AN ESTIMATE OF USE OF FARM YARD MANURE (FYM)/COMPOST IN FIELD CROPS IN THE KOSHI HILLS

G B Gurung[1]
R K Neupane[2]

PAC WORKING PAPER NO. 23

June 1991

Pakhribas Agricultural Centre,
c/o BTCO, P O Box 106,
Kathmandu, Nepal.

---

[1] Asst Soil Scientist
[2] Asst Agronomist

CONTENTS

सारांश :

नेपालको पहाडी भेगमा उर्वरा शक्तिलाई कायम राख्न गोठे अथवा कम्पोष्ट मलको के कति महत्व छ भन्ने कुरा सहजै अनुमान गर्न सकिन्छ। तर हिजो आज खेतबारीमा प्रयोग गर्ने गोठे अथवा कम्पोष्ट मलको मात्रा क्रमशः घटदै गएकोले पहाडी भेगको माटोको उर्वरा शक्तिमा आएको ह्रास पनि मुख्यतः यसैको प्रतिफल हो। कोशी पहाडी जिल्लाका कृषकहरुले विभिन्न खाद्यान्न बालीहरुमा के कति मात्रामा गोठे अथवा कम्पोष्ट मल प्रयोग गर्दछन भन्ने सिलसिलामा यो प्रतिवेदन तयार पारिएको हो।

प्राप्त नतिजा अनुसार कोशी पहाडी क्षेत्रका कृषकहरुले खेतमा भन्दा बारीमा नै बढी मात्रामा गोठे अथवा कम्पोष्ट मलको प्रयोग गर्दछन। तल्लो उचाईमा पर्ने खेतमा प्रायः गोठे अथवा कम्पोष्ट मल प्रयोग गरिदैन।

लेकमा खेती गरिने आलु बालीमा अरु बालीहरुभन्दा निकै बढी मात्रामा गोठे अथवा कम्पोष्ट मल प्रयोग गरिन्छ। आलु+मकै बाली पद्धति अन्तरगत आलुमा ३३ टन प्रति हेक्टरका दरले गोठे अथवा कम्पोष्ट मल प्रयोग गरिन्छ भने मकै/कोदो र मकै-तोरी पद्धति अन्तरगत मकैमा १५ टन प्रति हेक्टरका दरले प्रयोग गरिन्छ। तर मकै+भटमास र मकै-धान पद्धति अन्तरगत मकै बालीमा क्रमशः ६ र ११ टन प्रति हेक्टरमा दरले मात्र गोठे अथवा कम्पोष्ट मलको प्रयोग गरिन्छ। मध्य उचाईको खेतमा अपनाइने धान-गहुं पद्धति अन्तरगत गहुंमा पनि गोठे अथवा कम्पोष्ट मलको प्रयोग गरिन्छ। तल्लो उचाईको खेतमा अपनाइने धान-बाली र धान-धान-बाली पद्धति अन्तरगत कहिले पनि धान खेतमा गोठे अथवा कम्पोष्ट मलको प्रयोग गरिदैन।

जाडो महिनामा वस्तुको थला (गोठ) सारेर जग्गा मल्ने चलन पनि कोशी पहाडी भेगमा प्रचलित छ। मकै/कोदो र मकै-तोरी पद्धति अपनाइने बारी र धान-गहुं पद्धति अपनाइने खेतमा यो चलन व्यापक छ।

SUMMARY

The importance of Farm Yard Manure (FYM)/Compost in maintaining soil fertility in the hills of Nepal (where farming is subsistence in nature) is well understood. However, the problem of declining soil fertility in the hills is associated mainly with the reduced amount of FYM/Compost used by the farmers these days. This paper is the result of an attempt made to estimate the amount of FYM/Compost used by farmers of the Koshi hills in the main field crops.

Koshi hill farmers use relatively higher doses of FYM/Compost on *bari* lands than on *khet* lands. Generally, FYM/Compost is not used on low altitude *khet* lands.

High altitude potatoes receive the highest amount of FYM/Compost, followed by maize in mid altitude. Farmers use 33 t/ha of FYM/Compost on the potato crop grown under a potato+maize pattern and 15 t/ha of FYM/Compost on maize crop under maize/millet and maize-mustard patterns on *bari* lands. But maize receives only 9 t/ha and 11 t/ha of FYM/Compost under maize+soyabean pattern in high altitude *bari* lands and maize-rice pattern in mid altitude *khet* lands respectively. Farmers use FYM/Compost on wheat crops also under rice-wheat pattern in mid altitude *khet* land. FYM/Compost is not used for rice under rice-fallow and rice-rice-fallow patterns in low altitude *khet* lands.

In the Koshi hills, *in situ* manuring is common in the winter season. This practice is adopted both on *bari* and *khet* lands where maize/millet, maize-mustard and rice-wheat cropping patterns are followed.

