AN ASSESSMENT OF SOIL FERTILITY STATUS AND PREPARATION OF THEIR MAPS OF HORTICULTURE RESEARCH STATION, MALEPATAN, NEPAL

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ABSTRACT

A study was conducted to examine and map the soil fertility status of the Horticulture Research Station, Malepatan. The research farm is situated within latitude 28°13'07"N and longitude 83°58'21"E at altitude 850 m above sea level. Forty samples were collected randomly at depth 0-20 cm. A GPS device was used to identify the location of the soil sampling points. Soil samples thus collected were analyzed for their texture, pH, OM, N, P, K, Ca, Mg, S, Zn, Fe, Cu, Mn and B status following standard methods in the laboratory of SSD, Khumaltar. The soil fertility status maps of each nutrient were prepared using ArcGIS 10.1 software. Evaluation of data showed that the soil was silt-loam, very acidic to moderately alkaline in pH (4.4- 7.6) and very low to high in Organic Matter (0.50-7.2%). Regarding the macronutrients; low to high total N (0.05 - 0.23%), very low to very high available phosphorus (6-710Kg ha^{-1}), Very low to medium extractable potassium (13- 260 Kg ha^{-1}), low to high extractable calcium (96 - 2470 ppm), low to medium extractable magnesium (27.8 -131.8 ppm) and very low to high Sulphur (1- 16.6 ppm) were observed. Likewise, the status of micronutrients was low to high in DTPA-Zinc (0.8-7.7 ppm), The specific locations of various soil sampling points were determined using Global Positioning low to very high in DTPA-Iron (8.7-47.1ppm), medium to very high in DTPA-Copper (0.9-7.5ppm), very low to high in DTPA-Manganese (2.3-18.9ppm) and very high in hot water Boron (2.3 – 5.9 ppm). The overall assessment of the research farm revealed very high variation on the fertility status, which might be due to the heterogeneity on the management practices for various research purposes within the farm. Looking upon this variation in fertility status, application of the fertilizer dose to each crop based on the soil test rather than on a blanket approach is suggested to make research works more reliable and the farm management more efficient and sustainable. Nutrient categories portrayed on the prepared soil fertility maps can serve as an important aid in this regard.

Key words: *ArcGIS, Global Positioning system, Soil fertility status and Soil fertility Maps*

Introduction

Soil is the "soul" of infinite life and is generally referred to the loose materials composed of weathered rock and other materials including partly decayed organic matter. The sustainable productivity of a soil mainly depends upon its ability to supply essential nutrients to the growing plants. Soil fertility is defined as the ability of a soil to supply essential elements for plant growth without a toxic concentration of any element (Foth, 1990). It is determined by the presence or absence of nutrients i.e. macro and micronutrients. The success or failure of agriculture is closely related to the existing soil conditions. A shortage of nutrients due to declining fertility of the soil can cause serious restrictions to crop growth.

Soil fertility evaluation is a key feature of modern soil fertility management. The basic purpose of soil fertility evaluation has always been to quantify the ability of soils to supply the nutrients required for optimum plant growth. Knowing this, we can optimize the nutrient management practice needed to achieve economically optimum plant performance. Soil analysis is a key of soil fertility evaluation. It includes interpretation, evaluationand recommendations of fertilizer and amendments based on the result of chemical analyses and other considerations (Peck and Soltanpour, 1990). Describing the spatial variability of soil fertility across a field has been difficult until new technologies such as Global Positioning Systems (GPS) and Geographic Information Systems (GIS) were introduced. GIS is a powerful set of tools for collecting, storing, retrieving, transforming and displaying spatial data (Burrough and McDonnell, 1998).

Nepal agricultural research council (NARC) was established to conduct agricultural research in the country to uplift the economic level of the people. Horticulture research station, Malepatan was established in western region of Nepal to run the horticultural crop research efficiently. The soil fertility condition of the research farm is deteriorating gradually because of the blanket application of macro-nutrients regularly before the commencement of every field experiment. The crop performance in the farm is also not satisfactory due to the very problems caused by unmanagedsoils. The assessment of nutrient status in the farm as well as the preparation of their status maps have not been done yet. Therefore, this study was conducted with following objectives:

1. To assess soil fertility status of Horticulture research station, Malepatan
2. To prepare soil fertility maps for the determined soil fertility parameters

Materials and Methods

Description of the Study Area

The study area i.e.Horticulture research station lies in Malepatan of Kaski district. The research farm is geographically situated within latitude 28°13'07"N and longitude 83°58'21"E at altitude 850 m above sea level (Fig. 1).

Soil Samples Collection

Altogether forty Soil samples were collected randomly at 0-20 cm depth during March 2014. The sampling points were selected based on the variability of the land. The distribution of soil sample points are shown on the fig 2. The specific locations of various soil sampling Points were identified using handheld Global Positioning System (GPS) receiver.

