Journal of Natural Resource Conservation and Management
Vol. 7, No. 1, pp 115-118, 2026
doi: 10.51396/ANRCM.7.1.2026.115-118

Micronutrient status of soils under Zabo farming system of Nagaland, India

Sanjay-Swami* **and Shilpa Mohanty**

School of Natural Resource Management, College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University, Umiam (Barapani) - 793103, Meghalaya, India
**Corresponding author email: sanjayswamionline@gmail.com*

Received : April 04, 2026
Revised : May 28, 2026
Accepted : May 29, 2026
Published : June 30, 2026

ABSTRACT

Long-term usage of a certain land use system may alter the micro-nutrients status of the soil, changing its soil quality and nutrient availability to crops. Keeping this in view, an investigation was carried out to assess the micro-nutrients availability under Zabo farming system, an indigenous farming system practiced by the Naga tribe in Nagaland. Three villages from Phek district of Nagaland where farmers are practicing Zabo farming system were selected. From each village, 3 sites i.e., terrace, valley and hilltop forest as a reference were selected and from each site, one composite soil sample from 0-15 cm and 15-30 soil depth were collected. The soil samples were analyzed for soil available micro-nutrients status. For group comparison among 3 villages and 3 forest sites, non-parametric Kruskal-Wallis H-test incorporating Monte-Carlo significance test at 95% confidence limit was used. The result revealed that the content of DTPA Fe varied from 24.73-25.97 ppm in cultivated soil of Zabo farming system and 19.37-25.77 ppm in forest soil under both soil depths. The values of DTPA-Cu ranged from 1.22-1.44 ppm in cultivated soil of Zabo farming system and 0.12-0.37 ppm in forest soil. The concentration of DTPA-Mn ranged from 4.95-7.11 ppm in cultivated soil and 1.16-2.41 ppm in forest soil. The value of DTPA Zn ranged from 0.12-0.43 ppm in cultivated soil of Zabo system and 0.06-0.08 ppm in forest soil.

Keywords: Zabo farming system, Forest soils, Soil micro-nutrient status, Nagaland

INTRODUCTION

Traditional agriculture is often considered a step between the local hunt-and-gather practice, which provides communities with subsistence levels of food, and the practices of modern agriculture, used for mass-production of food for global distribution. This traditional agriculture practice develops a balance between meeting our present needs, conserving natural resources, and protecting the environment for the benefit of future generations (Sanjay-Swami, 2018). Traditional agricultural approaches are not practical for mass food production, but accounts for a substantial amount of local food production in the developing world. The farmers of North-East India rely on a variety of agricultural practices, including a variety of sedentary systems, such as wet-rice cultivation, fallow systems, shifting cultivation, home gardens, etc. (Ramakrishna, 1992; Sanjay-Swami, 2021). In Nagaland, a highly scientific approach for combining various crops, livestock, and fisheries is used which is known as Zabo farming system. The word 'Zabo' is derived from the Chakhesang word 'zabö' which means 'impounding runoff water.' In certain other areas, Zabo is sometimes referred to as the Dzüdü or Ruza system. It combines forestry with horticulture, agriculture, fisheries, and animal husbandry and has a strong foundation in soil and water conservation. The system, created by smart and skilled tribal people, is so exceptional in the development and administration of water resources that even contemporary approaches appear to be no match for it. It is now practiced in many Chakhesang tribe inhabited areas of Phek district. Even though the Kikruma region of the Phek receives sufficient rainfall, people there experience a water shortage because of surface runoff. Due to the lack of water, they were obliged to develop a complex system of water gathering, which gave rise to Zabo farming system (Sanjay-Swami *et al.,* 2021).