1. INTRODUCTION

1.1. Traditionally, Nepalese farmers have been using organic manures to restore soil fertility. In the hills of Nepal the maintenance of the soil fertility is almost exclusively based on FYM/Compost. Since 1960, the use of chemical fertilizer has increased considerably, but it's spread has been mainly restricted to the terai and Kathmandu valley (Khadka and Chand, 1987). It is estimated that of the total fertilizer imported, only 5% is being used in the hills (Bhattarai, Maskey and Shah, 1987).

1.2. ADB/HMGN (1982) reported that overall yields of most crops in the hills have declined over the last 20 years (Sthapit, 1987). The main reason for this could be the very low nutrient supplying capacity of soils (especially nitrogen) due to continuous cropping and farmers' inability to maintain soil productivity (Sthapit, 1987).

1.3. Obviously, judicious combinations of organic manures and chemical fertilizers are necessary for higher crop yields. However, Nepalese farmers in the hills have to depend solely on FYM/Compost due to unavailability of chemical fertilizer in time and their low purchasing power. It has been observed that use of FYM/Compost is gradually being reduced these days because the number of animals per household is declining due to the short supply of fodder in the hills of Nepal. The Integrated Cereals Project (1977-1984) reported that the average amount of organic manure used in the hills ranged from 8 to 12 t/ha, whereas, the Department of Soil Science and Agricultural Chemistry recommends a dose of 20 to 29 t/ha (Bhattarai *et al.*, 1987). Feldman (1977) also estimated that 50 t/ha of FYM/Compost should be applied per year in the soil, irrespective of cropping pattern, in order to maintain the current level of soil fertility in Nepal.

1.4. Conlin and Falk (1979) reported that farmers in the Koshi hills use very low doses of FYM/Compost. They reported that small farmers use 5.3 to 6.1 t/ha, whereas large farmers use only 2.9 t/ha under the maize/millet cropping pattern. Khadka and Chand (1987) have also reported on the amount of FYM/Compost used by farmers in the Koshi hills under different cropping patterns. They pointed out that the highest dose of FYM/Compost is applied to the potato+maize cropping pattern (39 t/ha) and the lowest to maize-rice-fallow cropping pattern (11 t/ha).

1.5. This paper presents a brief account of the farmers' dose of FYM/Compost application to the main field crops in the Koshi hills. The existing methods and materials of FYM/Compost making in the Koshi hills are also discused.

2. MATERIALS AND METHODS

2.1. Data presented in this paper on the farmers' dose of FYM/Compost for various crops are mainly derived from Pre Production Verification Trial (PPVT) records (1985 to 1988). The PPVTs were conducted by the Agronomy Section, Pakhribas Agricultural Centre (PAC), at different locations of the Koshi hills. Though the primary objective of the PPVTs was to verify varieties/technologies in the farmers' field, as a secondary

objective the farmers' use of FYM/Compost was determined by counting the number of *dokos* (traditional basket used to transport FYM) of FYM/Compost used. The weight of three randomly selected *dokos* of FYM/Compost was taken from the total number of *dokos* of FYM/Compost used by the farmer in a PPVT to assess the total weight used. This job was done by field based JTAs and records were maintained accordingly under close supervision of on-farm JTs and Agronomists. It is assumed by the Agronomy section, PAC that the amount of FYM/Compost used by the farmers in the PPVTs represents the farmers' practice because PPVT is a farmer managed trial.

2.2. The PPVT records provided the number of *dokos* of FYM/Compost used and the weight of three randomly selected *dokos* of FYM/Compost. With the help of average weight of a *doko* of FYM/Compost, the number of *dokos* and the area under PPVT, the amount of FYM/Compost used by the farmer for that crop was calculated in t/ha. From the records of replicated PPVTs within an Agricultural Service Centre (ASC), farmers' dose of FYM/Compost for each crop and respective cropping pattern was found out for the years 1985, 1986, 1987 and 1988 (Appendix 1). The data were averaged for each ASC and farmers' dose of FYM/Compost for each crop and respective cropping pattern was computed for each year. By averaging yearly data, farmers' dose of FYM/Compost for each crop and respective cropping pattern was obtained (Table 1). Field based JTAs (who are local residents) were used as key informants for other necessary information.

3. RESULTS AND DISCUSSIONS

Composting materials and methods used by farmers of the Koshi hills

3.1. Koshi hill farmers, like other Nepalese farmers have a practice of making compost close to animal sheds in the form of a FYM heap. Compost is mainly prepared from animal dung and bedding materials. Weeds such as Banmara (*Eupatorium adenophorum*), Titepati (*Artemesia vulgaris*), ferns (*Dryopteris filixmas*) and other grasses such as Banso (*Digitaria sanguinalis*), Ratnaulo (*Polygonum amplexicaulis*), Rimai (*Galinsoga parriflora*) etc. which are abundantly found during the rainy season, are generally collected and used as cattle feed or bedding material. For this purpose, crop residues are also commonly used. Farmers living close to the forest use large amounts of forest leaves for composting during spring and summer. However, there is shortage of green vegetative materials especially in low altitude sites. Due to the shortage of bedding materials, the FYM mainly contains dung and therefore loss of nitrogen due to volatilization may reach as high as 40% (Lewis, 1979).