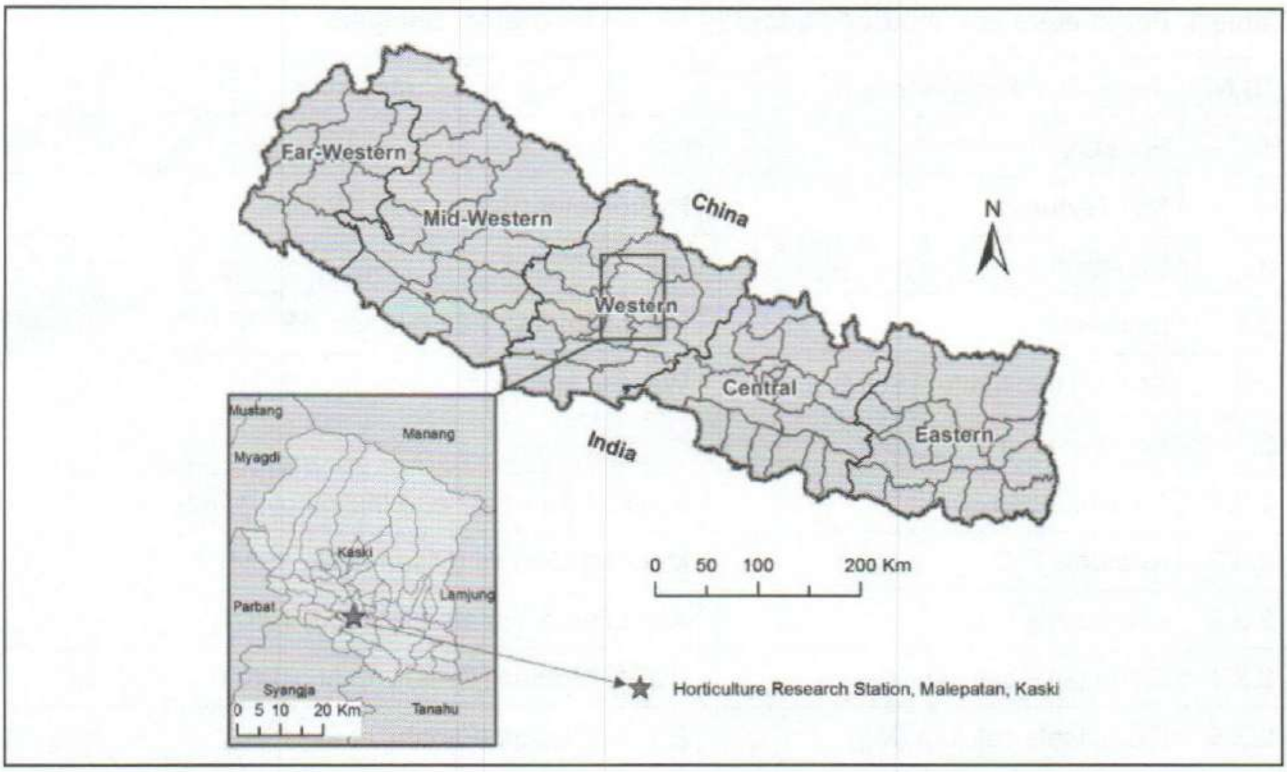

Figure 1. Location Map of Horticulture Research Station, Malepatan

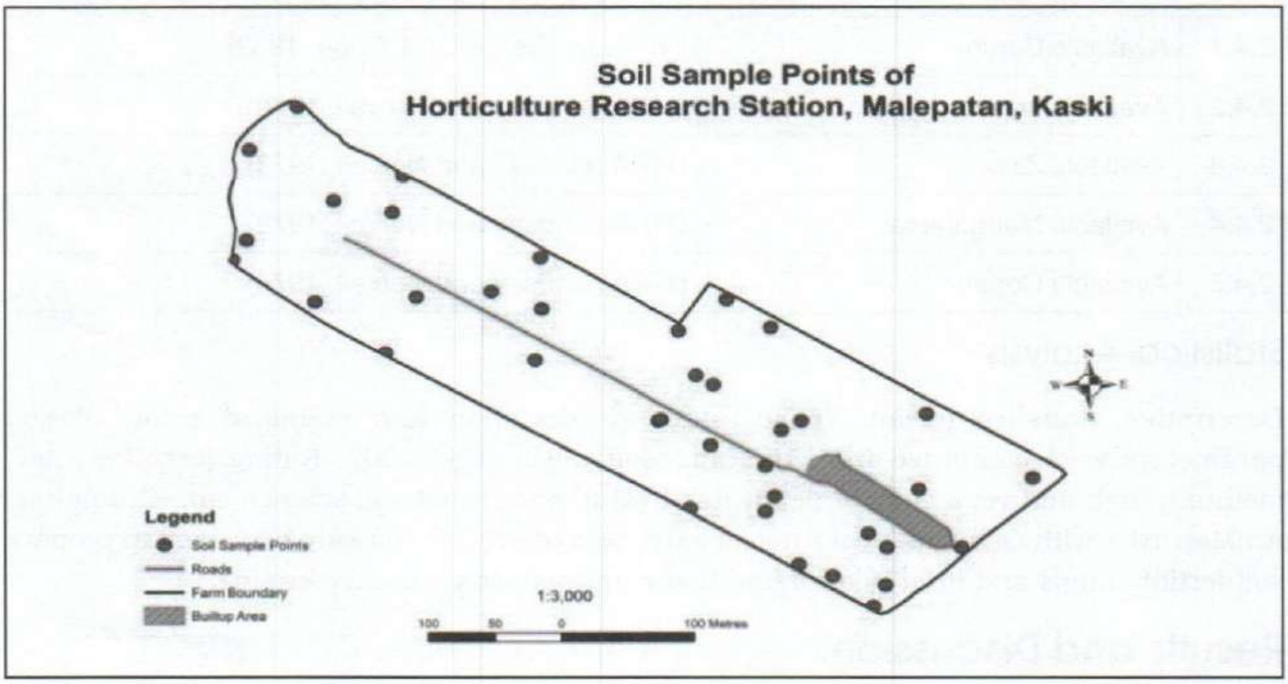

Figure 2. Distribution of soil sample points in the Horticulture Research Station, Malepatan

Laboratory Analysis of Samples

The collected samples were dried at room temperature and ground in powder form and analyzed in the laboratory for the determination of different chemical properties at Soil Science Division, Khumaltar. The different methods adopted for Physical and chemical properties determinations are listed under the table 1.

