

PLANT NUTRIENT CONTENT OF ANIMAL WASTES

SHIFAYA MARAIKAR and S. L. AMARASIRI¹

Central Agricultural Research Institute, Gannoruwa

ABSTRACT

A considerable awareness exists of the need to use organic manures in crop production. Animal wastes are a good source of carbon and plant nutrients but unlike chemical fertilizers the nutrient content of animal wastes varies considerably. Information on the nutrient content of animal wastes is necessary for their proper utilization as fertilizer. In this study fresh dung of buffalo, cattle, goat, sheep, pig and poultry were oven dried at 60°C and chemically analysed. The pH of fresh dung ranged from neutral to alkaline. Poultry dung contained the highest amount of nitrogen, phosphorus and potassium. It also showed the greatest variation in P content. The variation in N and P content in the dung of ruminants was relatively low. Dung of all animals did not show much variation in K content. Calculations based on livestock population figures indicate that the nutrients contained in animal wastes comprise as much as 41, 109 and 37 per cent respectively, of the quantity of nitrogen, phosphate and potash consumed as chemical fertilizer by Sri Lanka in 1988.

KEY WORDS: Pig dung, Poultry dung, Ruminant dung

INTRODUCTION

Fertilizers, both chemical and organic have played a significant role in increasing agricultural production in Sri Lanka during the past two decades. They are expected to make an even bigger impact in the future in the national effort to be self sufficient in the basic food requirements. Almost the entire quantity of chemical fertilizers consumed in Sri Lanka is imported at present at a cost of nearly Rs. 2384 million per annum. Greater use of locally available organic fertilizers can help to reduce this import bill.

Apart from supplying plant nutrients, organics provide several other benefits to the soil-plant system. They improve soil structure, decrease susceptibility to erosion and encourage soil microbial activity. Organic fertilizers also supply growth hormones and substances that impart resistance to plants against pests and diseases (Flaig, 1984). During and

¹Present address: Research Division, Department of Agriculture,
P. O. Box 5, Peradeniya.

Weeda (1973) and During *et al.* (1973) have reported that cattle dung helps to increase soil pH, organic carbon, total N and exchangeable Ca and Mg content. They also showed that the increased soil pH brought about a reduction of phosphate and sulphate sorption by soil.

Use of chemical fertilizers and animal wastes in combination is a common practice in intensively cultivated cropping systems in Jaffna, Nuwara Eliya, Bandarawela and Welimada. Whereas the amounts of plant nutrients added to the soils from chemical fertilizer are well known, farmers have no reliable estimates of the nutrients supplied by animal wastes. As a result, unnecessary additions of chemical fertilizer may occur at cost to the farmer, to the consumer and to the country as well.

Furthermore, the soils may build up certain plant nutrients to levels that may even be harmful to plant growth and to soil organisms. In order to optimize the use of chemical fertilizer when used in combination with organics, the chemical analysis of the organic material as well as the rate of release of the nutrients contained therein must be known. Such information is scarce in Sri Lanka. This paper presents the results of chemical analysis of more than 100 samples each of the dung of buffalo, cattle, goat, sheep, pig and poultry.

MATERIALS AND METHODS

Fresh dung of buffalo, cattle, goat, sheep, pig and poultry were collected from the central, southern and western regions of Sri Lanka during the period March 1985 to January 1987. Samples were brought to the laboratory in sealed polythene bags. pH was determined in a slurry prepared by adding sufficient distilled water to about 10g fresh dung. The quantity of water that had to be added to the different wastes ranged from about 10 to 25 ml. Dry matter content was determined by oven drying at 60°C for 24 hours. The dried samples were ground by hand to a fine powder and chemically analysed.

Nitrogen was determined by micro-Kjeldahl method (Black, 1965). Wet digestion with perchloric and nitric acids was employed for P and K analysis (Jackson, 1958). Aliquots of the acid digest were analysed for P by the vanado-molybdate yellow method (Jackson, 1958) and for K by flame photometry.

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Loss of nutrients due to oven drying at 60°C was determined in ten samples of each type of waste by analysing the samples when fresh and after oven drying.

RESULTS AND DISCUSSION

The dry matter content, pH and chemical analyses of the oven dried samples of animal wastes are given in Table 1. Oven drying at 60°C resulted in N losses of as much as 20% in buffalo and cattle dung, and about 30% in goat, sheep, pig and poultry dung. The N content computed for the fresh samples will therefore be somewhat underestimated. Losses of P and K by oven drying were negligible. pH of cattle dung was neutral while that of the other wastes was alkaline.