Zabo farming system is a magnificent planning of harvest runoff water and cultivate which has been practicing over a decade ago. But the properties of the soil, the dynamics of the nutrient cycle, and soil fertility are unknown which may harm the ecological balance (Sanjay-Swami, 2020a). Long-term usage of a certain land use system may alter the physico-chemical characteristics, especially micro-nutrient status of the soil, changing its fertility status and nutrient availability to plants (Tsanglao *et al.*, 2014). One of the key environmental elements that might affect plant growth and severely restrict crop growth and production is soil acidity. In hilly states like Nagaland, the issue of soil acidity is particularly serious and is acknowledged as a significant agricultural issue (Mishra, 2004). Plant growth, development, and yield are significantly influenced by the micro nutrient availability of the soil, and knowledge of the status can help with planning effective nutrients usage and soil management techniques. The inherent capacity of soil to provide essential plant nutrients for absorption by crops is made easier with knowledge about the status of the soil's nutrient resources (Sanjay Swami, 2020b; Yumnam and Sanjay Swami, 2022). However, scanty information is available on micro-nutrient availability status of Zabo farming system being practiced in Phek district of Nagaland. Therefore, the present investigation was carried out to assess the micro-nutrient status in Zabo farming system.

Study area

Zabo farming system is now practiced in many Chakhesang tribe inhabited areas of Phek district. Phek district is located in the south-eastern part of Nagaland (Fig. 1). It is bounded between 94°11′ and 95° East Longitudes and 25°28′ and 26° North Latitudes. The name of the district headquarters is also Phek. The district is bounded by Myanmar in the East, Zunheboto and Tuensang districts in the North, Manipur state in the South and Kohima district of Nagaland in the West. The main tribes of the district are "Chakhesangs" and "Pochurys". The district enjoys a humid sub-tropical climate. It receives southwest monsoon with annual average rainfall of 1,527 mm. The maximum rainfall occurs during the months of June and July. Rainfall generally begins from April and continues till the end of September. The area enjoys a cold winter and mild summer.

Fig. 1. Study area

Physiographically, the district is mostly occupied by NE-SW trending hill ranges, with limited intermountain valleys. The average mean temperature is 25-30°C during summer and the temperature fall even to around 0°C during peak winter in some place. In winter season occasionally the district enjoys snow fall also. The landscape is mostly covered with closed to open broadleaved evergreen or semi deciduous forests. Agriculture is the main occupation with 80.84 % of the population engaged in agriculture. The total cropped area of the district is 27500 ha (inclusive of fruit crops) however the net area sown is 25521 ha with net irrigated area of 12700 ha.

MATERIALS AND METHODS

The present study was conducted during 2022-23 to assess the micro-nutrient availability status under cultivated (terrace and valley) and hilltop forest soil (0-15 cm) under Zabo farming system. Three villages from the Phek district were selected for soil sampling. One composite soil sample from cultivated area and one sample from the hilltop forest soil were collected from each selected village depth wise (0-15 cm and 15-30 cm). Collected soil samples were analyzed for the micronutrients *viz.*, Zn, Fe, Cu, Mn which were estimated using the method suggested by Lindsay and Norvell (1978). Ten gram of 2 mm sieved soil was shaken with 20 ml of the

Diethylene triamine pentaacetic acid (DTPA) (0.005 M) + Triethanolamine (TEA) (0.1M) + Calcium chloride ($CaCl_2.2H_20$) (0.01 M) reagent (pH 7.3) for 2 hrs. The extract was filtered through Whatman No. 42 filter paper. The clear filtrate was used for the estimation of micronutrient cations *viz.*, Zn, Fe, Cu, Mn and concentrations were measured by atomic absorption spectroscopy (Lindsay and Norvell, 1978) and expressed in ppm. The values were analyzed by SPSS (v.01) for group comparison using non-parametric Kruskal-Wallis H test incorporating Monte-Carlo significant test at 95% confidence limit.

