STUDY REPORT ON ORGANIC MANURE AND MICRONUTRIENTS

By

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Production and utilization of organic manure by farmersin four selected districts of Nepal

1.Introduction

Organic and inorganic sources of fertilizer play key role for crop production in the country. The use of chemical fertilizer in Nepal started in the early sixties but the use of fertilizer is very small as compared with developing countries in Asia(31 kg /ha as nutrient basis). Due to hilly region, lack of chemical fertilizer industries, and so many other factors the availability of chemical fertilizers is a great problem in the country. Prior to the introduction of chemical fertilizers or even now, organic manure is basically the only applied source of nutrients for crops. So it is very important to use the locally available resources as composting materials, green manuring or animal bed for the increment of organic manure amount. The most significant contribution of compost is its sustainable effect on soil fertility and soil productivity increment. Organic manure maintains and improves soil structure. Increasing organic matter, improves soil water holding capacity, reduces loss of nutrient leaching in light soils, increase the microbial activity, improves porosity, reduces water run off and erosion losses. In brief, organic manure improve the physical, chemical and biological properties of soil. The traditional Nepalese agriculture is based on Farm yard manure (FYM) and compost application although the quality compost is lacking because of lack of technical know-how for making compost, poor storage and management techniques. So keeping the following objective this study was conducted from the fiscal year 1996/97 . The study result of this fiscal year 1998/99 is described in this report.

2. Objectives

- To find out the know-how of composting at farmers level.
- To find out differences in compost making and application practices in different districts.

- To find out the area where improvement is needed in compost preparation and its applications so that it can be a guide to future planning for intensive use of organic manure for sustainable soil fertility management.

3. Location of the study areas :

a. Dang The study area covered Urahari and Halbar of Dang valley
b. Kailali Study area covered Geta , Darakha, Pahalmanpur, Phulbari & Dhangadi.
c. Sankhuwasabha: The study area covered Baneshore, Malaya, Khandbari, Kharyang and Chainpur.
d. Sarlahi: The study area covered Ishwarpur, Khariyatole, Hariwan, Hathiaul, Balara, Bhansar, Sagrampur, Mirjapur and Bhawanipur.

4.Methodology

A set of simple questionnaires were prepared and technicians (Soil Scientist) of STSS visited the farmers and collected the information on questionnaire sheet. The districts covered under study are Kailali and Sarlahi from Tarai belt , Sankhuwasabha from hilly belt and Dang from the valley. Out of 145 farmers 35 were from Dang, 50 from Kailali and 31 from Sankhuwashabha and 29 from Sarlahi.

5. Results

Related Social Information:

5.1. Family size:

In all the 4 districts, medium size family (i.e. 5-10 member) is more prevalent in Dang, Sankhuwasabha and Sarlahi but Kailali has greater than 10 members.

Table 1: Family size of farmers household in the districts under study

District	THH	Family size		
	Total house hold	< 4 member	5-10 member	> 10 member
Dang	35	1(2.8)	17(48.6)	15(42.8)
Kailali	50	9(18)	15(30)	26(52)
Sankuwashabha	31	7(22.6)	24(77.4)	-
Sarlahi	29	4 (14)	20(68)	5(17)

(% in parenthesis)

5.2. Farm size (land holding)

Twenty-six households from 50 in Kailali district and 17households from 29 house hold in Sarlahi district falls under > 1.5 ha land holding .Majority land holding in study areas falls under 0.5-1.5ha. Thirteen households from31 in Sankhuwasabha have land holding below 0.5 ha

Table 2. Area of cultivated land of farmers in the districts under study.

District	THH	< 0.5 ha (Small farmer)	0.5-1.5 ha (Medium farmer)	> 1.5 ha (Large farmer)
Dang	35	1	18	16
Kailali	50	9	15	26
Sankuwashabha	31	13	15	3
Sarlahi	29	2	10	17

5.3. Main Crops:

Paddy, wheat, maize, mustard and lentil are the major field crops in Dang and Kailali districts. Paddy, wheat, mustard and lentil are the major field crops of Sarlahi district. Paddy, wheat ,maize and finger millet are the major field crops in Sankhuwasabha district

5.4. Livestock keeping:

Animals play an important role in Nepalese agriculture, providing manure for farm, fuel for household as well as protein source for human consumption. In the study area, larger family generally appeared to keep more numbers of livestock. The relation appeared to be more the number of livestock more will be the fodder or feed requirement, and more manure production for use in their field. (Table 3a, 3b, 3c, 3d. 3e, .).

Table 3a. Number of animal heads per household in Dang District

Farmers' category	THH	Big animal	Medium animal	Poultry
Small farmer	1	6	7	3
Medium farmer	18	7	4	12
Large farmer	16	10	7	16

Table 3b. Number of animal heads per household in Kailali district

Farmers' category	THH	Big animal	Medium animal	Poultry
Small farmer	9	3.6	1.23	5.78
Medium farmer	15	4.8	5.54	4
Large farmer	26	10.1	6.4	11

Table 3c. Number of animal heads per household in Sankhuwashava

Farmers' category	THH	Big animal	Medium animal	Poultry
Small farmer	13	4	2.5	10
Medium farmer	15	5	4.2	8.7
Large farmer	3	5	6.5	10

Table 3.d. Number of animal heads per household in Sarlahi district.