Nitrogen content in the different wastes ranged from 1.44% in buffalo dung to 2.95 % in that of poultry. A comparison of sample means showed that the N, P₂O₅ and K₂O contents of poultry dung were significantly higher than that of the other wastes at the 1% level. However, compared to N and P₂O₅ contents, the K₂O content of the wastes was low. In Sri Lanka cattle and poultry manure are commonly used in intensified vegetable cultivation. Hence it may be useful to compare the nutrient content of these materials. Although the term 'manure' really refers to a mixture of dung and bedding material, for the purpose of comparison it may not be incorrect to use the nutrient content values of pure dung given in Table 1. These values show that while a tonne of cattle dung contains about 43.4 kg of plant nutrients, a tonne of poultry dung contains twice as much. Thus poultry manure can be expected to have a higher plant nutrient content than cattle manure.

The range of N, P₂O₅ and K₂O content in samples of the different wastes are shown in Fig. 1. Based on standard error values, the greatest variation in nitrogen content was observed in poultry dung. Phosphorus content in both pig and poultry dung also showed much variation. The variation in the nitrogen and phosphorus content in the dung of ruminants was relatively low. The potassium content in the dung of all animals also showed relatively low variation.

The values given in Table 1 are comparable to some values reported in the literature (Table 2). However, a close comparison is difficult as most workers have not given the moisture content and have not stated whether

the values reported are on wet or dry matter basis. Few workers have mentioned the number of samples analysed (Salgado, 1951; Kemppainen, 1986). Information on the variations in nutrient content and on the range obtained is also scarce.

Variations in the nutrient content of animal wastes have been attributed to many factors. Some of them are: kind, breed and age of the animal and the type and digestibility of the feed (Muller, 1980). Barrow and Lambourne (1962) found that the distribution of N and S between dung and urine in sheep varies with the content of these two nutrients in the feed. Similarly the partition of P in the dung into organic and inorganic forms was found to vary with the P content of the feed. Mangali and Armcna (1981) reported that with the increase in body weight of pigs, the quantity of waste voided increases, and the NPK content of the waste also changes.

Thus the chemical composition of animal wastes cannot be generalized. The values indicated in Table 1 give only an approximate idea of the nutrient content. Hence caution is needed in using these specific values in estimating the amounts of chemical fertilizer that would be required for crops to which animal wastes are also added. Accurate estimates are possible only by analysing a sample of the waste being used. Since chemical analysis of every load of cattle manure for example, is impractical, the analysis may have to be limited to a few representative samples in a particular farming community. Some criteria that may be used in subdividing animal wastes for this purpose are the breed of animal, type of food intake, method of storage and nature of extraneous materials that may be mixed with the dung prior to application.

The quantity of plant nutrients in animal wastes produced in Sri Lanka in 1987 is estimated in Table 3 based on the analyses given in Table 1. This amounts to about 43,000 tonnes N, 42,000 tonnes P_2O_5 and 23,000 tonnes K_2O . Comparison of these figures with the nutrients present in the chemical fertilizers consumed in 1988, shows that solid animal wastes contain as much as 41, 109, 37% respectively of the N, P_2O_5 and K_2O consumed. Almost 80% of the total nutrient content is from buffalo and cattle. It must be noted however, that only a portion of this manure is used as fertilizer. This is because of the free range rearing pattern of ruminants in Sri Lanka. For example, over 60% of the national cattle

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population found in the dry zone graze freely and under these conditions most of the dung cannot be collected. With regard to poultry and to some extent pigs, larger proportions of the wastes may be collected as they are reared in enclosed sheds.

The liquid component of animal wastes too contains appreciable amounts of plant nutrients. The distribution of nutrients between solid and liquid wastes varies in different kinds of animals. Kemppainen (1986) found that about half the amount of N and three fourths the amount of K excreted by cattle and pig are in the urine while P is excreted almost entirely as solid wastes. In Sri Lanka the liquid component of animal wastes is seldom collected. Perhaps the use of straw and green leaves as bedding material helps to retain a part of the liquid wastes. Thus efficient methods need to be developed to handle and store both solid and liquid wastes of animals.

CONCLUSION

Animal wastes contain appreciable amounts of plant nutrients. The variations observed in the NPK content of animal wastes clearly indicate that their chemical composition cannot be generalized. Thus in order to make adjustments in the amounts of chemical fertilizer that would be required for crops to which animal wastes are also added, chemical analysis of the sample of waste being used is necessary.

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REFERENCES

- Barrow, N. J. and L. J. Lambourne. 1962. Partition of excreted nitrogen, sulphur and phosphorus between the faeces and urine of sheep being fed pasture. *Aust. J. Agric. Res.* 13: 461 — 471.
- Black, C. A. 1965. *Methods of Soil Analysis. Part 2. Chemical and Microbiological properties.* Amer. Soc. Agron. Inc., Madison, Wisconsin, U. S. A. 1572 p.