3.2. Existing composting practices involve putting urine soaked bedding materials in a pit or in a heap along with dung from the cattle shed. Large amounts of animal urine, which is rich in nitrogen and potassium, is lost due to a lack of sufficient bedding material and a poor urine collecting structure of the shed floor. Farmers pile bedding material and dung haphazardly without placing them in alternate layers. The heap is raised above the ground level exposing it to a larger area without protecting the heap from the rain. Therefore, the intense rain during the monsoon may wash away nutrients to the extent of 50% of nitrogen,

50% of phosphorus and 90% of potassium due to leaching (Sharma, 1983). Turning of materials in the heap is not generally practised by farmers. As a result, the lower portion of the heap may be well decomposed (or sometimes spoilt due to anaerobic decomposition) whereas the upper portion may only be partially decomposed.

3.3. Farmers keeping goats, sheep and pigs collect the manure from the shed in smaller amounts. Since these animals give small amount of dung, the farmers can not make FYM/Compost in large amount by mixing the dung with bedding materials. But most of the farmers who keep pigs in a semi-instensive type of confinements make FYM/Compost relatively in larger amounts. A small portion of the confined area is occupied by the shed provided with the roof but the rest of the area is left open where the pigs prefer to stay. Farmers go on adding forest leaves, grasses and crop residues as bedding material for several days on the floor of the open area. Since the pigs stay longer on the bedding material in the open area than in the shed, urine and dung excreted by the pigs is well mixed with the bedding material. Such material used for the pigs is not removed for several weeks so that it serves as an *in situ* FYM/Compost heap. The trampling effects of pigs facilitate decomposition of the bedding material due to higher temperature in the lower portion of the heap. When the lower portion is well decomposed, a thin top layer of the bedding material (undecomposed) is removed and the decomposed material is carried to the field.

3.4. Farmers make FYM/Compost in larger amounts during the rainy season. This is due to the increased availability of composting materials, ample moisture and favourable temperatures for faster and better decomposition of FYM/Compost. However, the lack of aeration and heavy loss of nutrients through washing by rain are the main problems associated with compost making during this season. In the winter and dry summer, only small amounts of FYM/Compost are made primarily from animal dung. There is a shortage of vegetative material and the small amounts of vegetative material, which are added with animal dung, remain undecomposed for a long time due to low winter temperatures (especially in high and mid altitudes) and low moisture in summer.

Amount of FYM/Compost used by farmers of the Koshi hills

3.5. The PPVTs reveal that farmers in the Koshi hills use variable doses of FYM/Compost depending upon the crop, cropping patterns and land type. But there is also variation in the dose of FYM/Compost used among ASCs and over the years within an ASC and a crop which could be mainly due to the differences in moisture contents, the materials used (composition) and state of decomposition of FYM/Compost and size of the *dokos*.

3.6. Farmers use relatively larger amounts of FYM/Compost on *bari* lands (18 t/ha) than *khet* lands (11 t/ha) because *khet* land is far from the farmers' home or animal shed. Another reason might be the fact that the decline in soil productivity is more severe on *bari* land (due to sheet erosion) than *khet* land. This is true in the hills because *bari* land terraces are not well levelled whereas *khet* land terraces are well levelled and fertility on *khet* land is maintained itself to some extent by the decomposition of aquatic organisms during the rice growing season.

3.7. The highest dose of FYM/Compost is used on potato (33 t/ha) followed by maize (15 t/ha). This seems to be quite relevant because potato is the main staple crop in high altitudes and maize is the main crop in mid altitudes. Such a high dose of FYM/Compost (33 t/ha) available for potato crop could be also due to larger numbers of livestock being kept by farmers in high altitude because of larger grazing areas and better availability of bedding material for animals. In Tankhuwa ASC, the dose of FYM/Compost used on potato crop was found as high as 97 t/ha which seems to be much higher than in other ASCs, because most of the PPVTs were conducted in those farmers' field who grew potato only in a small area. Usually no FYM/Compost is used for rice on khet land.

3.8. The dose of FYM/Compost used by farmers in the Koshi hills under different cropping patterns are; potato+maize 33 t/ha; maize/millet-fallow 15 t/ha; maize/soyabean-fallow 9 t/ha; maize-mustard-fallow 15 t/ha; rice-wheat-fallow 11 t/ha, maize-rice-wheat, or mustard, or peas, or fallow 11 t/ha. Table 1 gives farmers' use of FYM/Compost under various cropping patterns in the Koshi hills (see Appendix 1 for more details).