Farmers' category	THH	Big animal	Medium animal	Poultry
Small farmer	2	3		2.5
Medium farmer	10	2.3		0.2
Large farmer	17	3.7		-

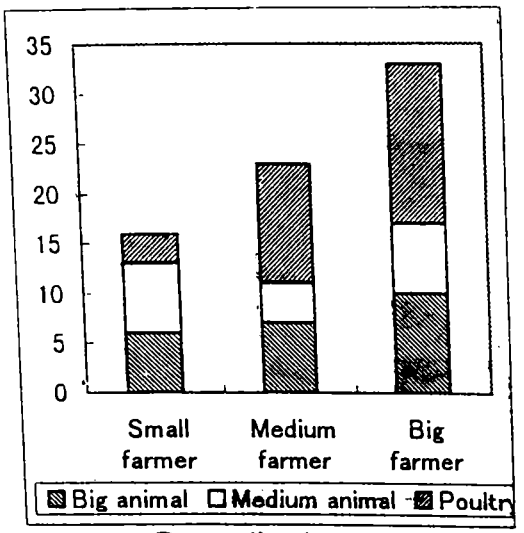
Table 3.e. Comparative study of numbers head per family in four districts

District	THH	Biganimal	Medium animal	Poultry
Dang	35	8.3	5.5	13.6
Kailali	50	6.2	5.2	8
Sankhuwashabha	31	4.6	3.7	9.4
Sarlahi	29	3.2	-	-

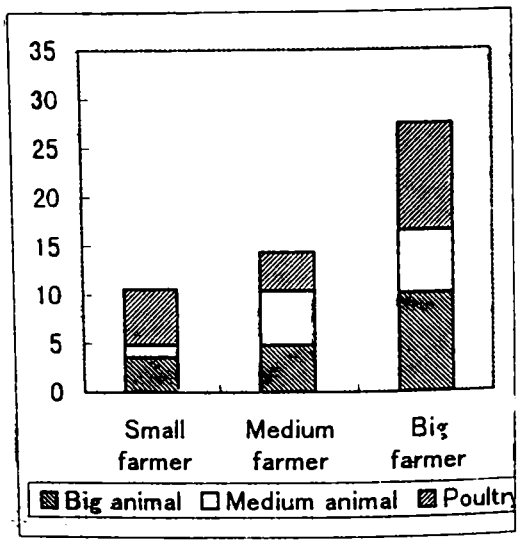
The number of animal in Dang is more than other districts. but Sarlahi has less number of animal. Report represents that bullock keeping in this district is more popular. Every household have one pair of bullock. There is no medium animal in Sarlahi district in study area. Except Sarlahi district, others have big animal, medium animal and poultry in study area but poultry keeping is not a commercial way. Big animal like cows, buffaloes, bullock keeping is more common in comparison to medium animals like goat, sheep and pig keeping in the districts under study.

5.5. Average yield of major cereal crop in the study area.

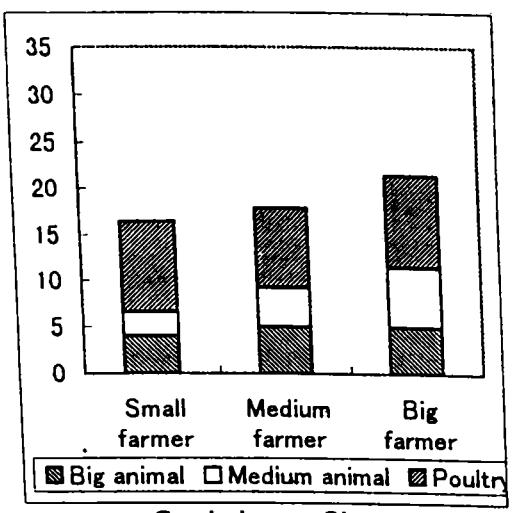
Paddy yield is 3.6t/ha in Kailali followed by Sankhuwashabha (2.96 t/ha.). Wheat yield is 2.74 t/ha .in Sankhuwashabha and 2.24t/ha in Sarlahi. Dang is highest yielded (1.21 t/ha) in mustard. Sankhuwasabha is highest yielded (2.1 t/ha)in maize. Lentil yield is 0.57t/ha in Sarlahi district. If we look Table 4.e. it is clear that the medium land holders are leading in yield in paddy, wheat, mustard, millet and lentil and high land holder are able to lead in maize yield.



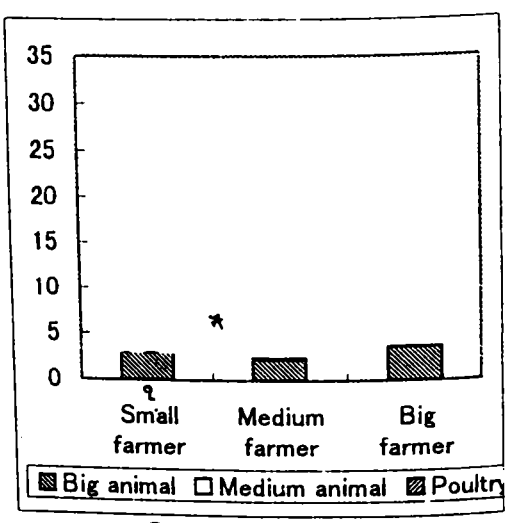
1a Dang district



1b Kailali district



1c Sankshuwa Shava



1d Sarlahi district

Fig. 1a–1d Number of animal heads per household

Table 4.a. Average yield of major field crops in Dang Districts (t/ha)

Farmers	THH	Paddy	wheat	Mustard	Maize	lentil
Small	1	1.60	1.74	-	1.20	0.40
Medium	18	2.36	1.65	1.45	1.36	0.48
Big	16	2.38	1.81	0.94	1.44	0.47
Average		2.34	1.72	1.21	1.39	0.47

