iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** III **Month of publication:** March 2020

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue III Mar 2020- Available at www.ijraset.com

Assessment of Soil Fertility Status and Nutrient Mapping of Paddy Field of Dhangadimai Municipality, Nepal

Shreya Thapaliya[1], Chandeshwor Shriwastav[2]
[1]Agriculture Instructor, Council of Technical Education and Vocational Training, Nepal
[2]Professor, Department of Soil Science and Agri-Engineering, Agriculture and Forestry University, Nepal

Abstract: Soil fertility evaluation is most basic decision making tool for effective sustainable soil nutrient management of a particular area. Thus, the present study was carried out to evaluate soil fertility status of rice fields in Dhangadi municipality which is one of the coverage areas of Rice zone, Siraha. A total of 25 soil samples were randomly collected based on the variability of land at a depth of 0-20 cm. A GPS device was used to identify the location of the soil sampling points. Soil samples were analyzed for texture, pH, OM, N, P2O5, K2O, and Zn status following standard analytic methods in the Regional Soil Testing Laboratory, Jhumka.

The Arc-GIS 10.3 was used to prepare the soil fertility maps. The data revealed three textural classes; sandy loam, loamy and clay loam. Majority of the research locations, i.e. 52% were found to contain loamy soil, 28% sandy loam and 20% clay loam. The soil pH (6.11±0.09) was slightly acidic with majority of research location i.e. 68% were found to contain acidic soil and 32% of location with neutral soil.

The available zinc (0.45± 0.04 ppm) was found to be low with majority of research location i.e. 68% were found to be low in zinc and organic matter (1.97±0.17%) with majority of research location i.e. 68% were found to be low in organic matter. Total nitrogen (0.10±0.006 %) was found to be medium with majority of research location i.e. 52% to be low in nitrogen content. Available phosphorus (39±4.64 kg/ha) and extractable potassium (154.6±14.96 ppm) status were found to be medium with majority of research location i.e. 44% were found to be low in phosphorus content and 40% of the research location with low potassium content.

From this study, it can be concluded that for enhancing efficacy of the rice research, future research strategy should be built based on the soil fertility status of the research farm.

Keywords: Soil Nutrient Management, Soil Fertility Maps, Rice Research, Soil Sampling, Soil Fertility

I. INTRODUCTION

Rice (*Oryza sativa L.)* is most important cereal crop of the world providing staple food for more than 50 percent of the world population and ranks first in Nepal. Share of rice on agricultural GDP is 13.85% however agricultural GDP contributes 31.32% of total GDP (MoAD, 2016/17). In case of Siraha, the area of rice cultivation is 33,500 hectare, total rice production is 85,000 Metric tons and total yield is 2,537 kg/ha (MoAD, 2016).

Low soil fertility is a major constraint in rice producing areas. Improving soil fertility status is therefore very important in order to increase rice production. One of the possible solutions is to assess nutrients status of soils to know the plant nutrients deficit and the required amount to be added for the crop to complete its life cycle.

Rice productivity in Siraha has not increased as expected (Khadka, 2017). There are major factors facing poor rice production in Siraha district, those are declining soil nutrients due to low organic matter content, soil erosion and continuous crop removal of nutrients from the soils without replenishment.

It is estimated that during rice harvest, about 110 kg N, 34 kg P and 156 kg per hectare per year is removed from the soil (De Dutta, 1989). It is estimated that 60% soils of Nepal have low OM, 23% have low P and 18% have low potash and 67% of the soils are acidic (Mandal, 2007).

Also, the farmers of Siraha are not much acquainted with the use of Chemical fertilizers. They use 115 kg/ha Urea, 95 kg/ha DAP and 17 kg/ha Potash which is equivalent to 70 kg/ha N. 43 kg/ha P, 10 kg/ha K (Bhandari, Bhattarai, & Bista, 2017) which is totally irrational to the recommended dose of fertilizer. This irrational use of fertilizer is continuously degrading the soils of Siraha.

II. MATERIALS AND METHOD

A. Area of Study and Sampling Technique

The study was carried out at Prime Minister Agriculture Modernisation Project, Rice Zone, Siraha Nepal. The research farm is situated at Dhangadimai municipality with coordinates, latitude 26º39'10" N latitude and Longitude 86º12'27" E and elevation of 101m from msl. Total cultivable land of Dhangadimai is 4,795 hectare. Rice production is 18,700 mt with productivity 3.9 mt/ha. (DADO, 2073).

