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RESEARCH ARTICLE

A CASE STUDY ON SOIL FERTILITY STATUS AND MAIZE PRODUCTIVITY IN DANG DISTRICT, NEPAL

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ABSTRACT

The study was conducted to know the soil fertility status and maize productivity along with soil management practices being adopted in Lamahi municipality and Rapti rural municipality of Dang district to have a basis for the understanding of possible management options for better soil fertility and productivity. 333 soil samples from different maize farmers' field were tested for soil fertility parameters during the program in which 60 soil samples were also collected from maize fields. Next, crop and soil management survey was carried out through a household interview in the sampled field. These data were used to identify the range of critical soil-test concentrations of nutrients and to assess the production status of maize and the soil management practices in farmers filed and evaluate the current fertilizer practices of farmers. The result showed that there was a dominance of neutral-alkaline soils with low organic matter & nitrogen levels with high P and medium K. Similarly, maize productivity of the district was found to be 3.3 ton per hectare. It is found that most farmers were adopting traditional crop management practices for maize cultivation with a high dependency on chemical fertilizers for fertilization.

KEYWORDS

Maize, Soil, Productivity.

1. INTRODUCTION

Maize (Zea mays L.) is the second important crop after rice of the district and staple crop of hills of Nepal in terms of area (District Agriculture Development Office, Dang, 2072) and third important crop in worldwide after rice and wheat. In Nepal, maize was introduced probably at the beginning of the 17th century and it is growing throughout the year in Dang district. In the Dang district, the productivity of maize in the irrigated field was found 2.01 MT/ha while in the non-irrigated field, it is 2.5 MT/ha (District Agriculture Development Office, Dang, 2072). In the Dang district, the area under maize crop was 23,200 ha in the FY 2015, producing 46,168 ton of grains (which represents just 2.15% of total annual maize production) with mean yield of 1.99 MT/ha, which is low compared to national productivity 2.5 MT/ha [7]. Furthermore, in Dang district, most of the maize area is occupied by hybrid during the various growing season especially for spring and winter with adequate irrigation system among commercial farmers. To increase the yield, farmers need to apply a high level of N, P, K and adequate amount of organic fertilizer in combination in hybrid maize so that soil fertility status can be maintained. However, soil analysis is not done at all by maize commercial farmers in the district to know soil inherent nutrient supply capacity and to determine N, P, K fertilizer doses.

In Dang, there is a lack of information about the nutrient status of soil to facilitate the implementation of better soil fertility practices. Despite the great potential of maize farming, production is a low and substantial amount of maize is imported every year. The farm level yield of maize (2.45 t/ha) is not satisfactory as compared to attainable yield (5.7 t/ha) in Nepal [5-6]. Maize is a heavy feeder crop, soil fertility status and nutrient management practices directly affect its production. Soil-test based fertility management is important for sustainable soil management and sustained productivity. This study aims to identify the status of soil fertility and maize productivity existed in the district and know the soil management practices being adopted. To reach this focal mission, the following specific objectives were considered.

- To study soil fertility parameters (pH, organic matter, N, P, K) of Dang district.
- To find out maize productivity in the above-mentioned municipality.
- To know about soil management practices adopted in these areas through the survey.

2. MATERIALS AND METHODS

2.1 Case Study Site and Sub-sector

Maize is a popular cereal crop ranking second in terms of area and production in Nepal [8]. The Lamahi municipality and Rapti Municipality of Deukhuri valley of Dang district were the study site. In the above-mentioned municipalities, almost all farmers household were growing maize in different scales. Here, Maize is sown in summer, winter and spring i.e. throughout the year. Usually, commercial hybrid maize adapted to this area sowed behind the plough through the use of rope or use of rope and spade only. During the growing season, the maize was irrigated using a furrow system with low water use efficiency. All fields included in this study have a climate described as semi-arid with hot summer and relatively cold winter, a mean annual air temperature of cold winter, mean annual precipitation around mostly falling between June to September.

2.2 Case Study Unit of Analysis

As mentioned before, this study was carried out in one of the Midwestern Terai district of Nepal. The District as a whole and two municipalities (Lamahi municipality & Rapti rural municipality) have been taken as a unit for the analysis for the case study.

