the soil. 3. Organic matter, a key soil health component, can increase over an extended period as the residue is added back to the system. Combining no-till and canopy crops may be a good way to stay your soil covered, minimize disturbance, maximize living root growth, and maximize plant diversity. Cover crops also can help manage nutrients within the field by scavenging nitrogen from the soil during typically fallow months. The strategy is to attenuate erosion, create positive SOC and N budgets, and enhance activity and species diversity of soil biota (micro, meso, and macro), and improve structural stability and pore geometry. Improving soil quality can reduce risks of soil degradation (physical, chemical, biological, and ecological) while improving the environment. Site-specific techniques of restoring soil quality include conservation agriculture, integrated nutrient management, continuous vegetative cover like residue mulch and canopy cropping, and controlled grazing at appropriate stocking rates. The strategy is to supply "more from less" by reducing losses and increasing soil, water, and nutrient use efficiency. The ultimate goal should be to adopt a holistic and integrated approach to soil resource management.

Keywords: *Soil health, no-till, conservation agriculture etc.*

Delineation of available Sulphur and Micronutrient status in soils of district Allahabad, Uttar Pradesh

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Abstract

GPS based Six hundred forty eight random surface (0-15 cm) soil samples were collected from all twenty blocks, of district, Allahabad Uttar Pradesh during May and June 2017. The collected soil samples were analyzed for available S, Zn, Fe, Cu, Mn, and B. The analytical results showed that the deficiencies of these nutrients were to the extent of S 33.64 %, Zn 39.97 %, B 13.74 %, Fe 4.78 %, Cu 2.93 %, and Mn 2.93 %, in the soil samples. Significant positive correlations were found between O.C. and nutrients in the question of districts Allahabad Uttar Pradesh. Considering critical nutrient index as 1.5, none of the analyzed nutrients comes in low category. Negative correlations also observe between nutrients with pH & $CaCO_3$ except Boron which are positively correlated with $CaCO_3$.

Keywords: *GPS, micronutrient, deficiency, sulphur*

Effect of FYM, Potassium and Zinc on Yield, Quality and Uptake of Nutrients by Oat in Alluvial soil of Uttar Pradesh

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Abstract

A field experiment was conducted to evaluate the "effect of FYM, potassium and zinc on yield, quality and uptake of nutrients by oat in alluvial soil of Uttar Pradesh" at Fertilizer Research Station Uttaripura Farm, CSAUA &Tech. Kanpur during Rabi, 2018. A field experiment was laid out according to study the effect FYM 0 and 5t ha^{-1}), potassium (0, 30, 60, and 90 kg K_2O ha^{-1}) and zinc (0, 2.5, 5 and 10 kg ha^{-1}) levels on the yield quality and uptake of nutrients in forage oat (Avena sativa).The experiment was laid out in split plot design with three replications. Data revealed that the plant height, green foliage and dry matter yields and content and yield of protein increased significantly with the application of 5t FYM, 90 kg K_2O and 10 kg Zn ha^{-1} over their respective controls. Application of 5t FYM ha-1 gave 20.5 and 20.8 percent higher green foliage and dry matter yield of fodder oat over control, respectively. It also increased the uptake of nutrients by the forage crop over control. Application of 90 kg K_2O ha^{-1} was more effective in increasing plant height, green foliage and dry matter yields than those of 30 and 60 K_2O ha^{-1}. The higher green foliage (445.8q ha^{-1}) and dry matter yield (90.2q ha^{-1}) were recorded 90 K_2O ha^{-1}, which was 49.2 and 38.9 percent higher than that of control. The uptake of nutrients by the crop increased significantly up to 90 K_2O ha^{-1}. Potassium application tended to increase the content and yield of protein in oat. Application of zinc provide superior to control in terms of protein content and yield in oat. The uptake of nutrients by the crop increased significantly with zinc addition up to 10 kg Zn ha^{-1} over control. Green foliage (448.3qha^{-1}) and dry matter yields (89.7 qha^{-1}) of oat were the highest with 10 kg Zn ha^{-1}.

Keywords: *FYM, Potassium, Zinc, Yield, uptake of Nutrients, quality, oat*

Effect of long term application of FYM and nitrogen on nutrients uptake by crop and weeds

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Abstract

A long term field experiment on the use of FYM and nitrogen fertilizer was started in October, 1967 at Research Farm of Department of Soil Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana (India). The present study was conducted on this field during *Rabi* season of 2014-15. The experiment consisted a combination of two level of FYM (0, 15 t/ha) and three mode of application (*kharif*, *rabi* and both *kharif* and *rabi*) in main plots whereas, two level of nitrogen (0 and 120 kg/ha) and two weed control treatment (weed free and weedy check) in sub plot were laid out in split-plot design with three replications. Application of various mode and doses of FYM increased nitrogen, phosphorus and potassium contents and their uptake by wheat grain and straw significantly over no FYM application. Application of nitrogen was also found to increase the N status of the soil. Contents of N, P and K and their uptake by wheat were observed higher under various levels of nitrogen than no nitrogen application. The weed control measures also showed significant increase in the uptake of NPK over the weedy check treatment. As far as nutrient uptake by the weed plants is considered, nutrient content and uptake increased significantly by the addition of FYM over the control at all the stages of crop growth. Application of 120 kg N/ha was recorded with higher nutrient uptake by weed as compared to no nitrogen application. Weed control treatments also showed significant effect on NPK uptake by weeds. Higher uptake of NPK by weeds was recorded under weedy check treatment.

Keywords: *FYM, Kharif, Long term, Rabi, Weed, Wheat*

Effect of irrigation and nitrogen management on distribution of nitrate nitrogen in soil profile, plant N uptake, N use efficiencies and yield of wheat crop under zero tilled condition

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Abstract

A field experiment was conducted on wheat in two years (2015-16 & 2016-17) at research farm of the University, Pundibari (26°23'N, 89°23'E; 41 m msl), Cooch Behar, West Bengal, India. The experiment was in a split-plot design with four irrigation(I) levels includingcontrol *viz.* control or no irrigation (I_0),one irrigation at 25 DAS (I_1), two irrigations at 25 and 40 DAS (I_2), three irrigations at 25, 40 and 55 DAS (I_3) i.e. 122,263 and 386 mm; referred as I_1, I_2 and I_3 as main plot and four nitrogen (N) application rates (0,60,120, and 150 kg ha^{-1} referred as N_0, N_{60}, N_{120} and N_{150}) as sub-plot treatments and each replicated thrice. Highest mean grain yield (4.26 Mg/ha) was produced due to combined influence of I_2 (263mm) and N_2 (60 kg/ha); maximum plant N uptake (153.46 kg/ha), however, was observed by highest level of irrigation and N (I_3N_3) and it was almost similar (151.35 kg/ha) to that by I_2N_3. Concentration of NO_3^--N at lower soil depth (60-90 cm) appeared to be the least (1.06 mg/kg) by highest irrigation and lowest N level (I_3N_1) and it was statistically at per with I_2N_3 (1.07 mg/kg) and I_3N_3 (1.09 mg/kg). Across N levels, irrigation at I_3 level (386 mm) recorded to maintain highest mean water reserve (43.53 cm) in soil profile. Based on 2-year results, 263mm irrigation water and N @120kg/ha, among all combinations, was superior with respect to grain yield, nitrogen use efficiencies (NUEs), NO_3^--N leaching beyond the root zone and to maintain higher water reserve in soil profile after the harvest of wheat crop.

Keywords: Irrigation, N rates, NUEs, yield, Water storage, Soil profile.

Nutrient Indexing for Forecasting Emerging Deficiencies of Micro and Secondary Nutrients in Sorghum-Wheat based Cropping System

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Abstract

A survey work was carried out by All India Coordinated Research Project on Micro and Secondary Nutrients and Pollutant Elements in Soils and Plants, Department of Soil Science and Agricultural Chemistry, Dr. PanjabraoDeshmukhKrishiVidyapeeth, Akola, Maharashtraduring 2009-10 to 2018-19 to fix the thirty bench mark sites on farmers' field growing predominantly sorghum-wheat crops regularly in Aurangabad district (AER 6.2) to forecast the emerging nutrient deficiencies, assess the periodic changes in soil and crop nutrient status. The latitude, longitude and altitude of each site were recorded using GPS to fix each bench mark site.The bench mark sites were fixed in Naigaon, Daregaon-Fulumbri villages in Aurangabad district. During kharif sorghum crop and in Rabi wheat crop are predominantly grown in these villages. Every third year *i.e.*2009-10, 2012-13, 2015-16 and 2018-19 assessment was done to know the status of micro and secondary nutrients and yield of sorghum and wheat from the same sites. The georeferenced surface soil samples were collected from bench mark sites. Micronutrients (Zn, Fe, Mn and Cu) and sulphur were recorded higher in the surface horizon and decreased with the depth of soil. Sulphur and zinc were found marginal at both the locations.

Keywords: *Nutrient indexing, sorghum-wheat*

Role of biochar for increasing soil fertility and productivity

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Abstract

Biochar is defined as the carbonaceous product obtained when plant or animal biomass is subjected to heat treatment in an oxygen-limited environment and when applied to soil as an amendment. Biochars made from diverse biomass species (feedstock) are characterized by different morphological and chemical properties but also characteristically differ based on specific pyrolysis conditions (*i.e.*, final pyrolysis temperature or peak temperature, rate of charring or ramp rate, and duration of charring time). In the context of this article, the term biochar refers to all residual products of biomass pyrolysis excluding those that are condensates from the vapor phase. It is produced by incomplete pyrolysis of biomass, or sometimes as a co-product of pyrolysis and thus commonly occurs as a component of soil organic matter (SOM) where slash-and-burn agriculture is widely practiced, and in soils of the fire-prone ecoregions. In general, biochar may not support microbial activity due to the refractory nature of C and thus, can represent a long-term C sink in soil. However, some studies show that a small labile part of biochar is utilized by microbial processes. Biochar, a co-product of a controlled pyrolysis process, can be used as a tool for sequestering C in soil to offset greenhouse gas (GHG) emissions, and as a soil amendment. Whereas the impacts of biochar application on soil chemical properties are widely known, the research information on soil physical properties is scarce. The objectives of this review are to (i) synthesize available data on soil physical properties and GHG emissions, (ii) offer possible mechanisms related to the biochar-amended soil processes, and (iii) identify researchable priorities. Application rates of 1%–2% (w/w) of biochar can significantly improve soil physical quality in terms of bulk density (BD), and water holding capacity (WHC). Agriculture intensification, future food security and residual managements are the most urgent concerns contributing to the serious problem of climate change. To resolve these major issues, a new material has emerged known as *black gold* or biochar. Biochar being the pyrolyzed product of any biomass are highly eco-friendly which also promises utilization of agro waste for bioremediation.

Keywords: *biochar; green house gas (GHG) emissions; soil amendment; soil physical properties; soil quality*

Nutrient Management in Pigeonpea [*Cajanus cajan* (L.) Millisp.] Based Inter-cropping system under rainfed condition

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Abstract

A field experiment was conducted during *kharif* season of 2013-14 and 2014-15 at Agronomy Research Farm of Narendra Dev University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh, to study the effect of Nutrient Management in Pigeonpea [*Cajanus cajan* (L.) Millisp.] based Inter-cropping System under Rainfed condition". The treatments were comprised as three inter cropping systems (Pigeonpea sole, Pigeonpea + Blackgram and Pigeonpea + maize) and four integrated nutrient management system (N_1-RDF alone, N_2-RDF + PSB + *Rhizobium,* N_3-RDF + PSB + *Rhizobium* + FYM @ 3 t ha^{-1} and N_4-RDF+PSB+*Rhizobium*+FYM @ 3 t ha^{-1}+Harit-Vardan @ 5 kg ha^{-1}). The experiment was laid out in factorial randomized block design (Two Factors) with three replications. The varieties namely Pigeonpea (Narendra Arhar-1), Blackgram (Narendra Urd-1) and Maize (MM-1107) were sown in 4th and 12 July during 2013-14 and 2014-15 respectively. A basal dose of 20 kg N, 40 kg P_2O_5 and 0 kg K_2O for Pigeonpea and Blackgram and for maize 80 kg N 40 kg P_2O_5 and 30 kg K_2O kg ha^{-1} was furrow place at the time of sowing. Urea, DAP and MOP were applied as basal dose. On the basis of two years results, pigeonpea + black gram intercropping system recorded significantly higher pigeonpea seed yield (18.65 and 15.82 q/ha), pigeonpea equivalent yield (25.35 and 23.47 q/ha), B:C ratio (2.18 and 2.20, and also gave the total uptake of N, P, K, Zn and Fe by plant, respectively over pigeonpea sole and pigeonpea + maize intercropping system during both year. Among the INM practices, application of RDF+PSB+ Rhizobium + FYM @ 3 t/ha + 'Harit-vardan' @ 5 kg/ha recorded significantly higher pigeonpea seed yield (18.65 and 15.82 q/ha), pigeonpea equivalent yield (25.35 and 23.47 q/ha), B:C ratio (2.18 and 2.20, and total uptake of N, P, K, Zn and Fe by plant, respectively over RDF.

Effect of Organics on P fertilizer optimization in Onion crop

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Abstract

A field experiment was conducted on onion crop in a sandy clay loam soils of college farm, College of Agriculture, Rajendranagar, Hyderabad to study the response of P levels (0, 30 and 60 kg P_2O_5 ha^{-1}) either alone or in combination with PSB @ 5 kg ha-1, biochar @ 5 t ha-1, humic acid @ 20 kg ha-1 and citric acid @ 10 mM concentration to study the direct, residual and cumulative effects of the treatments imposed on onion crop(Residual and Cumulative. Among the organics, biochar application lead to a statistically significant positive effect on both biomass and yield. Biochar resulted in a significant increase in mean onion yield to 22.1 t ha^{-1} against 15.8 t ha^{-1} when organics were not supplemented, the yield response being 39.9 per cent across inorganic P and mode of effect. Biochar addition can increase crop production by improving the physical (viz., soil bulk density, and soil structure and soil porosity) and chemical properties and soil fertility via effects on the microbial community. So, biochar has the potential for reducing the N fertilizer requirement while maintaining crop yield. It has been hypothesized that long term effect of biochar on nutrient availability and uptake is due to increase in surface oxidation and CEC. Among the mode of effect (residual/cumulative), cumulative effect was found to show significant influence resulting in a mean yield of 21 t ha^{-1} which was higher by 22.1 per cent as against 17.2 t ha^{-1} due to the residual effect. Cumulative application of 50% reduced level of inorganic P (30 kg P_2O_5 ha^{-1}) along with biochar to onion, the treatment found to fare well with soybean, showed significantly higher yield than the residual effect across organics and inorganic P. Biochar application to soybean was found to be benefited more due to the cumulative application of resulting in a mean yield of 24.1 t ha^{-1} against 20.0 t ha^{-1} due to the residual effect, the yield response being 20.5 per cent. While, when organics were not applied the corresponding yields were 14.2 and 17.5 t ha^{-1} resulted by residual and cumulative effects. Biochar could hold the native and applied nutrients and supply slowly over a long period and increase the use efficiency of applied inorganic P. This might be the reason for the residual effect of biochar. While, when the short term nutritional requirements of the crop are met from the conjunctively applied 30 kg P_2O_5 ha^{-1}, the long term requirements are met from the application of biochar.

Keywords: *Biochar, Organics, Onion, Phosphorus, Yield*

Influence of Soil Test Crop Response based manure and fertilizer application on nutrient uptake and yield of Okra

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Abstract

The long term food security requires a balance between increasing crop production, maintaining soil health and environmental sustainability. Soil Test Crop Response (STCR) based integrated plant Nutrient System (IPNS) takes into account the nutrient requirement of the crops, contribution of nutrients from soil, fertilizer and organic manure in deriving fertilizer prescriptions ensuring balanced nutrition to the crop with sustained soil fertility. A field experiment was carried out with ten treatments *viz*., farmer's practice, FYM alone @ 12.5 t ha^{-1}, blanket recommendation, STCR-NPK alone @ 160, 170 and 180 q ha^{-1} and STCR-IPNS @ 160, 170 and 180 q ha^{-1} and control with three replications in bahour soil series of puducherry. The plant and fruit samples were drawn at different stages of crop growth and analyzed for various parameters. The final fruit yield was recorded and nutrient uptake was calculated. The results shown that the application of STCR+IPNS- 180 q ha^{-1} treatment could favourably improve nutrient uptake and yield of bhendi. In STCR-IPNS technology, the fertilizer doses are tailored to the requirements of specific yield levels of crop taking into account the nutrient requirement of the crop, the contribution of nutrients from soil, fertilizers and organic manures. When fertilizers are applied based on the STCR equations there is neither excess nor deficient levels of fertilizer doses. Therefore STCR forms an important innovative component for maximizing the productivity of crops. Use of integrated plant nutrient management system resulted in saving of fertilizer nutrients in bhendi crop. Target yield equations generated from STCR-IPNS technology ensures not only sustainable crop production but also sustains soil health. Practice of fertilizing crops using fertilizer prescription equations needs to be popularized among the farmers to achieve higher productivity, nutrient use efficiencies and profitability.

Keywords: *Security, STCR, IPNS, improve, sustainable, sustain*

Feasibility of customised fertilizers for nutrients availability of soil and yield of rice (*Oryza sativa* L.)

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Abstract

A field experiment was conducted to study the nutrients availability of soil and yield of rice (*Oryza Sativa* L.) as influence by various customized fertilizers at Agronomy Research Farm of ND University of Agriculture and Technology, Faizabad during *Kharif,* 2014 and 2015. The application of Soil Test Based Recommendation (N-140:P_2O_5-60: K2O-30: S-30: Zn-5: B-2 kg ha^{-1}) was found maximum plant height (cm), number of tillers m_{-}^{2} at different stages, number of grains per panicle, test weight of rice crop which was at par with (Indo Gulf) and (Tata Chemical Limited) and significantly superior over control, RDF and Farmer's' practices during both the year. Pooled data of two year grain and straw yield of rice and nutrients availability of nitrogen, phosphorus, potassium, sulphur, zinc and boron in soil were recorded highest in T_3 (Soil test based recommendation) treatments which was significantly superior over the control, RDF and Farmers' practices and statically at par with Vardan (Indo gulf) and Paras (TCL). The highest net return (Rs.32204 and Rs.34968 ha^{-1}) and B:C (0.74 and 0.84) during 2014 and 2015, respectively were also obtained due to application of soil test based recommendation which was followed by application of Indo Gulf- Customized Fertilizers- Vardan and TCL- Customized fertilizers- Paras.

Soil phosphorus fractions as influenced by crop residue retention and phosphorus fertilization under maize-wheat cropping system

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Abstract

In most of the soils, phosphorus concentration and solubility is very low due to its reactive nature with different soil components, which results in low efficacy of P fertilizers. In current scenario, crop residue (CR) retention is one of the viable options for improving soil properties as well as soil microbial community, which in turn plays an important role in soil P transformation. Thus the present study was carried out to see the impact of crop residue retention and phosphorus fertilization rate on phosphorus transformation under Maize-Wheat cropping system in an Inceptisol of semi-arid subtropical region of India. Soil samples were collected at tasseling stage of maize (Sept., 2015) from the ongoing conservation agriculture based field experiment at IARI, New Delhi. The experiment was laid out in split plot design, in which crop residue (CR) retention with different rates, *viz.* No-CR, 25% CR, 50% CR, 75% CR constituted as main plot treatments, and phosphorus fertilization rates *i.e.* No-P, 50% RDP, 100% RDP, 150% RDP and 50% RDP + PSB & AM constituted sub plot treatments. Soil samples were analyzed for different P fractions. Results indicated that P released from crop residue was recovered as the organic–P fraction. The Al-bound P, Fe-bound P, Ca-bound P and reductant soluble-P fraction in surface soil decreased from 30.3 to 27.3 mg kg^{-1}, 44.7 to 31.3 mg kg^{-1}, 303 to 270 mg kg^{-1}, 121 to 110 mg kg^{-1}, respectively with increase in crop residue retention. Only soluble & loosely-bound P was increased from 6.11 to 7.64 mg kg^{-1} with increasing rate of crop residue retention. The crop residue retention rate decreased total inorganic P significantly from 468 (No-CR) to 404 mg kg^{-1} (75% CR) in surface soil and increased organic P from 32 to 42%. Phosphorus fertilization rate increased the soluble and loosely-bound P, Al-bound P, Fe-bound P, Ca-bound P and reductant soluble-P fraction from 5.24 to 8.35 mg kg^{-1}, 23.1 to 33.5 mg kg^{-1}, 31.5 to 41.3 mg kg^{-1}, 231 to 335 mg kg^{-1}, 104 to 130 mg kg^{-1}, respectively. Addition of P through inorganic fertilization improved Ca-P from 30% (No-P) to 38% (50% RDP + PSB & AM), decreased organic-P from 44% (No-P) to 38% (150% RDP and 50% RDP + PSB & AM) and other fractions remained unaffected in 0-15 cm of soil. In conclusion, application of 50% RDP + PSB & AM in combination with 50 or 75% CR was found most beneficial in terms of improving the available fraction of phosphorus. Cumulative effects of repeated cropping cycles where high crop residues (more than 50%) are returned to soil may lead to a significant accumulation of organically-cycled P and reduced requirement for fertilizer P inputs by maintaining or improving functional capacity of soils. Microbial inoculation can mobilise P from bound pools to easily available pools.