In order to assess the fertility status of some rice growing areas, Dhangadimai municipality was involved in the study area, whereby soil sampling was done in 25 randomly selected sites from that municipality. 25 soil samples were randomly collected at 0 – 20 cm depth from the soil surface and thoroughly mixed to constitute a composite sample as described by (Motsara & Roy, 2008). The exact locations of the samples were recorded using a handheld GPS receiver. A composite sample of approximately one kilogram was taken, air dried and ground to pass through 2.0 mm sieve. The samples were analysed for physical and chemical analysis at Regional Soil Testing Laboratory, Jhumka.

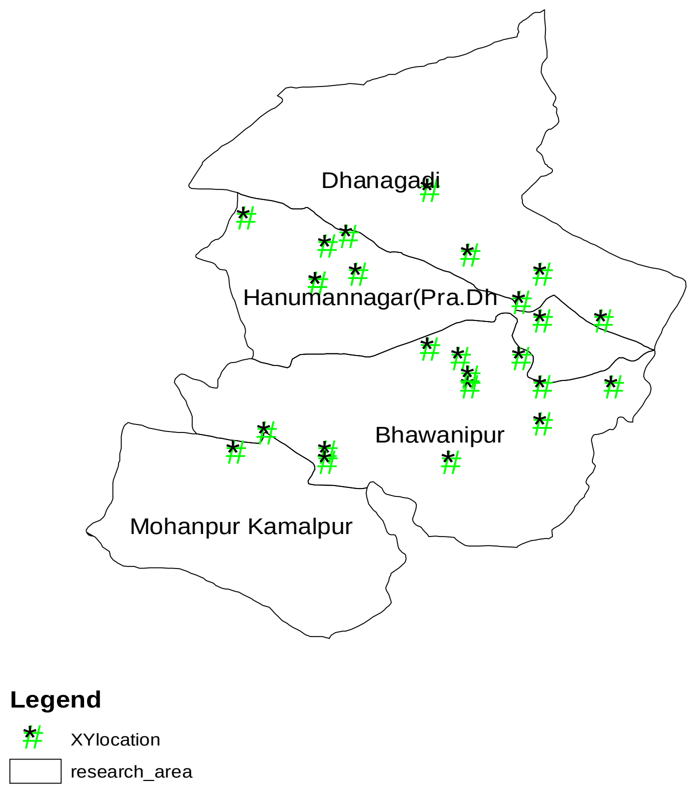

Fig. 1 Distribution of Sampling Points

B. Soil Laboratory and Statistical Analysis

The collected soil samples were analysed at Regional Soil Testing Laboratory, Jhumka. The soil sample was analysed for particle size distribution (soil texture), soil pH, soil organic matter, total nitrogen exchangeable Zn, total N, extractable P and Potassium. Descriptive statistics (mean, range, standard deviation, root mean square error, coefficient of variation of soil parameters were computed using the Microsoft excel. Rating (very low, low, medium, high and very high) of determined values were based on Regional Soil Testing Laboratory, Jhumka.

C. Soil Fertility Map

Based on the known numeric value of different parameters of soil at different location in the map, the values of remaining points can be estimated using GIS Interpolation. Inverse Distant Weight (IDW) under deterministic interpolation was used to determine soil parameters value using a linear-weighted combination set of sample points. Soil fertility map is constructed for whole Sweet Orange Zone area using IDW functions under GIS Interpolation.

III.RESULTS AND DISCUSSION

In the study area, its soil fertility status with respect to organic matter, ph, soil texture, primary nutrients like nitrogen, phosphorus, potassium and micro nutrient zinc were assessed and the results obtained are presented and discussed in the following headings.

TABLE I
Soil Fertility Status of Dhangadimai Municipality, Siraha

	Nitrogen	Phosphorus	Potassium	Zinc	pH	OM
Mean	0.1052	39	154.6	0.453	6.11	1.97
Standard Deviation	0.0315	23.24	74.98	0.236	0.45	0.88
Standard Error	0.0063	4.64	14.96	0.047	0.09	0.18
CV	29.9%	59.84%	48.49%	52.07	7.5	46.47
Minimum	0.06	18	69	0.14	5.1	0.36
Maximum	0.17	92	305	1.2	6.8	3.5
Root mean square error	0.03	27.91	65.35	0.254	0.432	0.9
Median	0.0925	29	128	0.427	6.2	1.88

A. *Total Nitrogen*

Nitrogen (N) is one of the most important plant nutrients and the most frequently deficient of all nutrients (Tisdale, Nelson, Beaton & Halvin, 1993). The variation in nitrogen content with depth is pronounced in the soil of different region (A Yearbook of Agriculture, 1975). Majority of the soil samples (58%) in the study area were found as Low in nitrogen. The medium nitrogen content was observed at 46% of the sample's location and no sample location was found to have high nitrogen content. Department of Soil Science, Narc rated N ranges of <0.1% as low, 0.1 – 0.2% as moderate and >0.2% as high.