2.3 Sample and Sampling Techniques

The sample population is the representative. The population of the case study was farmers from the municipality mentioned before. At first, the sampling frame was prepared by using the various source of information such as discussion with Maize Superzone inn-keepers committee and

cooperatives heads. 60 households/farmers were selected from maize growing farmers under Superzone PM-AMP. For the household survey, probability-based simple random sampling was used. 30 from Lamahi municipality and 30 from Rapti rural municipality, 60 in total were interviewed with the pre-tested semi-structured questionnaire for data collection related to crop/soil management practices being adopted.

2.4 Research Design

A household survey was carried out to collect data from responding to farmers. A standardized pre-tested interview schedule was administered to the farmers. Information related to maize cultivating household, household characteristics, constraint of maize production, level of production, and crop and soil management practices during maize farming had been collected from the farmers. Observation, informal group discussion, and key informant survey were also carried based on snowball sampling method.

2.5 Observation and Observation Methods

Mostly observation is seen as either a participant or non-participant method of observation. In this study, the observation method of complementing was used and contextualize the issue. Since maize is grown throughout the year in the study area, it was possible to observe the maize standing crop in the field and farmer working in the maize field and other agricultural activities performed in the farm.

2.6 Data Collection and Analysis

Data collected include maize yield for the household, quantity and type of fertilizer used, quantity and type of seed used, labour used (both family and hired). Additionally, data was also collected for the method of ploughing – hand, Bullock or tractor, and method of sowing and crop/soil management practices cropping method – mono-cropping or intercropping, use of organic manure, method of fertilizer application. For soil characteristics, soil samples were collected from randomly selected farmer's field and tested in mobile soil testing van by soil scientist from Regional soil testing laboratory, khajura, Banke. A total of 333 soil samples were tested with funding from Superzone Implementation Unit, PM-AMP, Deukhuri, Dang.

The quantitative information obtained from the household was entered systematically in the computer system. Proper coding was done to feed the data in Microsoft Excel. Soil test report data were entered in the MS-Excel and analyzed in it. Data collected from the survey were entered and analyzed in SPSS.16.0. The table and graphs were generated to present the result.

3. RESULT AND DISCUSSION

3.1 Soil Nutrient Status

Soil pH is an important chemical parameter of soil that affects nutrient availability [2]. Soil pH analyses showed that soils were classified as slightly acidic (3%), neutral (56.67%) and slightly alkaline (33.33%). It can be clearly seen that there was a dominance of neutral-alkaline soils that is mainly due to low-rainfall and high level of reference evapotranspiration.

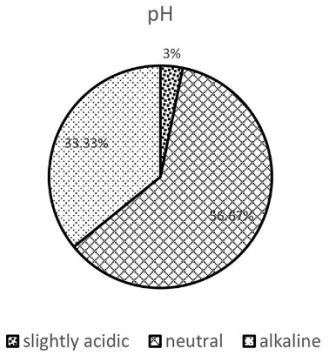

Figure 1: pH Status of Soil

Soil samples were also tested for soil organic matter contents and results showed that very low (1-3.33%), low (24-80%) and medium (5 to 16.67%) organic matter in the soil. It is important to note that in the soils the highest OM levels were found where farmers use different organic farmers such as FYM, poultry manure, goat manure, or mixture once or twice in the crop cycle and also incorporated the residues back to the soil while field preparation.OM lows due to the application of chemical fertilizers only; as there is easy access to chemical fertilizer. And the poor supply of organic manure application practices.

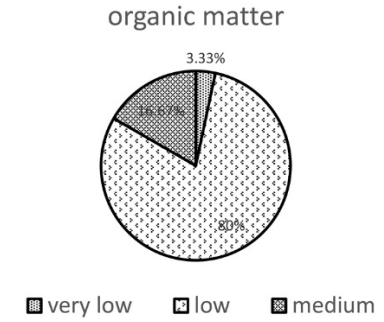

Figure 2: Organic Matter Status of Soil

Nitrogen content in the soil was mainly low (60% of total) with a few very low (3.33%) and medium (36.67%). Available P values were mostly very high(53.33% of total), and high(20%) and medium (6.67%) whereas fewer soil samples had low (10 %) and very low (10 %), which suggested that previous practices of burning of the residue have increased P content in soil . Also, with the increased use of DAP has been building up a high P status in these soils.

Similarly, soil available K were very high (13 %), medium (50 %), low (6 %), high (30 %). This is majorly due to low K fertilization practices and high K source which is inherent from parental material is decreasing in Nepalese soil, but the risk of K leaching in the soil is low so much of the soils are high in K.