3.9. The farmers have a practice of using FYM/Compost only for the main crop and do not apply an additional dose for an intercrop or relay crop. Since FYM/Compost has residual fertility effect in soil, this does seem to be a positive effect for the intercrop or relay crop. At high altitude, FYM/Compost is used on potato crop in potato+maize pattern and on maize crop in maize/soyabean pattern on the *bari* land. The dose of FYM/Compost used in maize+soyabean pattern is much lower than potato+maize pattern because majority of the farmers know that soyabean improves the fertility of soil and thus, farmers grow maize+soyabean on *bari* land where they will have limited amount of FYM/Compost to use. At mid altitude, FYM/Compost is used on maize crop in maize/millet pattern on *bari* land and on wheat crop in rice-wheat-fallow pattern on *khet* land. In maize-mustard-fallow pattern, maize crop receives FYM/Compost and some of the farmers use FYM/Compost on mustard too. At low altitude, FYM/Compost is used on the maize crop in maize-rice-wheat or mustard or peas or fallow patterns. No FYM/Compost is used under the rice-fallow and rice-rice-fallow patterns. Farmers rarely use FYM/Compost for the wheat crop in the rice-rice-wheat and rice-wheat-fallow patterns.

3.10. *In situ* manuring is also commonly practised by the farmers under maize-mustard-fallow and maize/millet-fallow patterns in winter using a shifting "*goth*" (traditional shed for animal) system, when the *bari* land remains fallow in mid altitudes. This practice is also adopted by the farmers in nearby *khet* land in winter under rice-wheat-fallow pattern. In this practice, cattle and buffaloes are tethered inside a temporary shed for two to seven days at one site and then moved to another site. If the number of animals is more and the size of the terrace is small, animals are kept at one site for only two to three days and if the number of animals is less and size of terrace is big, animals are kept at one site for seven days or even longer (personal communication with farmers). Farmers have the opinion that *in situ* manuring is more efficient than applying FYM in the field because it makes the soil more fertile.

Table 1. Mean farmers' dose of FYM/Compost application for various crops in the Koshi hills (from PPVTs, 1985-1988)

Year	No. of samples	Cropping pattern	Crop	Max. dose (t/ha)	Min. dose (t/ha)	Av. dose (t/ha)
1985	25	Potato+Maize	Potato	43	13	21
1986	15	Potato+Maize	Potato	46	27	36
1987	30	Potato+Maize	Potato	52	32	40
1988	25	Potato+Maize	Potato	43	23	34
85-88	**95**	**Potato+Maize**	**Potato**	**46**	**24**	**33**
1985	10	Maize/Millet-F	Maize	10	6	7
1986	17	Maize/Millet-F	Maize	21	12	16
1987	19	Maize/Millet-F	Maize	22	13	17
1988	16	Maize/Millet-F	Maize	21	10	18
85-88	**62**	**Maize/Millet-F**	**Maize**	**19**	**10**	**15**
1985	17	Maize/Soyabean	Maize	4	1	4
1986	12	Maize/Soyabean	Maize	21	7	13
85-86	**29**	**Maize/Soyabean**	**Maize**	**13**	**4**	**9**
1985	22	Maize-Mustard	Maize	15	6	10
1986	18	Maize-Mustars	Maize	23	7	14
1987	12	Maize-Mustard	Maize	23	17	20
85-87	**52**	**Maize-Mustard**	**Maize**	**21**	**10**	**15**
1985	13	Rice-Wheat	Wheat	11	3	7
1986	17	Rice-Wheat	Wheat	19	9	14
1987	24	Rice-Wheat	Wheat	17	7	12
1988	12	Rice-Wheat	Wheat	12	6	9
85-88	**66**	**Rice-Wheat**	**Wheat**	**15**	**6**	**11**
1985	4	Maize-Rice-A	Maize	14	7	11
1986	8	Maize-Rice-A	Maize	15	9	11
1987	12	Maize-Rice-A	Maize	13	10	11
1988	20	Maize-Rice-A	Maize	11	6	9
85-88	**44**	**Maize-Rice-A**	**Maize**	**13**	**8**	**11**

A - Maize-Rice cropping pattern on *khet* land at low altitude may be followed by wheat or mustard or peas or may be left fallow.

4. CONCLUSIONS

1. The use of locally made FYM/Compost is the only appropriate readily available source of plant nutrients to maintain soil productivity in the hills of Nepal. Widespread use of chemical fertilizer in the hills would only be feasible if chemical fertilizer could be cheaply manufactured within the country and if a network of roads could be developed giving access to remote areas.

2. The present dose of FYM/Compost used by farmers in the Koshi hills under different cropping patterns seems to be lower than the requirement to maintain soil fertility and will not supply the required nutrients for higher crop yields.

3. It is also possible that FYM/Compost prepared by Koshi hill farmers is of inferior quality. This is due to faulty techniques of compost making and application by the farmers.