Table 4.b. Average yield of major field crops in Kailali Districts (t/ha)

Farmers	THH	Paddy	wheat	Mustard	Maize	lentil
Small	9	3.5	2.5	0.35	1.71	0.57
Medium	15	4.2	2.7	0.61	1.62	0.60
Big	26	3.3	1.6	0.64	0.75	0.5
average		3.6	2.1	0.57	1.18	0.54

Table 4. c. Average yield of major field crops in Sankhuwasava Districts (t/ha)

Farmers	THH	Paddy	Wheat	Mustard	Maize	Millet
Small	13	2.64	1.86	-	2.05	1.40
Medium	15	3.30	3.50	-	2.02	1.54
Big	3	2.74	-	-	2.44	1.50
Average		2.96	2.74	-	2.10	1.48

Table 4.d. Average yield of major field crops in Sarlahi Districts (t/ha)

Farmers	THH	Paddy	Wheat	Mustard	Maize	Lentil
Small	2	3.00	2.30	-	-	-
Medium	10	2.18	2.09	0.72	-	.77
Big	17	2.40	2.33	0.92	-	0.46
Average		2.37	2.24	0.84	-	0.57

Table 4.e. Comparative study of average yield of major field crops (t/ha)

Farmers	THH	Paddy	Wheat	Mustard	Maize	Millet	Lentil
Small	25	2.94	2.12	0.35	1.88	1.40	0.45
Medium	58	3.05	2.47	0.98	1.64	1.54	0.56
Big	62	2.79	1.87	-	2.11	1.50	-
Average		2.92	2.15	0.79	1.88	1.49	0.53

5.6. Occupation other than agriculture

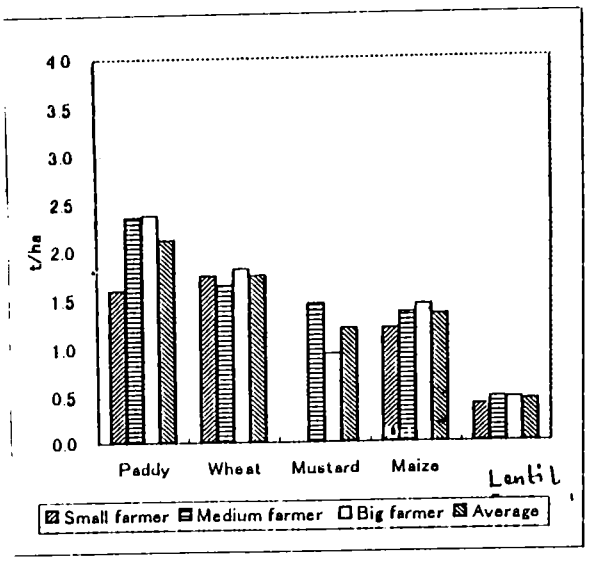
fifteen farm house hold out of 35 in Dang, 26 out of 50 in Kailali 13 out of 31 in Sankhuwasabha have government and non- government employment as well as engaged in business. In average 13.33 persons are involving in service followed by business(9person).

Table 5 Occupation other than agriculture

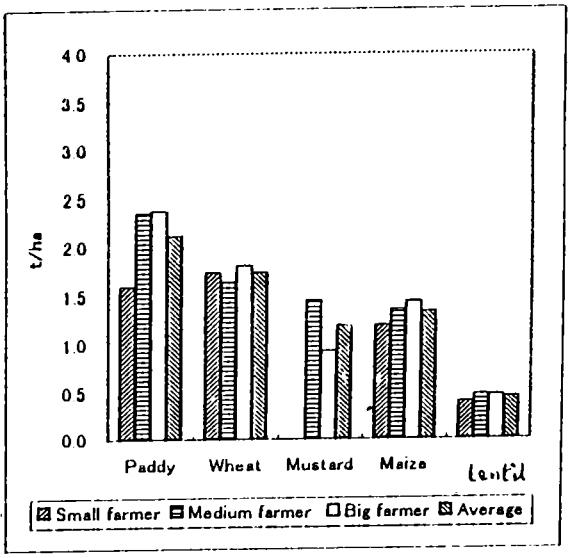
Districts	THH	Services	Business	Others
Dang	35	15	9	
Kailali	50	13	9	4.0
Sankhuwasava	31	12		1.0
Sarlahi				
Average		13.3	9	2.8

5.7. Use of chemical fertilizer

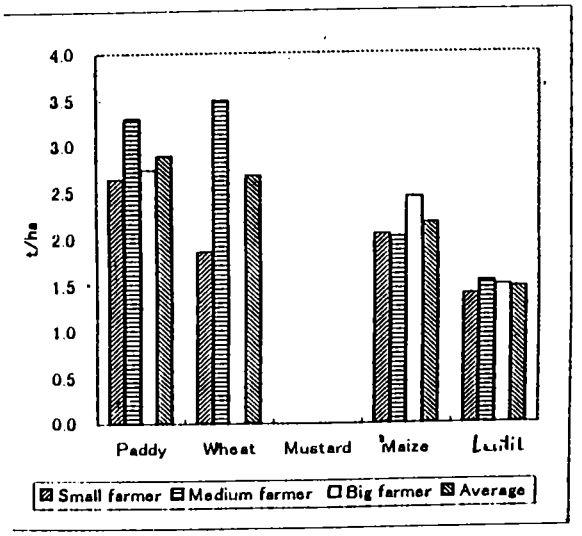
Except one farmer each from Kalali and Srlahi all other farmers are using organic manure and chemical fertilizer most of the farmers are using chemical fertilizer as well. Four farmers are using only organic manure and 2 farmers are using chemical fertilizer in Kailali district. All the farmers in Dang are using manure and fertilizer but K fertilizer is not in practice in study areas. The dose is very high in all the four district investigated as compared to the average of the country which is 31kg / ha . Specially in Dang district the use of chemical fertilizer is highest among 4 district.