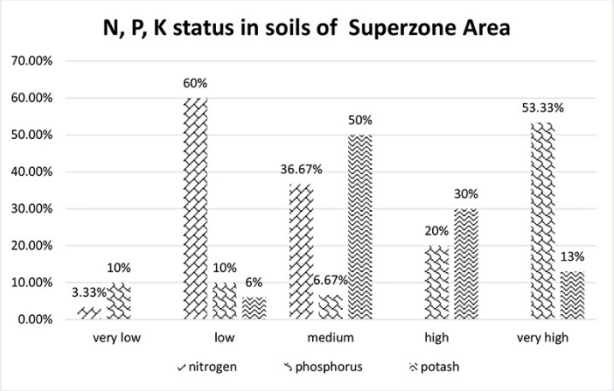

Figure 3: Nitrogen, Phosphorous and Potash status of the soil

3.2 Maize productivity Situation

The yield of maize in Superzone (maize), Deukhuri Dang under which Lamahi municipality and Rapti municipality occurs was found to be 3.3 ton per hectare. The yield was found to be 2.40 ton/ha in spring season while in winter, the yield was higher i.e. 4.27 ton/ha. This huge gap between spring and winter yield is due to the fact that almost all farmers grow hybrid maize in winter which has the capacity of double production than improved maize. The yield of maize is lower compared to attainable yield i.e. 5.7 MT/ha due to lower plant population maintenance & poor nutrient management practices i.e. most apply single dose of urea and no/poor combination of organic &inorganic fertilizer [10]. Integration of organic and inorganic nutrient sources generated the highest yields in maize-based cropping system [9].

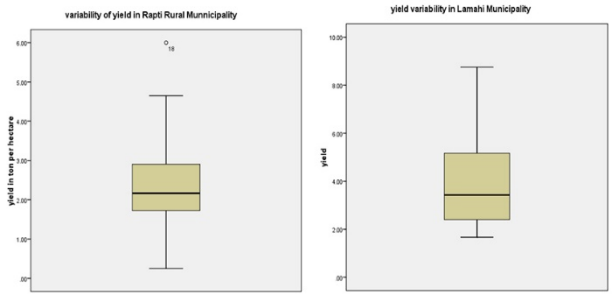

Figure 4: Variability of maize yield in Lamahi Municipality and Rapti rural Municipality under Superzone (maize)

3.3 Soil Fertility Management Practices

In the study area, the farmers were not found much aware of soil fertility degradation and were not adopting any suitable soil management practices as just two out of sixty respondents ever tested their soil from their field. However, the application of FYM and chemical fertilizers were noted principle practices for maintaining soil fertility in which a combination of both was not so common.

3.3.1 Application of Organic Manure

Farmers in the study were adopting the integration of crop and livestock in which livestock provides FYM to crops. Quality and quantity of manure are important to enhance soil fertility and increase the productivity of maize. Integrated farming is the main source of organic manure in Nepal. The major livestock and birds reared in the study area were a cow, buffalo, calves, poultry, goats, sheep and pig.

Table 1: Status of Integrated farming in Superzone (2017)

	Integrated	Non-Integrated
Lamahi municipality	76.5%	23.5%
Rapti rural municipality	81.5%	18.5%

The application of organic fertilizer appears to improve soil fertility [9]. Though only 55 percent of the respondents use organic manure in the maize and 59 percent of the respondent use organic manure once in a year, mainly for vegetables during spring. The main source of organic manure is FYM followed by poultry manure and compost manure. Only two out of total respondent has the practice of using green manure. Although, the quantity used is very low ranging from 0.4 ton to 15 ton.

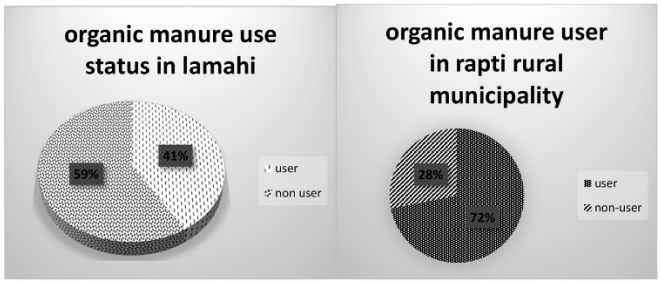

Figure 5: Organic manure use situation in Superzone Dang

Farm Yard Manure Preservation & Application time in the field:

Most of the farm shed (61%) in the study area is the traditional one (Figure no. 6). The quality of FYM in improved cowshed is better supporting the growth of the crops. Proper use of FYM needs a great knowledge to preserve its nutrient.