Table 1. Parameters and methods adopted for the laboratory analysis

S.N.	Parameters	Methods
1.	Physical	
	Soil Texture	Hydrometer (Bouyoucos, 1927)
2.	Chemical	
2.1	Soil pH	Potentiometric 1:2 (Jackson, 1973)
2.2	Soil organic matter (SOM)	Walkely and Black (Walkely, 1947)
2.3	Macro-nutrients	
2.3.1	Total nitrogen	Kjeldahl (Bremner and Mulvaney, 1982)
2.3.2	Available P_2O_5	Modified Olsen's (Olsen et al., 1954)
2.3.3	Extractable K_2O	Ammonium acetate (Jackson, 1967)
2.3.4	Extractable calcium (Ca)	EDTA Titration (Elmahi, et.al. ,1987)
2.3.5	Extractable calcium (Mg)	EDTA Titration (Elmahi, et.al. ,1987)
2.3.6	Available Sulphur ($SO_{4-}S$)	Turbidimetric (Verma,, 1977)
2.4	Micro-nutrients	
2.4.1	Available Boron	Hot water (Berger and Truog, 1939)
2.4.2	Available Iron	DTPA (Lindsay and Norvell, 1978)
2.4.3	Available Zinc	DTPA (Lindsay and Norvell, 1978)
2.4.4	Available Manganese	DTPA (Lindsay and Norvell, 1978)
2.4.5	Available Copper	DTPA (Lindsay and Norvell, 1978)

Statistical Analysis

Descriptive statistics (mean, range, standard deviation and standard error) of soil parameters were computed from the Microsoft office excel 2007. Rating (very low, low, medium, high and very high) of determined value was based soil science lab, Khumaltar. ArcMap 10.1 with Geostatistical Analyst extension of ArcGIS software was used to prepare soil fertility maps and interpolation method employed was ordinary kriging.

Results and Discussion

Mean, range, standard deviation (SD) and standard error (SE) of soil properties of the research farm are presented on the Tables and Figures.

Soil Texture

Silt loam soil texture was observed on the majority of the study area of the farm.

Soil pH

Acidic soil reaction was observed on the study area of the farm (fig.3). The lowest mean was 4.35, while highest mean was 7.48.

Soil Organic Matter

Medium status of soil organic matter was observed on the study area of the farm (fig.4). The highest mean was 4.0%, while lowest mean was 2.4%.

Total Nitrogen

Medium range of nitrogen was observed on the study area of the farm (fig.5). The highest mean was 0.23%, while lowest mean was 0.05%.

Available Phosphorus

The high status of the available phosphorus was observed on the study area of this farm (fig.6). The highest mean was 202.9 Kg ha^{-1}, while lowest mean was 99.0 Kg ha^{-1}.

Extractable Potassium

The very low to medium status of extractable potassium was observed on the study area of the farm (fig.7). The lowest mean was 35.1Kg ha^{-1}, while highest mean was 154.0 Kg ha^{-1}.

Extractable Calcium

Very low status of extractable calcium was observed on the study area (fig. 8). The lowest mean was 96 ppm, while highest mean was 2470 ppm.

Table 2. Soil fertility status of Horticulture Research Station, Malepatan, Kaski, 2014

Summary statistics	Soil Fertility Parameters						
	pH	OM (%)	N (%)	P_2O_5 Kg ha^{-1}	K_2O Kg ha^{-1}	Ca (ppm)	Mg (ppm)
Mean	5.76	3.35	0.13	133.29	89.47	721.40	57.80
Standard Error	0.13	0.22	0.01	26.21	10.57	95.49	3.71
Median	5.68	3.29	0.13	65.08	64.28	574.00	54.45
Standard Deviation	0.82	1.40	0.04	165.77	66.88	603.96	23.45
Minimum	4.35	0.50	0.05	6.00	13.02	96.00	27.83
Maximum	7.58	7.23	0.23	710.41	260.31	2470.00	131.89
Count	40	40	40	40	40	40	40

Extractable Magnesium

Low to medium status of extractable calcium was observed on the study area (fig. 9). The lowest mean was 27.83 ppm, while highest mean was 131.89 ppm.

Available Sulphur

Low to medium status of extractable magnesium was observed on the study area (fig. 10). The lowest mean was 27.83 ppm, while highest mean was 131.89 ppm.

Available Boron

Very high status of extractable boron was observed on the study area (fig. 14). The lowest mean was 2.27 ppm, while highest mean was 5.93 ppm.

Available Zinc

High status of extractable zinc was observed on the study area (fig. 12). The lowest mean was 0.8 ppm, while highest mean was 7.73 ppm.

Available Iron

High status of extractable iron was observed on the study area (fig. 11). The lowest mean was 8.73 ppm, while highest mean was 47.13 ppm.

Available Copper

High to very high status of extractable iron was observed on the study area (fig. 13). The lowest mean was 0.93 ppm, while highest mean was 7.53 ppm.