4. Generally *khet* lands receive less amount of FYM/Compost as compared to *bari* lands. *Khet* lands where rice-fallow and rice-rice-fallow patterns are followed should also receive considerable amount of FYM/Compost or alternative sources of plant nutrients to increase productivity of the crop.

5. SUGGESTIONS FOR THE PROMOTION OF FYM/COMPOST

1. It is important to improve fodder supplies in the hills so that the number of animals can be increased. Additionally the livestock will be better fed and manure production will also be increased.

2. There is a substantial loss of dung and urine due to present animal grazing system. These losses could be minimized and FYM/Compost could be prepared in large amounts if animals are stall fed and provided with sufficient fodder and bedding materials.

3. The traditional method of *in situ* manuring in the winter should be promoted in areas where crop intensification is not followed, because if saves labour time and loss of dung and urine. Emphasis should be given to prepare FYM/Compost in large amounts by stall feeding with the use of sufficient bedding materials. Use of activators such as fertilizer, lime and wood ash in the compost pit is also suggested.

4. Farmers in the Koshi hills should be trained in proper composting techniques and application.

5. Sections of PAC which are using farmers' land for conducting FFTs and PPVTs, or seed multiplication, should utilize waste vegetation from these areas to make a demonstration compost heap with the active involvement and participation of neighbouring farmers.

6. Farmers should also be advised to make compost on their *khet* land, because *khet* land receives less amount of FYM/Compost due to it's distance from the farmers home or animal shed. In this case large amount of vegetative material can be used with the use of starter and activators in smaller amounts.

7. Crop residues should be utilized to make compost and to recycle the organic waste where cropping intensity is high and where green vegetation is in short supply (especially in low altitudes).

8. Piling of FYM/Compost in small heaps in the field several weeks before incorporation into the soil is normal farmers' practice. This practice causes loss of 30 to 40% of nitrogen by denitrification (Khadka and Chand, 1987). This loss could be reduced by incorpotating FYM/Compost in the soil immediately after carrying it to the field.

9. The low dose of FYM/Compost used by the farmers is mainly due to the time constraint for making FYM/Compost. In rainy season FYM/Compost can be prepared in large amounts because bedding material for animals is sufficiently available and dung output is also high but farmers remain busy transplanting rice, millet and harvesting and storing maize, which are very important operations for the farmers. Therefore, they can devote little time to preparing FYM/Compost and they can not prepare as much as they want. Since FYM/Compost making is also an important and labour consuming task, some labour should be utilized to make FYM/Compost in larger amounts.

10. Fertilizer recommendations for major cereals like paddy, wheat and maize for the country as a whole are 100:30:30, 100:40:30 and 120:50:40 NPK kg/ha respectively (Joshy and Deo, 1976). If the farmers are only using FYM/Compost which contains on average 0.5% N, 0.2% P and 0.3% K of which only 25% of nitrogen, 100% of phosphorus and 80% of potassium become available to the standing crop in the year of application, FYM/Compost @ 50 t/ha is also not sufficient for the crops even if we ignore the nutrient losses by soil erosion and other factors (Chand, 1987). Therefore, a higher dose of FYM/Compost should be applied to replenish soil fertility as well as to retard the rate and extent of soil erosion in the hills.

11. There is a great potential for making high quality compost in large amounts in the Koshi hills. The Koshi hill has a high livestock density producing 1583100 t of dung/year (Dunsmore, 1987). Abundant weeds growing everywhere in the rainy season and other locally available forest vegetation and crop residues should be utilized to make good quality compost after using them as animal bedding material.

12. Since organic manures are at the moment the only feasible way to sustain agricultural production in the hills, a socio-economic study to understand why farmers do not follow improved techniques of FYM/Compost making is extremely important. A Samuhik Bhraman to study various methods of maintaining soil fertility in the Koshi hills should also be initiated.

ACKNOWLEDGEMENTS

The authors wish to express their sincere gratitude to Mr S P Chand, Cheif Agronomist and Mr D P Sherchan, Senior Soil Scientist, PAC, for encouraging us to write this paper and for the critical review of the manuscript. Mr P G Rood, Farming Systems Research Advisor and all the senior staff of Agronomy Section are thankfully acknowledged for their valuable suggestions and constructive criticisms. Last but not the least, thanks are due to JTAs and JTs of Agronomy Section for their hard work in conducting PPVTs at different locations and for their help in compiling data from PPVT records.

REFERENCES

Bhattarai, S, S Maskey and R Shah (1987). Use and Promotion of Bio-fertilizers in Nepal. Paper Presented at the First Review/Working Group Meeting on Bio-fertilizer Technology, 15 to 16 November, 1987, Kathmandu.

Chand, S P (1987). Composting, its Value and Limitations for Small Farmers in Nepal. M. Sc. TAD (Crop Option) Dissertation, University of Reading, U. K.

Dunsmore (1987). KHARDEP Rural Development in the Hills of Nepal. Land Resource Study, 36.