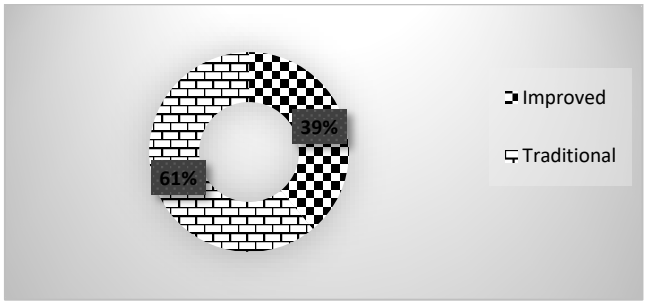

Figure 6: Farmer Having Improved and Traditional Type of Farm Shed

Most of the respondents in the study area showed good practices of FYM application i.e. most mixed the manure into the soil within the same day to 10 days after application in the field.

3.3.2 Application of Chemical Fertilizer

The farmers in the study area were found heavily dependent on chemical fertilizers, especially urea, for fertilization in the maize field. Most of the farmers used chemical fertilizer solely for maize cultivation. The commonly used fertilizers were urea, Diammonium phosphate (DAP) and Muriate of Potash. Most of the farmers in Lamahi municipality were using a combination of three chemical fertilizers while in case of Rapti rural municipality, most were using urea only as a source of fertilizer for maize production.

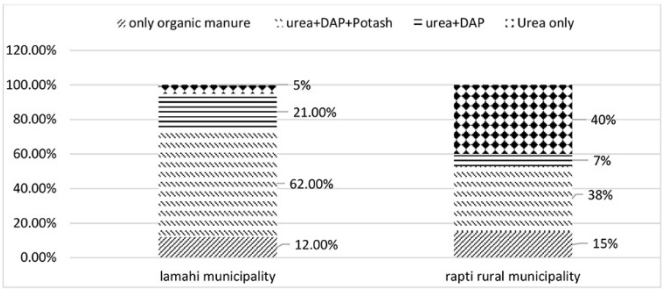

Figure 7: Use of Chemical Fertilizers Singly or In Combination in Superzone

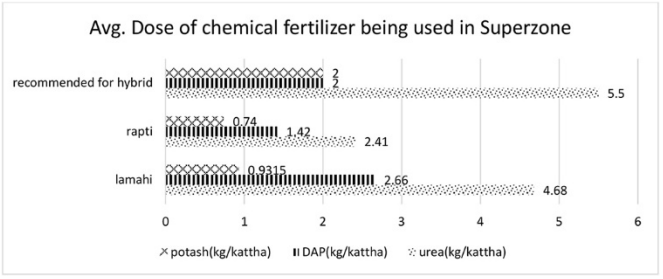

Figure 8: Average dose of urea, DAP and Potash used in the Superzone

Most of the farmers did not apply chemical fertilizers at a recommended dose as they used their own judgment in the study area as shown in Figure no. 9. The study revealed that most of the farmers have increased the application rate of chemical fertilizers overall due to subsidies provided by the government whereas the use of FYM has decreased because of less livestock rearing in practice and fewer family members in the family. However, the farmers' practices of chemical fertilizer application in the maize field differ vastly among Lamahi municipality and Rapti rural municipality with more quantity being used in the former one. This is mainly due to the fact the Lamahi is one of the main city of the Dang district where Farmers from Lamahi municipality has easier access than farmers from the rural municipality and are more trained. The reasons for the low use of chemical fertilizer included high cost, non-availability at key times and a lack of knowledge of their use [5].

Table 2: Ranges of doses of various fertilizers being adopted for maize

	Urea (kg/kattha)			DAP (kg/kattha)			Potash (kg/kattha)		
	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
Lamahi	4.6824	16	0	2.66	5	0	0.931	2.5	0
Rapti	2.41	6	0	1.42	6.5	0	0.74	3.3	0

Basically, they used urea on different splits on maize i.e. once (after first weeding); twice (at field preparation and at first weeding / after first weeding and at the tasselling stage) and thrice (at field preparation, after first weeding and at the tasselling stage) as shown in figure no. 7.