RESULTS AND DISCUSSION

Micro-nutrients status

The result obtained in this study demonstrated that the content of DTPA Fe varied from 24.73-25.97 ppm in cultivated soil of Zabo farming system and 19.37-25.77 ppm in forest soil under both soil depths. The maximum (25.97 ppm) and minimum (24.73 ppm) concentration of DTPA-Fe was in Tetsumi (0-15 cm) and Losami (15-30 cm), respectively. Values of DTPA-Cu ranged from 1.22-1.44 ppm in cultivated soil of Zabo farming system and 0.12-0.37 ppm in forest soil. The maximum content of DTPA-Cu i.e., 1.44 ppm was observed in Losami (0-15 cm) and minimum was recorded 0.12 ppm in Tetsumi (15-30 cm) in Zabo farming system. The concentration of DTPA-Mn ranged from 4.95-7.11 ppm in cultivated soil and 1.16-2.41 ppm in forest soil. The maximum concentration of DTPA Mn i.e., 7.11 ppm was recorded in Losami (0-15 cm) and the minimum i.e., 1.16 ppm was also recorded in Losami but in 15-30 cm soil depth. The value of DTPA Zn ranged from 0.12-0.43 ppm in cultivated soil of Zabo system and 0.06-0.08 ppm in forest soil. The maximum (0.43 ppm) and minimum (0.06 ppm) concentration of DTPA-Zn was in Losami (0-15 cm) and Tetsumi (15-30 cm), respectively. There is significant difference among means rank of cultivated soil and forest soil in terms of their micronutrient i.e., DTPA-Cu, Mn, Zn, except DTPA-Fe, which was non-significant (Table 1 and 2 tests of significance at 5%).

In this study, the content of DTPA- Fe, Mn, Zn, Cu were higher at cultivated soil of Zabo system than forest soil. An increase in DTPA-extractable Zn may be due to the chelating activity of organic molecules generated during organic source degradation, which boosted micronutrient availability by inhibiting fixing, oxidation, precipitation, and leaching. Similar findings were also noted by Talukdar *et al.* (2009) and Yadav *et al.* (2018). Zn availability is associated with pH and its deficiency can be seen with soil having pH above 6.5 (Nene, 1966; Katyal and Ponnamperuma, 1974). Zn availability is decreased due to increase in pH and precipitation of $Zn(OH)_2$ (Trierweiler and Lindsay, 1969). The increase in soil Fe status above its starting state may be due to induced submerged circum-

Table 1. Micro-nutrients of soils (0-15 cm) under Zabo farming system

Properties / Villages	Fe (ppm)		Cu (ppm)		Mn (ppm)		Zn (ppm)	
	CS	FS	CS	FS	CS	FS	CS	FS
Kikurma	25.71	20.72	1.33	0.37	5.23	2.41	0.15	0.08
Losami	25.36	25.77	1.44	0.12	7.11	2.09	0.43	0.08
Tetsumi	25.97	24.76	1.36	0.31	6.03	1.51	0.38	0.06
Mean	24.23 ± 3.44		1.01 ± 0.79		4.36 ± 2.00		0.19 ± 0.12	
Monte-carlo test of significance (p≤0.05)	0.100		0.000		0.000		0.000	

Table 2. Micro-nutrients of soils (15-30 cm) under Zabo farming system

Properties / Villages	Fe (ppm)		Cu (ppm)		Mn (ppm)		Zn (ppm)	
	CS	FS	CS	FS	CS	FS	CS	FS
Kikurma	24.84	19.37	1.22	0.37	4.95	1.67	0.12	0.07
Losami	24.73	25.15	1.39	0.12	5.76	1.16	0.37	0.07
Tetsumi	24.73	23.36	1.33	0.28	5.88	1.62	0.35	0.06
Mean	23.34 ± 3.78		1.00 ± 0.79		4.05 ± 1.84		0.16 ± 0.11	
Monte-carlo test of significance (p≤0.05)	0.067		0.001		0..001		0.000	

stances and lowering of soil pH throughout the rice growing season, resulting in an increase in soluble Fe^{2+} ions in the soil. All cationic micronutrient shows increasing to decreasing order comparing to surface to subsurface depth in Zabo farming system. The reduction of Fe^{3+} to Fe^{2+} and Mn^{4+} to Mn^{2+} results increase in availability of plants uptake in the flooded soil (Fageria and Stone*,* 2008). The toxicity of Fe in rice field under submerged condition is the most common problem observed which leads to deficiency of other nutrients like K, P, Ca and Mg. Fish-cum-paddy culture also practiced in Zabo farming system.

CONCLUSION

In the present study, it has been observed that the DTPA–Fe was much higher in cultivated soil due to which bronzing of rice was seen and there was no significant variation between mean ranks. The DTPA extractable Cu, Zn, and Mn were also higher in cultivated soil than forest soil of Zabo farming system. Further, all cationic micronutrient showed decreasing values from surface (0-15 cm) to subsurface depth (15-30 cm) in both cultivated soils under Zabo farming system and forest soils.

