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Manurial Potential of India *

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The secret of good farming is the maintenance of soil fertility. It must be accepted as an axiom in agriculture that what is taken off the land in crops must in some way be put back into the soil or else soil will suffer exhaustion, and starvation of the soil is said to be the root cause of human starvation.

Plants require a number of essential elements. Nitrogen, phosphoric acid and potash are called the chief fertiliser elements. Their requirements depend on the nature of crops raised as well as soil conditions. Bulk of nitrogen supply of any normal soil is present as a constituent of the decayed or decaying plant and animal materials, including microbes, all of which are grouped together under 'organic matter'. In addition to organic nitrogen, the soil contains small amounts of nitrogen in inorganic form, mainly nitrates and to some extent as ammonium compounds. Quantities of both organic and inorganic nitrogen found in the soil vary greatly from soil to soil.

Small amounts of inorganic nitrogen are immediately available for plant use while the larger supply of organic nitrogen is not. But the two are linked through a biological process by which the latter is tranformed, into the former. This change is brought about through the action of soil micro-organisms and is going on continuously at rates which vary according to environmental or other conditions. Because of this process, it is the total nitrogen content which is most important in evaluating the nitrogen fertility status of the soil. Even though only a small part of the total nitrogen is utilised by plants at any given time, eventially, most of it becomes available.

Total nitrogen values of Indian soils are low, compared to those of many other regions of the world. For example, soils of the mid-western United States or of England, average considerably higher, perhaps twice or thrice as high. The relatively low total nitrogen content of Indian soils is partly due to climate and partly

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to differences in regional agricultural practices. It is almost impossible to maintain as high a content of organic matter in the soil of tropics as of temperate zones due to climate.

There are in India four broad categories of soils - red, laterite and lateritic, black and alluvial. Red, Black and alluvial soils are deficient in N, P_2O_5 and humus while in lateritic soils the major problem is of P_2O_5 and lime deficiency. The remaining three types have sufficient potash and lime. A majore portion of the cultivated area in the country is deficient in N and P_2O_5 (21). Augustus, 1893).

More work on systematic lines has, however, to be done to find out the full utility of P_2O_5 and K_2O. Some inconclusive data show that phosphates and potassic fertilisers, besides increasing the yield and improving the quality of grain, also help to maintain the fertility of the soil, (8). There is yet an urgent need for an exhaustive soil study in the country. Royal Commission on Agriculture recommended a comprehensive soil map of India. It is time that concrete steps are taken in the direction.

Whatever the existing position, for a long-term development of agriculture, it is extremely necessary to have an idea of the existing sources of plant nutrients and their future potentialities.

Existing Sources of Supply : Since agricultural production in India has reached a sort of an equilibrium stage over a long period, it would be wrong to say that our soils are being depleted by about 2 million tons of nitrogen annually at the existing level. (16). Having exhausted the soil bank of the country over a number of years, a balance has now been established which means that whatever is being removed from the soil is being replenished in one or the other form (17). If this was not so, a constant drain of such a heavy magnitude would bring our averageyields toppling down. They on the other hand have shown some increases during the past few years.

The supply of crop nutrients to the soil is either from tangible sources like cow dung manure, green manure and fertilisers or a number of miscellaneous sources which cannot be precisely accounted for.

Cattle Dung : According to a pilot survey conducted by the Economic and Statistical Adviser to the Government of Madras, in 150 villages of Chingleput district, farm-yard manure which supplied

by far the largest quantity of manures, provided only 26 per cent of the manurial requirements of the District. It was held that this was true of other Districts as well.

Average quantity used per acre there was about 30 maunds of farm yard manure or roughly 9 lb of nitrogen per acre (4). It is a matter of common knowledge that the use of manures in areas of scanty rainfall or without irrigation, is very little. And such areas for the country as a whole are more than two-thirds. Use of manure in the Bengal region under study can be considered as quite above the all-India average.