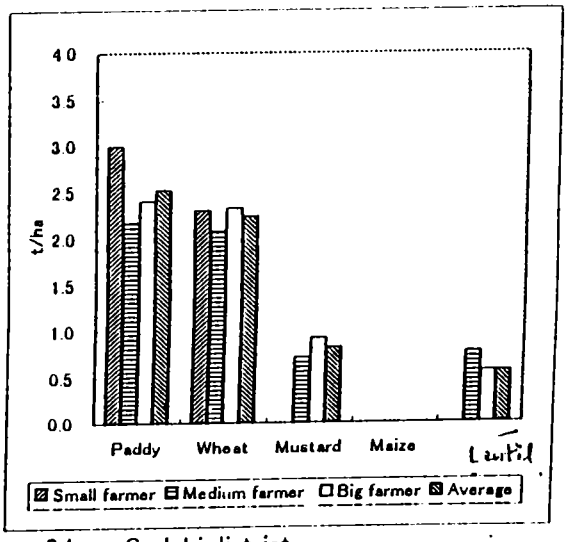
2a Dang district



2b Kailali district



2c Sankhuwa Shava



2d Sarlahi district

Fig. 2a–2d Average yield of major field crops

Table 6. Use of manure and fertilizers

District	THH	Chemicals	Organic	Both	No any
Dang	35	-	-	35	-
Kailali	50	2	4	43	1
Sankuwashabha	31	-	-	31	-
Sarlahi	29	-	-	28	1

Very few farmers are using micronutients fertilizer. Multiplex is using in potato in Dang and Kailali. Fertimin Z is popular in paddy in Kailali but no any micro nutrients applied in any crops in Sankhuwasabha.

Table 7. Dose of chemical fertilizer for crops(kg/ha)

District	Paddy		Wheat		Mustard		Maize		Lentil		Millet	
	N	P	N	P	N	P	N	P	N	P		
Dang	85	43	52	25	15	16	22	20	-		-	-
Kailali	30	21	30	21	23	23	18	23	21	19	-	-
Sankuwashabha	20.43	12.23	15	4.6	-	-	5.4	12.23	-	-	-	-
Sarlahi	40	18	48	28	-	-	-	-		-	-	-

Note : Fertilizer dose of Dang is high due to vegetable pocket area. These doses of fertilizer does not cover whole districts because these studies were done in vegetable and food grain pocket areas

Table 8 Type of organic manure used

District	THH	FYM	Compost	Green manure	Others
Dang	35	33	4	18	-
Kailali	50	48	9	17	2
Sankuwashabha	31	27	5	2	-
Sarlahi	28	28	-	-	-

Farmers are using FYM in all study areas followed by compost. Green manuring crop is also familiar in study area of Dang and Kailali. Eighteen persons in Dang (33) and 17 person in Kailali (50) are using green manuring. Locally available weeds, Dhaincha, and azolla are the popular green manuring crops in Dang. Dhaincha and local weeds are popular in Kailali

Table 9.Type of green manure

District	THH	Person involved	
Dang	35	18	Local weed Dhaincha, azolla
Kailali	50	17	Dhaincha, local weed
Sankuwashabha	31	2	Titepati and Banmara
Sarlahi	-	-	

5.8. Source of organic manure:

Organic manure is prepared by the farmers in all study areas but 9 person from Sankhuwasabha and 2 person in Kailali purchased the organic manure from their village for more use of organic manure in their field

Table 10.Source of organic manure

District	THH	Own preparation	Purchasing	Others
Dang	35	33	-	-
Kailali	50	45	2	-
Sankuwashabha	31	29	9	-
Sarlahi	29	28	-	-

5.9. Organic manure used crops:

Farmers are preferring to use the organic manure in paddy followed by vegetable

•Table 11 Organic manure used crops

District	Paddy	Wheat	Vegetable	Maize	Others
Dang	33	-	33	4	-
Kailali	41	13	19	5	10
Sankhuwasabha	28	-	1	1	-
Sarlahi	28	-	5	-	-

5.10. Frequency of organic manure application:

Dang farmers are using organic manure more than two times and in other districts using once a year

Table 11.Frequency of organic manure application

District	THH	Once a year	More than once		
Dang	35	5	30		
Kailali	50	31	18		
Sankuwashabha	31	29	-		
Sarlahi	29	27	1		

5.11. Dose of organic manure :

Most of the farmers are using less than 2.5 t/ha organic manure .But the dose of organic manure which is used by Sarlahi farmers (large farmers) is seems to be controversial because the animal head is lower than other districts. But the fact is that whole of the animal excrement is used as FYM preparation in those group of farmers.

Table 12. Dose of organic manure

District	THH	2.5 t/ha	3.5 t/ha	5.5-7.5 t/ha	7.5t/ha
Dang	35	27	5	-	-
Kailali	50	34	10	2	2
Sankuwashabha	31	16	13		-
Sarlahi	29	4	3	7	15

5.12. Know how of composting:

The farmers in Dang District are not familiar for composting , 29 person out of 50 familiar for composting in Kailali district, and 28person out of 35 familiar for composting in Sankhuwasabha district.