Table 3. Soil fertility status of Horticulture Research Station, Malepatan, Kaski, 2014

Summary Statistics	Soil Fertility Parameters (ppm)					
	S	Zn	Fe	Cu	Mn	B
Mean	7.27	3.86	22.80	2.67	7.90	3.70
Standard Error	0.83	0.25	1.32	0.28	0.49	0.15
Median	5.33	3.72	21.40	1.95	7.97	3.66
Standard Deviation	5.22	1.59	8.36	1.77	3.12	0.97
Minimum	1.00	0.80	8.73	0.93	2.27	2.27
Maximum	16.33	7.73	47.13	7.53	18.90	5.93
Count	40	40	40	40	40	40

Available Manganese

Low to medium status of extractable iron was observed on the study area (fig. 15). The lowest mean was 2.27 ppm, while highest mean was 18.9 ppm.

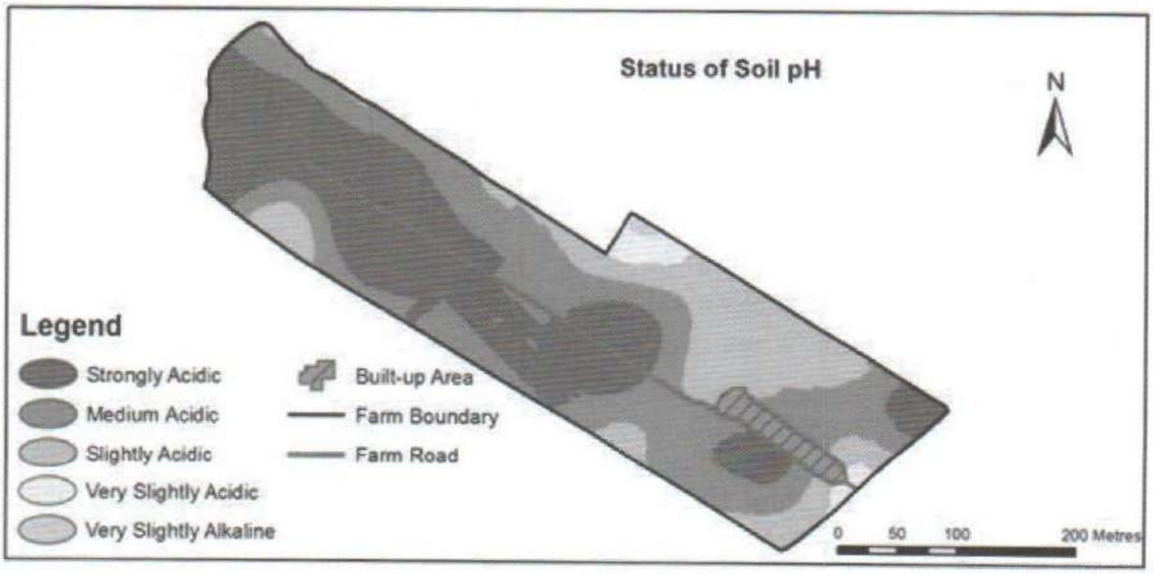

Figure 3. Soil pH status of Horticulture Research Station, Malepatan

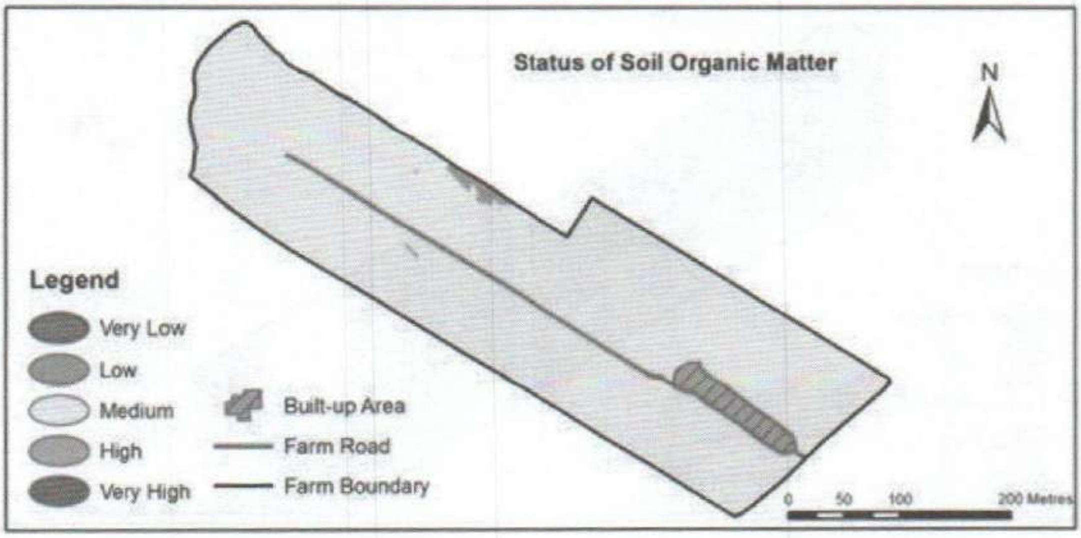

Figure 4. Soil Organic Matter status of Horticulture Research Station, Malepatan

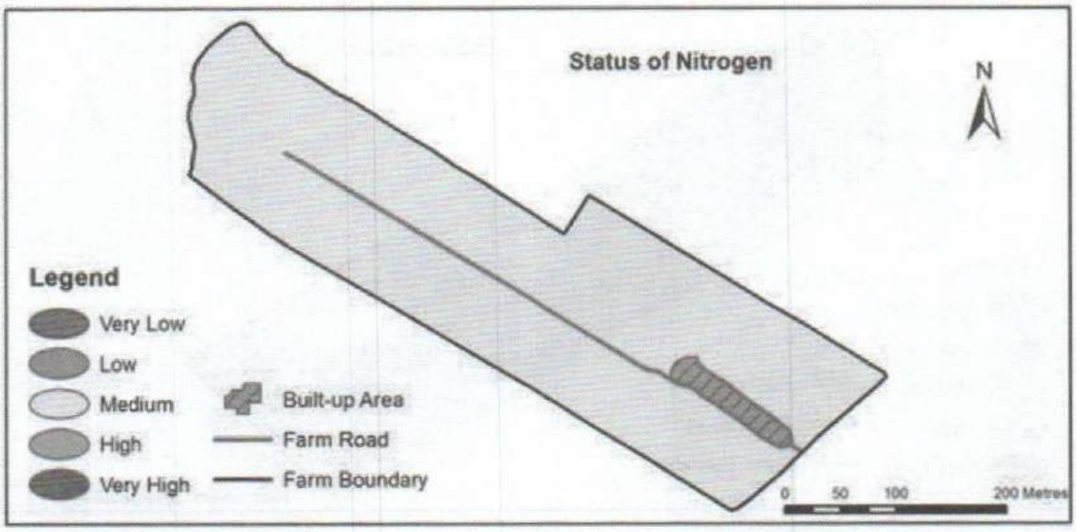

Figure 5. Nitrogen status of Horticulture Research Station, Malepatan

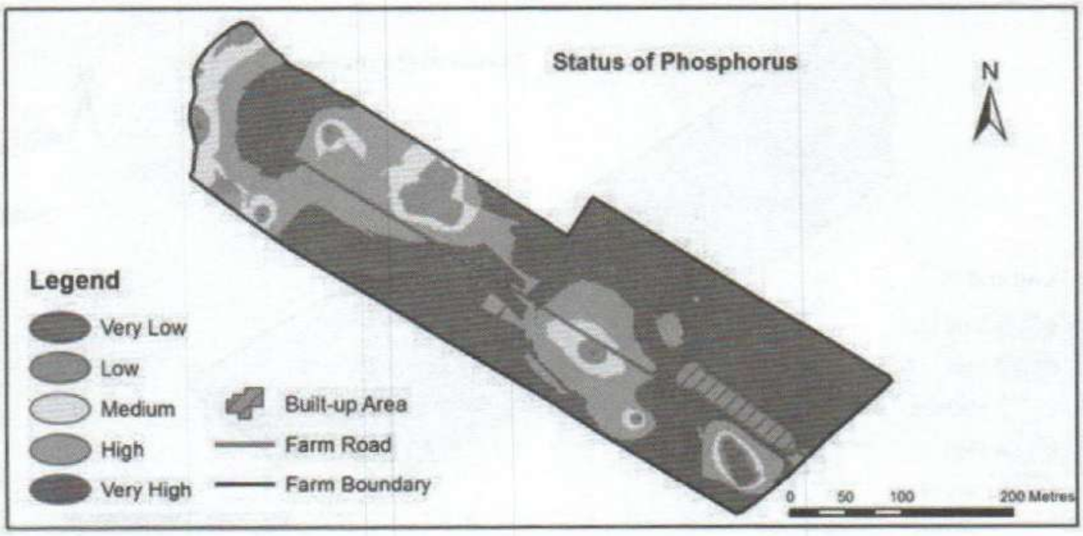