Keywords: Phosphorus fractions, crop residue, arbuscular mycorrhiza

Effect of Long Term Fertilization on Nutrient Availability in Irrigated Soybean-Wheat Cropping System

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Abstract

In present study, primary and micronutrient availability was assessedin 22-year-old long-term fertilizer experiment started in 1995-96 with irrigated soybean-wheat cropping system (SWCS). Soil samples were collected after wheat harvesting in 2019 and analysed for nutrient availability in soils under various treatments. The data revealed that highest nitrogen (N) content was recorded in N+FYM (527 kg ha^{-1}) followed by NPK+NPK (515kg ha^{-1}) and NPK+FYM (502kg ha^{-1}) and lowest in control (459kg ha^{-1}). While soil phosphorus and potassium content was found highest in NPK+NPK followed by NPK+FYM and FYM and lowest in only N receiving plots. The DTPA-extractable Zn, Cu, Fe and Mn content,under various nutrient supply options in irrigated wheat-soybean system conditions, were ranged from 0.66 to 0.95, 0.65 to 1.07, 33 to 53 and 30 to 43 mg kg^{-1}, respectively.Long term application of organic manure (FYM) as alone or along with chemical fertilizers (NPK) maintained the primary and micronutrients content while continuous application of chemical fertilizers (N and NPK) and control treatment reduced the nutrient availabilty significantly in comparison to combined application of organic and chemical fertilizers (NPK+FYM and N+FYM).

Crop Residues a boom for effective Soil Nutrient Management

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Abstract

Soil is a very important factor of the plant growth and crop yield. But now a days, very small area of the soil can actually be fertile for agriculture, and if we manage improperly it can be depleted. So the big problem, how we manage and increase the fertility of soil. It has been reported that soil organic carbon and soil organic matter is the most important indicator of soil quality and soil health. It is also beneficial for agricultural sustainability. In this paper, we summarized how crop residue management affects soil chemical parameters. Proper use of crop residue can increase or maintain the physical and chemical properties of SOM and improve the quality of soil. Although, crop residue alone may not be adequate to maintain SOC levels as well as fertility levels of soil. There are several positive effects of retaining crop residues on soil quality, soil organic matter and carbon storage, soil moisture retention, enhanced nutrient cycling, and decreased soil loss, among other environmental and soil health benefits. Negative effects of crop residue retention attributed to nitrogen immobilization, water logging, decreased soil temperature and attack of termites. The incorporation of crop residue can save and substitute inorganic potassic fertilizer up to some extent and it also improve soil health.

Keywords: Crop residues, Soil nutrients, Soil organic carbon, Soil pH

Land uses affect the soil carbon stocks and metabolic quotient in alfisol ecosystem altering soil health and environmental sustainability

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Abstract

Existing ecosystems are under increasing pressure of land-use changes, strongly disturbing the carbon cycle. Conversion from forestland to other land uses is often accompanied by a decrease in the soil carbon stocks as well as changes in microbial activity and litter decomposition.Subtropical alfisol ecosystem of Eastern India was used to investigate impacts of land-use changes on soil carbon stocks as well as the metabolic quotient in surface soil and subsurface soil. Four land uses namely forest, cultivated, orchards and grazing lands were investigated in two soil depths 0-15 cm and 15-30 cm. Organic carbon in the cultivated land was found to be lower by 47, 23 & 13, and 37, 12 & 12 per cent, as compared with the forests, orchards and grazing lands of the surface and sub surface soils, in the same order. Land management resulted in decrease of cumulative soil carbon stocks by 14.4 per cent compared to forest land whereas orchard and grazing land showed 12.3 and 12.9 per cent decline in cumulative soil carbon stocks and caused increase in carbon dioxide equivalent emissions from the land uses than forest land. In addition, cultivated land was characterized by low microbial carbon: soil organic carbon ratio at both soil depths, indicating a decline in available substrate. Similarly, low metabolic quotient was found in orchards and grazing lands compared to forestland. In surface soil, carbon management index values for grazing, cultivated and orchards were 93, 83 & 95 and 95, 92 and 96 per cent, in the same order for grazing, cultivated and orchards in surface and sub-surface soil as compared to forest land at respective depth. Overall, soil carbon stock and metabolic quotient was found to decline on conversion of forest land to other land uses in the region. This is an alarming situation and requires managing cultivated soils properly; otherwise soil quality and microbial activity will deteriorate and in turn will affect crop productivity in the region over the long run.

Keywords: *Soil Organic Carbon, Microbial Biomass Carbon, Carbon Management Index, Forest Land, Cultivated Land, Soil Quality*

Field validation of soil test crop response based fertilizer recommendations for targeted yields of onion in red soils

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Abstract

A field experiment was conducted to validate the Soil test crop response equation developed for prescribing fertilizer doses of onion in red soils of ARS, Utukur Kadapa district of Andhra Pradesh state. It comprised of four treatments namely farmers practice (FP), General or Recommended dose of fertilizers (RDF), STCR recommendations for 200 qha^{-1} with fertilizers alone and STCR recommendations for target yield of 200 qha^{-1} + vermicompost 2tha^{-1}(IPNS). The fertilizer doses applied in different treatments are about 250-100-40 kg NPK/ha - Farmers practice, 200-80-60 kg NPK/ha - General or Recommended dose of fertilizers, 140-50-40 kg NPK /ha- STCR only chemical fertilizer dose, 135-47-36 kg NPK /ha - STCR IPNS treatment. The experimental results indicated that, the highest bulb yield of 187 q ha^{-1} was obtained at target yield of 200 q ha^{-1} was under STCR-IPNS treatment followed by STCR chemical fertilizers alone (176 q ha^{-1}). The achievement of yield was 93 percent at 200 q ha^{-1} yield target with IPNS and 88 percent with chemical fertilizers alone. The saving of fertilizer was about 60-30-20 kg NPK/ha with only chemical fertilizers and 65-33-24 kg NPK/ha under IPNS with STCR approach in comparison with recommended dose of fertilizers (RDF). The amount fertilizer saved with STCR approach over Farmers practice was 110-50-0 kg NPK/ha with only Chemical Fertilizers and 115-53-4 kg NPK/ha with IPNS, respectively.

Keywords: *Field validation, Target yield, onion*

Effect of nitrogen and zinc management on growth, yield and economics of bread wheat (*Triticuma estivum*) varieties

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Abstract

Field experiments were conducted during *Rabi* season of 2016-17 and 2017-18 at Udaipur (Rajasthan) to studythe effect of nitrogen and zinc management on growth, yield and economics of different wheat varieties. The treatments consist of four wheat varieties, *viz.* Raj 4120, Raj 4037, Raj 4079 and Raj 4238 in main plots and seven nutrient management treatments *viz.*100% RDN, 100% RDN + $ZnSO_4$ 25 kg/ha soil application, 100% RDN + $ZnSO_4$ 0.5% foliar spray, 100% RDN + $ZnSO_4$ 25 kg/ha soil application + $ZnSO_4$ 0.5% foliar spray, 125% RDN + $ZnSO_4$ 25 kg/ha soil application, 125% RDN + $ZnSO_4$ 0.5% foliar spray and 125% RDN + $ZnSO_4$ 25 kg/ha soil application + $ZnSO_4$ 0.5% foliar spray in sub plots. The study of different wheat varieties indicated that highest values of growth parameters; yield attributes; yield *viz.* grain (5707 kg/ha), straw (8869 kg/ha) and biological (14576 kg/ha) yield; and net returns (86255/ha) and B:C ratio (2.36) was recorded with wheat variety Raj 4037. Further, application of treatment 125% RDN + $ZnSO_4$ 25 kg/ha soil application + $ZnSO_4$ 0.5% foliar sprayrecorded significantly higher values of growth parameters; yield attributes; yields *viz.* grain (5681 kg/ha), straw (8265 kg/ha) and biological (13946 kg/ha) yield; and net returns (Rs 83230/ha).

Effect of Organic Sources of Nutrients in Yield, Soil Health and Economics of Vegetable Crop for maintaining Sustainable Agriculture in Ri-Bhoi District of Meghalaya, North-east India

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Abstract

Agriculture is the backbone of poverty reduction as well as socio-economic development of Northeast India. But the application of organic as well as inorganic fertilizer has been very limited among the Farmers of RiBhoi District of Meghalaya. The farmers get lower yield due to improper fertility management. Due to mono-cropping as well as imbalance fertilizer application to the crop field, soils are also deteriorated day by day in some cases. A Front Line Demonstration was conducted at the farmers' field to demonstrate the integrated nutrient management for tomato crop for maintaining the soil health, reducing the rate of chemical fertilizer and to increase the yield of tomato. The demonstration was conducted at ten different farmers' field of RiBhoi District of Meghalaya during the year 2015-16 and 2016-17. The area under each demonstration was 0.4 ha. The treatment comprise of Azotobacter and PSB 2 kg each by root dip treatment + vermicompost @ 2.0 t/ha along with 50% recommended dose of chemical fertilizer and Azotobacter +PSB @ 2kg each + 30 kg cow dung in 5 liter water/ha by root dip treatment for 30 min and the Farmers' practice. The results of the FLD revealed that the application of Azotobacter and PSB 2 kg each by root dip treatment + vermicompost @ 2.0 t/ha along with 50% recommended dose of chemical fertilizer had given significantly higher yield i.e. 241 q/ ha and B.C ratio of 1.71 followed by Azotobacter +PSB @ 2kg each + 30 kg cow dung in 5 liter water/ha by root dip treatment for 30 min (204 q/ha yield, B.C ratio 1.52) and the farmers practice (168 q/ha yield, B.C ratio 1.29). Moreover, soil health was also improved with the increased amount of soil nutrients at the time of harvesting as compared to farmers practice.

Keywords: *FLD, Tomato, soil health, organic farming, sustainable agriculture.*

Enhancing Nitrogen use efficiency through different tools and techniques

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Abstract

In the post green revolution era, fertilizer acts as a vital input to agricultural system which is essential for food production. During 2019, NPK consumption was reported to be 133.12 kg ha^{-1} and crops like wheat, rice, cotton, sugarcane, and mustard and rapeseed accounts for more than two-thirds of total fertilizer consumption in India. Nitrogen is a major plant nutrient which provides tremendous benefits to the plants, encouraging healthy tissue development while projecting higher output. Nitrogenous fertilizers have an axial role in increasing sustainability and productivity of food grains. Improving nitrogen uptake and utilization efficiency in plants could be a reassuring strategy for escalating crop productivity while optimizing use of nitrogen. Despite increased nitrogen input in the last few decades in crop production, the NUE is very low ranging between 30-40 % due to the rapid loss through ammonia volatilization, denitrification, nitrate leaching, surface runoff or temporary unavailability due to immobilization impacting yield potential and return on capital employed, leading to nitrate accumulation in ground water, soil acidification, eutrofication and other related environmental problems. Lack of synchronization between nutrient demand by crop and soil nutrient supply results in poor nutrient use efficiency. To ensure food security for the burgeoning population there is an urgent need to adopt combined approaches and best management practices (BMPs) which would help in precise nitrogen use as per agronomic needs. Modern and sensor based techniques (chlorophyll meter, green seeker, slow release nitrogenous fertilizers, nitrification inhibitors, optical sensor, leaf color chart, satellite imagery etc.) has been found promising for this purpose over conventional methodsto a considerable extent. After this soil type, physical and chemical properties of soil, cropping system, tillage practices, fertilizer characteristics and 4R nutrient stewardship framework viz. right source, right rate, right time and right place has its own importance in increasing NUE. Soil and tissue testing and several agronomic indices i.e. agronomic efficiency, physiological efficiency, apparent recovery efficiency, apparent N recovery and partial factor productivity measures nitrogen use efficiency. Thus, there is a need to use balanced fertilization to meet the crop nutrient requirement, to create a healthy and sustainable ecosystem which is economical and of great importance to farmers and agrarian society, sooner or later in the future.

Keywords: *Efficiency, Food, Management, Nitrogen, Production, Sustainable.*

Integrated Plant Nutrient Management for Sustainable Agriculture

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Abstract

Integrated plant nutrient supply involves monitoring all the path ways of plant nutrient supply in crops and cropping systems and calls for judicious combination of fertilizer, bio-fertilizer and organic manures. Organic sources of plan nutrients including growing of legumes in cropping systems, green manures, crop residues, organic manures (FYM, compost, Vermi compost, biogas slurry, phosphor compost, bio compost, press mud, cakes etc) and bio-fertilizers. The available information has shown that by addition of organic manures in addition of fertilizers (add-on series) good crop yields were sustained over long periods as compared to a decline in crop yields when only fertilizers were applied, especially when N alone was applied. The data from replacement series of trials shown that in most cropping systems specially in rice wheat, rice wheat sugarcane systems application on 50% N through green manures, FYM or crop residues or 50% recommended dose of fertilizer (RDF) (NPK) to Kharif rice and 100% recommended dose of fertilizer to Rabi crop (wheat) gave the same yield as obtained with 100% recommended dose of fertilizer of Kharif and Rabi crops (rice/wheat). These results show that 25% NPK applied to the cropping system can be saved. Further addition of organic manures both in add-on and replacement series always improved chemical, physical and biological properties of soils. As regards bio-fertilizers usefulness of rhizobial inoculation of pulses and leguminous oilseeds (soya bean, groundnut) along with recommended dose of fertilizer (NPK) has been proved beyond doubt. Rhizobial inoculation helps not only in increasing crop yields but also increasing the amount of an left after succeeding crops use of cultures of PSO's [phosphate solubilising bacteria (PSB) and phosphate solubilising fungi (PSF)] can help in making native soil P as well as rock phosphate P move available to crops. It's benefits are seen even with DAP or SSP. Azotobacter and Azospirillum cultures can be usefully utilized under dry land agriculture, where N applications are much less than under irrigation. An all out effort is needed to take these useful research findings on IPNS to the farmers. From the environmental view point IPNS can reduce the nutrient load on soil.

Keywords: *Phosphocompost, FYM, Biofertilizer, Azospirillum, Azotobacter, Biological Properties, Crop – residue, Soil Moisture, pH, Press mud Cake, Biogas Slurry, Azolla, Blue green algae. Rhizobium*

Soil organic carbon stocks under various temperature and moisture regimes as an indicator of climate change

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Abstract

The present investigation is a targeted review of available literature in public domain to explore the potential of monitoring soil carbon stocks as indicator of climate change. Soil organic carbon (SOC) is an essential factor for enhancing soil quality, sustaining and improving food production, maintaining clean water and reducing carbon dioxide in the atmosphere. Temperature and moisture are among the most important factors that affect the extent of carbon stocks present in the soils and vegetation. Globally, the prevailing soil moisture and temperature regimes are ice, permafrost, aridic, xeric, ustic & udic and pergelic, cryic, mesic, thermic & hyperthermic respectively. Soil temperature and moisture directly affect the water and nutrient uptake by plants which indirectly affect the plant growth. World's mineral soils are a large reservoir of carbon with estimate of carbon stock ranging from 1115 to 2200 Pg in a meter of soil profile. It has been observed that the soil organic carbon stocks, soil moisture and active layer of thickness correlate strongly in discontinuous permafrost regions; while on the other hand, no correlation is found between soil organic carbon stocks and active layer thickness in continuous permafrost regions. Soil organic carbon increases with increased mean annual precipitation in mesic regime. Soil carbon content decreases with increasing in the depth. Soil organic carbon content varies significantly in accordance with various soil temperature and moisture regimes. High amount of soil organic carbon in combination with soil temperature and moisture regime is found in cryic-udic regime and minimum in thermic-xeric regime. An increase or decrease in soil temperature affects soil organic carbon and its mineralization which directly or indirectly affects the crop production. Hence, a periodic assessment of carbon stocks may establish a trend to indicate the effect of changing land use and management scenarios as well as of changing climates with long term similar land use and management.

Keywords: *Soil carbon stocks, temperate regimes, soil quality, climate change*

Jasmonate and Zinc: A booming tools in Plant defense mechanisms

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Abstract

Plant defense responses may involve the activation of certain phytohormones in small amounts which ultimately acts as key signaling compounds in biotic and abiotic stresses. The exogenous application of these phytohormones in significant amounts may up-regulates the plant defense machinery against stresses moreover, the exhausted nutrient application in plants may results in additive responses. The potential roles of novel phytohormones like Jasmonates (JA) and micronutrient Zinc (Zn) in plant defense responses had been considered so far and copious investigation is going on in finding the impending role of jasmonates and Zn in abiotic and biotic stresses. Jasmonates, the oxidized lipids are important cellular regulators involved in diverse developmental processes, such as seed germination, root growth, fertility, fruit ripening, and senescence and may trigger a transcriptional reprogramming that allows cells to cope with pathogens and stress. In addition, plant responses to Zn nutrition have been widely studied. Zn deficiency induces oxidative stress in plants by affecting both generation and detoxification of O_2 free radicals. Based on these prolific roles of jasmonates and Zn in different sectors of agriculture, we summarize recent advances and give an updated overview of JA and Zn researches in plant growth and development in this article.

Keywords: *Phytohormones, Jasmonates and its derivatives, Zinc and its role in plant defense, Zinc crosstalk*

Climate Smart Agriculture: Making Agriculture Smart to Combat Climate Change

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Abstract

The population of the world is increasing day by day and due to degradation of natural resources and increasing impact of climate change on agriculture is a serious concern. Climate change negatively affects stability of production and productivity, income of the farmers and food security. Therefore, climate smart agriculture technologies can help in achieving optimum production under this situation of changing climate. It has been estimated that production should be enhanced by 65% in order to meet the demand of increasing population by 2050. The prominent source as well as sink for greenhouse gases is agricultural activities. So, there is a need to adopt climate smart technologies in order to achieve food security as well as environmental sustainability. These technologies by adaptation and mitigation strategies helps the agricultural system to resist damage and recover quickly. Mitigation strategies helps in reduction of emission of greenhouse gases, and adaptation strategies provide optimum production under climate changing situation. This chapter explains different practices or strategies to deal with changing climatic scenario.

Keywords: *Climate change, Green house gases, Food security.*

Soil Fertility Management in various ecological belts of Nepal

Shree Prasad Vista

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Abstract

Nepal have been a food sufficient country till eighties but with increase in population, it has been a major cereal importer. Declining in soil fertility has been a major constraint for higher crop production and hence soil fertility management has been a challenge. The practice of soil fertility management varies with the physiography and ecology. The country is divided into five physiographic regions: Terai, Siwalik, Middle mountain, High Mountain and High Himalayas with only three ecological belts Terai, Hills and Mountains. Terai, the plain is mainly dependent on chemical fertilizers and the hilly regions are mostly organic dependent, chemical fertilizer is considered as supplement in high hills. The cropping system also determines the use of various sources of nutrients. Application of farm yard manure or compost is predominant in hills whereas in terai, chemical fertilizer is the main source of nutrients. Unfortunately, Nepal do not have chemical fertilizer plant and the demand for fertilizer is never met, therefore, integrated nutrient management is mostly prevalent. The government policy in recent years too favors organic farming and hence, farmers started using vermicompost, cattle urine, crop residues, etc. in general and in some areas, they use green manures, biofertilizers, biogas slurry and even commercial organic fertilizers. In hilly and mountainous region, integration of legumes is a common practice for soil fertility management. However, the soils in sloppy hills are facing a threat of erosion, acidification and constant nutrient losses. Therefore, a sustainable approach for managing soil fertility is the need of the day.

Effect of sediment particle orientation on incipient motion

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Abstract

The high rate of sediment outflow from catchments is a serious cause of concern for soil conservationists and environmentalists worldwide. When we study sediment transport first question arises in our mind is when sediment initiated to move, how it move and at what velocity. The Knowledge of the hydraulic conditions at which sediment particles of a given characteristics just start moving (The condition of incipient motion) of considerable importance to hydraulic engineers. These conditions are associated with the equilibrium of various forces acting on individual particles. These forces dependent on number of variables including discharge, channel bottom slope, specific weight and shape & size of the sediment particle. In natural conditions where sediment particles are irregular in shape, the orientation or placement of these particles over the bed will play an important role in their initiation. The critical shear stress will change, with the change of orientation of particle because of the total hydrodynamic force being experienced by the particle for the given flow will change. The study was carried out in laboratory with objectives to determine hydraulic condition at incipient motion for different orientations of solitary particles of non-spherical and non-cubical shapes with different sizes using various combinations of channel slope and discharge. The magnitude of shear force, in general, was found to be increasing with discharge for a particular orientation. However, it was observed that for a given discharge by changing orientation of a particle, the exposed area facing the flow and base area changed and so the critical shear stress changed accordingly. Mathematical relationships and graphical representation for critical shear stress being experienced by the sediment particle for various combinations of variables were also developed.

Keywords: *Sediment transport, Particle orientation, incipient motion, Critical Shear Stress, Particle Size*

Effect of Agriculture on Water Pollution

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Abstract

Agriculture is the largest users of fresh water resources, and nearly 70% of surface water is used in agriculture. To meet the food requirement of United Nations' predictions of global population by the year 2025, an additional 40-45% food production is required. To achieve this goal, agricultural intensification is required. Irrigated agriculture, which presently covers 17% of world agricultural land but yields only 36% of the world's food, is a vital strategy to escalate the global food production. Agricultural intensification and irrigated agriculture causes water pollution through the nutrients release (because of soil management and fertiliser use) and other chemicals (e.g. pesticides) into the aquatic environment, through biological contamination (like microbes present in farm yard manure) and by soil being eroded and washed off agricultural land. Agricultural pollution are of two types namely point source (e.g. slurry store) or non- point or diffuse source (e.g. run off from larger areas of agricultural land). Surface and ground water pollution in an area is mostly due to improper agricultural management practices. These include excessive use of fertilizers for high yields, flooded irrigation method, indiscriminate use of pesticides and herbicides and poorly managed livestock activities. The water quality degrade in terms of nitrate, phosphorus, pesticide, soil sediment, salt, and pathogen pollution of water from crop and livestock activities. Augmented nutrient piling from animal waste leads to eutrophication of water bodies which may ultimately damage aquatic ecosystems. Suitable management practices are required for controlling the water pollution from agriculture. Use of optimum dose of fertilizer helps in reducing water pollution. Use of minimum dose of phosphatic fertilizer can reduce eutrophication. Use of slow release nitrogenous fertilizer can reduce water pollution. Check dam or culverts can be used to filter the runoff and protection from sedimentation.