Table 13 Know-how of compost technique

District	THH	Familiar	Not familiar
Dang	35	4	31
Kailali	50	29	21
Sankuwashabha	31	28	3
Sarlahi	29	28	1

5.13. Person involved in composting:

Highest numbers of households (28) of Sankhuwasabha are involving in composting.

Table 14. HH involved in composting

District	THH	Composting	Non composting	Non responding
Dang	35	3	-	32
Kailali	50	16	25	9
Sankuwashabha	31	28	2	1
Sarlahi	29	28	1	-

Heap method is popular in Kailali and pit method is popular in Sarlahi.

Table 15. Method of composting

District	THH Involved in composting	Pit	Heap	Not responding	Heap/Pit
Dang	3	3	-	30	-
Kailali	16	6	10	34	-
Sankuwashabha	28	1	27	3	-
Sarlahi	28	21	2	1	4

5.14. Use of starter:

Twenty eight house holds are using starter in Sankhuwasabha followed by Kailali (21) .The popular starters are ash, lime, soil and urea . It is rather surprising that most of farmers are not familiar with compost making in Dang district. Intensive training is required.

Table 16.Use of starter

District	THH	Use	Not use
Dang	35	3	32
Kailali	50	16	34
Sankuwashabha	31	28	3
Sarlahi	-	-	-

5.15. Duration of composting :

Majority of house hold reported the composting period is 4-6 month.

Table 17. Duration of composting

District	THH Involved in composting	2-4 months	4-6 months	>6 months
Dang	3	3	-	-
Kailali	16	1	13	2
Sankuwashabha	28	-	28	-
Sarlahi	28	11	11	6

6. Discussion and Conclusion

Due to unavailability of adequate amount of chemical fertilizers in time and increase in price of chemical fertilizer, increasing the use of organic manure has become the only alternative to sustain soil fertility.

Based on the study on use of compost in four districts (Tanahu, Kaski, Parbat and Chitawan) in the fiscal year 1997/98,in three districts (Dhankuta, Kathmandu, and Nawalparasi) in the fiscal year, 1996/97 four district(Dang Kailali, Sankhuwasabha and Sarlahi) in the fiscal year 1998 /99, it can be concluded that proper method of composting is not followed by farmers. Collecting of animal bedding litter and dumping in a pit itself is called compost by most farmers. The manure is not turned over and loss of nutrients by leaching and runoff is high. Sharma, 1983 as cited by Khadka and Chanda 1987, estimated a loss of 50% nitrogen and 90% potash from compost heaps, particularly during the rainy season. Amount of organic manure can be increased by using crop residues and weeds along with farmyard manure in composting and loss of nutrient can be reduced by proper storage. Period of composting can be reduced by using starter like little

amount of nitrogen fertilizer, lime, top soil also using succulent plant residues and reducing the size of plant material to small pieces. From the same number of livestock's, more compost can be prepared and farmers need to be made aware of that. Conserving the nutrient content of composts through use of proper method, we would be able to replace part of fertilizer requirement. The amount of the organic manure is in most cases, 2.5-3.5 t/ha The nutrients element content in 3 tones of FYM is roughly estimated to contain 12 kg of nitrogen, 6kg of phosphorus and 25 kg of potassium. This amount is not sufficient, however, the dose of chemical fertilizer is several times more than the average of Nepal, as long as the chemical fertilizer is applied at this rate, there is no problem even though the rate of organic manure application remains under low level like 2.5-3.5t/ha .If the dose of fertilizer is near the average amount of Nepal, it is necessary to apply more organic manure for sustainable soil fertility management. If we want to maintain the fertility status of Nepal we have to apply more than 10t/ha or more of FYM or compost.

7. Suggestion of quality compost

-Composting is an aerobic and anaerobic process but aerobic decomposition faster than anaerobic process. Aerobic process of composting is less odorous . In another words heap method is an aerobic process and pit method is basically an aerobic process. Pit method is also can be arranged for aerobic by inserting the perforated pipe in certain distance in the composting pit .

- Provide the favorable environment for microbial activity to hasten the decomposition.

-Keep the composting material moist.

-Adjust the carbon nitrogen ratio to hasten the decomposition or increase the nitrogen content in the composting.

-For the nutritive value add manure, phosphate ,bone meal, wood ashes and nitrogen, lime or (fertilizer, dung and urine solution , slaughter wastes like blood fish crapes, top soil , fungus from the old compost etc) are the good sources for starter.

-Use the suitable materials for composting like leguminous crops, grasses , weeds (do not use viable seed containing weeds) Vegetables wastes, Azolla, tender vegetation from forest, dry and green leaves of trees.

-Saw dust and mature woody plant can be used for compost materials but in Nepal these materials are not in practice.

-Nepali farmers are using conifer needles, trees green leaves with small woody parts, corn stalk, straw of rice and finger millet but these materials are very hardy and decomposition take longer period. Such materials should be chopped in small pieces before using

-For quality compost , provide sufficient eration , suitable temperature, high optimum moisture, suitable starter, mixing or turning in a proper time , (at least three times at an interval of one month).

-Use the plastic or moisture barrier to cover the compost pile in dry hot period and rainy season also.

-Soil of mid hills Nepal is more acidic use the starter to control the acidity like lime stone, and wood ashes.

- Burning problems of Nepali soil is the depletion of organic matter. Organic manure is the main source of organic matter . To increase the organic matter in the soil, the organic manure should be applied. For the development organic manure as well as organic matter in the soil the following activities should be in practice.

