Journal of Agroecology and Natural Resource Management
Print ISSN: 2394-0786, Online ISSN: 2394-0794, Volume 2, Number 2; April-June 2015 pp. 168-170

http://www.krishisanskriti.org/janrm.html

Livestock Manure–An Economical Source of Phosphorus Fertilizer

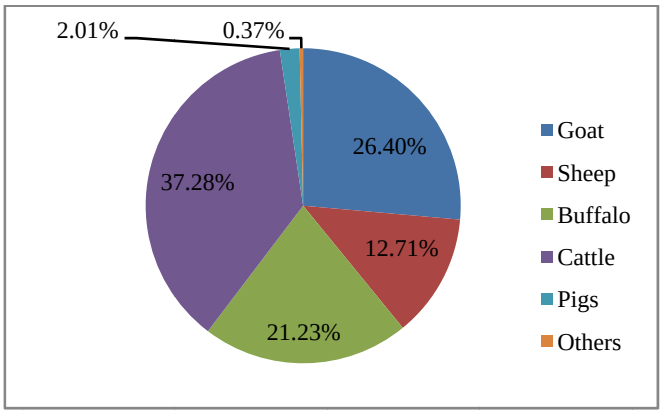
Sunita Gaind

Microbiology Division, Indian Agricultural Research Institute, New Delhi-110012
E-mail: sugaind175@rediffmail.com

Abstract—*Manure is a necessary by-product of livestock industry. Untreated manure is nothing but faecal matter, but treated or processed manure is a value added organic residue that can be a cost effective substitute for commercial fertilizers for nitrogen, phosphorus and potassium (N, P, and K). The technology used for manure treatment has a significant influence on the quality of final by product. Often considered as an under-valued resource of nutrients, processed manure when applied to soil, not only enriches the soil with major and some minor nutrients but the organic matter content added through its input improves the soil structure, soil aeration, water infiltration and moisture content of soil. India is abundant in livestock waste resources, but its livestock production management is inefficient, particularly in the rural area resulting in huge nutrient losses. The objective of this article is to provide some options for its use as an economical source of P in soil.*

1. INTRODUCTION

The total livestock population consisting of cattle, buffalo, sheep, goat, pig, horses, ponies, mules, donkeys, camels, mithun and yak in the country was million populations of poultry with a waste 512.05 million in 2012 (Fig. 1). India inhabits 3430 generation of 3.30 million tonnes per year. Average-size cattle produce 4 to 6 tonnes of fresh dung each year. Animal wastes are important resources that can be used to supplement major nutrients (N, P, and K) and some minor nutrients such as Ca, Mg in the soil.



*Source (*19th Livestock census All IndiaReport2012)
Fig. 1: Distribution of livestock population

The organic matter added through manure application improves the soil quality. Due to improper management of livestock manure, India is losing 237 m.t of organic matter, 6.37 m.t of N, 1.35 m.t of P and 4.25 m.t of potash. Even if ½ of above cited losses can be saved and manure after treatment is applied to land, food production can substantially be increased. The P present in different organic residues is summarized in Table 1.

Table 1: Phosphorus content in organic residues

Organic material	% P
Crop residues	0.04-0.33
Farm yard manure	0.07-0.88
Poultry manure	0.88-1.27
Cow dung	0.04-0.07
Vermicompost	0.65
Oil cake by products from processing industry	0.39-1.27
Bone meal	8.73-10.91

Source (Pappu et al 2007)

2. TYPE OF P PRESENT IN ANIMAL MANURE

The content of phosphorus (P) in animal manure varies depending upon the animal species, size of the animal and feed given to animals. The P in animal manure is a combination of inorganic and organic form. Generally, 45 - 70 % of manure P is in the inorganic form whereas 30 - 55 % manure P exists in the organic form. The inorganic P present as orthophosphate (H_2PO_4) is taken up by the growing plants.