- During, C. and W. C. Weeda. 1973. Some effects of cattle dung on soil properties, pasture production and nutrient uptake. 1. Dung as a source of phosphorus. N. Z. J. Agric. Res. 16: 423—430.
- During C., W. C. Weeda and F. D. Dorofaeff. 1973. Some effects of cattle dung on soil properties, pasture production and nutrient uptake. 11. Influence of dung and fertilizers on sulphate sorption, pH, cation exchange capacity, and the potassium, magnesium, calcium and nitrogen economy. N. Z. J. Agric. Res. 16: 431—438.
- FAO. 1977. China: recycling of organic wastes in Agriculture. Soils Bulletin No. 40. FAO, Rome. 107 p.
- Flaig, W. 1984. Soil organic matter as a source of nutrients. In Organic matter and rice. pp. 73—92. International Rice Research Institute, P. O. Box 933, Manila, Philippines.
- Gaur, A. C. 1975. A manual of rural composting. Project Field Doct. No. 15 (RAS/75/004). FAO/UNDP Project on Improving soil fertility through organic recycling. FAO, Rome. 102 p.
- Jackson, M. L. 1958. Soil Chemical Analysis. Constable and Company Ltd., London. 498 p.
- Kemppainen, E. 1986. Utilization of animal manure. In Report on the FAO seminar and training course on micronutrients and macronutrients in soils and agriculture. Jokioinen, Finland, June 2—14. pp. 114—120.
- Lian, Kho Boon and Jalaludin Jipelos. 1981. Management aspects of organic recycling in Malaysia. In Proc. of the FAO/UNDP seminar on improving soil fertility through organic recycling. Kathmandu, March 9—14. pp. 123—141.
- Mangali, F. and E. E. Armena. 1981. The status of organic recycling programmes in the Philippines. In Proc. of the FAO/UNDP seminar on improving soil fertility through organic recycling. Kathmandu, March 9—14. pp. 162—196.
- Muller, Z. O. 1980. Feed from animal wastes: state of knowledge. FAO Animal Production and Health paper No. 18. FAO, Rome. 190 p.
- National Fertilizer Secretariat. 1989. The review of fertilizer year 1988. The Ministry of Agriculture, Food and Co-operatives, Colombo, Sri Lanka. 86 p.
- Wen, Qi-Xiao. 1984. Utilization of organic materials in rice production in China. In Organic matter and rice. pp. 45—46. International Rice Research Institute, P.O. Box 933. Manila, Philippines.
- Salgado, M. L. M. 1938. Goat manure. Tropical Agriculturist 90: 30—33.
- Salgado, M. L. M. 1951. Preliminary studies on the chemistry of cattle manuring on coconut estates. Tropical Agriculturist 107: 218—224

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Table 1. Analysis of animal wastes

Animal	Number of samples	pH*	Dry Matter (%)	Total Nutrient (dry basis) (%)			N+P ₂ O ₅ +K ₂ O (kg/t)
				N	P ₂ O ₅	K ₂ O	
Buffalo	106	7.4	18.0	1.44	1.30	0.80	35.4
Cattle	220	7.0	16.7	1.74	1.68	0.92	43.4
Goat	126	8.1	43.9	2.47	1.60	0.93	50.0
Sheep	103	8.6	40.6	1.85	1.52	0.60	39.7
Pig	105	7.7	38.0	2.00	3.33	0.94	62.7
Poultry	110	8.2	29.3	2.95	3.46	2.25	86.6

*pH is the average of ten samples

Table 2. Reported values of N P K content of animal wastes

Animal	Country	Total Nutrient (%)			Reference
		N	P ₂ O ₅	K ₂ O	
Buffalo	India	0.26	0.18	0.17	Gaur, 1975
	Malaysia	1.99	1.52	2.40	Lian and Jipelos, 1981
	Sri Lanka	1.15	NR	0.35	Salgado, 1951
Cattle	Finland	0.46	NR	NR	Kemppainen, 1986
	Malaysia	2.02	1.48	2.43	Lian and Jipelos, 1981
	Sri Lanka	1.62	0.74	0.43	Salgado, 1951
Goat	China	0.65	0.50	0.25	Wen, 1984
	Malaysia	1.89	2.17	2.85	Lian and Jipelos, 1981
	Sri Lanka	2.72	1.57	0.77	Salgado, 1938
Sheep	China	0.65	0.50	0.25	Wen, 1984
	Malaysia	2.77	3.17	3.33	Lian and Jipelos, 1981
	Philippines	0.75	1.48	0.87	Mangali and Armena, 1981
Pig	Finland	0.72	NR	NR	Kemppainen, 1986
	India	0.59	0.46	0.43	Gaur, 1975
	Malaysia	1.95	2.93	0.44	Lian and Jipelos, 1981
Poultry	Finland	1.56	NR	NR	Kemppainen, 1986
	Malaysia	4.03	4.78	1.89	Lian and Jipelos, 1981
	Philippines	2.75	2.95	1.75	Mangali and Armena, 1981