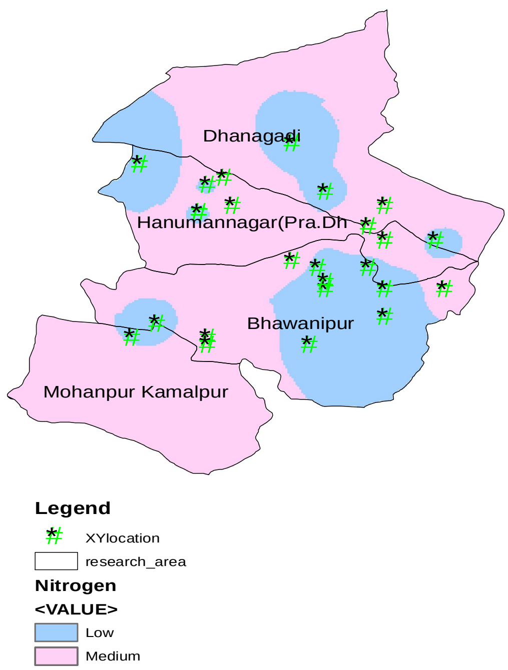

Fig. 2 Soil Nitrogen Status of Dhangadimai Municipality, Siraha

B. *Available Phosphorus*

The growth of both cultivated plants is limited by availability of Phosphorus (P) in the soils (Foth & Ellis, 1997). The available phosphorus (P205) was ranged from 19 kg/ha to 92 kg/ha with an average of 39 kg/ha. Majority (44%) of the soil samples were found to be low in phosphorus content. About 36% and 20% of the soil samples were found medium and low in Soil Phosphorus content respectively in the study area.

Department of Soul Science, Narc rated P ranges 0-26 kg/ha as low, 26-56 kg/ha as moderate and >56 kg/ha as high. Phosphorus availability is usually better in flooded than in drylands soils, mainly because phosphate occluded in and absorbed on ferric oxide is released during reduction, as is phosphate in ferric phosphate (Moormann & Breemen, 1978). Phosphorous is essential for energy transfer system. It is component of RNA and DNA, regulating genetic information. It is also essential for phytin, an important component of seeds (Yoshida, 1981).

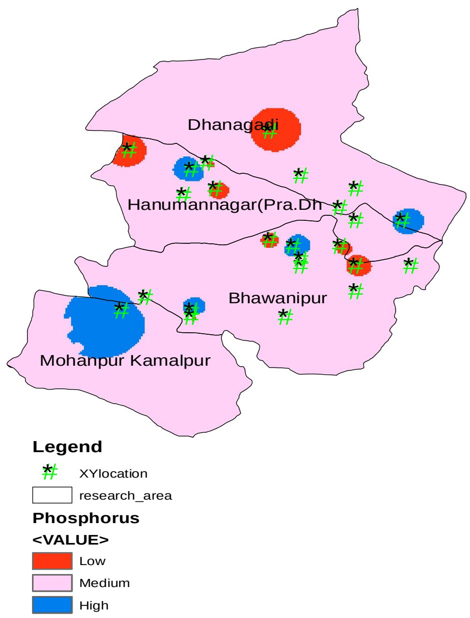

Fig. 3 Soil Phosphorus Status of Dhangadimai Municipality, Siraha

C. Extractable Potassium

Next to N and P, Potassium (K) is the third most important essential element that limit plant productivity. Potassium (K) is an essential nutrient that affects most of the biochemical and physiological processes that influence plant growth and metabolism. The extractable potassium (K2O) content was ranged from 69 kg/ha to 309 kg/ha with a mean value of 154.6 ka/ha. The Available potassium status of the research area shows that majority (40%) of the soil samples were found to be low in potassium content. About 32% and 20% of the total samples were found to be medium and in potassium content respectively. Department of Soil Science, Narc rated P ranges of <112 kg/ha as low, 112-180 kg/ha as moderate and >280 as high. Majority of soil samples (40% of total soil samples) was found to be deficient in potassium content but the average value was found to be moderate.