-Use all kinds of plant residue for composting or animal bed for bulk amount.

-Stop the dung or stables burning and use all kinds of manure as well as stables for composting materials for plant nutrients. Encourage the biogas plant

-Follow IPNS.

-Use legumes in crop rotation.

-Use conserve farming for organic matter as well as other nutrients to conserve

-Dung and urine from all kinds of animals , agro -industrial residue , night soil, food processing residue, city refuses(sewage and sludge) should be recycled.

- Use green manuring as a sole crops or as a relay or mix crops in maize.

-Use azolla as a green manuring in the paddy.

-Use rhizobium as well as azotobacter for symbiotic and non symbiotic nitrogen fixation.

Acknowledgement

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Study of micro nutrient deficienct areas And use of micronutrient fertilizer

1. Introduction

Plants need many nutrient elements. Carbon, hydrogen. oxygen, are non-mineral elements. Nitrogen, phosphorus, potassium are primary mineral elements required in higher amounts. Calcium, magnesium, and sulfur are secondary mineral elements required lesser than the pri mary elements. While iron, zinc, manganese, copper, boron, molybdenum, chlorine are tertiary or micronutrients, required in very less amount, but equally essential to plants. These micronutrients, if available lesser than plant needs, shows deficiency, and if available higher than required amount, may become toxic to plants.

According to Carson (1992) zinc, manganese, molybdenum, boron, copper and iron deficiency have been found in some cereals, vegetables and fruit crops in Nepal. Zinc deficiency is more common in paddy; boron and molybdenum deficiencies are more common in root and Cole crops. Some farmers are using micro nutrient fertilizers for the correction. So this study has been started to gather some information of micro nutrient deficiency areas and type of micronutrients used in the areas.

2. Objectives

1. To define micro nutrient deficient areas.
2. To gather information on type of micronutrient fertilizers used in the areas.

3. Materials and method

Written and oral information have been collected from the farmers, DADO, and micronutrient fertilizer retailers. Study has been launched in Chitwan, Banke, Dhangadi (Kailali), Kanchanpur, Kathmandu, Kavre, Nuwakot, Makawanpur, Bara, Parsa, Doti, Parbat, Palpa, Sarlahi, Dhanusa, and Nawalparasi districts

4. Micronutrient deficiencies in the study area

4.1 Nuwakot

Zinc deficiency is commonly found in Chaughada, Khadga Bhanjyang VDCs of Nuwakot district in paddy crops. Chhatre Phant, Chaughada, KhadkaBhanjyang, Katahare Phant are deficient in boron element, deficiency symptoms are seen mostly in root crops and vegetable crops.

4.2 Chitwan district

Zinc deficiency is common all over the district in paddy crops and boron deficiency is found in vegetable crops especially in case of Cole and root crops. In some places, molybdenum deficiency is also observed in cauliflower. Kathar and Godrang's paddy especially Mansuli and Sabitri varieties were affected by zinc deficiency. Chickpea and pigeon pea also affected by boron deficiency in this area.

4.3 Makawanpur

On the both sides, from Makawanpur to Chitwan, paddy is suffering from zinc deficiency. In Handikhola, vegetables especially Cole crops, bean, tomato are suffering from boron deficiency. Handikhola, Palung, Aambhanjyang areas have acidity problem. Wheat sterility problem was also observed in Aambhanjyang. Farmer's reaction was positive reqarding use of boron in cole vegetable crops.

4.4 Parsa

Zinc deficiency problem has been found all over the district in paddy and boron deficiency was observed in Cole crops.

4.5 Bara:

Similar reports as Parasa was found from Bara. Zinc deficiency in paddy and boron deficiency in vegetable. Naya Basti near Simara, Phosphorus deficiency was also found in Cauliflower.

4.6. Dhading :

Zinc and Boron deficiency in Paddy, citrus fruits and vegetable crops have observed in this district

4.7. Banke:

In this district also, the problems are similar to other districts like zinc deficiency in paddy and boron deficiency in vegetable.

4.8. Kailali:

Lentil and paddy suffered from zinc deficiency in Dhangadi municipality. Farmer are using Fertimin z, Fertimin b, Multiplex, Surya zinc. The dose of Surya zinc is 350 grams per Katha. According to RSTL Dhangadi Zn deficiency is a serious problem in paddy and boron deficiency is also a serious problems in vegetable.

4.9. Kanchanpur:

Surya zinc & zinc sulfate is in use. Zinc and boron deficiency symptoms were observed common respectively in paddy and vegetable crops.

4.10. Sarlahi:

Barahathawa, Jamunia, Haripur, Harakathawa, Ishorpur are the main micronutrients deficiencient areas specially zinc and boron.

4.11.Siraha:

Sarsar, Khirauna, Sukhipur, Mahespur& Marar are noted as micronutrients deficient areas for zinc and boron specially for paddy and vegetables.

4.12.Dhanusa:

Mahuwa, Kurtha, Raghunathpur, Baninia and Kuwarampur areas are known as zinc and boron deficient for paddy and vegetable.

4.13.Nawalparasi:

Zinc deficiency problems has been found all over the district in rice growing areas but boron deficiency is severe in commercial vegetable growing area (Pocket area) e.g. Gaindakot, Germi, Jamunia, Dewagaun, Agauli, Tamsaria.

4.14. Doti:

Banlek VDC wards No 1 Bandugrisen, vegetable crops are found suffered by Molybdenum deficiency. No micronutrient fertilizer is in practice.