However, the organic P needs to be mineralized into inorganic form by soil microorganisms before being taken up by the plants. The temperature, soil moisture, and soil pH affect the P mineralization efficiency of soil microbial biota. The total P present in manure is not available for plants rather its availability may range from 80 to 90 %, compared to 100 % soluble P present in commercial fertilizers. Thus, manure P can provide nearly the same effect as an equal amount of P from commercial fertilizers, as far as crop response is concerned. Animals manure in general adds more P in soil than is required by the crops plants, if the application rate is based on nitrogen requirements. Therefore, continuous application of animal manure will lead to accumulation of P in soil and high soluble P content, and higher potential runoff P. Thus, processing of manure and determining the nutrients present in it and its fractionation is very important before it application in soil to reduce its negative impacts on soil and water quality. The table (2) gives an idea of organic and inorganic P fractions present in different manures. The water soluble and bicarbonate P fractions are more easily available compared with alkali and acid extractable fractions.

Fig. 2: Commonly practiced method of cattle dung disposal

Table 2: Inorganic and organic P fraction in dairy, poultry and swine manures

P form	Extractant	Dairy manure		Poultry manure		Swine manure	
		mg P/kg	% of total	mg P/kg	% of total	mg P/kg	% of total
Inorganic	Water	2030	51	7430	26	6045	18
	Bicarbonate	360	9	7180	25	4168	13
	Hydroxide	70	2	320	1	16620	50
	Acid	60	1	9320	32	3294	10
Organic	Water	470	12	2360	8	1526	5
	Bicarbonate	90	2	1100	4	657	2
	Hydroxide	420	11	470	2	281	1
Total	Inorganic	2520	63	24250	84	30127	91
	organic	980	25	3930	14	2464	8
	Residual	487	12	472	2	361	1
	Total	3987		28652		32952	

Source (Buckley and Makortoff 2004)

Most of the cattle dung in rural areas is used as a fuel for cooking and heating after making its cakes (Fig. 2) or is thrown in open. This not only leads to environment pollution but also leads to loss of nutrients. Direct application of wet solid animal manure is not desirable due to the presence of pathogens and weed seeds. Thus, a proper processing is required to ensure its safe use in soil.

3. DRYING OF WET SOLID MANURE CAKE

Incineration of animal manures results in ash that is a rich source of phosphate (P), potassium (K), Al and Si. This ash can directly be used as phosphate fertilizer or used as a substitute for rock phosphate, in industrial production of P. The recovery of phosphate from the ash is made by treating it with sulfuric acid. The Zn and Cu can be removed from ash by adding selective heavy metal removal process

The wet manure cake is also used for a pyrolysis process to produce P rich biochar. Pyrolysis is a process that involves the indirect heating of organic matter to a temperature of 300-500^{o} C in the absence of oxygen to produce pyrolytic oil, gas and char. Bio-char refers to fine grained, carbon rich, porous product produced by thermal decomposition of biomass under low oxygen supply and is used for agriculture or environmental purposes. However, production of P-rich biochar is much more expensive than production of ashes. The market price of biochar is relatively higher than ashes because it is presumed that application of biochar contributes to lower the emission of green house gases (Cayuela et al. 2010). Biochar differs from conventionally produced charcoal being generally created at high temperature than the conventional charcoal produced at low temperature. Biochar can be produced from pig, poultry manure and cattle manure. On application to soil, biochars produced at 300-400^{o}C mineralize much higher amount of carbon, nitrogen and phosphorus.