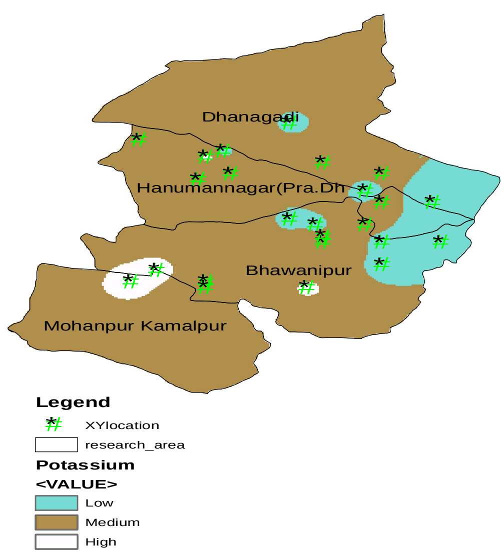

Fig. 4 Soil Potassium Status of Dhangadimai Municipality, Siraha

D. Soil Zinc

Zinc is one of the eight trace elements which are essential for the normal healthy growth and reproduction of crop plants (Alloway, 2008). Zinc is essential for several biochemical processes in plants, such as cytochrome and nucleotide synthesis, auxin metabolism, chlorophyll production, enzyme activation, and the maintenance of membrane integrity (Havlin et al., 2010). The available zinc content was ranged from 0.14 to 1.2 ppm. The available zinc showed high variability (52.07%) among the soil samples. Majority (68%) of the soil samples in the study area were found to be low in soil Zinc content. About 28% and 4% of the soil samples were found to be medium and high in soil Zinc content respectively. Department of Soil Science, Narc rated Zn ranges of <0.5ppm as low, 0.5-1.1ppm as moderate and >1.1ppm as high.

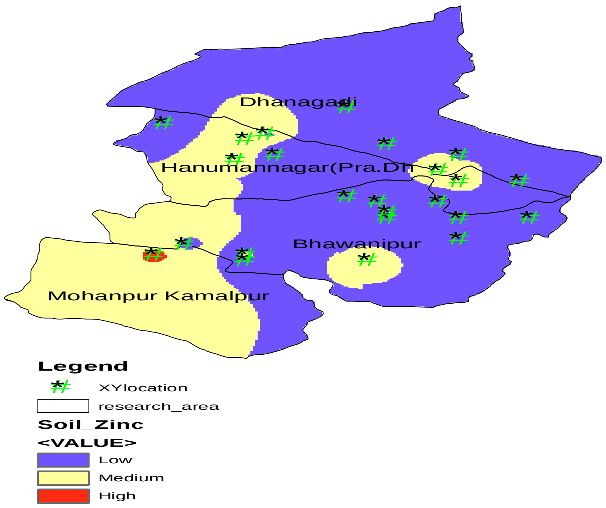

Fig. 5 Soil Zinc Status of Dhangadimai Municipality, Siraha

E. Soil pH

The pH of soil was varied from 5.1 to 6.8 with a mean value of 6.1 . The majority (68%) of soil of research area were found acidic and 32% of soil samples were found neutral. This indicates moderately acidic soil pH (Figure 4). The soil pH showed low variability (7.5%) among the soil samples.

1) *Organic Matter:* Organic matter is important source of plant essential nutrients after their decomposition by microorganisms (Johnston, 2007). The organic matter content was varied from 0.36 to 3.6% with a mean value of 1.97%. It indicates that the organic matter content was low. It was revealed that majority (68%) of the soil samples of the research area were found to be low in soil organic matter content (SOM). The high content of SOM was not found. Therefore, incorporation of organic matter adding materials is important for improvement of organic matter in the soils. However, 32% of the soil samples were found to be medium in organic matter content. Department of Soil Science, Narc rated OM ranges of <2.5% as low, 2.5-5% as moderate and >5% as high.
2) *Soil Texture:* It affects absorption of nutrients, microbial activities, the infiltration and retention of water, soil aeration, tillage and irrigation practices (Gupta, 2004). Highest yields are from soils with 25 to 50% clay in the surface soil and a similar or somewhat higher percentage in the subsoil. (Moormann & Breemen, 1978). Majority of samples (52% of total soil samples) were identified as loamy textured whie 28% of soil samples were identified as Sandy Loam textured and 20% of soil samples were identified as Clay Loam textured.