4.15. Parbat:

Boron deficiency in vegetables were found all over the district but zinc deficiency symptoms is seen in Phalebas area and Katuwachaupari. Where sa the application of micronutrient fertilizer was found negligible.

4.16. Palpa:

Mostly boron deficiency found in vegetable specially in Cole crops in Madanpokhara and Argali area.

Similarly zinc deficiency found common in paddy and boron deficiency in vegetable crops and in coconut in Jhapa, Morang and Sunsari districts, complex micronutrient deficiency symptoms were observed.

The study reports of micronutrients deficient areas, which are presented by Regional Soil Testing Laboratories, are given below.

4.17. Regional Soil Testing Laboratory, Nuwakot. (Ram Dular Yadab).

Study has been conducted in all districts of the mid development region. Most of the rice growing areas found deficient in zinc. Boron deficiency was found in crops like cauliflower, radish, tomato, cabbage and some variety of wheat. Molybdenum deficiency was also found in cauliflower.0.5% foliar application of borax solution in wheat able to provide better yield in UP262, NL251 and NL297.

4.18. Regional Soil Testing Laboratory Tanahu. (Padam Prasad Adhikari):

Micronutrient content of the soil is very poor in Tarai as well as hilly region of western development region. Zinc deficiency in rice, boron and molybdenum in Cole crops and radish. It is essential to apply the micro nutrient fertilizer in the land. Study was conducted Myagdi, Baglung, Parbat, Rupandehi and Nawalparasi.

4.19. Regional Soil Testing Laboratory Khajura Banke (Bharat Mani Adhikari):

Major nutrients elements like nitrogen; phosphorus and potassium are deficient in most soil and responsible for decreased yield. Beside some micronutrients are also deficient. Zinc deficiency in rice, maize and citrus is serious. Boron and molybdenum deficiencies are common in vegetable. Application of zinc in rice as fertilizer is advisable.

4.20. Regional Soil Testing Laboratory Dhangadi Kailali (Mukta Nath Kuwar).

According to Kuwar that the farmers is in problems to identify the *Rog* (Disease) and *Bhok* (Deficiency symptom of plant nutrients). It was observed that Kailali and Kanchanpur are the highly zinc deficient district in case of rice. Similarly Tikapur, Dhangadi, Mala kheti, Lamki, in Kailali and Majhgaun, Mahendra Nagar in Kanchanpur district paddy was affected by zinc and vegetables were effected by boron and and molyb denum deficiency.

4.21. Nutrients activity in Horticulture (Janardan Khadka)

Profitable citrus orchards must have sandy loam, sandy gravelly loam and loam soils. Normal growth dose not occur in the soils having impervious sub soil or exceedingly shallow soil with sandy or gravelly sub soil or having very little moisture retaining capacity. Shallow soil less than 50 cm in depth for orchard plantation, citrus may grow and crop well for a few years but later show symptoms of decline. Die back is predominant in clay and sticky soil. It is caused by soil conditions. Soil with uniform profile within the normal root zone is most satisfactory for proper citrus cultivation. Khadka pointed out the following remark in nutrients in some fruit crops.

In citrus critical time for nitrogen deficiency is prior to and during flowering, fruit set and December leaf drop. Excess nitrogen causes poor fruit quality, fruit color, delay maturity, reduces juice content and thick skins. Similarly in phosphorus deficiency fruits contain low juice content and, thick skin. Magnesium deficiency causes yellow of leaves with an inverted V of green tissue at the base of the leaf. Manganese deficiency causes inter venial yellowing with a band of dark green along the midrib and veins.

Zinc deficiency produces symptoms which are similar to Mn deficiency but the inter veinal yellowing is less blotchy and more clearly defined. In extreme cases leaves can be small and narrow. Manganese and zinc deficiency often occurs together and can be corrected together on singly.

5. Types of Micronutrient fertilizers available in the study areas

Many Micronutrient fertilizers by different names are available in the market. That micronutrient fertilizer product sold in the market and their nutrient content is given in table 1.

Table 1. Micronutrient Fertilizers sold in the market and their nutrient content:

Type of product	Ca	Mg	S	Zn	Cu	Fe	Mn	Mo	B	Cl
Surya Zinc	12	3.2	8	12	0.5	3.2	2.35	0.4	0.2	0.2
Agromin	-	-	-	3	0.5	0.5	0.2	0.02	0.5	
Microplex				5	0.5	0.5	0.5	0.02	1	
Multiplex				5				0.2	0.5	
Graficon			12	7	1.5	1.5	5	0.005	0.005	
Zinc chelate				12.5						
Fertmin-Z			7	14						
Zinc sulfate				35					11	
Borax									17	
Boric acid										
Vagimax	0.67	0.68	0.34	0.02	0.02	0.12	0.04	.0001	0.02	

6. Key deficiency symptoms of nutrients in Agronomical and Horticultural crops

Nitrogen- Chlorosis from leaf tipsPhosphorus: Reddish color green leaves or stem.Potassium: - Necrosis on leaf marginCalcium: - Youngest leaf distortedMagnesium: Chlorosis mainly between the veins but veins remains green Sulfur: Mottle yellow green leaves.