It would have been very useful if similar studies were available for the country as a whole. But in the absence of any such data, we may assume that on an all-India basis, some 20 to 25 per cent of nitrogen requirements of the soil are being supplied from farm yard manure. If total requirements of nitrogen at present are 3 million tons, the share of cow dung etc. would be of the order of 0·7 million tons. This works out to just 5 lb. per acre for the total cropped area.

Other Sources: As for the balance of 2·3 million tons of nitrogen, during 1955–'56, 0·14 million ton was supplied by chemical fertilisers and roughly another 0·15 million ton by tangible sources like city compost, green manures and oil cakes etc. (18). Remaining 2·0 million tons can thus be considered as the contribution of sources like :

(i) Urine and excreta of cattle while on the field as well as sheep penning etc.

(ii) Human urine and excreta from rural areas where open field latrine system exists

(iii) Plant roots and other vegetable matter left in the field.

(iv) Atmospheric fixture of nitrogen from the air and rain.

(v) Miscellaneous sources like 'rab' system, fish manure etc.

Potentialities of Organic Sources: Cattle and human population of India should normally come in quite handy for providing plant nutrients to the soil. On cent per cent utilization, they alone can supply (Table 1) about 14 million tons of nitrogen.

Assuming that the miscellaneous sources as detailed will continue to supply 2·0 million tons of nitrogen, we would be left with hardly 3·3 million tons of origanic sources from stabled livestock that

can be tapped further. This may be an under-estimate because the quantity of dung excreted by well fed cattle will increase by about 100 per cent.

TABLE 1.

Manurial potential of livestock and human beings.

Source	Number (million)	Quantity per unit per day (lbs)	Quantity total annual m. tons	Percentage constituents N.	Percentage constituents P_2O_5	Percentage constituents K_2O	Total constituents per year '000' tons N.	Total constituents per year '000' tons P_2O_5	Total constituents per year '000' tons K_2O
Cattle ...	*158·6*	*33*	*891*	*0·3*	0·3	0·2	*2673*	*1336*	*1782*
Adult ...	114·8	40	748	0·3	0.15	0·2	2244	1122	1496
Youngstock ...	43·8	20	143	0·3	0·15	0·2	429	214	286
Buffaloes ...	*44·9*	*39*	*287*	0·3	0·15	0·2	*861*	*431*	*574*
Adult ...	28·8	50	235	0·3	0·15	0·2	705	353	470
Youngstock ...	61·1	20	52	0·3	0·15	0·2	156	78	104
Total Cattle & Buffaloes..	203·5	35	1178	0·3	0·15	0·2	3534	1767	2356
Sheep & goat..	94·6	15	231	0·8	0·6	0·3	1848	1386	693
Horses & ponies	1·5	40	10	0·5	0·4	0·3	50	40	30
Other livestock	6·8	25	28	0·6	0·5	0·5	168	140	140
Total livestock	306·5	29	1447	—	—	—	5600	3333	3219
Poultry ...	94·7	25	0·8	1·6	1·5	0·9	13	12	7
Total ...	401·2	—	1447	—	—	—	5613	3345	3226
Livestock urine ...	307·1	15	751	0·8	0·01	1·4	6008	75	10514
Cattle bones...	30 *	30	0·401	3·0	23·5	—	12	942	—
Human excreta & urine ...	550	4	359	0·7	0·3	0·2	2513	1077	718
Total ...	—	—	—	—	—	—	14146	5439	14458

* This has been calculated at 15% cattle mortality.

The next question that calls for examination is the quantity of nitrogen that can be easily tapped from these tangible sources. China, where use of the organic sources is superb, has not been able to utilise more than 70 per cent of its night soil and 60 per cent of the stable manure (10). It would be an achievement if we can succeed to utilise a total of about 50 per cent or roughly 2 million tons of N from these potential tangible sources. This along with 2·0 million

tons from miscellaneous sources would work out to hardly 30 per cent of the total organic resources of the country. Additional quantity of nitrogen that can be tapped from this source would thus be of the order of 1·3 million tons. This is because 0·7 million tons out of this is already being utilised.