NR = Not reported

Table 3, Estimate of plant nutrients in animal wastes in Sri Lanka

Animal	Number* (10 ³)	Dry Manure† (10 ³ t/yr)	Nutrients (10 ³ t)			Total
			N	P ₂ O ₅	K ₂ O	
Buffalo	0.78	0.84	11.8	10.9	6.7	29.4
Cattle	1.35	1.35	23.0	23.0	12.2	58.2
Goat	0.50	0.18	4.5	2.9	1.6	9.0
Sheep	0.03	0.01	0.2	0.2	0.1	0.5
Pig	0.10	0.11	2.2	3.6	1.0	6.8
Poultry	6.55	0.05	1.5	1.8	1.2	4.5
TOTAL		2.54	43.2	42.4	22.8	108.4
Mineral Fertilizer Consumption, 1988‡			106.1	39.0	62.1	207.2

* Dept. of Census and Statistics, Sri Lanka (unpublished);
only adult animals have been considered.

† FAO, 1977

‡ National Fertilizer Secretariat, 1989

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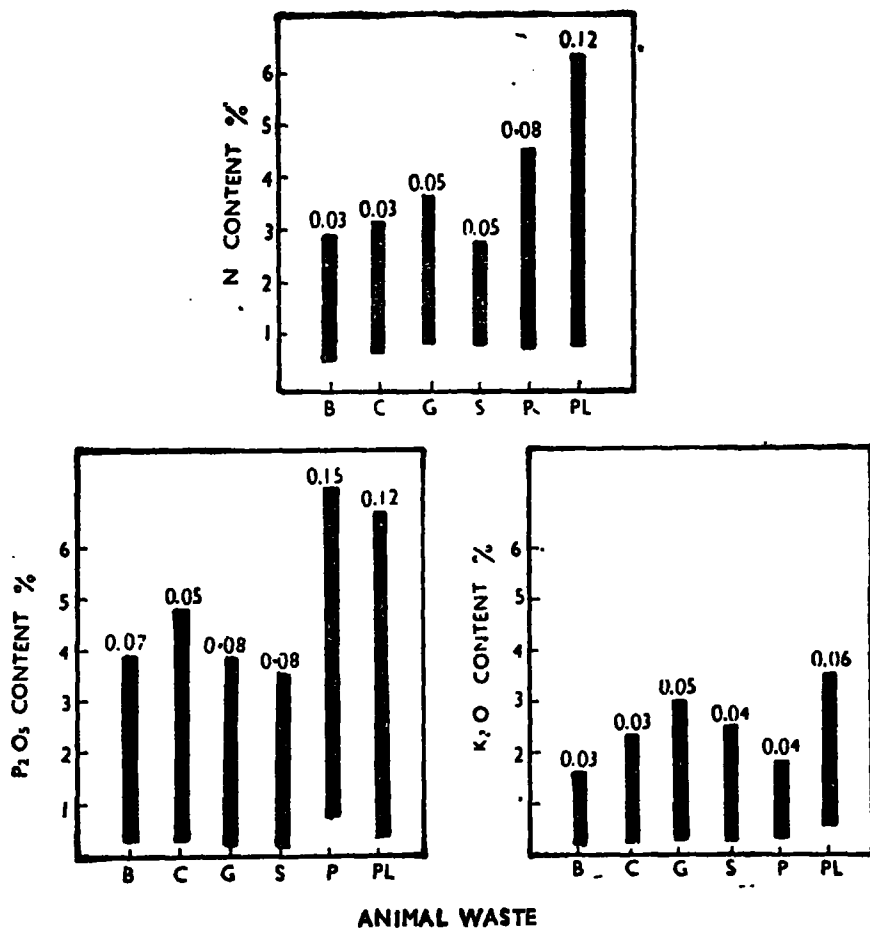


Figure 1. Range of N, P₂O₅ and K₂O content in animal wastes
 Figures / above bars indicate S. E.; B=Buffalo, C=Cattle, G=Goat, S=Sheep,
 P=Pig, PL=Poultry