6.1 Deficiency symptoms of micro nutrients in Agronomical and Horticultural crops

- In case of zinc deficiency, inter veinal chlorosis is seen first in younger leaves. Dead cells are commonly found in yellow leaf area and the production of auxin will be decreased resulting in shortening the inter node of the stem and branches, bushy and rosette appearance, small and narrow leaf and premature fall of leaf. Malformation in fruit, white bud in maize, and khairadisease in paddy, rosette on the top of the branch and flower part leaf less in apple, leaf mottling in zinc, interveinal chlorosis, drying, cracking of fruits and die back of guava, little leaf in mango, younger leaves mottling, little leaf and rosette appearance in peach.
- Zinc deficiency is mostly common in basic soil and soil of arid, limed acidic soil, calcareous soil, sandy leached soil, soil having high dose phosphate fertilizer, and in soil where crops requiring high zinc, such as paddy, corn, onion, sorghum, beans, citrus and deciduous fruits are grown, without addition of zinc yield can not be achieved as required. So soil and crop management should be done in such areas.

- Boron deficiency is common in sandy, leached acidic soil, organic soil, over limed soil and soil of humid areas because available boron can be leached in such soil. So such type of soil need to be managed well. Boron deficiency is more likely to be seen in drought period, so moisture supplement in such period prevent from boron deficiency.

Boron deficiency mostly seen in terminal bud due to the boron not readily mobile, growth ceased, reduce pollen tube and pollen grains. Deficiency is most common in high rainfall area. In vegetable deficiency mostly seen in apical region, brown curd, hallow stem of cauliflower, canker of beet, cracked stem of celery, stem end rosette of tomato rough leaf, cracking etc symptoms are seen in vegetables. Death of apical region of the shoot in pineapple. Failure of leaf and bud development in peach secretion of latex and formation of tumors in papaya, fruit cracking and fruit drop in litchi, Internal browning and spot in apple, multiple bud and fruit drooping in citrus, black tip in mango, sterility in wheat are the specific symptoms of boron deficiency for specific crops.

According to study, it is clear that the use of boron (micronutrients for vegetables specially cole and root crops and commercially fruits growing areas) essential like major nutrients.

- Copper deficiency is common mostly in sandy, organic and calcareous soil.

- Iron deficiency symptoms are common on wet, clayey, calcareous soil or over limed soil.
- Manganese deficiency is mostly observed on sandy, organic and calcareous soil.

- Molybdenum deficiency is common on sandy, leached acidic soil and highly weathered soil, metal oxide high content soil ,the soil where legume, cole crops (mostly cauliflower and broccoli), citrus are growing continuously required molybdenum micronutrients fertilizer. Narrowing the leaf margin of plant e.g. whiptail in cauliflower and yellow spots in cashew and midrib of the cole crops become twisted as the leaves develops

6.2 Remedies

1. Addition of organic manures as much as possible, because organic manures are the main sustainable source of plant nutrients, macro as well as micronutrients.
2. Chemicals containing the specific micronutrient can be applied.

Source of micro nutrient fertilizer, their application rate and high responsive crops are as follows:

Element	available form	Chemical source	Application dose		Crops
			Soil application	foliar application	
Zinc	Zn^{2+}	Zinc sulfate (23-35 %) Zn	10-20 kg/ha zinc	0.5-2 kg/ha zinc sulphate +0.25-1kg/ha lime (0.1 to 0.4%) solution	Maize, Jowar, onion, beans, Grapes, Citrus, apple, Paddy, Soybean
Molybdenum	MoO_4^{2-}	Ammonium molybdate (54%Mo), Molybdenum Trioxide 66 % Mo Sodium molybdate 39 % Mo	0.05-1kg/ha Mo	0.04 to 0.4 kg/ha Mo (0.008to 0.08% solution)	Cauliflower, Broccoli, Celery, Legumes, Citrus
Iron	Fe^{2+}, Fe^{3+},	Ferrous sulfate (19 % Fe), Ferrous oxide (77%Fe), Ferric oxide (69 % Fe), Iron chelate (5 to 10 % Fe)	0.5-10kg/ha Fe	2 % Ferrous sulfate solution with 1 %lime solution	Corn, Soybean, Bean
Manganese	Mn^{2+}, Mn^{3+},	Manganese sulfate (26-28 % Mn), Manganese oxide (41-68 Mn)	20-25 kg/ha Mn	0.5 kg/ha Mn(0.1% solution)	Fruits,soybean, vegetables, Cereals, Beans, Onion, Potato, Citrus, Wheat
Copper	Cu^{+} Cu^{+4}	Copper sulfate (25%), Copper oxide (75 %), Copper chelate (18-14%)	20 kg/ha Cu	0.2 kg/ha Cu(0.04% solution)	Citrus, Onion, Barley, Paddy, Wheat, Carrot etc
Boron	Bo_3^{3-}, HBo_4O_7	Borax (11 %), Boric acid (17 %)	20 kg Boric acid/ha	1-2 kg Boric acid/100 liters of water	Cauliflower, Celery, Apple, Carrot, Mustard

Note:- please mix half dose of lime in sulfur or sulfate containing fertilizer foliar application

6.3 Some other facts and suggestions

- Maintain the soil pH towards neutral level (6-7), because all the essential nutrient elements become available form in this range. In acid soil Fe, Mn, Zn, Cu, B, these elements becomes highly soluble which may cause toxic effect. Leaching may lose these elements.
- There may be antagonistic effect between the mineral nutrients.
  - Do not use more than recomended dose of nitrogen because copper and zinc deficiency may be intensified.
  - Do not use more than recomended of iron, copper, zinc, because these elements may reduce the absorption of manganese.
  - High dose copper or sulfate has adverse effect on molybdenum absorption.
  - High dose of phosphorus also encourage the deficiency of zinc, iron, or copper but beneficial for molybdenum absorption.

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