Effect of conservation agriculture on soil physical properties of soil

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Abstract

Conservation Agriculture (CA) is such an innovative resource-saving agricultural production system that aims to accomplish production intensification and high yields while enhancing the natural resource base and improving soil physical, chemical and biological health. To compare between conventional and conservation agricultural practices, an experiment was conducted in maize-wheat cropping system under the maize crop on *kharif* 2019 at Indian Agricultural Research Institute (IARI), New Delhi. The experimental treatments consisted of conventional tillage (CT), permanent narrow bed (PNB) (one row of Maize per 40 cm wide bed and 30 cm wide-furrow), permanent broad bed (PBB) (two rows of maize per 110 cm wide bed and 30 cm wide-furrow), PBB along with crop residue (PBB+R), and PNB along with crop residue (PNB+R) since 2010. From 2012 onwards, another two treatments zero tillage (ZT) and ZT with residue retention of previous crops (ZT+R)) were added. There were 1.5 m wide gaps between the plots and each plot. The mean bulk density (BD) for all the CA treatments in 0-5 cm soil depth was 1.45 g/cm^3 where as in CT it was 1.47 g/cm^3 the lowest BD was observed in PBB+R it may be due to better retention of residue, similar trend also followed in 5-15 cm soil depth. The average hydraulic conductivity in CA based treatments was 64.06 cm/day whereas in CT 60.50 cm/day for 0-15 cm soil depth. The aggregate stability in terms of Mean Weight Diameter (MWD) it was observed that in CA based treatments the MWD was 15.34% and 11.07% higher in 0-5 cm and 5-15 cm soil depth respectively than CT based treatments. The total organic carbon stock for 0-45 cm soil depth was 36.97 Mg/ha where as in CA based treatments was 44.63 Mg/ha the highest carbon stock was observed in PBB+R was 47.14 Mg/ha. In CA system, stubble of previous crop is left on the surface soil, indicating much lower stubble decomposition rate and thus, protecting of the soil surface from raindrop and wind action. These factors are possibly very useful in achieving higher SOC content in 0-15 cm soil layer of CA plots. CA practices help in improving the soil health parameters and increasing the sustainability of the agriculture system and better organic carbon in soil hence it helps in resource conservation.

Factors affecting infiltration and its management strategies

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Abstract

Soil is a reservoir that stores water for plant growth. The water in soil is replenished by infiltration which is the soil's ability to allow water movement into and through the soil profile. It allows the soil to temporarily store water, making it available for uptake by plants and soil organisms and it can be restricted as a result of improper management. Poor management of infiltration impedes vertical water movement by reducing pore space and size and results in either down slope runoff or ponding on upland soils where it is lost to evaporation. Runoff that can cause erosion occurs when rainfall intensity exceeds the infiltration capacity of the soil which is a measure of the ability of the soil to absorb and transmit rain water. Erosion results in the decline of soil fertility as a result of loss of topsoil and nutrients, loss of organic matter and clay and the consequent loss of the soil's capacity to retain nutrients and water. It can also result in the compaction and sealing of soil surface giving lower infiltration rates and increased runoff. The soil and vegetation properties that currently limit infiltration and the potential for increasing the infiltration rate must be considered in any management plan. The management strategies include some soil management and agronomic cultural practices that are normally the companion of profitable agriculture such as appropriate land use and preparation, fertility maintenance, crop residue management, the use of cover crops and appropriate crop husbandry, be considered.

Keywords: *Infiltration, runoff, erosion, vegetation, cover crop.*

Assessment of right source of nitrogen for calcareous soil under hybrid rice-wheat cropping system with Nutrient Expert

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Abstract

The sources of added nitrogenous fertilizers play an important role in regulating N transformations, changing N loss patterns and influencing nitrogen use efficiency (NUE). Nutrient Expert (NE), a new freely accessible nutrient decision support system based on principles of site specific nutrient management (SSNM), offers solutions for providing field specific fertilizer recommendations to improve yield and economics of rice-wheat growing farmers in the region. Thus, a field experiment was conducted at Experimental Farm of RPCAU, Pusa during 2016-18 in hybrid rice-wheat cropping system to evaluate the efficiency of N sources. Nine treatment combinations *viz.* **T_1 –** 100%N through prilled urea (PU), **T_2 –** 100% N through neem-coated urea (NCU), **T_3 –** basal N through ammonium sulphate and rest N top dressed with NCU, **T_4 –** basal N through Calcium Nitrate and rest N top dressed with NCU, **T_5 –** basal N through Di-ammonium phosphate and rest N top dressed with NCU, **T_6 –** 100% N through S- coated prilled urea, **T_7 –** 100% N through S-coated neem coated urea, **T_8 –** control (without N), **T_9 –** unfertilized (without NPK) were taken with three replications in randomized block design. The two years mean grain yield of hybrid rice and wheat was found to vary from 3.14 to 6.65, 1.53 to 4.45 t/ha and 4.39 to 6.42 q/ha in unfertilized and the treatment with the S-coated prilled urea, respectively. The rice and wheat grain yield increased significantly in the entire treated plot with different N sources over control and N omitted plot. The changes in available N in post harvest soil were not significant. In general the available N content was found to decrease in PU, NCU, AS, DAP, unfertilized and N omitted plot, while a slight improvement in its availability was recorded under CN, S-PU and S-NCU treated plot. The improvement in available N was recorded maximum under S-NCU treated plot that might be due to decrease in loss of N either by leaching or volatilization.

Effect of plantation on soil carbon stock and heavy metals in mined out forest area of Talcher, Odisha

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Abstract

A detail soil study was conducted at Talcher, Angul district of Odisha to know the effect of some dominant forest species like Eucalyptus, Teak and Sal on soil carbon stock and quantity of heavy and toxic elements in soil. Soil samples from genetic horizons were collected, processed and analyzed for soil organic carbon, other soil properties including heavy and toxic elements. From the above study, it was revealed that, the colour of soil varied from light olive brown to red with angular blocky to blocky structure. The bulk density varied from 1.47-1.72Mg/m^3 and pore space from 34-43%. The soils were light textured dominated by sand ranging 63.4-80.4% followed by silt ranging 11.4-22.4% whereas clay varied from 5.2% to 16.2%. Sand content decreased along the depth whereas silt and clay showed reverse trend. The soils were acidic to neutral and pH ranging 5.58-8.01 and increases with increasing depth. The soil organic carbon content varied from 1.8-9.5g/kg and showed a decreasing trend in below horizons. Similarly the cation exchange capacity value increased with low to medium with increasing depth ranging from 4.6 to 8.6 cmol (p$^+$)/kg. The available nutrient status of soils of Talcher for nitrogen was low varied from 36.5-256 kg/ha. The available phosphorus for different soils were from medium to low, available potassium was high to medium. The heavy metals like chromium, cadmium and lead ranged 0.028-0.074mg/kg, 0.036-0.0929 mg/kg and 1.924-3.438 mg/kg respectively. Toxic elements like Nickel, Zinc and copper ranged 0.38-2.35mg/kg, 1.278-1.886mg/kg and 1.286-1.976mg/kg respectively. It can be concluded that plantation helped in increasing the soil organic carbon, improve the physical, chemical and morphological properties of soil, upgraded the fertility status and reduced the heavy metal hazards. Eucalyptus was found most suitable plantation species followed by Sal and Teak in the Talcher area.

Keywords: *Soil organic carbon, plantation, cation exchange capacity, soil texture, heavy metals.*

THEME- V
Precision Agriculture and Climate Smart Approaches for Sustaiable Management of Resources

River Pollution & Qualitative Dilapidation of Water Resources in Gujarat

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Abstract

Indian subcontinent has its own hydrological importance in the world as it is one of the most densely populated regions of the world, hosting ∼23% of the global population within only ∼3% of the world's land area. It encompasses one of the glob's largest river systems of world with many peculiar rivers. These rivers remain the prime sources not only for agrarian & industrial water demands but also to build up critically required groundwater reserves i.e. aquifers. From Indian context these rivers are endowed with rich water resources, encompassing about 45000 km long riverine systems criss-cross the length and breadth of the country with 20 major river basins, 46 medium river basins and 14 minor/desert river basins. This is one face of the coin, while the other face releases apprehensions towards factors like judicious utilization/conservation/management of river water at one end while assessing and mitigating various kinds of pollutions of river water bodies on other end. Rapidly increasing population, intensive agricultural operations, rising standards of living, exponential growth of industrialization and urbanisation have exposed water resources, in general, and rivers, in particular, to greater degrees of pollution. Under such scenario looking into the recent threats of climate change, the rivers flowing in and around industrial areas/commercial agricultural interventions, demands pressing evaluations in regards to quantitative as well as qualitative pollution of river water bodies. Present paper describe an updated status of river pollution in regards to Gujarat, the most leading industrial state of country by incorporating probable influences, causes and effects of surface water as well ground water resources in the region. It is evident from the findings of various researchers that the conjunctive consequences of over exploitation/ deterioration of surface & ground water resources tends to pollute not only the rivers but the underground water bodies too. Considering this point of view, the theme of this write up is set as "river water pollution" where an attempt is made to overview the issue with its causes, effects and probable solutions and food for thought. A thin volume of stuff towards national scenario is opted , followed by an in depth updated statue of water resources of Gujarat state being more inclined towards pollution of major rivers of Gujarat and also the adjacent bodies of surface and groundwater resources. It could be of some utilities for water resources manager, engineers, environmental experts, field officers, planners and policy makers.

Ecological Weed Management Practices and Seed Bed Preparation Optimized the Yield of Dry Direct Seeded Rice in Sub Humid Condition of Chitwan, Nepal

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Abstract

Weeds are a major constraint to growing dry direct seeded rice (DSR) due to dominance of competitive weeds such as grasses and sedges. For optimizing the yield of dry-DSR through improved weed management practices, two field experiments were conducted during the monsoon season of 2014 in Chitwan, Nepal. The first experiment was conducted in strip plot design with factors (seed rate of *Sesbania*: 60, 80 and 90 kg ha^{-1}; age for knocking down: 21, 28, 35 and 42 days after sowing (DAS)) with three replication to determine the optimum seed rate of *Sesbania* and optimum age for knocking it down under rice-*Sesbania* co-culture. Whereas the second experiment was to evaluate stale seed bed against the normal seed bed technique and to identify the best weed management practice for DSR. Regression results showed that optimum seed rate of *Sesbania* was 60 kg ha^{-1} while its optimum age for knocking down was 32 DAS. The *Sesbania* co-culture with 60 kg ha^{-1} seed rate and knocking it down at 28 DAS resulted in significantly higher ($p \leq 0.05$) grain yield (4309 kg ha^{-1}) than sole Bispyribac Na application (2030 kg ha^{-1}), and 4.8% higher ($p \geq 0.05$) grain yield compared to farmers' practice of two hand weeding (4112 kg ha^{-1}). In contrary to weed free control, Pendimethalin followed by either Bispyribac Na application or followed by 2,4-D application resulted in statistically similar yield. In the dry-DSR, the effectiveness of stale seed bed technique in terms of yield increase was greater by 0.37% compared to the normal seed bed.

Keywords: *Dry direct seeded rice, Hand weeding,Sesbania co-culture, Stale seed bed, Weed density, weed biomass*

Influence of Irrigation Methods and Weed Management Practices Direct-seeded Rice

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Abstract

A field experiment was conducted during *Kharif* season of 2016 and 2017 to evaluate the effect of irrigation methods and weed management practices on direct- seeded rice. The experiment was laid-out in split plot design with three replications. The irrigation methods were kept in main plots viz. flood irrigation, sprinkler irrigation and sprinkler with VSD and weed management treatments in sub plots viz. pendimethalin1000 g/ha PE *fb* bispyribac-sodium 25 g/ha, pendimethalin1000 g/ha PE *fb* bispyribac-sodium 25 g/ha+ ethoxysulfuron- ethyl 18 g/ha, pendimethalin1000 g/ha PE *fb* fenoxaprop 60 g/ha+ ethoxysulfuron 18 g/ha, pendimethalin1000 g/ha PE *fb* penoxsulam + cyhalofop-butyl 135 g/ha and weedy check. The irrigation scheduling was done on the basis of soil moisture depletion approach. Amongst, irrigation methods, flooding irrigation gave higher grain and straw yield of rice with lower density of weeds and biomass however, it found statistically non significantly with sprinkler and sprinkler with VSD. However, sprinkler with VSD gave higher water use efficiency (WUE 2.74 kg/hamm) which was 10 % more saving the water than flood irrigation. Among the weed management treatments, pendimethalin1000 g/ha (PRE) *fb* bispyribac-sodium 25 g/ha + ethoxysulfuron-ethyl 18 g/ha gave higher grain yield of rice with lower density of weeds and biomass but it was statistically at par with pendimethalin1000 g/ha (PRE) *fb* penoxsulam + cyhalofop-butyl 135 g/ha.

Keywords: *Irrigation method, weed management, rice yield*

Diversification of maize based cropping system under middle Gujarat conditions

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Abstract

Maize (*Zea mays* L.) is one of the important cereal crop considered as "Queen of cereals" next only to wheat and rice in the world. In India, maize is cultivated in 9.86 m ha with the production of 26.26 m tonnes and 2663 kg ha^{-1} productivity. However in Gujarat, maize is cultivated on 0.40 m ha area with production of 0.72 m tonnes and much lower productivity (1800 kg ha^{-1})than the national average.Various studies states that the basic requirement for improving the crop productivity lies in the betterment of soil fertility. The fertility of soil is highly related with soil organicmatter. Intensive cropping and tillage system resulted in substantial decrease in soil organic matter levels. Rotating cereals and legumes is a cheaper means of improving soil fertility and system productivity.In searching for alternative of mono-cropping, diversification of cropping systems with short duration legume crops should be done.Growing several species of crops together or sequentially also utilize nutrients more efficiently than monoculture. Under middle Gujarat conditions, diversification of maize based cropping systems with short duration legume crops could increase the systems productivity, while decreasing the environmental impact intensive agriculture.Keeping these points in viewa field experiment was conducted at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India during summer-*kharif* seasons of years 2017 and 2018.Three legume crops *viz.*, green gram, groundnut and cluster bean has been grown in summer season and tworesidue management treatments after their harvest *viz.,* residue removal and residue incorporation of legumes; was followed before sowing ofsucceeding*kharif* maize. Three nitrogen level treatment *viz.*, 100%, 75% and 50% recommended dose of nitrogen were also given to *kharif*maize. Results revealed that cluster bean-maize cropping system+residue incorporation+100%RDNrecorded significantly higher grain yield of maizein second year of experimentation, followed by groundnut-maize cropping system+residue incorporation+100%RDN. In case of straw yield of maize it was observed that irrespective of cropping system legume residue incorporation+100% RDN gave significantly the highest straw yield of maizein second year of experimentation.System productivity in terms of total maize equivalent yield was calculated by adding the treatment wise maize yields in the maize equivalent yields of seed and haulm yield of different legumes. Maize equivalent yield was calculated by multiplying the seed and haulm yield of legumes and stover yield of maize crop with price per kg of individual crops and divided by price per kg of maize. System productivity in terms of the highest total maize equivalent yields was observed under groundnut-maize cropping system + residue incorporation+100%RDN. On the basis of these findings it can be concluded that diversification of maize based cropping system by inclusion of legumes in summer season not only increase the production of maize but also affect the system productivity positively.

Keywords: *Diversification**,** Cropping system, Legume, Maize, System productivity*

Impact of Crop Residue Management on Soil Properties and Crop Productivity under Conservation Agriculture in Vertisols of Central India

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Abstract

At present, global food and environmental security threatened by climate change which is one of the most prevalent challenges to supply sufficient and quality food to rising population in near future under stressed environmental conditions. Conservation Agriculture (CA) is an advance approach of managing agro-ecosystems for improved soil health, sustained crop productivity, profitability, and food security while preserving and enhancing the natural resource base under changing climatic conditions. Crop residues are valuable natural resources, which improve physical, chemical and biological properties of soil after being retained on the soil surface under CA. Hence, a study was carried out in an ongoing long-term experiment under CA at the research farm of ICAR–Indian Institute of Soil Science, Bhopal during Rabi season of 2018-19 to evaluate the impact of residue management with zero tillage (ZT) on soil quality parameters under maize (Zea mays L.)-chickpea (Cicer arietinum L.) cropping system in Vertisols of central India. The experiment was laid out in randomized complete block design with six replications and four treatments comprising tillage methods and different residue retention levels viz. conventional tillage (CT) without residue retention; ZT with 30% residue retention; ZT with 60% residue retention and ZT with 90% residue retention. The results showed that residue retention under CA significantly improved the physical properties of soil viz. bulk density and porosity at 0-5 and 5-10 cm depth. The highest soil organic carbon (1.01%) and soil available nutrients (i.e. nitrogen, phosphorus and potassium) were recorded with 90% residue retention which was followed by 60% (0.88%) and 30% (0.73%) residue retention level. However, the lowest soil organic carbon and available nutrients were observed in the treatment of CT without residue retention. Likewise, grain yield of chickpea was increased by 8.4-25.3% in ZT with residue retention plots over CT. Different pools of soil carbon, soil moisture, porosity, and available nutrients and fungal and actinomycetes counts were also significantly enhanced due to residue retention over without residue retention. Therefore, it is recommended that CA with residue retention is environmentally sustainable technology and offers an opportunity for arresting natural resource degradation through improved soil quality parameters with increased and sustained crop productivity in Vertisols of Central India.

Keywords: *Conservation agriculture, Organic carbon, Residue retention, Soil properties, Vertisols*

Characterizing hydraulic architecture and soil properties in fruit orchards for precision farming

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Abstract

To ensure orchard sustainability, characterization of hydraulic architecture both in soil and tree are essential for precision farming. Motoring of soil properties either short or long-term basis is the key for successful precision management. Assessments of hydraulic components in soil i.e. water flow, temperature dynamics, hydraulic conductivity, pore characteristics interactions are mandatory for precise fertigation management. Within tree hydraulic dynamics; root, stem and leaf water potential and hydraulic conductivity needs to be monitored both temporally and spatially. Diurnal, annual and seasonal variations in soil moisture *vis-a-vis* tree water sap determine the need for best management practice to be adopted. Abiotic stresses at critical phonological stages to be avoided and simultaneous monitoring of soil-tree-water-weather interactions using sensors. Changing in soil fertility status and deficiency in soil, foliar parts needs to be explored and advocated to fruit growers/farmers/stakeholders for real time basis management. Based on IIHR collaborative study under ICAR networking project on "Micronutrient management in Horticultural crops for enhancing Yield and quality", it was concluded that foliar micronutrient technology with Zn and Boron significantly improved the guava yield sustainability (SYI: 0.63 to 0.80). Likewise, soil and foliar treatment with crucial Zn improved the yield sustainability in mango (from 0.67 to 0.87 with yield increment of 4.3 to 27.1%). Therefore, in order to maintain the soil functions properly and timely for future use, hydraulic component along with soil fertility should be studied thoroughly in an integrated manner. Successful precision farming technologies thus developed should be beneficial for farmers for enhancing income and their socio-economic status. The data set will be presented in detailed way.

Keywords: *Hydraulic conductivity, soil hydraulic architecture, tree hydraulic component, soil properties, precision farming in horticulture*

Improved Neuro-wavelet model for flood forecast of Nagavali river basin

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Abstract

The dynamic and accurate flood forecasting of daily stream flow processes of a river are important in the management of extreme events such as flash floods, floods and optimal design of water storage structures and drainage network. Data based forecasting methods are becoming increasingly popular in flood forecasting applications due to their rapid development times, minimum information requirements, and ease of real-time implementation. Using hybrid model or combining several models has become a common practice to improve the forecasting accuracy. The combination of forecasts from more than one model often leads to improved forecasting performance. An attempt has been made to find an alternative method for accurate flood forecast by combining the wavelet technique with Artificial Neural Networks (ANN). Wavelets, due to their attractive properties, have been explored for use in time series analysis. Wavelet transforms provide useful decompositions of original time series, so that wavelet-transformed data improves the ability of a forecasting model by capturing useful information on various resolution levels. Wavelet analysis effectively decomposes the main signal and diagnoses its main frequency component and abstract local information. The observed time series is decomposed into sub-series using discrete wavelet transform and then appropriate sub-series is used as an independent variable for the Neural Network model. Several hybrid models have been developed to flood forecast of Nagavali river basin in one day advance. Daily flow data was collected from India-WRIS and rainfall from IMD from 1990 to 2013; however 60% data was used for model calibration and 40% for validation. The calibration and validation performance of the developed models is evaluated with appropriate global statistics. The results were compared with the standard models with undecomposed data. The application of wavelet based neural network models were found to be more effective as its prediction efficiency is more and its peak value is closer to observed value.

Keywords: *Forecast, Flood, Network. Model, Wavelet*

Long term annual and seasonal rainfall variability of Agartala

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Abstract

Rainfall is an important component of hydrologic cycle and plays an important role in the crop and food production process. Variability in rainfall affects the crop growth and yield if water is not available during the crop growth period. Agriculture is the main livelihood for the peoples of north eastern states. Although the all the states receives the ample quantity of rainfall but spatial and temporal variation of much more. In view of above, in this study long term annual and seasonal rainfall variability for the Agartala station of Tripura state was studied. Tripura state is situated between 22^{o}7' and 24^{o}2' North latitudes and 91^{o}0' and 92^{o}0' East longitudes. Tripura state has three distinct physiographic zones namely hill ranges, undulating plateau land and low-lying alluvial land. The state is characterized by a warm and humid tropical climate. Results show that annual rainfall varies from 1353.70 mm to 2985.10 mm. South west monsoon rainfall varies from 772.10 mm to 1963.50 mm.NE monsoon rainfall varies from 64.10 mm to 369.60 mm. The Coefficient variation for annual, south west monsoon, NE monsoon, winter and summer season was 17.62, 26.65, 46.22, 102.92 and 34.23 per cent respectively.The share of SW monsoon rainfall, NE monsoon rainfall, winter season rainfall and summer season rainfall is about 59.59%, 9.55%, 1.14% and 29.72%, respectively.