TABLE III

Nutrient index of studied parameters

S.N.	Parameters	% Distribution of Soil Samples			Nutrient Index	Remarks
		Low	Medium	High		
1	N	52	48	-	1.32	Low
2	P	44	36	20	1.48	Low
3	K	40	44	16	1.76	Medium
4	O.M	68	32	-	1.76	Medium
5	Zn	68	28	4	1.28	Low

TABLE IIIII
Overall fertility status of the research area at sampling locations

Variable	Rating	Percentage
Overall Fertility Rating	Low	56
	Medium	36
	High	8

IV. CONCLUSION

Overall, soils were loamy in texture. They were slightly acidic in reaction and it is advisable to apply agricultural lime periodically for its amelioration. The organic matter and zinc status were very low. The nitrogen, phosphorus and potassium status were medium. Soil pH was found in optimum conditions for rice growing soils. Rice may suffer from deficiency of nitrogen and zinc and toxicity of very high plant available phosphorus and potassium. Thus, proper nutrient management strategy should be adopted especially for these nutrients. Considering the low status of soil organic matter, the practices like manure or compost incorporation, crop residue retention, green manuring etc. can be suggested for its improvement. From this study, it can be concluded that for enhancing efficacy of the rice production, future research strategy should be built based on the soil fertility status of the rice zone area in Siraha district.

V. ACKNOWLEDGMENT

I would like to express my deep sense of gratitude to Prof. Chandreshwor Prasad Shrivastav (Major Advisor) and Dr. Mani Ratna Aryal, Member Advisor (Senior Economist, MoAD) for their valuable guidance, constant support, encouragement and supervision, critical correction and constructive comments during entire period of study.

I am deeply indebted to Mr. Narendra Kumar Mahaseth, site advisor (PM – AMP Rice Zone Siraha), for providing constructive comments during the course of thesis preparation. Project Implementing Unit, PMAMP is also acknowledged for providing valuable ideas for the research work. I would also like to express my genuine appreciation to Mr. Ram Prabesh Chauhan, Mr. Sunil Chaudhary, my friends and entire Siraha Rice Zone family for their continuous guidance and technical support during my research period.

REFERENCES

[1] Washington D.C: “A Yearbook of Agriculture”, *The United States Government Printing Office. 1957.*
[2] AICC, “Krishi Diary”, Agriculture Information and Communication Centre, Hariharbhawan, Lalitpur. 2016.
[3] B. Alloway, “Zinc in Soils and Crop Nutrition (second edition)”, Brussels, Belgium: International Zinc Association. 2008.
[4] D. R. Bhandarai, D. Bhattarai & D. R. Bista, “Status of Chemical Fertilizer Use for Rice in Nepal”, In Rice Science and Technology in Nepal. Hariharbhawan, Lalitpur: Crop Development Directorate, pp. 384-393. 2017.
[5] DADO, “Yearly Agricultural Development Program and Statistical Book”, Lahan: Janak Offset Printers. 2017.
[6] De Dutta, S. Rice, D. Plucknett & H. Sprague, “Detecting mineral nutrient defeciencies in tropical and temperate crops”, Colorado: Westview Press. 1989.
[7] J. Foth & B. Ellis, “Soil Fertility (Second edition)”, USA: Lewis CRC Press. 1997.
[8] P. Gupta, “Soil, Plant, Water and Fertilizer Analysis”, India: Shyam Printing Press. 2004
[9] J. L. Havlin, S. L. Tisdale, W. L. Nelson & J. D. Beaton, “Soil Fertility and Fertilizers (Eighth Edition)”, USA: Pearson Education. 2014.
[10] G. Johnson, W. Raun & J. Hattey, “Oklahoma Soil Fertility Handbool, Fifth Edition”, Department of Plant and Soil Sciences Oklahoma Agricultural Experiment Station Oklahoma Cooperative Extension Service. 2017.
[11] Y. G. Khadka, “Management of Organic and Inorganic Fertilizer for Rice Production in Nepal”, In Rice Science and Technology in Nepal, Hariharbhawan Lalitpur: Crop Development Directorate. 2017.
[12] S. N. Mandal, “National Workshop on Sustainable Soil Management Program”, Lalitpur: Soil Management Directorate. 2016.
[13] Moad, “Statistical Information on Nepalese Agriculture 2015/2016 (2072/2073)”, Singha Durbar, Kathmandu: Triveni Chhapakhana, 2016.
[14] F. R. Moormann & N. V. Breemen, “Rice: Soil, Water, Land”, Laguna, Philippines: International Rice Research Institute. 1978.
[15] M. Moorman & R. Roy, “Guide to Laboratory Establishment for Plant”, Rome. 2008.
[16] S. Tisdale, W. Nelson, J. Beaton & J. Halvin, “Soil Fertility and Fertilizers, Fifth Edition”, New York: MacMillan Publishing Company. 1993.
[17] Yoshida, “Physiological Analysis of Rice Yield”, In Fundamentals of Rice Crop Science, Los Banos, Philippines: International Rice Research Institutte. 1981.