Feldman, David (1977). Compost or Chemicals. ODG Nepal Project, Working Paper No. 20.

Hill, John M (1982). A Fertilizer Strategy for Nepal. Consultancy Report, December, 982.

Joshy, D and G P Deo (1976). Fertilizer Recommendation for Major Crops of Nepal. Division of Soil Science and Agricultural Chemistry, Department of Agriculture, Ministry of Food, Agricultural and Irrigation HMG/Nepal, October,1976.

Khadka, R J and S P Chand (1987). Organic Materials; A Valuable Source of Soil Nutrients in the Eastern Hills of Nepal. PAC Working Paper No. 12/87. Paper Presented at the First Review/Working Group Meeting on Bio-Fertilizer Technology, 15-16 Nov. 1987, Kathmandu.

Lacsina, R Q, S Bhattarai, S L Maskey and R Shah (1987). Review of Bio-Fertilizer Technology Implications for Research in Nepal. Paper Presented at the First Review/Working Group Meeting on Bio-Fertilizer Technology, 15-16 Nov. 1987, Kathmandu.

Lewis, R (1979). Making and Using Compost. Result and Experiment Conducted at PAC and Discussion of Methods Applicable to Hill Farmers.

Pakhribas Agricultural Centre. PPVT Records (1985-1988). Conducted by Agronomy Section in the Koshi Hills.

Sharma, R R (1983). Conservation of Farm Yard Manure (Nepali). Krishi (Bhadra-Aswin) Edited by Krishnaman Dixit. Year 2, Vol. 3.

Sherchan, D P (1989). Review of Work Carried out on Manures, Fertilizer and Bio-Fertilizers since 1975 at PAC. PAC Working Paper No. 3.

Sthapit, B R (1987). Lumle Report on Soil Feretility Research 1986/87. Paper Presented at the First Review/Working Group meeting on Bio-Fertilizer Technology, 15-16 Nov. 1987, Kathmandu.

APPENDICES

Appendix 1. ASC wise farmers dose of FYM/Compost for various crops in Koshi hills (from PPVTs 1985 to 1988).

S. no.	Year	Location ASC	No. of samples	Alt.	Land type	Cropping pattern	Crop	Dose of FYM/Compost t/ha		
								Max.	Min.	Avg.
1	1985	Tankhuwa	6	High	Bari	Potato+Maize	Potato	90	19	35
2	1985	Morahang	4	High	Bari	Potato+Maize	Potato	24	16	20
3	1985	M/Mulkharka	4	High	Bari	Potato+Maize	Potato	16	3	9
4	1986	Morahang	5	High	Bari	Potato+Maize	Potato	25	20	23
5	1986	M/Mulkharka	5	High	Bari	Potato+Maize	Potato	34	20	28
6	1986	Sukrabare	5	High	Bari	Potato+Maize	Potato	78	40	58
7	1987	Tankhuwa	5	High	Bari	Potato+Maize	Potato	97	73	79
8	1987	Sukrabare	5	High	Bari	Potato+Maize	Potato	44	17	34
9	1987	M/Mulkharka	5	High	Bari	Potato+Maize	Potato	36	23	30
10	1987	Morahang	5	High	Bari	Potato+Maize	Potato	41	31	36
11	1987	Rajarani	5	High	Bari	Potato+Maize	Potato	59	18	29
12	1987	Mamling	5	High	Bari	Potato+Maize	Potato	34	32	32
13	1988	Sukrabare	5	High	Bari	Potato+Maize	Potato	42	21	31
14	1988	M/Mulkharka	5	High	Bari	Potato+Maize	Potato	39	27	34
15	1988	Tankhuwa	5	High	Bari	Potato+Maize	Potato	44	28	35
16	1988	Mamling	5	High	Bari	Potato+Maize	Potato	49	14	34
17	1988	Morahang	5	High	Bari	Potato+Maize	Potato	43	23	36
18	1985	Sakranti	4	Mid	Bari	Maize/Millet-F	Maize	10	2	6
19	1985	Dingla	3	Mid	Bari	Maize/Millet-F	Maize	8	7	6
20	1985	Morahang	3	Mid	Bari	Maize/Millet-F	Maize	12	8	9
21	1986	Morahang	4	Mid	Bari	Maize/Millet-F	Maize	31	22	27
22	1986	Tankhuwa	5	Mid	Bari	Maize/Millet-F	Maize	21	12	16
23	1986	Chyangre	4	Mid	Bari	Maize/Millet-F	Maize	13	2	6
24	1986	Ghoretar	4	Mid	Bari	Maize/Millet-F	Maize	17	7	13
25	1987	Chainpur	4	Mid	Bari	Maize/Millet-F	Maize	38	20	27
26	1987	Dingla	4	Mid	Bari	Maize/Millet-F	Maize	19	10	13
27	1987	Muga	3	Mid	Bari	Maize/Millet-F	Maize	15	10	12
28	1987	Chyangre	4	Mid	Bari	Maize/Millet-F	Maize	21	16	18
29	1987	Sakranti	4	Mid	Bari	Maize/Millet-F	Maize	17	8	14
30	1988	Amarpur	4	Mid	Bari	Maize/Millet-F	Maize	40	20	35
31	1988	Lungrupa	4	Mid	Bari	Maize/Millet-F	Maize	9	6	8
32	1988	Sakranti	4	Mid	Bari	Maize/Millet-F	Maize	24	8	18
33	1988	Dingla	4	Mid	Bari	Maize/Millet-F	Maize	11	7	10
34	1985	Rajarani	7	High	Bari	Maize/Soyabean	Maize	5	1	2
35	1985	Chyangre	6	High	Bari	Maize/Soyabean	Maize	4	1	3
36	1985	M/Mulkharka	4	High	Bari	Maize/Soyabean	Maize	3	2	3