Keywords: *Rainfall, CV, meteorological, seasonal, variability, Tripura*

Soil moisture effect on potassium availability and fixation

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Abstract

The present study is a targeted review of available literature in public domain to explore the potential of soil moisture in making available the nutrients. The frequent diversifications in climate is leading to the problem of water shortage and on the other hand, over-fertilization is causing environment pollution but still high doses of fertilizers are used by farmers to obtain maximum yield.Moisture content of the soil proved to be an essential factor in making available the nutrients for plants. The acquisition of mineral nutrients by plants requiresmainly two processes viz., a better root growth to reach nutrients; and transport of those nutrients from soil to plant roots. These processes are mediated by soil water. Among the various essential elements required for plant growth, potassium (K) is one of the major nutrient elements vital for various fundamental and metabolic processes of plants. Soil moisture affects potassium availability and diffusion, as well as its uptake via its effects on root growth and activity. The diffusion of ions in soil is found to be directly related with volumetric moisture content of soil. While analyzing the availability of potassium under different moisture conditions, it was observed thatprolonged drought condition or low soil moisture led to a decrease in K contents in standing crops by reducing soil mineralization rates. Total K content was found greater in drought plots as potassium mostly resides in silicates, and solubility & mineralization of those silicates is reduced if soil moisture decreases. Fixation of potassium also influences the effectiveness of fertilization in soil-plant system. Therefore, understanding the fixation mechanism is important for soil fertility management strategies. It was observed that with drying of soil, K fixation increased as the labile K became more concentrated in a small volume of soil. Since, climate change is subsequently leading to water shortage, so wastewater in this context can prove to be beneficial as irrigation source. While using high potassium wastewater, appropriate management technology must be improved which can minimize leaching losses and maximize crop uptake. Keeping all these viewpoints in concern, there is a requirement of a suitable fertilizer recommendation technology that could be used by considering the moisture status of soil too.

Keywords: *potassium diffusion, nutrient uptake, potassium fixation, moisture condition, management strategy*

Land suitability assessment of Moridhal watershed in Dhemaji district of Assam using remote sensing and GIS

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Abstract

Land suitability evaluation is a multidisciplinary approach involving various methods, systems and factors. It serves as rational indicator to land use planners and decision makers for the sustainable use of resource. The current study was carried out to evaluate the land suitability of Moridhal watershed located in Dhemaji district of Assam. Remote sensing data obtained from geocoded satellite image of Resourcet-2 (LISS-4) in conjunction with toposheets (1:50,000) revealed four distinct physiographic units in the watershed area which include: Upper piedmont plain, Lower piedmont plain, Alluvial plain and Flood plain. Soil samples were collected from all the four different physiographic units and were analyzed in the laboratory for various soil parameters. The productivity and potentiality indices of the soils were evaluated following Riquier et al. (1970) method and estimating factor-wise scores pertaining to soil moisture content, drainage, effective soil depth, texture and structure of root zone, base saturation, soluble salt content, organic matter of A horizon, cation exchange capacity and mineral reserve in B horizon. Based on the estimated score, the productivity and potentiality maps were created under GIS environment using ArcMap 10.4 version. The study revealed that the productivity index and potentiality index of the studied soils varied from 12.13 to 62.14 and 41.04 to 90.25, respectively. Among the physiographic units, the flood plain soils having mean productivity index values of 38.74 were rated as poor to good classes for cultivation of crops. Adopting probable improvement measure, the productivity of these soils could be improved to good to excellent classes. The productivity rating class of alluvial plain (Mean 45.14) was also average to good which could be further improved to good and excellent (Mean 80.72). The productivity index of average to good rating of lower piedmont plain soils can be increased from a mean value of 28.87 to a 49.18. The upper piedmont soils had poor to average productivity due to acidic pH, low organic matter, base saturation, mineral reserve and coarse texture being the major limiting factors for crop production. The judicious application of organic manures, lime and proper management practices can improve the productivity rating of these soils to good classes. The coefficient of improvement values of studied soils varied from 1.11 to 4.69 with a mean value of 1.89. The upper piedmont plain and flood plain soils had more potentiality as compared to alluvial plain and lower piedmont plain soils. The assessment of the soils divulged various productivity related constraints in Moridhal watershed area. However, some of these limitations related to soil fertility and acidity could be managed by adopting integrated soil fertility management practices. The spatial distribution of the productivity index values as depicted through potentiality map revealed that the studied area had 15,049 ha (48.97 per cent) average rated soils and 15,469 ha (50.34 per cent) good rating soils. The potentiality map showed that the watershed had 13,431 ha (43.70 per cent) potentiality good rating soils and 17,299 ha (56.30 per cent) potentiality excellent soils.

Keywords: *Land suitability, Watershed, Remote sensing, GIS*

The role of conservation agriculture in mitigation to climate change

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Abstract

Conservation agriculture is as an approach to farming that seeks to increase food security, alleviate poverty, conserve biodiversity and safeguard ecosystem services. Conservation agriculture practices can also contribute to making agricultural systems more resilient to climate change. In many cases, conservation agriculture has been proven to reduce farming systems greenhouse gas emissions and enhance their role as carbon sinks. Climate change is undoubtedly induced and accelerated by human activity and can pose a serious threat to mankind by reducing food production. Significant weather aberrations in form of the uneven precipitation pattern, more frequent and intense occurrence of temperature fluctuations accompanied by changes in wind intensity and frequency, amount of clouds, intensity and quality of sunlight can be expected. Maybe the most vulnerable sector affected by Climate change is agriculture. So, it is important to mitigate and adapt to a new situation through different and most adaptable agricultural strategies. One of the best solutions for sustainable agricultural production, under Climate change conditions, can be conservation agriculture. Climate change is not only an abstraction, which is why one of the most important roles of conservation agriculture today is its ability to adapt and mitigate these changes. The basis of conservation agriculture production is in management set on three fundamental postulates, which contextually unify climate-soil-plant, while respecting agro ecological and socio-economic differences.

Keywords: *Climate change, mitigation, conservation agriculture, sustainability*

Examination of Horton and Kostiakov infiltration model for suitability on hilly slopes

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Abstract

Infiltration is a dynamic process, variable in existence and assumes an essential job in the hydrological process of soil and water regimes. Information on infiltration has also great importance in irrigation and drainage system design. Since the infiltration depends on various soil physical properties including soil cover complex, models based on physical process or empirical studies help to a large extent in assessment of infiltration rates as well as basic infiltration rates. The study was done to decide the appropriateness of infiltration models that can be utilized effectively in hill slopes.The study was carried out in College of Post Graduate Studies in Agricultural Sciences at Umiam.In this investigation infiltration in channel section was estimated with the assistance of cutthroat flumes, since utilization of double ring infiltrometer on sloppy surface was troublesome. Infiltration study was conducted in ten different points. The R^2 statistical comparison criteria was utilized to calculate the best performing infiltration model. The value of R^2 (0.93) indicated that Horton model gave the better prediction of both infiltration rate as well as basic infiltration rate in hilly surface. Horton model already gave better prediction in flat surface.

Keywords: *Cutthroat flume, Double Ring Infiltrometer*

Assessing the performance of machine learning techniques to map soil properties from multispectral imageries

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Abstract

Remote sensing techniques provide a rapid and efficient tool to estimate the soil properties. We compared the three multispectral imageries (Landsat-8, Sentinel-2 and IRS P6- LISS III) for predicting soil properties. A total of 90 surface soil samples during March 2018 were collected from the Anand region of Gujarat state and analyzed for pH, electrical conductivity (EC), organic carbon, available phosphorus, potassium and sulphur. The Landsat-8 (11 bands) and Sentinel-2 (12 bands), and IRS P6- LISS III (4 bands) multispectral images of April 2018 were used to extract the surface reflectance corresponding to sampling locations. Several soils related indices were also derived using the bands of all the three satellite images. The relationships among soil properties, surface reflectance of different bands and spectral indices were derived using three machine learning techniques: Linear Correlation, Multiple Regression and Artificial Neural Network (ANN). There were no significant linear relationships among soil properties, surface reflectance of bands and spectral indices of satellite imageries The ANN model showed higher performance in estimating pH (R^2=0.90 for Landsat-8, R^2=0.77 for LISSIII and R^2=0.75 for Sentinel-2), EC (R^2= 0.95 for Landsat-8, R^2= 0.82 for LISSIII and R^2= 0.88 for Sentinel-2), organic carbon (R^2= 0.90 for Landsat-8, R^2= 0.76 for LISSIII and R^2= 0.82 for Sentinel-2), available phosphorus (R^2= 0.93 for Landsat-8, R^2= 0.96 for LISSIII and R^2= 0.98 for Sentinel-2), available potassium (R^2= 0.95 for Landsat-8, R^2= 0.93 for LISSIII and R^2= 0.90 for Sentinel-2) and available sulphur (R^2= 0.92 for Landsat-8, R^2= 0.91 for LISSIII and R^2= 0.99 for Sentinel-2) using the spectral indices These results show the potential of multispectral imagery coupled with ANN to estimate soil properties which may help in remote monitoring of soil quality.

Keywords: *Landsat-8, LISS-III, Sentinel-2, Soil Properties, ANN*

Climate Smart Agriculture to mitigate the effect of climate change on vegetables

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Abstract

Climate change may be a change in the mean of the various climatic parameters such as temperature, precipitation, relative humidity and atmospheric gases configuration over a longer period of time and a larger geographical area. The human activities such as industrialization, deforestation as well as automobiles changes in the climate are being taken place, which will again turn detrimental to life. Climate variability is one of the most substantial issues manipulating year to year crop production, even in high-yield as well as high technology agricultural areas. Climate change may have more effect on small and marginal farmers, particularly who are mainly dependent on vegetables. All vegetable needs an optimum temperature for their proper growth and development, but optimum temperature requirement varies from crop to crop. Under changing climatic situations crop failures, shortage of yields, reduction in quality and increasing pest and disease problems are common and they affect the vegetable cultivation. Vegetables are generally sensitive to environmental extremes, and thus high temperatures and limited soil moisture are the major causes of low yields as they greatly affect several physiological and biochemical processes like reduced photo synthetic activity, altered metabolism and enzymatic activity, thermal injury to the tissues, reduced pollination and fruit set etc., which will be further magnified by climate change. Climate Smart Agriculture is a technique to improve the scientific rule and investment setting to attain sustainable agricultural progress to ensure the food availability under changing climate. In this context germplasm of the major vegetable crops which are tolerant of high temperatures, flooding and drought has been identified and advanced breeding lines are being developed. Efforts are also underway to identify nitrogen-use efficient germplasm. Strategies include modifying fertilizer application to enhance nutrient availability to plants, direct delivery of water to roots (drip irrigation), grafting to increase flood and disease tolerance, and use of soil amendments to improve soil fertility and enhance nutrient uptake by plants. Various crop management Practices such as mulching and raised beds helps to conserve soil moisture, prevent soil degradation and protect vegetables from heavy rains high temperature and flooding. For sustainable cultivation of vegetable under changing climate, climate smart agriculture is only option.

Keywords: *Climate Change, Vegetables, Climate Smart Agriculture*

Challenges in Adopting Precision Farming Technologies

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Abstract

Our Indian farming system is changing towards traditional to traditional and technology- oriented farming system which makes the farmers to use artificial intelligence and information technology tools in the fields.In our Indian terms we can define precision farming as "precise utilization of inputs with respect to the crop, soil, and weather conditions to achieve effective and optimum utilization of resources without wastage".To meet the huge food grain requirement of 480 million tonnes by 2050, with the increasing challenges of biotic and abiotic stresses experienced by crops, introduction and adoption of modern technology in Indian agriculture is unavoidable. Precision farming is highly concentrated on three component viz., climate, environment and farm economy.Technology based farming helps in managing the fields by analysing the status of the crops by which farmers can easily apply crop production and protection measures at the right place at the right time. Precision farming uses remote sensing, GPS and GIS to monitor the crops.These proper monitoring and management helps to get optimum profitability and sustainability with less resource wastage.Even though precision farming have many advantages likereduction of soil and environmental degradation, effective utilization of resources, it is difficult to Indian farmers to take up precision farming due to small and fragmented land holdings (more than 58 per cent of the Indian farmers are having less than one hectare of land), lack of technical expertise and high capital investment.To remove these barriers experts has to form a multidisciplinary expert team to innovate appropriate technologies for Indian context, Provision of complete technical backup for the farmers, conducting result demonstrations and awareness programmes on the consequences of adopting precision agriculture.

Keywords: *Artificial intelligence, farm economy, resource wastage, small land holdings*

Influence of Fertility Management on Soil Carbon Stocks under Different Agro Climate Zones

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Abstract

The increase in greenhouse gases (GHG) in the atmosphere and the resulting climatic change will have major effects in the 21st century is contributed by the decomposition of SOC [2]. The global climate change as a result of green house gas emission such as CO2 has brought a new emphasis and new perspective to the importance of SOM and SOC which not only improve soil properties but also shows its impacts on global carbon budget through sequestration of atmospheric carbon in soil. Enrichment of soil organic carbon (SOC) stocks through sequestration of atmospheric CO_2 in agricultural soils is important because of its impacts on soil quality, agronomic production, and adaptation to and mitigation of climate change. The long-term fertilizer experiments are being conducted in Andhra Pradesh and Telangana under four different agro climatic zones, viz. Southern Telangana Zone (STZ) [rice-rice (27 years) and maize-onion (13 years) cropping systems at All India Co-ordinated research Project on Integrated Farming systems, Rajendranagar], Northern Telangana Zone (NTZ) [rice-rice (14 years) cropping system at Regional Agricultural Research Station, Jagtial], Godavari Zone (GZ) [rice-rice (26 years) cropping system at Andhra Pradesh Rice Research Institute, Maruteru] and Scarce Rainfall Zone (SRZ) [groundnut-fallow (30 years) cropping system at All India Co-ordinated research Project on Dryland Agricultural Research Station, Ananthapur. Among the different Agro Climatic zones, GZ showed higher content of soil organic and inorganic carbon stock (38.07 and 7.17 Mg ha^{-1}, respectively) followed by NTZ (22.93 and 10.32 Mg ha^{-1}, respectively), STZ (17.28 and 6.08 Mg ha^{-1}) and SRZ (15.38 and 6.61 Mg ha^{-1}). The results related to total carbon stock (Mg ha^{-1}) and carbon sequestration rate (mg ha^{-1} yr^{-1}) reveled that GZ recorded higher total carbon stock (45.12) and carbon sequestration rate (1.04) followed by NTZ (33.25 and 0.39) and STZ (21.83, 0.70) whereas lowest was recorded under SRZ (20.63, 0.08). The treatment receiving inorganic fertilizers along with organic manures resulted higher amounts of total carbon stock in all the zones. The percent increase of total carbon stock over control was nearly 200, 100, 47, 31 and 22% in GZ, STZ (maize-onion), SRZ, NTZ and STZ (rice-rice), respectively. Integration of inorganic fertilizer with organic sources such as FYM enhanced the soil organic carbon content by 17-100 % and carbon sequestration from 100-1200 kg C ha^{-1} yr^{-1}. These results suggest that long-term application of organic manures alone or in combination with recommended dose of fertilizers have resulted in the buildup of soil organic carbon content even under tropical climate. The soils were rich in clay content (Godavari Zone and Northern Telengana Zone) and there was relatively higher soil organic carbon content. Further, addition of organic manures improved the macro aggregates and carbon storage inside the aggregates which was protected from decomposition.

Keywords: *Agro Carbon stocks, Carbon sequestration rate, integrated nutrient management*

Precision n managementin rice-wheat cropping systemfor higher productivity and sustainability

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Abstract

The rice-wheat cropping system (RWCS) is a major production system in the Indo-Gangetic Plains of India covering nearly 10.5 million hectares including 4.1 million hectares of the north western (NW) states comprising Punjab, Haryana, Uttarakhand and western Uttar Pradesh. In India, RW systems account for >80% of the total cereal production and about 50% of the total calorie intake. More than 90% area of the RW area is irrigated and is facing yield stagnation, soil degradation, declining ground water table and air pollution. Planting techniques are among the important factors affecting soil properties and crop yield. Among the crop production factors, tillage contributes up to 20% and affects the sustainable use of soil resources through its influence on soil properties. Conservation tillage positively influences several aspects of the soil whereas excessive and unnecessary tillage operations give rise to opposite phenomena that are harmful to soil. Therefore, currently there is a significant interest and emphasis on the shift from extreme tillage to conservation and no-tillage methods for the purpose of controlling erosion process. The human population continues to grow steadily with the shrinking resources being used for agricultural production situates great challenge against Indian agricultural system to attain food and environmental security. To counter these twin challenges in the country there is urgent need of application of modern Hi-tech technologies for enhancing the productivity and sustainability of the rice-wheat system for long term on scientific basis. Precision farming (PF) looks a win technology towards improving the capability of agricultural land to produce crops on sustainable basis. The PF is based on the concept of determination of spatial and temporal variability in the crop production which in turn aimed for increasing crop productivity and reducing environmental menaces. It is innovative technology which comprises the application of several Hi-tech tools like Geographical Information System (GIS), Global Positioning System (GPS), Remote Sensing (RS), Variable Rate Technology (VRT), Decision Support System (DSS), and Farmer. Precision land levelling, precision planting, precision nutrient management by using Green Seeker, leaf colour chart (LCC), site specific nutrient management (SSNM) has a lot of potential for enhancing crop yield and input use efficiency under field conditions, while reducing the cost of production and deleterious impacts on environmental. In India, there are wide possibilities to practice a part of PF technologies in rice-wheat system in order to enhance productivity, profitability and nutrient use efficiency.

Keywords: *Precision farming, productivity, rice-wheat cropping system, sustainability*

Precision Agriculture: A tool towards Sustainable Management of Resoruces

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Abstract

Precision agriculture (PA) has emerged as an important component of the framework to accomplish this goal. PA provides important issues for more sustainable agriculture. Many farmers have the necessary technology to operate site-specifically, but they do not use it in practice, and thus available information and communications technology (ICT) systems are not used to their full potential. Social-economic changes in developing countries, including India, are creating new scopes for the appliance of PA. Due to the present situation Precision Agriculture is a very significant part of the solution for both Climate Change mitigation and Sustainable Agriculture. PA farm management strategy that is changing the way people farm and help in managing crop production inputs in an environmentally friendly way. PA using site-specific knowledge and substitute's information of physical inputs that target rates of fertilizer, seed, and chemicals for soil and other conditions. PA can contribute in many ways to the long-term sustainability of production agriculture, confirming the intuitive idea that which reduce environmental loading by applying fertilizers and pesticides only where they are needed, and when they are needed. PA benefits to the environment come from more targeted use of inputs that reduce losses from excess applications and reduction of losses due to nutrient imbalances, weed escapes, insect damage, reduction in pesticide resistance development, etc. In the example, the variable rate of N maintains farm profitability even when nitrogen is restricted to less than half of the recommended uniform rate. Now, there is an increasing commitment to reduce reliance on unnecessary chemical inputs in agriculture. Various technologies have been applied to make agricultural products safer and to lower their adverse impacts on the environment, a goal that is consistent with sustainable agriculture. Precision Agriculture describes the different components that can be used for sustainability and environmental protection. Especially in the case of small farmers in developing countries, PA holds the promise of substantial yield enhancement with minimal external input. The PA Database Generally Includes (Venkataratnam, 2001) 1.Crop information such as nutrient requirement, growth stage, health. 2. Soil physical and chemical properties, nutrient status, depth, texture, salinity and toxicity, soil temperature, productivity potential. 3. Micro-climatic data (daily and seasonal) such as canopy temperature, wind speed, and direction, humidity. 4. Surface and subsurface drainage conditions. 5. Irrigation facilities, water availability, and development of other inputs. Agriculture has much to contribute to a low emissions development strategy. PA provides a high mitigation potential, Green House Gases (GHG) emissions reduction efforts must include agriculture. Climate-smart agriculture is essential for building capacity, experience, and guiding future choices, as well as smart management of natural resources. Two aspects of Climate-Smart Agriculture will be discussed, macro and micro.

The macro aspect will elaborate policies and global efforts and the objective of global initiatives of the Global Alliance is to seek improvements in people's food and nutrition security by helping governments, farmers, scientists, businesses, and civil society, to facilitate climate change mitigation and efficient use of natural resources. Initial action areas include knowledge, investment, and enabling environment while micro aspects will elaborate specific techniques and technologies for the implementation of Climate-smart Agriculture, the use of aerospace technology, and engineering analysis techniques to facilitate higher yields for a certain crop will be elaborated and exemplified. These techniques can provide data which the farmers can use to monitor and to help determine yields of their farming products, through the provision of relevant satellite data. The precision farming developments of today provide the skill for the environment-friendly agriculture of tomorrow.