- The wet manure cake is also used for production of dry manure pellets that can be used as fertilizer

4. LIQUID MANURE FRACTION

- The liquid fraction of animal manure can be separated from solid fraction by mechanical separation procedure. The liquid fraction has negative economic value because of low nutrient content and high water content. The most cost effective way to use liquid fraction is its direct application to agricultural land. This fraction contains, K, P, S and some other elements.
- Liquid fraction can also be treated by adding calcium hydroxide to recover phosphate as calcium phosphate. The precipitate of calcium phosphate may be added to wet manure cake while stuvite and ammonium sulphate can be supplied to fertilizer industry for further processing and upgrading to NP fertilizers. Manure of all species can be treated with aluminium sulfate, aluminium choride, ferric chloride, calcium sulfate, fly ash or synthetic polymers to precipitate soluble P and reduce the risk of P runoff. However, this process may raise the conc. of chlorides and sulfates in soil and cause secondary environmental pollution.

5. USE OF ANIMAL MANURE IN COMPOSTING

Cattle manure is easily available and can be obtained from feedlots and dairies at no cost provided the transportation cost is born by the buyer. The raw manure contains high content of pathogens and weed seed besides nutrients. Thus, it needs to be composted for at least 2 months before its application to soil. The composting mixture must be piled. The C/N ratio of bulking materials of plant origin and animal manure varies greatly (Table 3). Carbon to nitrogen ratio of composting mixture should be in the range of 25-30:1. Too narrow ratio will cause loss of nutrients and too wide ratio will cause immobilization of nutrients by microorganisms. It is preferable to prepare compost by mixing crop residues with animal manure, as it is the best way to recycle the nutrients present in crop and animal manures.

For efficient composting of manure, a moisture content of 45-50 % must be maintained initially and the composting pile needs to be turned at fortnightly interval. During composting, due to microbial digestion, a part of carbon and nitrogen are lost as CO_2 and NH_3. The volume of composting mixture decreases by one-third to one-half However, the content of P remains the same as the P is neither lost by leaching or volatilization.

Table 3: C/N ratio of animal manure and some plant residues

Manure/material	C/N ratio
Cattle manure	19:1
Dairy manure	20:1
Horse manure	30:1
Poultry manure	7:1
Sheep manure	16:1
Swine manure	12:1
Turkey litter	16:1
Wheat straw	100:1
Paddy straw	>80:1
Leaves	54:1
Wood chips	600:1

Source (Rynk et al 1992)

The low volume with same P content results in its increased concentration. A 70 % of the total P present in manure should be considered available for plants.

Amendment of composting mixture (consisting of animal manure and crop residue) with rock phosphate and its inoculation with phosphate solubilising microorganisms will result in P enriched compost. For recovery of organically bound P, inoculation of composting mixture with phosphate mineralizing microorganisms is desired. The resulting compost with higher P availability on application to soil can reduce the input of chemical P fertilizer (Gaind 2014).

Compost nutrient levels vary based on the source material used to produce the amendment. The well-finished, cured compost is free from a strong ammonia odor; nutrients are stabilized and provide a slow release of plant available nutrients.

REFERENCES

[1] Buckley K., Makortoff M. Phosphorus in livestock manure. www.farmwest.com
[2] Cayuela ML, Oenma O, Kuikman PJ, Bakker RR, Van Groenigen JW. 2010. Bioenergy byproducts as soil amendments: Implications for carbon sequestration and green house gas emission. Global Change Biology-Bioenergy. 2: 201-213.
[3] Gaind Sunita (2014) Effect of fungal consortium and animal manure amendments on phosphorus fractions of paddy-straw compost. Int. Biodeterioration Biodegradation. 94: 90-97.
[4] Pappu A., Saxena M., Asokar SR., 2007. Solid waste generation in India and their recycling potential in building materials. Journal Building Environment 42 (6), 2311–2324.
[5] Rynk, R., M. van de Kamp, G.B. Willson, M.E. Singley, T.L. Richard, J.J. Kolega, F.R. Gouin, L. Laliberty Jr., D. Kay, D.W. Murphy, H.A.J. Hoitink and W.F. Brinton. 1992. On-Farm composting handbook. (ed). R. Rynk. p. 6-13, 106-113.
[6] 19th Livestock census All India Report 2012 pp.1-130