Figure 6. Phosphorus status of Horticulture Research Station, Malepatan

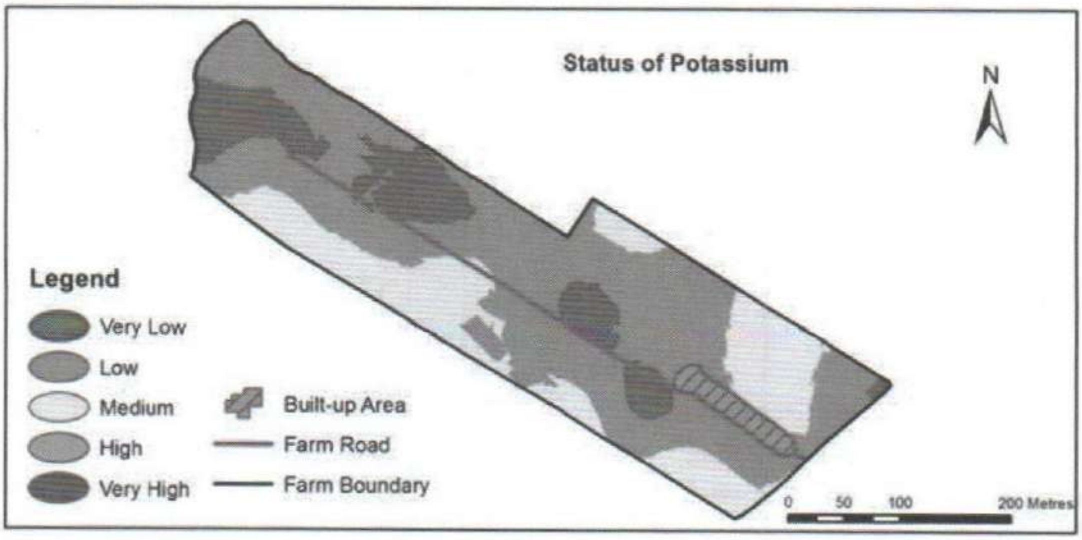

Figure 7. Potassium status of Horticulture Research Station, Malepatan

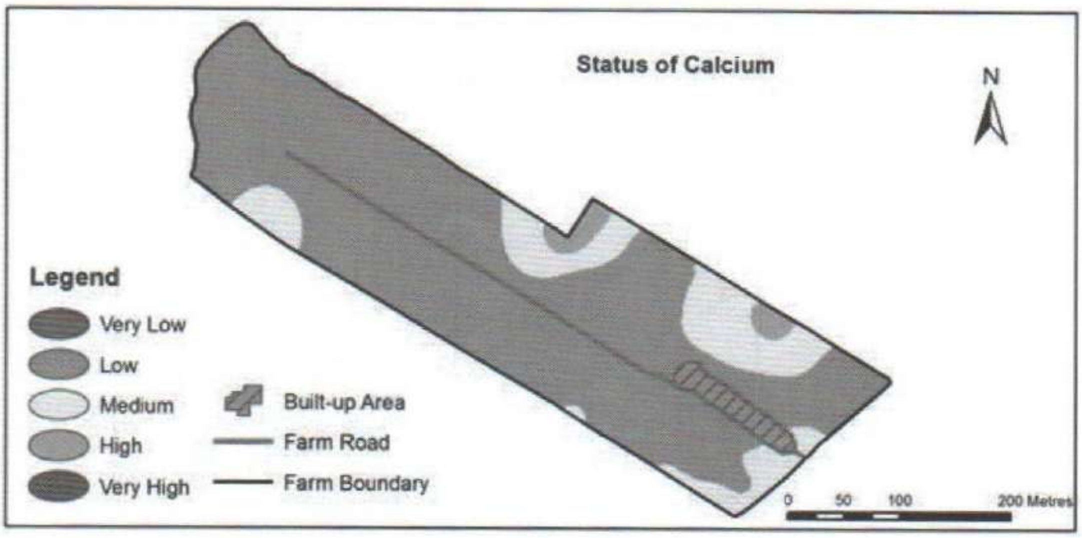

Figure 8. Calcium status of Horticulture Research Station, Malepatan

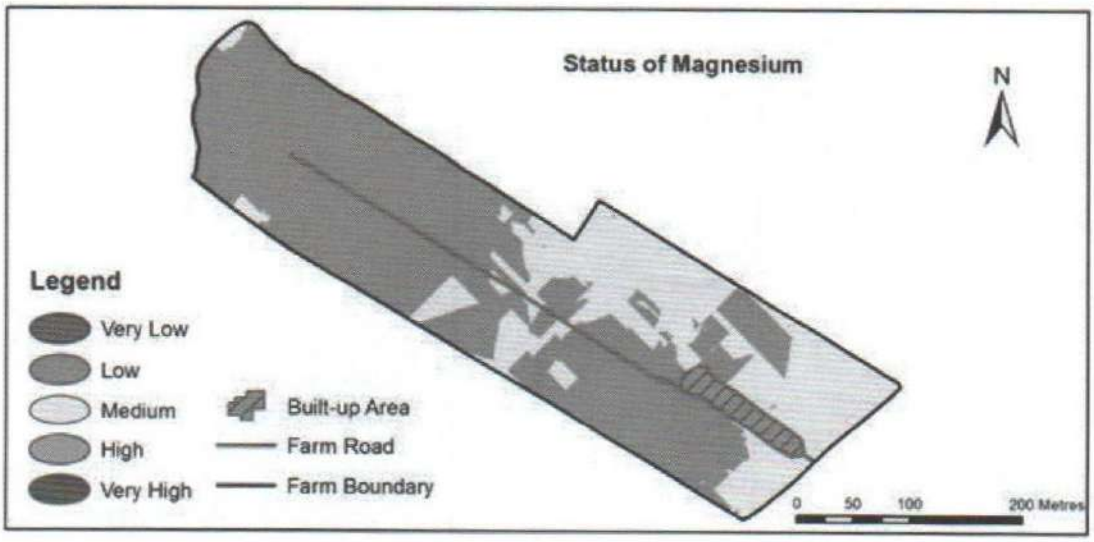

Figure 9. Magnesium status of Horticulture Research Station, Malepatan

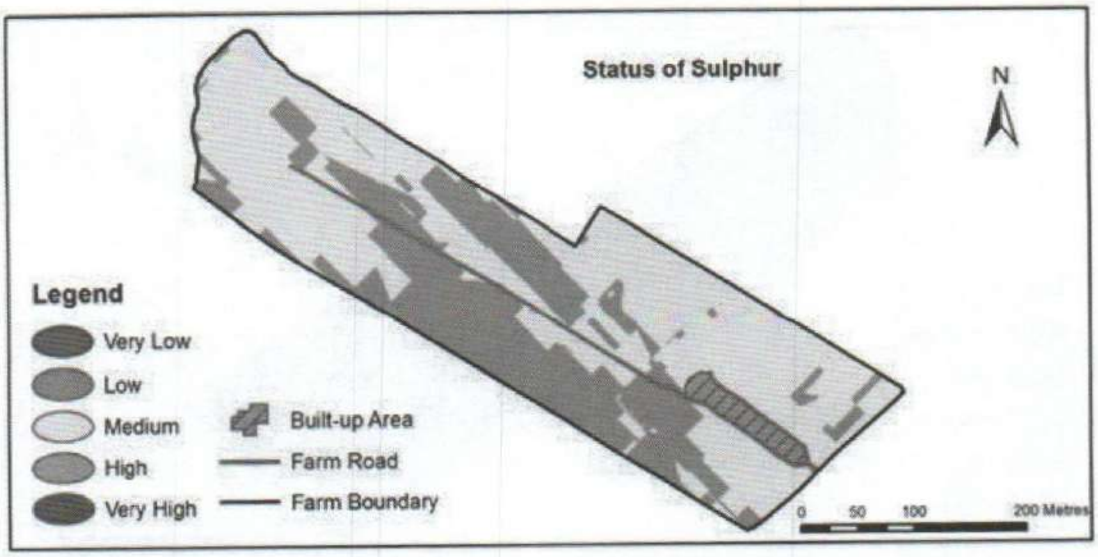

Figure 10. Sulphur status of Horticulture Research Station, Malepatan