Keywords: *Precision agriculture, sustainability, environment, Climate-Smart Agriculture*

Mapping and Characterization of Melang watershed foridentification of priority areas of agriculture using GIS – a case study from Assam

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Abstract

Watershed is the hydro-geological unit that drains entire water as runoff to a common outlet. All lands on earth are part of watershed or other. Mapping of soil and water quality parameters is one of the prerequisites for sound watershed management programme. The Melang watershed (BRMU091), under HolongaparMouza of Jorhat district of Assam, demarcated in Jorhat-Central block with an area of 900 ha is comprised of seven villages viz. 1 no. Fesual, 2 no. Fesual, Karigaon, Gaspuria, Munda basti, Jatakiagaon and Medhichuk. The primary water source from two small tributaries (Darioli 1 &Darioli 2) originated from Gibon reserve forest from southern part of the watershedisre-united at a common place at Na-salang after crossing Kilkila bund and bi-furcates towards Dihajan river in the east andMelang river towards North-western part before draining the entire water streams to the extreme northern side near Melangchariali.Some of the constraints that hinders overall sustainable productivity in agriculture and allied sectors identified in the watershed are - rainfed farming, mono-cropping and use of local cultivars, absence of HYV vegetables, absence of information on soil and water resources, lack of knowledge in improved agricultural practices and poor linkages with the development organizations, low productivity, water scarcity during rabi season, iron contaminated ground water, neglected wetlands, resource poor farmersetc. among others.Considering all, it is vital to conserve natural resources and provide livelihood security through adopting integrated watershed management interventions.The present study aims to characterize the soil and water quality parameters of the watershed for assessment and identification of priority areas with the aid of GIS (Geographic Information System) technology, so that formulation strategies for conservation of resources and devising need based site specific interventions for improved watershed managementcan be taken.After analysis of the soil samples, the pH value was found to range from 4.6 to 7.29, Organic Carbon ranged from 0.3% to 1.6%, the CEC of the soil ranged from 3.07 to 9.31, Water Holding Capacity ranged from 21.57% to 41.98%, the available nitrogen status(Kg/ha) was found to range within 156.80 to 281.04 and available P_2O_5 (Kg/ha),K_2O (Kg/ha) and S (Kg/ha) ranged between 2.604 to 37.85,9.95 to 430.1 and 26.01 to 70.35 respectively.Spatial variation of soil quality parameters map for the entire watershed area were created and salient database for each of the quality parameters are highlighted.Additionally, the water quality parameters of the major wetlands were also identified. Geographic Information System (GIS) -aided mapping of the whole watershed for soil and water quality parameters embracing their ranges at different locations, area, maximum and minimum values could give a better idea to opt for suitable need-based management strategy for the entire watershed.

Keywords: *GIS, Mapping, Melang, Soil, Water, Watershed.*

GIS-based Hypsometric Analysis of the Mand Sub-basin of Mahanadi River Basin, Chhattisgarh, India

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Abstract

Assessment of erosion status of the basin helps in selecting suitable conservation measures to check erosion and water conservative management practices in the basins. Hypsometric analysis with the aid of Geographic Information System (GIS) helps in understanding the geological development of the basin and for delineation of erosional proneness of the basin. The hypsometric curve and hypsometric integrals are the important indication factors of a basin condition. Hypsometric analysis is the relationship of horizontal cross-sectional drainage basin area to elevation. The graph of hypsometric curve indicates the geological stage of watershed and erosion susceptibility of basin. The present study has been carried out by using SRTM-Digital Elevation Model (DEM) remotely sensed data and GIS in the Mand sub-basin of Mahanadi River basin. The study area is Mand sub-basin of Mahanadi basin which is the part of Chhattisgarh having area of 5332 km^2, lies between 21°42'15.525"N to 23°4'19.746"N latitude and 82°50'54.503"E to 83°36'1.295"E longitude. Soils are mainly red sandy soil , red and yellow soils and red gravelly soils. The geology of the area has Barakar formation, Kamthi formation, Raigarh formation, Deccan trap and ChhotanagpurGniessic rocks majorly. The elevation in the Mand sub-basin varies from 187 to 1147 m above MSL. The catchment has general slope towards north-east direction with average elevation of 667 m above MSL. The hypsometric analysis of Mand sub-basin is carried out and value of hypsometric integral (HI) is found 0.5 which indicates the sub-basin is at Equilibrium or Mature stage. This method was observed to be less cumbersome and faster than the other methods in practice.

Keywords: *SRTM-DEM, Hypsometric Curve, Hypsometric Integral, Remote Sensing and GIS.*

Integrated Nutrient Management – A Novel Approach

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Abstract

Integrated Nutrient Management (INM) implies the most efficient use and management of organic, inorganic andbiological sources of major nutrients as well as micronutrients to attain higher levelsof crop productivity and to maintainthe fertility of the soil.It is the maintenance or adjustment of soil fertility and plantnutrient supply at an optimum level to sustain the desired crop productivity. This is done through optimization of the benefits from all possible sources of plant nutrients in an integrated manner. In other words, integrated nutrient management is the use of different sources of plant nutrients integrated to check nutrient depletion and maintain soil health and crop productivity. The aim of Integrated Nutrient Management (INM) is to integrate the use of natural and manmade soil nutrients to increase crop productivity and preserve soil productivityfor future generations (FAO, 1995a). Rather than focusing nutrition management practices on one crop, INM aims at optimal use of nutrient sources on a cropping system or crop rotation basis. This encourages farmers to focus on longterm planning and make greater consideration for environmental impacts. INM enables the adaptation of plant nutrition and soil fertility management in farming systems to site characteristics, taking advantage of the combined and harmonious use of organic and inorganic nutrient resources to serve the concurrent needs of food production and economic, environmental and social viability.There is an urgent need to adopt an integrated nutrient supply and management system for promoting efficient and balanced use of plant nutrients. While the main emphasis was given on increasing the proper and balanced used of mineral fertilizers, the role of organic manure, biofertilizers, green manuring and recycling of organic wastes should be considered supplementary and not substitutable. On the one hand, there isa vast scope for increasing plant nutrient supply through the use of organic fertilizers, but there is, on the other hand, no scope for reducing the consumption of mineral fertilizers since the present level of crop productivity has to be increased in the coming years.

Origin and mineralogy of nano clays of Indian Vertisols and their implications in selected soil properties

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Abstract

The mineralogical composition of nano-clays (NCs), and their potential implications in soil bulk properties of Indian Vertisols are unexplored. In this study, we isolated NCs (<100 nm) from Deccan basalt (DB) alluvium derived Vertisols (TypicHaplusterts) of central India and characterized them for their mineralogy and crystalline behavior. The soils were clayey (>60%) in texture, rich in smectite mineral (60-80% in <2 μm fraction), alkaline (pH 7.8-8.5), calcareous and contain <1.0 % organic carbon. The clay fraction (<2 μm) is dominated by smectitic NC (40-60%), followed by hydroxy-interlayered vermiculite (HIV), pedogenic chlorite (PCh), kaolin, and mica. The smectite is little hydroxy-interlayered (HIS), and hydroxy-interlayering is less pronounced in NC smectites than in the coarser clay smectites. The NC smectites are smaller crystallite size (3.5-5.5 nm) and higher in crystal strain (15-22 %) than coarser size clays due to its low lattice charge. The abundance of smectitic NCs considerably reduced the saturated hydraulic conductivity (<1 cm hr^{-1}) of the soils due to high dispersion and swelling (COLE ≥ 0.20) of smectite clays even at the low level of exchangeable sodium percentage (ESP ≤ 5) and a moderate amount of exchangeable magnesium. The report on nano clays (<0.1 μm) highlights the unique role of nano smectites in some selected soil properties as well as in the origin of SAT Vertisols of the Indian subcontinent.

Keywords: *Nano clay, Smectite, Cracking clay soils, Deccan Basalt*

Innovations for Climate Resilience in Rainfed Conditions in Village Warkhed, District Akola of Maharashtra State

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Abstract

Under dryland condition kharif crops mainly depends upon the rainfall, its onset, intensity and distribution which is highly unpredictable in this region and hence the productivity of the dryland crops is getting very low. In order to evaluate and disseminate the improved rainfed agro-technologies, on farmers field under different themes viz. rainwater management through in-situ and ex-situ moisture conservation practices and foliar sprays were conducted at village Warkhed, Taluka-Barshitakli, district Akola of Maharashtra State during 2018-19 to 2019-20 under National Innovations on Climate Resilient Agriculture project of AICRP for Dryland Agriculture. This study clearly indicated that advantage of adopting all improved rainfed agro-technologies for different crops in comparison with traditional farmer practices. Improved dryland technologies resulted in overall increase in crop production from 5.00 to 20.67 % over the farmers practice. The percent increase in yield was highest with adopting of various in-situ moisture conservation measures in soybean (11.11 %) and in cotton (10.36 %) and foliar spray of nutrients in cotton crop (10.46 %) and intercropping of soybean with pigeonpea with increase in equivalent yeild of (8.41%) over sole soybean. Hence, on farm interventions carried out through NICRA-project showed the worth of improved rainfed varieties and management practices for improved agro-technologies. NICRA project with its strong link between the technology developed by the scientist and the user of the technology is putting larger impact for the adoption of improved dryland agro technologies. This project also provides the feedback for refinement and upscaling improved dryland agro-technologies.

Keywords: *rainfed, innovative interventions, in-situ moisture conservation, foliar sprays, intercropping.*

Soil resource mapping and crop suitability assessment by using geo-spatial technologies in South-Eastern Rajasthan, India

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Abstract

The agro-eco-sub region (AESR) 4.2 encompasses Aravalli foot hills, central Rajasthan plains and adjoining areas. Visual interpretation of geo-coded satellite data (IRS-P6, LISS IV MX) on the same scale was done before starting the field work and identified five landforms such as moderately sloping subdued hills, gently sloping to undulating land (Pediments), upland, nearly level to gently sloping plain and nearly level to very gently sloping lands were delineated subject to inventorization, assessment of suitability and suggested land use options. Based on the interpretative units a high intensity detailed soil survey was carried out in cluster of ten villages of Bhadesar tehsil on cadastral map (1:4000 scale) and the soils were characterized with respect to landforms. In all, fourteen soil series were recognized and mapped into 29 mapping units using GIS techniques. The soils were characterized, classified and assessed for their fertility status, suitability for different crops and suggested alternate land use options. The soil map for each village has been finalized in the field itself after thorough checking of soil and site characteristics and correlation studies. The soil maps were prepared with village boundary showing digitized soil mapping units (phases of soil series) delineated in the cluster of 10 villages. After the analysis of soil samples, data were processed in GIS environment using Arc GIS 10.3 and thematic maps were generated on 1: 100000 scale for soil resource information. The soils were assessed for soil site suitability for maize, wheat, mustard and soybean. Daulatpura-c series soils are suitable for maize, mustard, soybean, and Daulatpura-d soils for soybean and moderately suitable for other crops. Soils of Bagund and Narbadiya-a series are moderately suitable for maize and marginally suitable for other crops. The soils of Bhadsoda-b series are marginally suitable only for mustard but moderately suitable for all other crops. Soils of Parliya series are moderately suitable only for mustard crop and marginally suitable for remaining crops. The soils of Guda series are marginally suitable for maize, wheat, and mustard but not suitable for soybean. The soils of Nardhari-a and Nardhari-b are moderately suitable, Daulatpura-b, Bhadsoda-a and Narbadiya-b are marginally suitable whereas soils of Madanpura and Daulatpura are not suitable for all the crops due to limitations of shallow soil depth.

Keywords: *Soil resource, Mapping, Crop suitability, Assessment, Geo-spatial technologies, South-Eastern Rajasthan*

Precision Agriculture for Sustainable Management of Resources

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Abstract

Agricultural productivity nowadays may seem to have reached a highest point due to the global availability of fertilizers and pesticides, which are used to improve crop yield. However, misuse of these products and lack of awareness of the field parameters can decrease our productivity and endanger the environmental balance in the cultivation area. Farming is becoming more scientific, with remote sensing, GPS and data analytics all being added to farming equipment. Farmers are adopting the new equipment to make their farming more precise. Precision farming is about managing variations in the field accurately to grow more food using fewer resources and reducing production costs. Precision Agriculture is one the most important fields with an increasing need of decision support systems.

Keywords: *Fertilizers, pesticides, GPS, precision, remote sensing*

Swat primarily based assessment and prediction of global climate change and its impact

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Abstract

Climate change impacts on watershed ecosystems and hydrologic processes are multifarious. The key considerable parameters liable for balancing the watershed ecosystems are temperature and rainfall. However, these parameters are uncertain, they play a superlative role within the projections of dimensional global climate change studies. The impact of global climate change is keener about temperature and precipitation which contributes at a bigger magnitude for characterizing heating issues. The aim of this paper to forecast the variations of temperature and precipitation during the period of 1999-2018 for the west banas river basin. This study is modeled using SWAT (Soil and Water Assessment Tool) – a scale model residential to predict the impact of changes that occurs in land, soil and water over a period of time. The results from this study show that there is a decrease in the rainfall for a maximum in the month of December during the predicted period of 1999 to 2018. This study assesses the feasible adverse impact of climate change on temperature and precipitation of river basin. This kind of predictions, will help the government agencies, rulers and decision makers in policy making and implementing the revision strategies for the changing climatic conditions.

Design and fabrication of single slope solar still

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Abstract

The purpose of this project is to fabricate a solar water distillation system that can purify the water, which is impure by using a systematic arrangement must have low cost for manufacturing and works based on renewable energy of solar. There is less amount of water only left on earth that is safe to drink without purification after 20-25 years from today. 99% of Earth's water is in a solid state and other impure form and the remaining is in liquid form. Due to this reason, water purification is necessary. Because of this, purposes the solar still is constructed which will convert the impure water into pure water using the renewable solar energy. The incoming solar radiation from the sun is heating the water, which placed in the basin in impure form, and this water gets evaporated and condensed into pure drinkable water.

Keywords: *Single slope solar still, solar energy, clean water, Distilled water, Sustainable technology. Basin still, Variable collector angle, solar radiation, Design Modifications.*

Prediction and comparision of water table heights in response to left and right skewed peak recharge rates within raised bed of integrated farming system model

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Abstract

Reclamation of waterlogged sodic soils for crop management is possible through Land Modification Based integrated Farming System (LMBIFS) model. Conventional gypsum or pyrite based reclamation process is not suitable for reclamation of waterlogged sodic soils due to high rate of salt accumulation within the root zone. Design of raised bed is crucial to keep rate of salt accumulation within the root zone to the minimum. Response of water table heights with against rainfall pattern needs to be known for design of LMBIFS model. To derive an analytical solution of nonlinear governing differential equation (Eqn. 1) given below for nonlinear recharge is difficult.

$$K\left[z\frac{\partial^2 z}{\partial x^2}+\left(\frac{\partial z}{\partial x}\right)^2\right]-sK\frac{\partial z}{\partial x}+R(t)=f\frac{\partial z}{\partial t} \qquad (1)$$

Where, K is saturated hydraulic conductivity of the soil, f is drainable porosity, s is the slope of the impervious barrier, z is the water table height and distance from the ditch end and t is time.

Present study was undertaken to predict water table heights midway of the raised bed with a model developed by using water balance approach in response to left and right skewed rainfall patterns. Left and right skewed recharge rates of given forms were used to simulate water table fluctuations within the raised bed having width of 22 m resting over a horizontal impervious layer 2.0 m deep, with drainable porosity of 0.10 and saturated hydraulic conductivity of 0.85 m/day. Following recharge functions (R_t) (Fig. 1) were used in the study.

$$R_t=\frac{1}{0.3424314-0.2013421\,t+0.032550889\,t^2} \qquad (2)$$

$$R_t=\frac{1}{1.5247306-0.4322421\,t+0.031275121\,t^2} \qquad (3)$$

The left skewed rain started with an intensity of 3 mm/hr and reached a peak of 32 mm/hr after 3rd hour and acquires a level of 1.0 mm/hr after 10 hour similarly right skewed rain started with an intensity of 1 mm/hr and reached the peak of 32 mm/hr after 7 hour and receded to a level of 3 mm/hr after 10th hour.

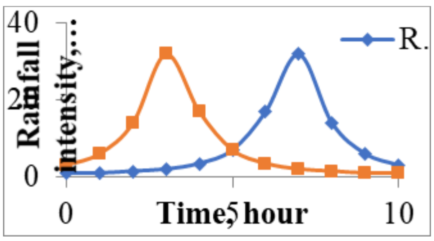

Fig. 1 Left and right skewed rainfall patterns.

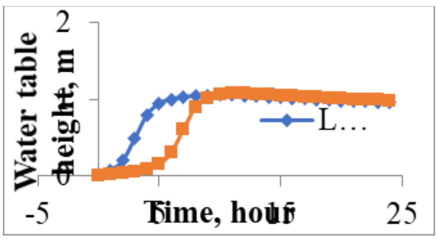

Fig. 2. Simulated water table heights.

The general solution to simulate water table fluctuations midway of the raised bed was obtained as below following a water balance approach.

$$h_t = \frac{h_{t-1}}{1+\beta t} + \frac{R_{\Delta t}}{\frac{\pi}{4} f\beta} \cdot \left(\frac{\beta t}{1+\beta t} \right) \tag{4}$$

where,

$$\beta = \frac{4Kh_{\partial}}{\frac{\pi}{4} fW^2} \tag{5}$$

f is drainable porosity, h_t is water table height against time, t; h_{t-1} is water table height against time t-1, K is saturated hydraulic conductivity of the soil, h_o is the depth raised bed, W is the width of raised bed and $R_{\Delta t}$ is recharge rain during time Δt. The model (Eqn. 4) was solved by successive approximation of water table heights and rainfall intensity. The model is also applicable to the pipe drain resting over an impervious layer for saline soil as well. The model simulated water table fluctuations quite well with left and right peak rainfall patterns. The maximum height of water table was obtained as 1.06 m after 10^{th} hour with left skewed peaked rain and 1.08 m after 11^{th} hour with right skewed peaked rain besides 4 hour difference in both peaks. Recession of water table heights became almost identical with minor difference. The model performed quite well with both rainfall patterns and could be satisfactorily used for simulation of water table heights in response of skewed recharge pattern for optimization of the bed width.

Keywords: *Land modification, saline soil, sodic soil, waterlogging & impervious layer*

Climate Resilient Agronomic Strategy for Rice Based Cropping System of Bihar

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Abstract

Agro-ecosystem restoration is a need of the day to develop climate resiliency in the agricultural system. To determine climate resiliency through agronomic practices in rice based cropping system, a field experiment was carried out during 2016-2019 at research farm, Bihar Agricultural University.The treatments consisted of two tillage practices viz. zero (M_1) and conventional tillage (M_2) as main plot, two cropping system viz. rice-wheat (S_1) and rice-maize system (S_2) as sub plot and four nitrogen management *viz*.100% inorganic fertilization (N_1), SPAD based nitrogen management (N_2), 25% of N supplement with vermicompost (N_3) and split application nitrogen at 20,40, 60 DAS in rice and wheat and 35, 70, 105 DAS in maize (N_4) as sub-sub plot. The results revealed that the Global warming Potentiality (GWP) was significantly lower under zero tillage 8033 kg CO_{2eq} ha^{-1} over conventional tillage. Between cropping system, rice-wheat cropping system has lowest GWP (7200 kg CO_{2eq} ha^{-1}) than rice-maize cropping system. Three top dressing of nitrogenous fertilizer (N_4) could lower down the Global Warming Potentiality by 7297 kg CO_{2eq} ha^{-1}. The minimum greenhouse gas Intensity (GHGI) of the system was recorded 0.83 kg CO_{2eq} kg^{-1}grain yield under zero tillage practice (M_1), while, lowest of 0.77 kg CO_{2eq} kg^{-1}grain yield was estimated from rice-wheat system and it was least at 0.70 kg CO_{2eq} kg^{-1}grain yield in split application of nitrogen management practices (N_4) as compared to other management practices. Therefore, numerous new agro-techniques should be endorsed to reduce the emission of mainly methane, nitrous oxide and carbon dioxide from agricultural system. So, rice-maize cropping system under zero tilled condition with three split application nitrogenous fertilizer would be one the climate resilient system under lower emission scenarios.Above study concluded thatadaptation of conservation agriculture especially zero tillage in rice based cropping system can curtail down global warming potential (GWP) as that of conventional tillage system without any significant loss in system yield.

Keywords: *Global warming potential, Greenhouse gas intensity, Nitrogen management, Rice-wheat system, Rice-maize system, Tillage practice*

Plant Biosecurity for Sustainable Food Security

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Abstract

India has richest bio-diversity and unique in having diverse agro-climatic zones. The great matter of concern is, possibility of invasive alien species and exotic plant pests moving into a new ecosystem due to globalization and advancements in transport, travel, tourism coupled with the liberalization of trade. Bioterrorism and biological warfare are the foremost emerging threats around the globe, which may adversely affect the nation's economy, growth and loss of lives. The transboundary movements of pathogens are major threats to plant, animal and human health. The ISSG (Invasive Species Specialist Group) of IUCN (International Union for Conservation of Nature) has identified 100 of the World's Worst Invasive Alien Species, which includes plants, animals and pests. All alien species are harmful, some are beneficial and every country has faced economic losses due to alien plant pest incursions. Import and export of agricultural commodities are major activities involving a huge amount of financial implications. Plant genetic resources for food and agriculture are crucial in feeding the world's growing population. No country is sufficient in itself and all depends on crops and the genetic diversity. Biosecurity has three main goals, i.e. Sustainability of agriculture, public health concerns and protection of environment including biodiversity. The fundamental justification for an integrated approach to biosecurity at the national level is because Human, animal and plant life and health and protection of the environment are inextricably linked. Biosecurity is a holistic concept to manage the risks to biotic and abiotic factors with policy and regulatory framework. The international standard setting bodies and the international organizations emphasis the need for an integrated biosecurity approach to tackle the risks posed to human, animal, plant and the environment.