Appendix 1. Contd.

37	1986	M/Mulkharka	4	High	Bari	Maize/Soyabean	Maize	32	12	19
38	1986	Rajarani	4	High	Bari	Maize/Soyabean	Maize	8	2	4
39	1986	Change	4	High	Bari	Maize/Soyabean	Maize	17	3	10
40	1986	Chyangre	4	High	Bari	Maize/Soyabean	Maize	13	6	10
41	1985	Ankhisalla	5	Mid	Bari	Maize-Mustard-F	Maize	16	4	9
42	1985	Chainpur	6	Mid	Bari	Maize-Mustard-F	Maize	20	12	15
43	1985	Chainpur	6	Mid	Bari	Maize-Mustard-F	Mustard	18	5	11
44	1985	M/Mulkharka	5	Mid	Bari	Maize-Mustard-F	Maize	10	2	5
45	1986	Ghoretar	4	Mid	Bari	Maize-Mustard-F	Maize	32	5	13
46	1986	Ankhisalla	2	Mid	Bari	Maize-Mustard-F	Maize	19	10	15
47	1986	M/Mulkharka	6	Mid	Bari	Maize-Mustard-F	Maize	30	11	18
48	1986	Chainpur	6	Mid	Bari	Maize-Mustard-F	Maize	13	3	10
49	1987	Ghoretar	4	Mid	Bari	Maize-Mustard-F	Maize	13	9	11
50	1987	Chainpur	4	Mid	Bari	Maize-Mustard-F	Maize	34	25	29
51	1987	M/Mulkharka	4	Mid	Bari	Maize-Mustard-F	Maize	32	14	20
52	1985	Muga	4	Low	Khet	Maize-Rice-F	Maize	14	7	11
53	1986	Muga	4	Low	Khet	Maize-Rice-F	Maize	13	11	12
54	1986	Sakranti	4	Low	Khet	Maize-Rice-F	Maize	16	7	10
55	1987	Muga	4	Low	Khet	Maize-Rice-F	Maize	12	10	11
56	1987	Change	4	Low	Khet	Maize-Rice-F	Maize	11	4	5
57	1987	Sakranti	4	Low	Khet	Maize-Rice-F	Maize	17	14	16
58	1988	Chyangre	4	Low	Khet	Maize-Rice-F	Maize	12	9	11
59	1988	Sakranti	4	Low	Khet	Maize-Rice-F	Maize	3	3	3
60	1988	M/Dhunga	4	Low	Khet	Maize-Rice-F	Maize	11	6	9
61	1988	Mamling	4	Low	Khet	Maize-Rice-F	Maize	15	6	11
62	1988	Dingla	4	Low	Khet	Maize-Rice-F	Maize	11	4	9
63	1985	Tankhuwa	5	Mid	Khet	Rice-Wheat-F	Wheat	18	2	8
64	1985	Morahang	4	Mid	Khet	Rice-Wheat-F	Wheat	8	2	5
65	1985	Chainpur	4	Mid	Khet	Rice-Wheat-F	Rice	7	5	6
66	1986	Chyangre	4	Mid	Khet	Rice-Wheat-F	Wheat	20	9	15
67	1986	Morahang	4	Mid	Khet	Rice-Wheat-F	Wheat	10	8	9
68	1986	M/Dhunga	4	Mid	Khet	Rice-Wheat-F	Wheat	20	11	16
69	1986	Sakranti	5	Mid	Khet	Rice-Wheat-F	Wheat	27	7	14
70	1987	Chyangre	4	Mid	Khet	Rice-Wheat-F	Wheat	22	9	16
71	1987	Sakranti	4	Mid	Khet	Rice-Wheat-F	Wheat	34	9	19
72	1987	M/Dhunga	4	Mid	Khet	Rice-Wheat-F	Wheat	20	11	16
73	1987	Morahang	4	Mid	Khet	Rice-Wheat-F	Wheat	7	4	6
74	1987	Chainpur	4	Mid	Khet	Rice-Wheat-F	Rice	15	5	10
75	1987	Morahang	4	Mid	Khet	Rice-Wheat-F	Rice	5	3	4
76	1988	Morahang	4	Mid	Khet	Rice-Wheat-F	Wheat	9	1	7
77	1988	Sakranti	4	Mid	Khet	Rice-Wheat-F	Wheat	14	7	10
78	1988	M/Dhunga	4	Mid	Khet	Rice-Wheat-F	Wheat	16	6	9
79	1988	Tankhuwa	4	Mid	Khet	Rice-Wheat-F	Wheat	10	8	9