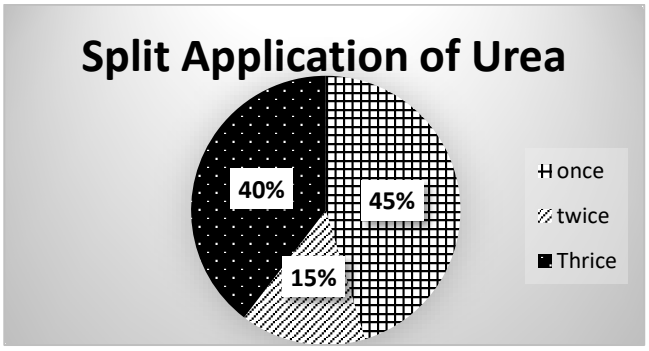

Figure 9: Situation of Split Application of Urea in Maize

3.3.3 Inclusion of Legumes & Intercropping Practices

Leguminous crops can play an important role to maintain soil fertility and sustain crop production. Legume also adds nutrient, provide ground cover reducing soil erosion & increase organic matter. Legumes grown in less fertile soil improves the soil health by fixing atmospheric N and may partially supplement the use of inorganic fertilizers [4]. In the study area, the inclusion of legumes was not common in practices. Few farmers (13

percent out of total) were practising intercropping with maize. Maintaining any form of plant cover reduces nutrient losses in the eroded soil materials. Intercropping in maize helps to protect the soil as it covers the ground and reduces the weed infestation [1].

Table 3: Situation of intercropping in maize

	Intercropping in maize	No intercropping in maize
Lamahi municipality	2.9%	97.1%
Rapti rural municipality	25.9%	74.1%

4. CONCLUSION

From this study, it can be concluded that in overall, the soil fertility status of the study area is poor and approaching towards alkalinity losing its productivity. Moreover, the maize yield of the area was found low compared to attainable yield. Use of minor quantity of organic manure (FYM, poultry manure, and green manure), use of chemical fertilizers, inclusion of legume crops in cropping system and use of nutrients carried down from the forest and villages in the first spring flood were some soil nutrient management activities adopted in the study area with little knowledge on sustainable soil management practices. So, for enhancing the efficacy of the maize production and soil fertility knowledge, future research strategy should be built based on the soil fertility status of the farm and some interventions is necessary to develop appropriate relation between soil nutrient status and maize production. This shows that the provision of training related to sustainable soil management practices and scientific use of both organic and inorganic fertilizers based on soil testing result is the prime need of the farmers for the sustainability of the system.

REFERENCES

[1] Atreya, K., Sharma. S., Bajracharya, R.M. 2005. Minimization of Soil and Nutrient Losses in Maize-Based Cropping Systems In The Mid-Hills Of Central Nepal, Journal of Science, Engineering and Technology, (1).

[2] Brady, N.C., Weil, R.R. 2002. The nature and properties of soils (13th edition), Pearson Education, New Jersey.

[3] Nepal, D. 2015. District Agriculture Development Office, Annual Agriculture Development Program and Progress: A glance, 2072/073.

[4] Ghosh, P.K., Bandyopadhyay, K.K., Wanjari, R.H., Manna, M.C., Misra, A.K., Mohanty, M., Rao, A.S. 2007. Legume effect for enhancing productivity and nutrient use-efficiency in major cropping systems - an Indian perspective: a review, Journal of Sustainable Agriculture, 30(1), 59-86.

[5] KC, G., Karki, T.B., Shrestha, J., Acchami, B.B. 2015. Status and prospects of maize research in Nepal, Journal of Maize Research and Development, 1(1), 1-9.

[6] MOAD. 2014. Statistical Information on Nepalese Agriculture, Ministry of Agricultural Development, 2014.

[7] MOAD. 2015. Statistical Information on Nepalese Agriculture, Ministry of Agricultural Development.

[8] MOAD. 2016. Statistical Information on Nepalese Agriculture, Ministry of Agricultural Development.

[9] Muyayabantu, G.M., Kadiata B.D., Nkongolo, K.K. 2012. The response of maize to different organic and inorganic fertilization regimes in monocrop and intercrop systems in a Sub-Saharan Africa Region. Journal of Soil Science and Environmental Management, 3(2), 42-48. DOI: 10.5897/JSSEM11.079 ISSN 2141-2391.

[10] NMRP. 2016. Maize Production in mid hills of Nepal: from food to feed security.