Keywords: *Biosecurity, Sustainable agriculture, Genetic diversity*

COVID-19 Impacts on Agriculture

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Abstract

The COVID-19 pandemic has influenced the society at varying levels. It has made fitness as its pinnacle priority. Protecting the life of individuals experiencing the infection just as bleeding-edge welfare responders has been the need of countries. Governments have swung into the activities since the corona virus assault made extraordinary circumstance. It is extremely important to deliver equal precedence to rural areas as put up COVID-19, the place will be a huge function in bringing the intake fashion and economy back on track. There are numerous difficulties due to ongoing pandemic as ranchers and homestead workers set out to modify their lives and jobs. This has lead to a fall in the economy. Though agriculture sector is the only one which contributed a positive growth rate of 3.4% in the growth rate of GDP in first quarter (-23.9%) of year 2020.

Keywords: *Country Lockdown, COVID, GDP, MSME, Pandemic*

COVID-19 and the impact on agriculture and food security

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Abstract

The COVID-19 pandemic is a worldwide wellbeing emergency that is as of now impact affecting the world economy – both legitimately and through fundamental measures to contain the spread of the virus. These effects are likewise being felt by the food and horticulture segment. While the flexibility of food has held up well to date, in numerous nations, the measures set up to contain the spread of the infection are beginning to upset the gracefully of agro-food items to business sectors and purchasers, both inside and across fringes. The area is likewise encountering a considerable move in the arrangement and – for certain wares – the degree of interest. In light of COVID-19, ensuring that the food system is more sustainable and resilient is now an even more urgent priority. The COVID-19 pandemic provides an opportunity to learn more about chokepoints and vulnerabilities in the food system, in order to identify necessary investments and reforms that would further strengthen the resilience of the sector to a range of future shocks and challenges. It will be crucial to engage stakeholders in the process of understanding the full impacts of the pandemic on various population groups and the lessons to be learned. In particular, it will be important to examine the current resilience toolkit in the food system, with a view to identifying which policy measures have proven most effective and what new measures may be needed to respond to system-wide shocks. It will be particularly important to understand the factors that enable some food and farming businesses to adapt their business models quickly enough to avoid the most negative consequences. How harming these effects end up being for food security, sustenance and the employments of farmers, fishers and others working along the food chain will depend in enormous part on strategy reactions over the short, medium and long haul. For the time being, governments must deal with numerous requests – reacting to the wellbeing emergency, dealing with the outcomes of the stun to the economy, and guaranteeing the smooth working of the food framework. While the pandemic represents some genuine difficulties for the food framework for the time being, it is likewise a chance to quicken changes in the food and agribusiness division to manufacture its versatility notwithstanding a scope of difficulties, including environmental change.

COVID-19 Impacts on Agriculture and Livelihood Security

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Abstract

Agriculture remains a central pillar of the Indian economy. The sector not only serves the food consumption needs of the whole country but also tops the exporters of agricultural produce in the world. Undoubtedly COVID-19 pandemic has dealt a massive blow to India's economy and has caused enormous hardships to working people of the country. The COVID-19 pandemic has brought new risks that threaten livelihoods as well as food security. The COVID-19 crisis is not permanent but it has highlighted the potential public health crisis awaiting rural India and farming communities. Preliminary reports showed that the non-availability of migrant labor is interrupting some harvesting activities, particularly in northwest India. Lacking ordinary pay rates or salaries, this horticulture and other casual laborers would be hardest-hit during the lockdown time frame. The growers felt a dip in their returns. Mostly due to lockdown the restrictions on the movement of agriculture commodities from its place of production to the ultimate consumer has been hampered. Despite the fact that not straightforwardly, however by implication the outcome of crown infection spreading impact has ended up being a dark opening for the cultivating network. Generally because of lockdown the limitations on the development of agribusiness wares from its place of creation to a definitive shopper have been hampered. Another issue lies with the deficiency of work power because of the dread of viral transmission which eventually prompts the wastage of reaped items, for the most part foods grown from the ground which are transitory in nature, in the rancher's field itself. The Corona infection pandemic has put a potential effect on the agribusiness item store network which is a mind boggling web of maker, transporter, distributer, retailer lastly the customer. The sector has faced a number of enactments and amendments in the policies and programmers between the first Industrial Policy and Micro, Small and Medium Enterprises Development Act for better performance. It has acquired a highly regarded rest in the socioeconomic giving of India even after a variety of shortcomings in the strategy proposal, poor infrastructure, inadequate training, incomplete credit facility, higher sickness rate.

Keywords: *COVID, Agriculture, livelihood, security*

Study of livelihood Security by Adoption of Cost Effective NRM Through Agroforestry in SAT Region, Central India

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Abstract

This study was carried out in SAT (Semi-Arid Tropics) region, Central India for assessing the impacts of cost effective natural resource management (NRM) *viz*. water harvesting structures, agroforestry development, crop demonstrations with improve package of practices on livelihood security. Most of the area was fallow due to lack of implementation of natural resource management and water availability. The average annual rainfall of study area is 877 mm but maximum portion of rainfall almost (>90%) is received between June to September. Out of 292 ha agricultural land, only 71.78 ha agricultural land is cropped in kharif and 136.30 ha in rabi which has been increased after interventions by 289.22 ha in kharif crops and 157.70 ha in rabi crops. Water harvesting structures like checkdams, cost-effective checkdams, nalla plugs, well recharge units, injection pits etc. generated 24.8 thousand cubic m water , reduced number of dry wells to 2 % from 86 %, increased average available water column depth in wells about 71.06% and enhanced water availability in whole year from four to five months. In this study it was also seen how the productivity increased by 45.75% for rabi crops and 46.32% for kharif crops and cropping intensity increased by 98.38% for rabi crops and 52.26% for kharif crops after interventions. The willingness for agroforestry adoption increased by 44% and migration decreased as 70.74%. The main purpose of this study to scale-up natural resource management along with agroforestry system to sustain the farmer's livelihood. Agroforestry Based cropping system will being very helpful to increase the economics of farmers resulting improve the socio-economic status also.

Keywords: *NRM, crop, human population and agroforestry*

Resource Conservation through Alley Cropping in Interspaces of Fruit Orchards under rainfed Conditions

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Abstract

Alley cropping is the cultivation of food, forage or special crops between the rows of trees. It is a larger version of intercropping or companion planting conducted over a longer time scale. Alley cropping can provide profitable opportunities for farmers, hardwood timber growers, nut growers and Christmas tree growers.The various benefits of alley cropping are income diversification, crop production, creates cash flow and diversifies farm income, improvement of marginal and unused lands, control wind erosion, create micro-climates that improves the yield and quality of crops growing in the alleys. Agri-horti system is considered as the most ideal strategy to provide food, nutrition, income security and mitigate the fodder shortage by utilizing the interspaces of fruit plant orchards. Among the various fruit crops grown in dryland areas, aonlais the most important and grown commercially because of its high economic returns, therapeutic and nutraceutical value and its suitability for marginal lands. The tree canopy of aonla allows intercepting light and permits intercropping even after it has made full growth. Its deep root system and deciduous nature, sparse foliage makes an ideal plant amenable for intercropping. Growing of vegetables, mixed fodder crops, grass, pigeon pea in pre and post bearing stage of fruit orchards is highly beneficial economically and also enriches the soil and save from erosion especially in hilly areas.There is a dire need of developing fodder based alternate land use systems which can provide employment, food and sustainable family income. Aonla, ber, bael, lasoda, pilu*etc.* are the main fruit tree species can be grown in arid ecosystem in association with field crops under agri-horticulture system. Among fruit trees, ber is the most suitable fruit tree and these are widely spaced and their interspaces provide a scope of growing fodder crops. Moreover, due to annual pruning of ber trees, they can be trained for above ground spreading for growing of fodder crops in both the season. Most of the studies conducted so far are based on rainfed conditions by taking grain crops in interspaces. The intense rainfall, unpredictable droughts, short rainy season, high variability in rainfall between seasons, high evapo-transpiration, low infiltrability of soil, high slopes with great water erosion have activated degradation of soils with low canopy cover. Denudation of the landscape and introduction of agriculture with civilization has led to severe nutrient mining and sub-optimal soil physical and physicochemical conditions. Hence, growing different crops in the alleys of fruit trees is remunerative with respect to higher net returns, B:C ratio, improved soil health, reduced soil erosion, *etc.*

Keywords: *Alley crops, fruit trees, wind erosion, sustainability, economics, rainfed*

SWAT primarily based assessment and prediction of global climate change and its impact

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Abstract

Climate change impacts on watershed ecosystems and hydrologic processes are multifarious. The key considerable parameters liable for balancing the watershed ecosystems are temperature and rainfall. However, these parameters are uncertain, they play a superlative role within the projections of dimensional global climate change studies. The impact of global climate change is more keen about temperature and precipitation which contributes at a bigger magnitude for characterizing heating issues. The aim of this paper to forecast the variations of temperature and precipitation during the period of 1999-2018 for the west banas river basin. This study is modelled using SWAT (Soil and Water Assessment Tool) – a scale model residential to predict the impact of changes that occurs in land, soil and water over a period of time. The results from this study show that there is a decrease in the rainfall for a maximum in the month of December during the predicted period of 1999 to 2018. This study assesses the feasible adverse impact of climate change on temperature and precipitation of river basin. This kind of predictions, will help the government agencies, rulers and decision makers in policy making and implementing the revision strategies for the changing climatic conditions.

Untapped Therapeutic Uses of Medicinal Orchids

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Abstract

Orchids are considered to be the most highly differentiated and horticulturally important plants. Additionally, orchids have been used as traditional medicines in many countries since ancient times. Different organs of orchid plants, such as leaves, stems, and bulbs, contain various biologically active substances such as alkaloids, phenolics, terpenoids, and derivatives thereof. These bioactive compounds are secondary metabolites synthesized from primary metabolites of plants. To improve the utility of orchids, it is important to identify the pharmacological function of these plants. Orchids are nature's most extravagant group of flowering plants distributed throughout the world from tropics to high alpine. They exhibit incredible range of diversity in size, shape and colour of their flowers. Though orchids are grown primarily as ornamentals, many are used as herbal medicines, food, and other have cultural value by different cultures and tribes in different parts of the world. Orchids have been used in many parts of the world in traditional healing system as well as in the treatment of a number of diseases since the ancient time. Though Orchidaceae is regarded as a largest family of plant kingdom, few studies have been done regarding their medicinal properties. Many of these orchids face the extreme danger of extinction due to over-exploitation and habitat loss. Biotechnological interventions could be used as suitable alternative tool to minimize the pressure on natural population of medicinal orchids and their sustainable utilization. Orchidaceae is regarded as the largest family of plant kingdom comprising 25,000-35,000 species. Orchids, in spite of being considered as highly valuable ornamental plants are also known to possess therapeutic properties because of its rich contents of alkaloid, glycerides and other useful phytochemicals. Their application as herbal medicine in traditional folklore system is well known and widely accepted.Orchids have been used all over the world in traditional healing and treatment system of a number of diseases. Knowledge of different ethno pharmacological studies, linking of the indigenous knowledge of medicinal orchids to modern research activities provides a new reliable approach, which makes the chances of discovery of drugs much more effective than with random collection. In this perspective, orchids which have been used for centuries are the potential resources for many novel drugs. It can be predicted that more genera and species of orchid possesses the possibility of having medicinal properties and in future they can be utilized for the ever demanding lifesaving drugs.

Keywords: *medicinal orchids, therapeutic uses, phytochemicals, traditional medicines*

Collection and Evaluation of Local Banana Cultivars of Southern Kerala under Coconut

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Abstract

Field experiments were conducted at Coconut Research Station, Balaramapuram with an objective to collect, conserve and assess the performance of local banana cultivars of Southern Kerala Under coconut. Seventeen local bananas *viz*., Red banana, Pachavettan of AAA genomic group, Nendran, Palyankodan, Poovan and Karinkadali of AAB genomic group, Rasakadali and Annaan of AB genomic group, Ambalakadali, Sannachenkadali and Matti of AA genomic group and Monthan, Peyan, Karpooravally, Malayannan and Padathy of ABB group were collected from the farmers field and raised in the interrow spaces of coconut which are maintained at a spacing of 7.5 m x 7.5 m having 50 years old. The experiment was conducted in RBD in three replications. The performance of the local cultivars was evaluated in terms of bunch weight (yield), net returns from the main crop as well as ratoon. The quality attributes were evaluated in the main crop. The results revealed that all the seventeen cultivars performed well under coconut. The cultivar Kaveri recorded the lowest duration and the Red banana recorded the longest duration. Among the cultivars, the highest bunch weight and net returns were recorded by Red banana. Ambalakadali recorded the lowest bunch weight, but the cultivar Kaveri recorded the lowest return. Among the quality attributes, the cultivar Karimkadali recorded the highest total sugar and reducing sugar content. Non reducing sugar content was the highest in Nendran and the lowest in Pachavettan. The TSS content was also the highest in Nendran and the lowest in Monthan. However, the ascorbic acid content was the highest in Karpooravally and the lowest in Peyan. Considering the yield of ratoon crop, the highest yield was recorded in Red banana. The quality of Red banana was also good which recorded a total sugar of 17.86 per cent, reducing sugar of 7.69 per cent, non-reducing sugar of 9.66 per cent and it recorded a brix reading of 16.4. Hence, it can be concluded from the results that the local cultivar, Red banana can be successfully raised as an intercrop in coconut garden and it also performed the best under ratoon also. The most remarkable achievement in the adoption of this project was to collect, conserve and maintain the germplasm of the above seventeen local banana cultivars at Coconut Research Station, Balaramapuram.

Keywords: *Bunch weight, Local banana cultivars, Quality attributes, Performance evaluation, Red banana*

Role of integrated nutrient management in soil health and microbial activity under Indian subcontinent: A meta-analysis approach

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Abstract

Intensive cultivation and imbalance inorganic fertilizers use in Indian subcontinent deprived off organic matter thereby resulting loss in microbial activity and soil organic carbon (SOC). Moreover, minimal use of organic sources in the cultivated land still worsened the contentof soil carbon content particularly under subtropical climatic condition. Therefore, researchers are now focused on integrated nutrient management (INM) as modified farming systems to tackle these problems. The use of INM has not only thought of balanced fertilization and integration of inorganic and organic sources of nutrients for food security but also helps to regain soil quality in terms of upholding carbon in the soil that further improve SOC stocks and manage soil-atmosphere carbon balance. However, the effect of INM practices on SOC and soil properties is poorly quantified under Indian subcontinent due to insufficient data. Hence, the present study was aimed to quantify the impact of INM on SOC and other related soil parameters in the Indian subcontinent through meta-analysis by using MetaWin2.1. Altogether 338 paired data were collected from published literatures during the period of 1989–2019 and computed theSOC, SOC stock, microbial quotient (MQ) and CO_2equivalent emissions and compared with no fertilizer application (as control) and NPK (balanced nutrient application through inorganic sources). Among rice and wheat crops, the SOC increased by 23.2% and 34.9% in INM over the NPK and control, respectively for rice and 16.2% and 52.1% increased in INM over the NPK and control, respectively for wheat. Among soil types, in loamy soil SOC increased by 26.5% and 51.2% in INM compared to NPK and control, respectively and inclayey soils, increased by 12.3% and 23.4% in INM than NPK and control. MQ was found improved in INM than other treatments showing better soil health and microbial activity. CO_2 equivalent emissions were observed lowered in INM than NPK and control which provide the information about the amount of loss of carbon in the atmosphere due to loss of SOC stock. For all the compared treatments, the use of INM had a positive effect on soil properties as compared to other nutrient management options. Overall, the maintenance of soil health and microbial activity due to INM practices over other nutrient management practices can be a sustainable nutrient management option in the Indian subcontinent.

Keywords: *Soil organic carbon, microbial quotient, CO_2 equivalent emissions, nutrient management, sustainability*

Innovative Processes and Technologies for Nutrient Recovery from Wastes

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Abstract

Waste management is necessary for environmental and economic sustainability, but it depends upon socioeconomic, political, and environmental factors. More countries are shifting toward recycling as compared to landfilling; thus, different researchers have presented the zero waste concept, considering the importance of sustainability. New/emerging technologies could be used to recover nutrients from wastes and bring zero waste concepts in practical life. Technologies can be broadly divided into the triangle of nutrient accumulation, extraction, and release. Physicochemical mechanisms, plants, and microorganisms (algae and prokaryotic) could be used to accumulate nutrients. Extraction of nutrient is possible through electrodialysis and crystallization while nutrient release can occur via thermo-chemical and biochemical treatments. Primary nutrients, i.e., nitrogen, phosphorus, and potassium, are used globally and are non-renewable. Augmented upsurges in prices of inorganic fertilizers and required discharge restrictions on nutrients have stimulated technological developments. Thus, well-proven technologies, such as biochar, composting, vermicomposting, composting with biochar, pyrolysis, and new emerging technologies (forward osmosis and electro-dialysis) have potential to recover nutrients from wastes. Therefore, reviewing the present and imminent potential of these technologies for adaptation of nutrient recycling from wastes is of great importance. Since waste management is a significant concern all over the globe and technologies, e.g., landfill, combustion, incineration, pyrolysis, and gasification, are available to manage generated wastes, they have adverse impacts on society and on the environment. Thus, climate-friendly technologies, such as composting, biodegradation, and anaerobic decomposition, with the generation of non-biodegradable wastes need to be adopted to ensure a sustainable future environment. Furthermore, environmental impacts of technology could be quantified by life cycle assessment (LCA). Therefore, LCA could be used to evaluate the performance of different environmentally-friendly technologies in waste management and in the designing of future policies.LCA, in combination with other approaches, may prove helpful in the development of strategies and policies for the selection of dynamic products and processes.

Keywords: *waste management, wastes, nutrient accumulation, extraction, release*

INTERNATIONAL WEB-CONFERENCE *on*
Resource Management and Biodiversity Conservation to Achieve Sustainable Development Goals

September 11-12, 2020

Organized by: Academy of Natural Resource Conservation and Management, Lucknow (UP), INDIA

www.anrcm.org

Programme

DAY 1

September 11, 2020	
INAUGURAL SESSION	
Chairman : **Dr. D.K. Sharma**, Ex-Director, ICAR-CSSRI, Karnal, Haryana, India ***Co-chair*** : **Prof Annie Melinda Paz-Alberto,** Central Luzon State University, Philippines ***Convener*** : **Dr. Pradeep K. Rai**, SKUAST Jammu, India; **Dr. C.S. Singh**, CSSRI, RRS, Lucknow, India	
10:00-10:05	Welcome Address by **Dr. Atul K. Singh**, President, ANRCM
10:05-10:10	About ANRCM by **Dr. Sanjay Arora**, Secretary, ANRCM
10:10-10:15	About International Web Conference by **Dr. Sanjay Swami**, Organizing Secretary
10:15-10:35	Inauguration of International Web-Conference and **Inaugural Address** by **Prof Carmelo Dazzi**, President, European Society for Soil Conservation, Universita di Palermo, Italy
10:35-10:50	Address by Guest of Honour, **Prof. S.H.R. Sadeghi**, Tarbiat Modares University, Iran
10:50-11:10	***eynote Speaker*** **Prof (Dr.) N.S. Rathore**, VC, MUPAT, Udaipur & Ex-DDG, ICAR, New Delhi, India ***opic:*** Renewable Energy Sources for Agriculture
11:10-11:30	***eynote Speaker*** **Dr. Ashok K. Patra**, Director, ICAR-Indian Institute of Soil Science, Bhopal & President, Indian Society of Soil Science, New Delhi, India ***opic:*** Enhancing Nitrogen Use Efficiency: A Key for Soil Health and Food Security
11:30-11:50	***Lead Speaker*** **Prof. Miodrag D. Zlatic**, Belgrade University, Serbia ***Topic:*** Necessity For Soil Management For Sustainability
11:50-12:10	***Lead Speaker*** **Prof. Jiftah Ben-Asher**, Ben Gurion University of the Negev- Beer Sheva, Israel ***Topic***: Proximal sensing of nitrogen needs by spring wheat
12:10-12:15	Vote of thanks by **Dr. Nilay Borah**, Organizing Secretary

TECHNICAL SESSION- I **Efficient Soil, Water and Energy Management under diverse ecosystems**		
Chairman : **Prof. S.H.R. Sadeghi,** Tarbiat Modares University, Iran **Co-chairman** : **Dr. Vikas Sharma**, SKUAST, Jammu, India **Convener** : **Dr. Shefali Srivastava**, Lucknow; **Mr. Navneet Sharma**, PAU, Ludhiana		
12:15-12:35	***Lead Speaker*** **Dr. Vikas Sharma**, SKUAST Jammu, India	Soil erosion risk mitigation from Agricultural production systems in foothill Himalayas
12:35-12:55	***Lead Speaker*** **Dr. Nand K. Agrawal**, ICIMOD, Nepal	Solutions centric approach to Adaptation and resilience building: Experience from Hindu Kush Himalaya
12:55-13:15	***Lead Speaker*** **Dr. Zainab Khalid**, Lanzhou University, Lanzhou	Efficient water management system in diverse ecosystems

13:15-13:45	**Oral Presentations**	
	Dr. Sreeja K.	Farm level soil, water and energy conservation through efficient irrigation practices

		Mamatha Prabhakar, Sreeja, K. and Anjaly C. Sunny
	Dr. M.S. Hadda	Resilience and interactive effects of soil depth and slope position on soil chemical characteristics as affected by fencing under semiarid tropical environments *M.S. Hadda, Sanjay Arora and K.B. Thapa*
	Dr. Sileshi Abbi	Temporal and spatial variations of salt affected soils at Dubti/Tendaho state farm, north eastern Ethiopia *Sileshi Abbi, Kibebew Kibret and Amanuel Zenebe*
	Dr. M. K. Sharma	Hydro-geochemical investigations in Upper Ganga Basin, India *M. K. Sharma, Parul Prajapati, Kunarika Bhanot, Udita Wadhwa and Garima Tomar*
13.45-14.00	**Poster Presentations**	
14:00-14:30	**Lunch Break**	