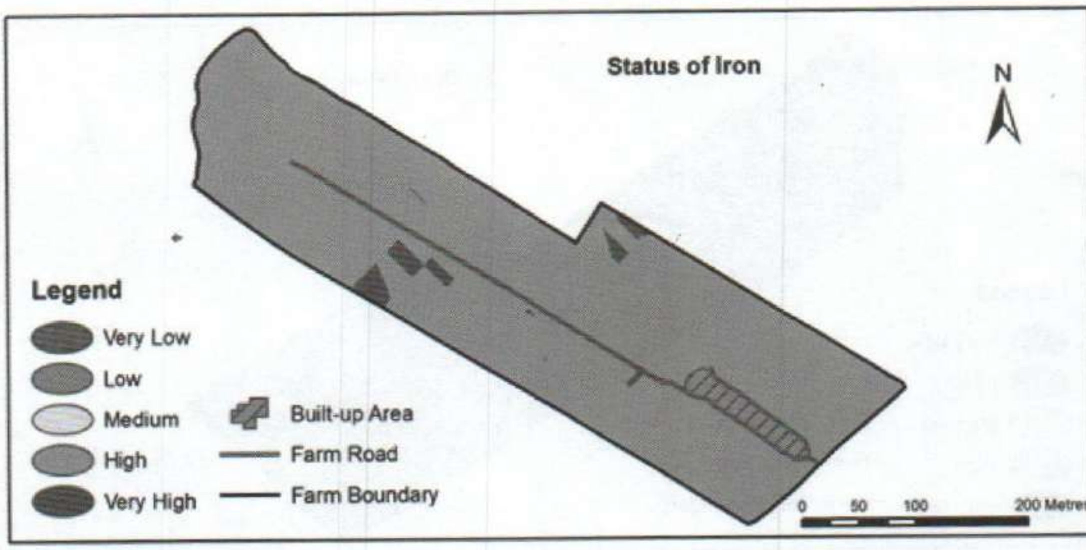

Figure 11. Iron status of Horticulture Research Station, Malepatan

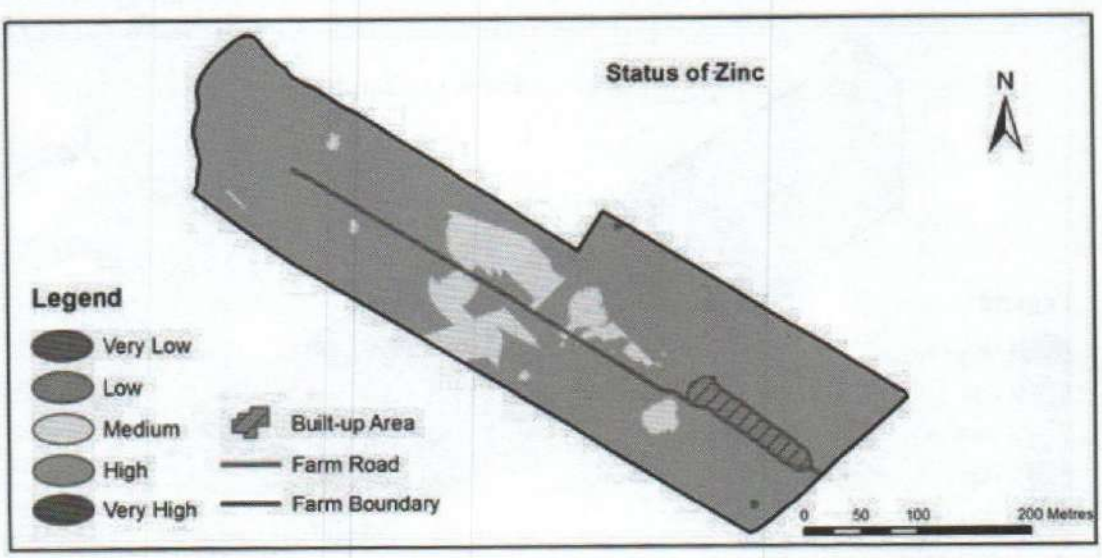

Figure 12. Zinc status of Horticulture Research Station, Malepatan

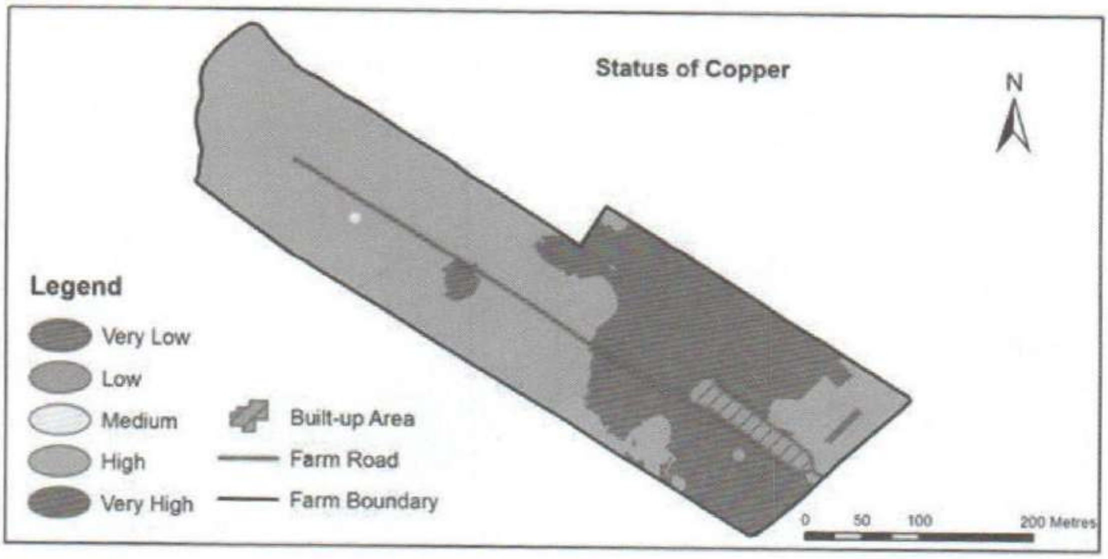

Figure 13. Copper status of Horticulture Research Station, Malepatan

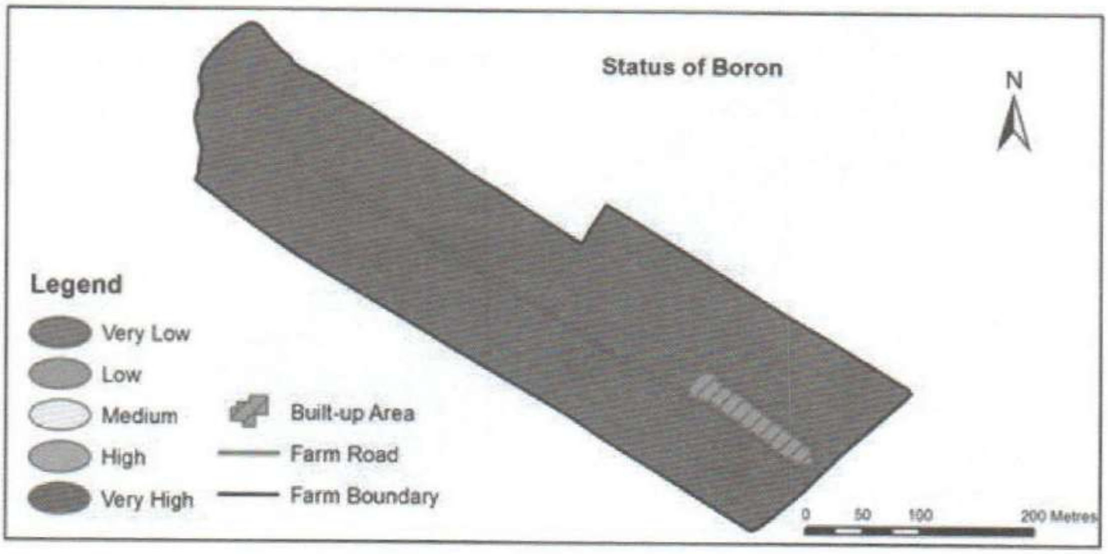

Figure 14. Boron status of Horticulture Research Station, Malepatan

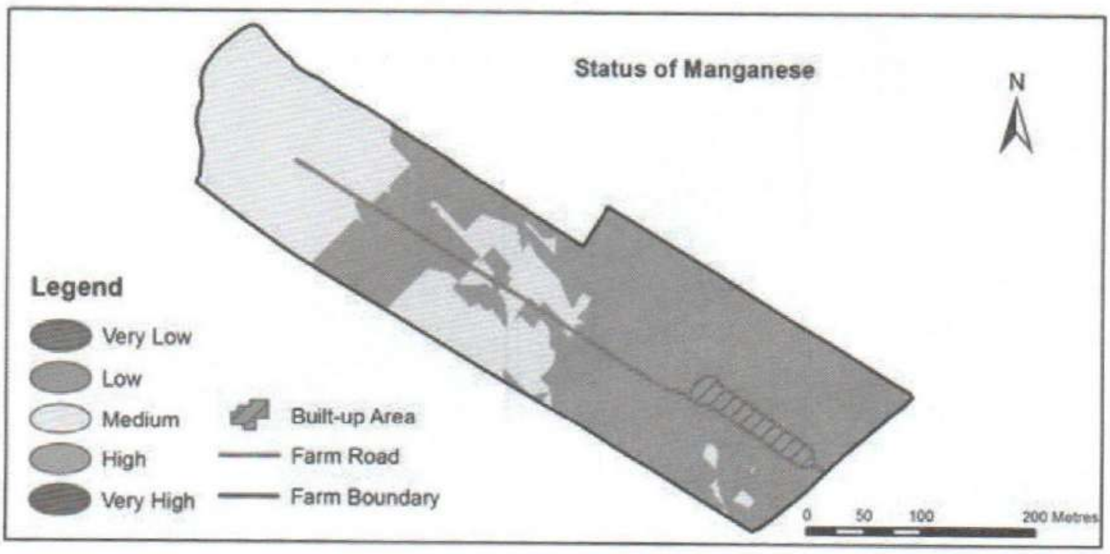

Figure 15. Manganese status of Horticulture Research Station, Malepatan

Conclusion

- Acidic status of reaction was observed on the farm.
- Low status of potassium, calcium, magnesium and manganese was observed on the farm.
- Medium status of organic matter, nitrogen and sulphur was observed on the farm.
- High status of iron, zinc and copper was observed on the farm.
- Very high status of phosphorus and boron was observed on the farm.

Acknowledgement

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