AUTHOR CONTRIBUTIONS

Each author contributed equally.

ACKNOWLEDGEMENT

The financial assistance provided by Central Agriculture University, Imphal for conducting the research is fully acknowledged.

CONFLICT OF INTEREST

There is no conflict of interest.

REFERENCES

Fageria, N.K. and Stone, L.F. (2008). Micronutrient deficiency problems in South America. In: Alloway, B.J., Ed., *Micronutrient Deficiencies in Global Crop Production*, Springer, New York, 245-266. http://dx.doi.org/10.1007/978-1-4020-6860-7_10.

Katyal, J.C. and Ponnamperuma, F.N. (1974). Zinc deficiency: A widespread nutritional disorder of rice in Agusan del Norte. *Philippine Agriculturist*, *58*(3&4), 79-89.

Lindsay, W.L. and Norvell, W.A. (1978). Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil Science Society of America Journal*, *42*(3), 421-428. https://doi.org/10.2136/sssaj1978.03615995004200030009x

Mishra, U.K. (2004). Acid soils and its management. *Journal of Indian Society of Soil Science, 52*, 332-343.

Nene, Y.L. (1966). Symptom, cause and control of Khaira disease of paddy. *Bull India Phytopathol Society*, *3*, 97-101.

Ramakrishna, P.S. (1992). Shifting agricultural and sustainable development: An interdisciplinary study from North Eastern India, MAB Book series, UNESCO, (Paries and Parthenen publishing group UK).

Sanjay-Swami (2018). Shifting cultivation: A tribal way of life in North East India and alternative approaches for increasing productivity. *The Pharma Innovation Journal, 7*(3), 380-385.

Sanjay-Swami (2020a). Ecosystem approach: Shaping the future of farming in North Eastern Region of India. *Research Trends in Agricultural Sciences,* Vol. 22, ed. Naresh, R.K., AkiNik Publications, New Delhi, India, pp. 169-191. ISBN: 978-93-90217-59-5.

Sanjay-Swami (2020b). Soil health management under organic production system. *International Journal of Chemical Studies, 8*(2), 330-339. DOI: https://doi.org/10.22271/chemi.2020.v8.i2e.8789

Sanjay-Swami (2021). Integrated management of land, water and bioresources for sustainable agriculture in North Eastern Region of India. *Grassroots Journal of Natural Resources, 4*(2), 136-150. DOI: https://doi.org/10.33002/nr2581.6853.040210.

Sanjay-Swami, Singh, S., Patgiri, P., Raj, V.A. and Singh, T.D. (2021). Ecological sustainability in agricultural production intensification: NER perspective. In: *Sustainable Agriculture: Recent Advances,* (eds.) Sanjay-Swami and Singh, S., Biotech Books, New Delhi, India. pp. 1-20. ISBN: 978-81-7622-493-2.

Talukdar, M.C., Basumatary, A. and Dutta, S.K. (2009). Status of DTPA–extractable cationic micronutrients in soils under rice and sugarcane ecosystems of Golaghat district in Assam. *Journal of the Indian Society of Soil Science*, *57*(3), 313-316.

Trierweiler, J.F. and Lindsay, W.L. (1969). EDTA-ammonium carbonate soil test for zinc. *Soil Science Society of America Journal*, *33*, 49-54. https://doi.org/10.2136/sssaj1969.03615995003300010017x

Tsanglao, C., Sharma, Y.K. and Sharma, S.K. (2014). Fertility status and soil acidity under different land use systems in Wokha district of Nagaland. *Journal of the Indian Society of Soil Science, 62*, 414-418.

Yadav, B.K., Sidhu, A.S. and Kumar, D. (2018). Status of DTPA-extractable micronutrients in soils of Bathinda district of Punjab, India. *Agricultural Research Journal*, *55*(2), 358. doi. 10.5958/2395-146X.2018.00065.0

Yumnam, V. and Sanjay-Swami. (2022). Performance of Lakadong turmeric (*Curcuma longa* L.) under integrated application of farm yard manure, vermicompost and chemical fertilizers. *Biological Forum – An International Journal, 14*(3), 515-520.