TECHNICAL SESSION- II **Innovative approaches & Policy Responses for Agricultural Sustainability and Livelihood Security**		
Chairman : **Dr. Y. P. Singh**, ICAR-CSSRI, RRS, Lucknow, India **Co-chairman** : **Dr. Zachary Gichuru Mainuri,** Egerton, Kenya **Convener** : **Dr Ratna Sahay**, KVK Unnao, India; **Mr. Rohit P. Ojha**, CSSRI, RRS, Lucknow, India		
14:30-14:50	***Lead Speaker*** **Dr. Stefanos Xenarlos,** Nazarbayev University, Kazakhsthan	Gender Impacts from Weather Extremes in South India
14:50-15:10	***Lead Speaker*** **Dr. Sudarshan Dutta**, APNI, Morocco	Climate Smart Nutrient Management Approaches in Smallholder Farming System
15:10-15:30	***Lead Speaker*** **Dr. Mahesh K. Gathala,** CIMMYT, Bangladesh	Enabling smallholder farmers to sustainably improve their food, energy and water nexus while achieving environmental and economic benefits in the EGP: Conservation agriculture-based sustainable intensification for smallholder systems

15:30-16:30	**Oral Presentations**	
	Dr. U. Surendran	Nutrient budgeting using NUTMON –model for sustenance of soil fertility in humid tropical Kerala *U. Surendran and P. Raja*
	Dr.Arvind Kumar Ishar	Impact of COVID-19 on agriculture and allied sectors in Rajouri district of Jammu & Kashmir, India *Arvind K. Ishar, Suraj Parkash, Parul Gupta, Vishal Sharma, Rohit Sharma and Rajesh Kumar*
	Dr. Ravindra Kumar	Dissemination pattern of available nutrients and biological properties of soil in different four blocks of Moradabad district of Uttar Pradesh under sugarcane – wheat cropping system *Ravindra Kumar, Manoj Singh, Devendra Pal Singh, A. K. Mishra and N.C.Tripathi*
	Dr. Samikshya Sedhai	Good agriculture practices in mandarin (*Citrus reticulata* Blanco); perception and factors affecting awareness among farmers at Gulmi, Nepal *Samikshya Sedhai, Surya Dhungan, Puspa Raj Dulal and Gaurav Adhikari*
	Dr. Faiz Mohsin	Performance of wheat and mustard in Agroforestry system under Terai conditions of UP *Faiz Mohsin, N.C. Tripathi, Afreen Mohsin and S.S. Dhaka*

	Dr. A. P. Singh	Evaluation of different alternate landuse systems for rainfed sub-tropics of Jammu *A. P. Singh, Jai Kumar, Brinder Singh, A.P. Rai, Vikas Gupta, Permendra Singh and Reena*
	Dr. Syed Shamim Ahmed Simnani	Studies on revival and conservation of Kashmiri Ambri apple *Shamim A.Simnani ,Sabiha Ashraf, K.M.Bhat and M.K. Sharma*
	Dr. Shravan M. Haldhar	Bottom-up effect of difference genotypes of ber, *Ziziphus mauritiana* against bruit borer, *Meridarchis scyrodes* Meyrick *S.M. Haldhar, A.K. Singh and S. S. Singh*
	Dr. Kohima Noopur	Evaluation of yellow vein mosaic virus resistant single cross hybrids for yield and quality traits in Okra (*Abelmoschus esculentus* L. Moench) *Kohima Noopur, R.K. Samnotra Manmohan Sharma and R. K. Salgotra*
	Dr. N. A. Deshmukh	New guava varieties for subtropics of North East India *N. A. Deshmukh, H. Rymbai and A. K. Jha*
16:30-18:00	**Poster Presentations**	

DAY 2

September 12, 2020		
TECHNICAL SESSION- III **Biodiversity Conservation, Resource Management and Ecological Restoration for Sustainable Development**		
Chairman : Dr. M.S. Hadda, PAU, Ludhiana, Punjab, India **Co-chairman : Dr. Ajay K. Bhardwaj**, ICAR-CSSRI, Karnal, India **Convener : Dr. Sarabdeep Kour**, SKUAST Jammu; **Mr. Pema Rinzin**, Royal University of Bhutan		
10:00-10:20	***Keynote Speaker* Dr. Warshi S. Dandeniya,** University of Peradeniya, Sri Lanka	Carbon sequestration in soils under annual crop cultivation: challenges and way forward
10:20-10:40	***Keynote Speaker* Dr. Nakul Chettri**, Programme Manager, ICIMOD, Nepal	Biodiversity Conservation, Sustainable Development and Climate Resilience in the Himalayas
10:40-11:00	***Lead Speaker* Prof. U.K. Behera,** Dean, CoA, CAU, Kyrdemkulai	nservation agriculture for enhancing resource use efficiency and crop productivity

1:00-11:30	**ral Presentations**	
	Dr. B. N. Hazarika	Underutilized citrus fruits of Arunachal Pradesh *B. N. Hazarika*
	Dr. Sheeba Rebecca Isaac	Resource management and sustainability through organic recycling in homestead agroforestry systems *Reshma Das, Harishma S. J. and Sheeba Rebecca Isaac*
	Dr. Meenakhi Prusty	Organic Farming-A Key To Sustainable Agriculture *Meenakhi Prusty*
	Dr. Sheeja K Raj	Crop intensification for enhanced production under organic farming in Nendran banana *Sheeja K. Raj, K. Prathapan and N.V Radhakrishnan*
	Ms. Nilakhi Dutta	Exploitation of zinc solubilizing bacteria for zinc nutrition in rice *Nilakhi Dutta, Anjuma Gayan, D.J. Nath and Jyotirupa Kalita*
1:30-12:00	**Poster Presentations**	

TECHNICAL SESSION- IV **Agriculture Diversification, Nutrient Management, Soil Health and Options for Environmental Sustainability**		
Chairman : Dr. T.K. Srivastava, ICAR-IISR, Lucknow **Co-chairman : Dr. K. Rajan**, ICAR-IISWC, RC, Udghamandlam, Tamil Nadu, India **Convener : Dr. Akbar Hossain**, Bangladesh; **Dr. Rajan Bhatt**, PAU, Ludhiana		
12:00-12:20	***Lead Speaker* Dr. R.K. Singh,** ICBA, UAE	Crop diversification: Key attributes for productivity in saline, drought and heat prone marginal environment
12:20-12:40	***Lead Speaker* Dr. S.P. Vista,** NARC & Secretary, NSSS, Nepal	l fertility management in various ecological belts of Nepal
12:40-13:00	***Lead Speaker* Dr. S.K. Sharma,** MPUAT, Udaipur	bal perspective of Organic farming

13:00-13:40	**Oral Presentations**	
	Dr. Rajeev Padbhushan	Role of integrated nutrient management in soil health and microbial activity under Indian subcontinent: A meta-analysis approach *Rajeev Padbhushan, Upendra Kumar, Anshuman Kohli, Sheetal Sharma and D. S. Rana*
	Dr. Kaberi Mahanta	Long term effect of fertilizer and herbicides on soil properties and productivity of rice-rice system in rainfed lowland ecosystem under subtropical region of eastern Himalayas, India *K. Mahanta, D. J. Rajkhowa, M.J. Konwar, R.K. Parit and D. Sonowal*
	Dr. Nongthombam	Nitrogen transformation in paddy soil fertilized with urea and organic manures

	Surbala Devi	*N. Surbala Devi, Kh. Manorama and T. Sanahanbi Devi*
	Dr. Mukesh Kumar Jat	Impact of INM on soil fertility and yield in *Abelmoschus esculentus – Allium cepa* cropping system in semi arid zone of southern Haryana *M. K. Jat, R. Singh, P. K. Yadav, Amit Kumar, R.P.S. Deswal and Bikram Singh*
12:30-13:40	**Concurrent Poster Presentations**	
13:40-14:00	**Lunch Break**	

TECHNICAL SESSION- V **Precision Agriculture and Climate Smart Approaches for Sustainable Management of Resources**		
Chairman : Dr. Ashwani Kumar, Ex-Director, ICAR-IIWM, Bhubaneshwar, Odisha, India **Co-chairman : Dr. Munish Kumar,** CSAUAST, Kanpur **Convener : Ms. Divya Sahni**, Amity University, Lucknow, India; **Dr. N.K. Pareek**, SKRAU, Bikaner, India		
14:00-14:20	***Keynote Speaker*** **Prof. Ildefonso Pla Sentis,** University of Lleida, Spain & Past President, ISCO	Soil and water use and management under climate changes for sustainable agricultural developments
14:20-14:40	***Lead Speaker*** **Dr. Reeta Rai,** Bhutan	Surface water pollution due to vehicle washing activities
14:40-15:00	***Lead Speaker*** **Prof. Dillip K. Swain,** IIT Kharagpur	Climate change adaptations for food security

15:00-16:30	**Oral Presentations**	
	Dr. M.L. Gaur	River pollution and quantitative dilapidation of water resources in Gujarat *Murari Lal Gaur and Bhavin Ram*
	Dr. A. Madhavi Lata	Climate smart approach through Silvi-medicinal system *A.Madhavi Lata and Ashly Abraham*
	Dr. Santosh Marahatta	Ecological weed management practices and seed bed preparation optimized the yield of dry direct seeded rice in sub humid condition of Chitwan, Nepal *Santosh Marahatta*
	Dr. G. T. Patle	On-farm rainwater harvesting for vegetable production using low cost poly houses in NEH region *G. T. Patle*
	Dr. B.R. Bazaya	Influence of irrigation methods and weed management practices direct-seeded rice *B. R. Bazaya, R. Puniya, S. M. Dadhich, Ashiana Javeed and Supneet Kaur*
	Dr. Monika Shukla	Diversification of maize based cropping system under middle Gujarat conditions *Monika Shukla, A. C. Sadhu and Pinal Patel*
	Dr. Nirmal Kumar Patra	Mapping District Level Emission of Greenhouse Gases from the Livestock Sector of Uttar Pradesh, India *N. K. Patra and Suresh Chandra Babu*
	Dr. Anita Kumawat	Impact of crop residue management on soil properties and crop productivity under conservation agriculture in Vertisols of Central India *Anita Kumawat, A.K. Vishawakarma and Devideen Yadav*
	Dr. Tarun Adak	Characterizing hydraulic architecture and soil properties in fruit orchards for precision farming *Tarun Adak, Kailash Kumar and Vinod Kumar Singh*
	Dr. Ajay K. Bhardwaj	Sustainable resource conservation strategies for rice-wheat cropping systems and their relevance to climate resilience *Ajay K. Bhardwaj*
15:00-16:30	**Concurrent Poster Presentations**	***All Poster Sessions:*** **Chairman: Dr. Anshuman Kohli** **Co-Chairman: Dr. Anil Sharma**

PLENARY SESSION	
Plenary Speaker: **Prof (Dr.) Rattan Lal, Distinguished Professor, The Ohio State University, USA; WORLD FOOD PRIZE LAUREATE 2020**	
16:30-16:35	Welcome of Plenary Speaker by **Dr. Sanjay Arora**, Secretary ANRCM & Convener Org. Committee
16:35-17:15	**Plenary Talk by Prof. (Dr.) Rattan Lal** ***Topic***: Climate-Resilient Agriculture for Sustainable Management of Natural Resources and Advancing Agenda 2030 of the United Nations
17:15-17:45	Interaction with participants
17:45-17:50	Vote of Thanks by **Dr. Sanjay Swami**, Organizing Secretary

VALEDICTORY SESSION	
18:00-18:30	Proceedings Report and Declaration of Awards

Time as per Indian Standard Time

POSTER PRESENTATIONS

September 11, 2020 (13:45 – 14:00)		
POSTER SESSION- I **Efficient Soil, Water and Energy Management under diverse ecosystems**		
1	Annual and seasonal rainfall variability of Shillong, Meghalaya	MirbanaLusick K. Sangma
2	Effect of scheduling of irrigation with mulch under different planting methods on sugarcane juice quality	Satendra Kumar
3	Application of no till technology for sowing of Wheat and Lentil	Vimlesh Kumar Pandey
4	Effect of irrigation levels and weed management on phytotoxicity in Chickpea	Sahaja Deva
5	Optimization of irrigation and fertigation levels for turmeric in western zone of Tamil Nadu	Thiyagarajan, G.
6	Suchitha– An innovative thermochemical technology for proper solid waste management	Geethu Jacob
7	Low cost rooftop level rainwater harvesting	Dharmendra Kumar
8	Effect of deficit irrigation and plastic mulch on growth and production of drip irrigated tomato under naturally ventilated polyhouse	Dhuri Pradnya Kamalakar
10	Low cost perennial water harvesting structure, jalkund for sustainable livelihood of the Nungbrang village of Imphal east district, Manipur,India	Gunajit Oinam
11	Precision water management in different rice establishment methods	Midde Sai Kumar
12	Irrigation and nutrient coupling on growth, yield, fruit quality and water use efficiency of Indian jujube in an Inceptisol	Riasha Kar
13	Irrigation scheduling in mango (*Mangifera indica* L.) for higher water use efficiency	Arti Sharma
14	Conservation agriculture-Principal, problems and prospects in Indian conditions	Yogendra Kumar Shukla
15	Optimization of parameters for microbial degradation of benzo-α-pyrene	Arjita Punetha
16	Proficiency of water purification system against bacterial contamination in water	Nandani Raghav
17	Development of various rainwater harvesting structures to strengthen groundwater and increase crop productivity in semi-arid areas - A case study	Sarvepalli Vijaya Kumar
18	Adoption of conservation agriculture: a sustainable approach towards an efficient resource management and soil health restoration	Dipankar Saikia
19	Innovations for climate resilience in rainfed conditions in village Warkhed, District Akola of Maharashtra State	Vishal Prakash Pandagale
20	Initial and conditional probabilities of South-West monsoon rainfall at Rajouri	Rohit Sharma
21	Water quality assessment for irrigation purposes in Yamuna River	Divya Thakur
22	Weed management of wheat in rice based cropping system under	Ramphool Puniya

	conservation agriculture system	
23	Effect of soil moisture and calcium carbonate content on leaf reddening in Bt. cotton	Swati Panjabrao Zade
24	Drought phenomena its occurrence and cost effective technologies for mitigating its impact	Mukesh Kumar
25	Assessing the influence of nutrient management and irrigation method on growth of two different rice cultivars - Uma and Kanchana	Sruthi P
26	In-situ conservation of kharif moisture for timely sowing of wheat in rabi season under rainfed conditions of Rajouri	Vishal Sharma
27	Conservation agricultural practices and soil nitrogen losses through erosion in foothill Shivaliks	Divya Sharma
28	Effect of drip irrigation level and micronutrient application method on yield of Indian mustard (*Brassica juncea* L.)	O. S. Bhukhar
29	Biostimulants: Source of mitigation of moisture stress in cow pea	Preety Rani and Sarita Devi
30	Conservation Agriculture- A climate smart approach for carbon enrichment	Bishnuprasad Dash
31	Emitter spacing under point and disc source flow geometry for surface drip irrigation	Chhedi Lal Verma
32	Evaluation of evapotranspiration models for estimating reference evapotranspiration in sub-tropic region	Yadvendra Pal Singh

September 11, 2020 (16:30 – 18:00)		
POSTER SESSION- II **Innovative approaches & Policy Responses for Agricultural Sustainability and Livelihood Security**		
1	Study of livelihood security by adoption of cost effective NRM through agroforestry in SAT region, Central India	Karuna Nidhan Singh
2	Covid- 19 impacts on agriculture	Swati Singh
3	Covid- 19 pandemic and its impact on livestock sector	Mohd Yousuf Dar
4	Impact of Covid-19 pandemic on food and agriculture	Gudapati Ashoka Chakravarthy
5	Value chain management in oilseed crops	Keisham Dony Devi
6	Agroclimatic indices for prediction of groundnut yield under the middle Gujarat agroclimatic zone	Santosh Tukaram Yadav
7	Leakage compositional changes accompanying to exposure of some mango cultivars to low temperature under field conditions	Ali Ashour Shaaban Sayed
8	Germplasm evaluation and conservation strategies for Indian Elecampane	Harpal Singh
9	SWOT analysis of organic farming with special reference to Nagaland	Nchumthung Murry
10	Sustainable agriculture module for livelihood security	Ajay Babu
11	Alternative sources of soil amendments for reclamation and management of salt affected soil	Vivek Kumar Patel
12	Impact of Covid-19 on Indian agriculture	Ayushi Agarwal
13	Covid-19 challenges to the agriculture policy	Sumit Bharat

		Wasnik
14	a review paper on impact of environmental externalities in agriculture and allied sector	Rachana Bansal
15	Biorational approaches for the management of various diseases of Indian mustard	Narender Singh
16	Foliar supplementation to enhance pulse productivity	Pooja Singh
17	Heterosis, inbreeding depression, heritability and genetic advance for grain iron and zinc concentration, yield and related traits in pearl millet [*Pennisetum glaucum* (L.) R. Br.]	Mithlesh Kumar
18	Identification of simple sequence repeat markers associated for grain micronutrients concentration in pearl millet [*Pennisetum glaucum* (L.) R. Br.]	Mithlesh Kumar
19	Impact of Covid-19 on livelihood security of mountain community	Rommila Chandra
20	Resource conservation technologies in rabi pulses at farmers field and their impact on crop yield, technological and extension yield gaps	Rajesh Kumar Kanojia
21	Impact of Covid-19 on Indian agriculture	Prashant Bagade
22	Plant growth regulators and their importance in abiotic stress management	Arvind Kumar
23	Integrated farming system and their impact on productivity and rural livelihood	Mattepally Vikram Sai
24	Resource capture and utilization through canopy stratification in homesteads: a blue print of sustainability	Arunjith P.
25	Impact of Covid-19 in agriculture at current scenario	Manish Raj
26	Nutrient requirement of papaya (*Carica papaya* L.) in the homestead farming system of Kerala for yield optimisation	Bindu B.
27	Resource conservation through alley cropping in interspaces of fruit orchards under rainfed conditions	Vikas Gupta
28	Strategies for boosting indian agriculture in the current scenario	Dayanidhi Chaubey
29	Yielding behaviour of chickpea varieties under varying plant rectangularities in late sown conditions of Pantnagar	Anita Arya
30	Baseline survey and identification of problems in hill cattle production system of Pauri Garhwal district of Uttarakhand	Naresh Prasad
31	Hi-tech agriculture and scopes of agri-entrepreneurship	Shaheemath Suhara K. K.
32	Interactive effect of green manure and zinc fertilization on the physical and nutritional quality of basmati rice under Indian rice-wheat system	Devideen Yadav
33	Nitrification regulation - a mitigation strategy for nitrogen pollution in agriculture	Sruthy A. B.
34	Leaf surface inhabiting pigmented methylotrophic bacteria tapped for their plant growth promoting traits	Anjuma Gayan
35	Lycopene: A nutraceutical	Fozia Hameed
36	Suggestions from farmers to overcome the constraints in the efficient use of mobile communication technologies to transfer agricultural information	Pankaj Kumar Meghwal
37	Hydrolysis of urea by immobilized urease : An integrated approach for urease stabilization and its utilization in environmental and	Rajnish Kumar Singh

	industrial applications	
38	Response of bottle gourd to organic and inorganic fertilizers	Amit Kumar
39	Seed Invigouration: A climate-smart crop production practice	Anju B. Raj
40	Impact of Covid-19 lockdown on farming community in cold desert region-Ladakh	Phuntsog Tundup
41	A study on use of banana leaves for the treatment of burn injuries in cows	Rudraswamy M.S.
42	Impact of Covid-19 pandemic on food supply chain and food industry	Skarma Choton
43	Plant breeding techniques in the era of changes	Shefali Gupta
44	Isolation and molecular characterization of zinc solubilising bacteria and evaluation of their potential to influence the growth and yield of maize (*Zea mays*)	Aradhana Sukhwal
45	Nutritional aspects of seabuckthorn to improve the livelihood condition in Gangotri region	Richa Badhani
46	Awareness and approach of people towards biomedical waste and household waste management during Covid-19	Naveena Nazim
47	Effect of surface sterilants on survival rate of *Dalbergia sissoo* roxb. through tissue culture technique	Aaradhna Chauhan
48	Effect of microclimate on the performance of salad cucumber under naturally ventilated polyhouse	Praveena K. K.
49	Affect of Covid 19 pandemic on Agri Start-ups	Anil Bhat
50	Repercussion of Covid 19 on Indian agriculture	Amardeep Kour
51	Mentha intercropping with wheat- A boon for the Farmers	Devendra Pal
52	Agriculture diversification in India	Sushila Aechra
53	Plants used in traditional health care of livestock of Uttarkashi, Garhwal Himalaya	Jai Laxmi Rawat
54	Shelf life study of fruits and vegetables using chemical and natural preservatives	B. Naveena
55	Performance of different chemical herbicides on weed dynamics, yield and economics in spring planted sugarcane (*Saccharum officinarum* L.).	Shiv Poojan Yadav and Deepak Kumar Yadav
56	Characterization and classification of soils under different land uses in Golaghat district of Assam	Pallabi Kalita
57	Vegetable grafting for environmental sustainability	Pooja P. Gowda
58	Bt cotton in India : An overview	Gangishetti Ranjithkumar
59	Sahiwal cattle, the pride of India: An overview	Devesh Singh
60	Role of GA3 and BA in floriculture	Renuka
61	Constraints perceived by the farmers in adoption of IPM practices in cauliflower cultivation in Jaipur district of Rajasthan	Sita Ram Bijarnia
62	Impact of climate change on crop production & food security	Praveen Mishra
63	Measures to overcome the effect of Covid-19 in agriculture	Anjali Verma
64	Invasion success and management strategies for Vespula wasps	Vikram
65	Recent advances of nitrogen management in rice	Milon Jyoti Konwar
66	Covid-19 impacts on agriculture, food security and mitigation	Kuldeep Sharma