Note: The average dose of FYM t/ha is the mean of all the samples of an ASC where as the maximum and minimum doses represent individual samples.

Appendix 2. A practical and improved system of compost making under village condition in the hills.

Composting can be done any time/season of the year depending on the availability of labour and composting materials. Compost can also be prepared on terraces where large amounts of waste vegetation are available and where compost is required. However, a system should be extended to farmers in the hills which will enable them to make quality compost in large amounts using waste vegetation along with the animal dung available from the animals kept.

The pit as well as heap method can be employed to make compost in the hills. The pit method is more suitable during winter and summer when there is a need to conserve heat and moisture. A pit size of 10'x 6'x 3' is desirable which should be dug near the animal shed or in any corner of the terrace/field, where large amounts of vegetation are available. The length and breadth of the pit can be adjusted according to the need but height should not be more than 3 ft. The pit should be filled with composting materials (animal bedding material or fresh vegetation) and dung placed in alternate layers. If the vegetative material used for composting is dry and not used as animal bedding material an additional thin layer of starter (dung solution) should also be used in alternate layers for faster decomposition. Starter can be prepared by mixing fresh dung and water at the ratio of 1:10. Use of activators such as agricultural lime, urea and phosphatic fertilizers is found to be beneficial. Use of wood ash also improves the quality of compost. After filling the pit with composting materials, the top of the pit should be covered with soil.

Turning the compost is necessary for thorough mixing of the ingredients in the pit and faster decomposition. Therefore, just near the compost pit another pit of the same size should be dug so that compost from the first pit can be shifted into the second pit and vice versa. Two to three turnings at an interval of one month are sufficient during the composting period which may vary from four to six months. In summer, turning should be followed by the addition of water to prevent the compostng material from drying.

The heap method is practised during the rainy season because excess water and insufficient aeration are likely to be the main problems associated with this method. The heap should be raised on a well drained spot by placing bedding material (vegetation) and dung in alternate layers. The base of the heap should be a little broader than the top so that the heap will not collapse. For good drainage and aeration it is advisable to use stones or bricks at he base of the compost heap. When the heap attains a height of 5 ft, the top of the heap should be coated with mud. The heap should also be protected from rain by constructing a thatch roof over the heap to minimize nutrient losses through rain washing. As in the pit method, turning of the compost materials in the heap is also important.

RECENT PAC WORKING PAPERS

8.	A Note on Long-Term Market Prices in the PAC Environs and Some Possible Policy Implications	U P Rai Y R Joshi A R Sharma	May 1990
9.	Millet, Buchwheat and Sorghum Research Report 1989	S P Chand B D Gurung D P Sherchan M B Gurung et al.	July 1990
10.	Samuhik Bhraman to Some Red Soil Areas of Dhankuta and Bhojpur Districts	LIAT Working Group	Jun 1990
11.	Winter Oilseed Research Report (1988/89)	R J Khadka S P Chand D P Sherchan Y B Thapa et al.	July 1990
12.	Summer Oilseed Research Report: 1989	S P Chand B D Gurung Y B Thapa et al.	July 1990
13.	Winter Grain Legumes Research Report: 1988/89	R J Khadka Y B Thapa S P Chand T P Tiwari D P Sherchan et al.	July 1990
14.	Report on 1989 Field Inspection of Summer Season Seed Crops in the Koshi and Mechi Hill Districts	R Khanal V R Duwadi P R Neupane S R Basnet A J Ghimire	July 1990
15.	Fodder Research and Development activities at PAC	B Thapa L Joshi S L Sherpa D Wallace	July 1990
16.	Observations on the Adaptability of Berseem as a winter Fodder in Koshi Hill Areas	N P Shrestha et al.	Jan 1991
17.	Maize Research Report 1989	S P Chand et al.	Jan 1991
18.	Rice Research Report 1989	S P Chand et al.	Jan 1991

19.	Barley and Buckwheat Research Report 1988/89	R J Khadka et al.	Jan 1991
20.	Grain Legume Research Report 1989	S P Chand et al.	Jan 1991
21.	Wheat Research Report 1988/89	R J Khadka et al.	Jan 1991
22.	Report on Evaluation of Summer Vegetables at Pakhribas Agricultural Centre during 1988/89	S R Gautam et al.	Jun 1991