	measures	
67	Resource management through foliar feeding for increasing the pulse production – A review	Pooja A. P.
68	Covid-19 probable impacts on post harvest management : agriculture	Jyotsna Setty
69	Covid-19 impact: Rise of reforms in Indian agriculture for sustainability	Akshita Maheshwari
70	Soil acidity tolerance in crop plants	Bapsila Loitongbam
71	Impact of Covid-19 on agriculture and livelihood security	Renu Gangwar
72	Impact of covid-19 on agricultural sector and socio economic conditions of the farming community of district Poonch (J&K)	Sudhir Singh Jamwal
73	Productivity and profitability of major rainfed rabi crops as affected by traditional and mechanized planting	Vikas Gupta
74	Mango fruit an agricultural commodity in northern India supply chain merchandise	Dhruv Sanandan Bhardwaj
75	Efficient management of sugarcane based intercropping practices for crop diversification, sustainable productivity, improving soil health and environmental quality	Pallavi Yadav
76	Cadmium tolerant PGPR as agricultural diversifier: an innovative strategy for maintaining soil's health and environmental sustainability.	Ananya Roy Chowdhury
77	Aftermath of Covid-19 pandemic on Indian agriculture: unprecedented challenges and its mitigating strategies	Tannishtha Bardhan
78	Rural environmental planning an approach to environmental sustainability	Katiki Srikar
79	Covid-19 impacts on agriculture	Manisha Kumari
80	Impact of polyethylene mulch on growth and yield of tomato (*Solanum lycopersicum* l.) in sub tropical condition	Viveka Nand Singh
81	Roof top gardening: viable option for nutritional security in urban areas	Veenika Singh
82	Thermal response of potato under different sowing dates and organic mulches in north east India	G. N. Gurjar
83	Mineralization pattern of organic mulches in potato under valley lands of north east India	G. N. Gurjar
84	Integrated farming systems: an approach for livelihood security of small and marginal farmers	Sushant
85	Studies on variability, heritability and genetic advance of brinjal (*Solanum melongena* L.) for different yield attributing characters	Ch. Durga Hemanth Kumar
86	Strategies to up-scaling fodder production to sustain livestock demand: a need of hours	Sandeep Kumar
87	Rearing performance and cocoon characters of muga silk worm on primary food plants in different crop	Vikram Kumar
88	Impact of Covid-19 on Indian agriculture	Anju Yadav and Shailza
89	Covid-19 impacts on agriculture, policy responses and livelihood security	Mayank
90	Deciphering genetic inheritance and interallelic interactions for	Mithlesh Kumar

	grain micronutrients concentration, yield and its component traits by generation mean analysis in pearl millet [*Pennisetum glaucum* (L.) R. Br.]	
91	Covid 19 impact on agriculture	Rukhsana Rahman
92	Evaluation of genotypes and non-conventional chemicals against sheath rot of rice caused by *Sarocladium oryzae* (sawada) Gams and Hawksworth in Haryana	R S Chauhan
93	Impact of Covid-19 on agriculture and it reconstruction with special reference to north-east India	Arindam Deb
94	Major constraints in mango production and productivity in some villages of Lucknow district, Uttar Pradesh	Meenakshi Malik
95	Strengthening linkage between researchers and farming community through various web based and android applications in Indian agriculture	Meenakshi Malik
96	Impact of growing environment on phenological development, growth and yield of Barley (*Hordeum vulgare*) cultivars under semi-arid regions of Haryana	Karan Chhabra
97	Long term effect of fertilizer and herbicides on soil properties and productivity of rice-rice system in rainfed lowland ecosystem under subtropical region of eastern Himalayas, India	K. Mahanta
98	Screening of traditional rice cultivars due to rice root-knot nematode *Meloidogyne graminicola*	Priyanka Gogoi
99	Resource management and sustainability through organic recycling in homestead agroforestry systems	Reshma Das
100	Studies on the collection and evaluation of bael cultivars	Satpal Singh
101	Leakage compositional changes accompanying to exposure of some mango cultivars to low temperature under field conditions	Farouk M. Gadallah
102	Conversation of point source field dipper method to line source field dipper method for in-situ measurement of unsaturated hydraulic conductivity	Shubham Ojha
103	Integrated farming systems for ensuring food, nutritional and livelihood security of tribal farmers in north-eastern hill region of India	Sanjay Swami
104	Frontier technological management of intensive rice-wheat systems of south-Asia for food and environmental security	Akbar Hossain
105	Effect of weed management practices on yield, economics and weed dynamics of spring maize at Dhading Besi, Nepal	Bhimsen Shrestha

September 12, 2020 (11:30 – 12:00)		
POSTER SESSION- III Biodiversity Conservation, Resource Management and Ecological Restoration for Sustainable Development		
1	Effects of herbicides on soil microbial count under mungbean cultivation	Kuldeep Singh
2	An overview entomopathogenic fungus biological control of locust	Rajendra Kumar
3	Studies on the collection and evaluation of bael cultivars	Ankit Gavri
4	Climate change: impact on horticultural crops	Dinesh Sah
5	Climate transform variation strategies for resource management	Gyanaranjan Sahoo
6	Pollution status and conservation of Manomictic lake of Kashmir Himalaya, India	Jahangeer Mohd Reshi
7	Impact of climate change on weed menace	Devrani Gupta
8	Effect of jute caddies on physico-chemical properties of soil under chilli production	Sagnika Bhattacharyya
9	Brown manuring for effective weed management and sustainable yield in rice	Thoudam Anupama Devi
10	Sustainable farming and its future needs	Mukesh Kumar
11	Impact of climatic conditions on horticultural crop production	Yogeshwari Sahu
12	Sustainable agriculture technologies: approaching natural resource management	Leela Kaur
13	Studies on cytology, phenology and breeding system of Viola Pilosa blume : a medicinally important herb	Geeta Sharma
14	Indigenous technical knowledge (ITK) – a means to climate smart agriculture (CSA)	Shashank Sharma
15	Role of biodiversity conservation to natural environment and nutritious	Patel Tirthkumar Dasharathbhai
16	Genetic variability of morphological traits among Indian mustard (*Brassica juncea* L. Czern&Coss) genotypes under non- irrigated and irrigated condition	Khushboo Chandra
17	Role of resistant gene in the management of root-knot nematodes	Sujata
18	*Trichoderma* potential biocontrol agent for management of plant parasitic nematodes	Ritul Saharan
19	Performance evaluation of local banana cultivars of southern kerala under coconut	Dhanu Unnikrishnan
20	Biodiversity: need of the current situation for sustainable crop production	Seema
21	Role of biodiversity conservation to natural environment and food security	Patel Pinalben Bharatbhai
22	Impacts of climate change on plant growth, biodiversity and potential adaptation measures	Manjeet Singh
23	Role of plant genetic diversity in sustainable agriculture	Sandeep Kumar Bangarwa
24	Untapped therapeutic uses of medicinal orchids	Sayooj S
25	Assessment of drought tolerant *Pseudomonas* sp. on Zn and Fe biofortification and drought tolerance conferring efficacy on wheat	Amir Khan

26	Impacts of climate change on plant growth, biodiversity and potential adaption measures	Gourav
27	Impact assessment of zooplankton diversity and pollution status of river Alaknanda, Uttarakhand	Garima Tomar
28	Molecular markers approaches and role of bioinformatics in assessing diversity of germplasm resources	Ravi Kumawat
29	Role of microbes in bioremediation of polluted environment	Jaison M.
30	Diversity studies in Himalayan ginger (*Zingiber officinalerosc*.) using phenotypic and molecular markers	Ankila Salathia
31	Biodiversity and conservation of Indian goat genetic resources for sustainable development - an overview	Balbir Singh Khadda
32	Role of coffee on biodiversity conservation, restoration of ecological balance & sustainable development in agency areas of Andhra Pradesh	Atiqur Rahman Bora
33	Rhizosphere - An unexplored vista for sustainable agriculture	Arunima Babu C. S.
34	Diversity of insect fauna associated with cowpea [*Vigna unguiculata* (L.) Walp.] in southern Rajasthan	Gaurang Chhangani
35	Rhizosphere mediated nutrient management using phosphate solubilising rhizobacteria in Inceptisols of Jammu, J&K	Renu Gupta
36	Maintaining the soil health by soil biodiversity conservation: an ecological approach towards the sustainable crop production	Kishor Kumar Sahu
37	Resource conservation management for sustainable development	Rakesh Kumar
38	Effect of plantation on soil carbon stock and heavy metals in mined out forest area of Talcher, Odisha	Shraddha Mohanty
39	Dynamics of microbial population in sodic soil as influenced by enriched municipal solid waste compost and other amendments	Mamta Prajapati
40	Phosphate solubilizing microorganisms (PSMS): A promising approach as bio-fertilizers	P.K. Rai
41	Plant growth promoting rhizobacteria (PGPR) for sustainable agriculture	P.K. Rai
42	Role of tribals in conservation of biodiversity in Pir Panchal ranges of Rajouri & Poonch districts of Jammu & Kashmir, India	Arvind Kumar Ishar
43	Exploring biodiversity of foothill Himalyas for production and anticancer efficiency of l-Asparaginase	Sweeta Manhas
44	Improving the farm biodiversity and sustainability through agroforestry	Ashish Kumar
45	Kitchen and garden waste management: using microbial inoculants for enhancing crop yield in Haryana	Rahul Choudhary
46	Bio fertilizers: a promising tool for sustainable farming	Geeta Kumari
47	Soil microbes in the service of humanity	Mousumi Malo
48	Harnessing productivity potential and rehabilitation of degraded sodic lands through Jatropha based intercropping systems	Y.P. Singh
49	Interplay between forest dependency, ecosystem services and biodiversity conservation in Kalsa-Gola sub-watershed, Nainital Uttarakhand	Harish Bahadur Chand
50	Efficacy of various insecticides against the major insect pests of summer squash (*Cucurbita pepo*) in Dhading, Nepal	Sapana Parajuli

September 12, 2020 (12:30 – 13:30) concurrent		
POSTER SESSION- IV **Agriculture diversification, nutrient management, soil health and options for environmental sustainability**		
1	Soil health management through enrichment of beneficial microbes	Jaimin Rameshchandra Pandya
2	Effect of foliar application of nutrients and growth regulator on fruit cracking and yield of Pomegranate Cv. Bhagwa	Satpal Baloda
3	Sulphur desorption with different physico-chemical properties of cultivated soils of Himachal Pradesh, India	Ajay Sharma
4	Role of micronutrient for crop production and future challenges	Arvind Kumar Mishra
5	Optimization of NPK fertilizer doses through STCR target yield approach for oat (*Avena sativa* L.) grown in inceptisols of Uttar Pradesh	Vimlesh Kumar
6	Manganese transformation and availability in soils under different wheat based cropping systems in north-western India	Shreyansh Mittal
7	Conservation agriculture for soil health and environmental sustainability	Shivani Ranjan
8	Impact of residual crop establishment methods and organic manures under zero tillage pea cultivation technique after harvest of black aromatic rice	Yumnam Sanatombi Devi
9	Integrated nutrient management for agricultural production and environmental sustainability	Sumit Sow
10	Spatial distribution of available micronutrient status under different land use systems of district Doda, J&K	Tajamul Aziz Alaie
11	Effect of micronutrients on growth, yield and economics of linseed under limited irrigation	Anchal Singh
12	Release pattern of boron as influenced by applied calcium and boron in acidic soils under different soil orders	Ajin S Anil
13	Synergistic effect of vesicular arbuscular mycorrhiza (VAM) with different amendments on soil pH and phosphatase activity	Aswitha K
14	Bio-fertilizers in fruit crops for soil health and fruit production	Shyam Ji Mishra
15	Development of multifunctional microbial consortia for sustaining soil health and improving nutrient use efficiency in high mountain Himalayan agro-ecosystem	Basharat Hamid
16	Effect of sugar industry solid waste on soil biological properties	Prabhavathi N
17	Effect of phosphorus and boron fertilization on yield of black gram and their temporal availability in acid Inceptisol	Muddana Sri Sai Charan Satya
18	Response of plant nutrients on productivity, economics and nutrient uptake of maize (*Zea mays* L.) - chickpea (*Cicer arietinum*) cropping system	Girishbhai Jethalal Patel
19	Effect of biochar in improving the soil health for environmental sustainability	Soumya Pattnaik
20	Influence of lime and organic manures on growth and yield performance of baby corn (*Zea mays* L.) under rainfed condition	Kalyan Pathak

21	Nutrient dynamics as influenced by organic and inorganic inputs in rice grown in Inceptisols	Divyansh Verma
22	Comparative evaluation of soil acidity in organic and conventional system of tea cultivation for long term sustainability	Samikhya Bhuyan
23	Effect of organic manures and phosphorus levels on growth, yield and economics of cowpea	G.D. Umadevi
24	Response of boron application on yield and economics of maize (*Zea mays* L.)	Amit Phonglosa
25	Effect of integration of organic and inorganic sources of nitrogen in rice crop on soil fertility status at harvest	Harish Shenoy
26	Crop and environmental sustainability through integrated nutrient management (INM)	Srikanth Bathula
27	Effect of vermicompost and FYM to enhance soil nutrient availability and nutrient uptake of rice	R. Kamaleshwaran
28	Role of applications of various organic sources in nutrient management on the basis of soil testing along with diversified agriculture to maintain ecological restoration and natural resources management	Pawan Kumar
29	Yield and soil fertility as effected by manures and fertilizers in rice	B.Vajantha
30	Impact of integrated nitrogen management on productivity of pearl millet under rainfed conditions of Jammu	Brinder Singh
31	Validation of soil test and yield target based balanced fertilizer prescription model for glory lily on an Alfisol	K M Sellamuthu
32	Agriculture diversification for food, nutrition, livelihood and environmental security	Sundar Anchra
33	Soil health and environment	Abhimanyu Yadav
34	Impact of soil health cards on soil fertility in India	Busi Naveen
35	Impact of FYM, zinc fertilization and different RSC waters on zinc fractions, response studies, productivity and profitability of barley in Typic Ustipsamment soils of III-a agroclimatic zone of Rajasthan	Prerna Dogra
36	Minimum soil disturbances for attaining good soil health	J. D. Saritha
37	Declination of available sulphur and micronutrient status in soils of district Allahabad, Uttar Pradesh	Ranvir Singh
38	Effect of long term application of fym and nitrogen on nutrients uptake by crop and weeds	Kavinder
39	Effect of irrigation and nitrogen management on distribution of nitrate nitrogen in soil profile, plant n uptake, n use efficiencies and yield of wheat crop under zero tilled condition.	Samaresh Sahoo
40	Role of microbes in bioremediation of polluted environment	Shiva Kumar Udayana
41	Nutrient indexing for forecasting emerging deficiencies of micro and secondary nutrients in sorghum-wheat based cropping system	Prashant Awadhut Sarap
42	Role of biochar for increasing soil fertility and productivity	Naresh Kumar Yadav
43	Nutrient management in pigeionpea based inter cropping system under rainfed condition	Atik Ahamad
44	Effect of organics on P fertilizer optimization in onion crop	Kalyani Kolanpaka

45	Nutrient indexing for forecasting emerging deficiencies of micro and secondary nutrients in sorghum-wheat based cropping system	Sandeep Sevakram Hadole
46	Influence of soil test crop response based manure and fertilizer application on nutrient uptake and yield of okra	V.R. Mageshen
47	Feasibility of customised fertilizers for nutrients availability in soil and yield of rice	Neeraj Kumar
48	Soil phosphorus fractions as influenced by crop residue retention and phosphorus fertilization under maize-wheat cropping system	ChiranjeevKumawat
49	Effect of long term fertilization on nutrient availability in irrigated Soybean-wheat cropping system	Manoj Parihar
50	Impact of Resource conservation techniques on chemical properties of soil in lower Shivaliks of Jammu	Meena Yadav
51	Nutrient indexing in soils of *Gloriosa superba* crop to forecast emerging nutrient disorders	P. Malathi
52	Crop Residues: A boom for effective soil nutrient management	Asisan Minz
53	Soil carbon sequestration - good for soil health, potential contribution to climate change mitigation	Manjushree B. K.
54	Integrated Plant Nutrient Management for agriculture	A.K. Mishra
55	Land uses affect the soil carbon stocks and metabolic quotient in Alfisol ecosystem altering soil health and environmental sustainability	Amarjeet Kumar
56	Soil Test Based Fertilizer recommendations for targeted yield of Soybean in Inceptisols of Telangana	T. Srijaya
57	Field validation of Soil Test Crop Response based fertilizer recommendations for targeted yields of onion in red soils	A. Madhavi
58	Effect of nitrogen and zinc management on growth, yield and economics of bread wheat (*Triticum aestivum*) varieties	Mohd. Arif
59	Chemical speciation and availability of macro and micro nutrients in different four blocks of Moradabad district of Uttar Pradesh	Ravindra Kumar
60	Effect of organic sources of nutrients in yield, soil health and economics of vegetable crop for maintaining sustainable agriculture in RiBhoi district of Meghalaya, North-east India	Popiha Bordoloi
61	Enhancing Nitrogen use efficiency through different tools and techniques	Shivani Kumari

September 12, 2020 (15:00 – 16:30) concurrent		
POSTER SESSION- V **Precision Agriculture and Climate Smart Approaches for Sustainable Management of Resources**		
1	Feasibility of laser land levelling on yield of wheat and water saving	Naveen Kumar Singh
2	Climate smart approaches with precision agriculture for managing resources sustainably	Supriya Kumari
3	Improved Neuro-Wavelet model for flood forecast of Nagavali river basin	Rambha Venkata Ramana
4	Long term annual and seasonal rainfall variability of Agartala	Hamtoiti Reang
5	Precision agriculture and climate smart agriculture- towards a	Pritisha Patgiri

	superior and sustainable future of the sector	
6	Soil moisture effect on potassium availability and fixation	Shailja Kumari
7	2-D flood simulation using hydrodynamic model Fornagavali river basin	Karri Sai Raghava Naveen Reddy
8	Land suitability assessment of Moridhal watershed in Dhemaji district of Assam using remote sensing and GIS	Prem Kumar Bharteey
9	The role of conservation agriculture in mitigation to climate change	Payal Vyas
10	Examination of Horton and Kostiakov infiltration model for suitability on hilly slopes	Libi Robin P.
11	Assessing the performance of machine learning techniques to map soil properties from multispectral imageries	Sagar Taneja
12	Climate smart agriculture to mitigate the effect of climate change on vegetables	Pramila
13	Flood simulation using Hechms and Hec ras for Vamsadhara river basin	T. Hari Krishna
14	Challenges in adopting precision farming technologies	Kungumaselvan T.
15	Influence of fertility management on soil carbon stocks under different agro climate zones	P.V. Geetha Sireesha
16	Effect of Urocystis agropyri and different inoculum levels of Heterodera avenae on chlorophyll content and growth of wheat	Lochan Sharma
17	Precision N management in rice-wheat cropping system for higher productivity and sustainability	Pratishruti Behera
18	Presicion Agriculture:A tool towards sustainable management of resources	Sarita
19	Mapping and characterization of Melang Watershed for identification of priority areas of agriculture using GIS – A case study from Assam	Prarthana Priyom Hazarika
20	Application of Nanoscience in rhizosphere studies and smart delivery systems	Shubham Singh
21	GIS-based hypsometric analysis of the Mand sub-basin of Mahanadi river basin, Chhattisgarh, India	Shreeya Baghel
22	1. Precision Farming - A new revolution 2. Importance of Nutrient Management 3. Integrated Nutrient Management- A novel approach	Theetla Tejaswini
23	Origin and Mineralogy of Nano Clays of Indian Vertisols and their implications in selected soil properties	Ranjan Paul
24	Innovations for climate resilience in rainfed conditions in village Warkhed, District Akola of Maharashtra State	Ravikiran Shantaram Mali
25	Soil Resource Mapping and Crop Suitability Assessment by using Geo-spatial technologies in South-Eastern Rajasthan, India	Rameshwar Singh
26	Precision agriculture for sustainable management of resources	Gauri Mohan
27	Swat primarily based assessment and prediction of global climate change and its impact	Bhagyashri Ramesh Jalgaonkar
28	Design and fabrication of single slope solar still	Snehal Nanarao Dongardive
29	Prediction and comparison of water table heights in response to left and right skewed peak recharge rates within raised bed of integrated farming system model	Gyan Singh

30	Climate resilient agronomic strategy for rice based cropping system of Bihar	Suborna Roy Choudhury
31	Sustainability in fruit orchard ecosystem-a way for assessing precision management	Tarun Adak
32	Climate smart breeding – need or greed?	Shanmugam A.
33	Soil organic carbon stocks under various temperature and moisture regimes as an indicator of climate change	Priyanka Kumari
34	Daily river flow forecasting using wavelet ANN hybrid models	Manish Kumar
35	Effect of sediment particle orientation on incipient motion	Anuradha Kumari
36	Reservoir water spread area estimation using different image classification techniques	Pydi Srinivasa Rao
37	Precision agriculture and climate smart approaches for sustainable management of resources	Yogita
38	Precision agriculture and climate smart approaches for sustainable management of resources	Neha
39	Enterprise selection in farming system for livelihood security under changing climate scenario	Lalit Kumar Verma
40	River basin modeling using SWAT model	Ayushi Trivedi
41	Application of nanoscience in Rhizosphere studies and smart delivery systems	Shubham Singh
42	Plant Biosecurity for Sustainable Food Security	Duddukur Rajasekhar
43	Impact of different herbicides on growth and yield of direct seeded rice (*Oryza sativa* L.)	Manoj K. Singh
44	Precision agriculture and climate smart approaches for sustainable management of resources	Astha Pandey
45	Effect of planting dates and sources of nitrogen on growth and yield of cauliflower (var-snow mystic) at Rampur, Chitwan, Nepal	Binaya Baral