If 1·3 million tons of additional nitrogen is to be procured from cow dung, that would mean an organised effort not only to educate the cultivator for the proper conservation of farm yard manure and farm waste, but also to provide an alternative source of fuel for him.

Quantity of dung (sun dry) being burnt at presant has been estimated from 80 to 250 million tons (13). Since fuel requirements will be increasing with the increase in population, possibility is that pressure on cow dung for burning will correspondly increase. Assuming that additional demand will be met from what is being wasted at present, we will have to chalk out a programme for replacing 1·3 million tons of nitrogen or say 90 million tons of sun-dry dung. This can be done either by setting up cowdung gas plants in the areas concerned or providing fuel wood at a reasonable price.

Town and Village Compost: As regards sewage and sullage, legislation has been passed by various State Governments compelling all Corporations, Municipalities and Town Committees not to waste urban refuse. Table 2 shows the potential capacity of compost from this source.

TABLE 2.

Sewage and sullage compost potentialities.

Source	Population (millions)	Compot * (thousand tons)
Corporation	10	1000
Muncipalities	32	3200
Town committees	20	2000
Total	62	6200

* Normally 1 million population is assumed to produce 100 thousand tons of compost.

This estimate of 6200 thousand tons of city compost is based on the population of 62 million. Potential city population available for compost by 1980–81 may be about 190 millions.

Besides this, efforts are also being made to educate bigger Panchayats for the use of night soil. Sufficient progress in this direction can also be expected during the coming 20 years. It can,

under the circumstances, be reasonably assumed that with some additions from Panchayats and short-falls from cities, total potentialities from city compost etc, may be 20,000 thousand tons. Working at 0·8 per cent of N, (5) plant nutrients released may be 1960 thousand tons

Town sewage and sullage water is the other potential source which is being tapped and can most conveniently be utilised for the supply of necessary plant nutrients. Report of the Expert Committee on Manures & Fertilisers calculated that 40,000 tons of N and 16,000 tons of P_2O_5 could be harnessed from this source by the end of first plan period. Sewage and sullage can be assumed to provide plant nutrients approximately equal to city compost.

Other Waste Products: There are a lot of other village waste products, which can be utilised (7) Sources of specific waste-organic materials exist in different localities which can be turned into compost manure (5). Forest areas in India cover about 100 million acres which can yield leaf litter for producing 10-15 million tons of compost per annum. About 4 million acres under sugarcane in India can provide sugarcane trash for 12-15 million tons of compost. It is estimated that nearly 1,00,000 acres of tanks, canals and pond areas in West Bengal, Orissa, Bihar, U. P. and Travancore alone are infested with water hyacinth and it would be possible to make nearly 1 million tons of good quality compost by utilising this source. Other waste materials of this type like groundnut husk, tea and coffee wastes, tobacco waste, dried blood meal, etc., where available, could be usefully put into compost pits.

Potentialities from some of these sources are shown in table 3.

TABLE 3.

Manurial potentialities from some waste products

Source	Compost million tons	Constituents		
		N	P_2O_5	K_2O
		(thousand tons)		
Forest leaf litter	12	120	84	120
Sugar cane trash	13	13	13	18
Water hyacinth	1	3	3	5
Dried blood meal (sheep and goat slaughtered)	0·02	25	—	—
Total	26·02	161	100	143

It would not be difficult to use at least 50 per cent of these tangible waste products. This works out to some thing like 80,000 tons of N, 50,000 tons of P_2O_5 and 70,000 tons of K_2O.

A number of experiments have been carried out at the Sheilla Dhar Institute of Soil Science, Allahabad for the utilisation of other waste materials like coal and basic slag as manure. It has been shown that besides supplying nutrients which in itself contains, it helps to fix atmospheric nitrogen and also release phosphates of the soil. (3). It may be difficult to assess the total potentialities of such like sources on the basis of limited experiments conducted at one Institute. But they cannot be ignored. Further experiments may be conducted and if found useful, these resources may also be tapped.

Green Manuring: Besides fixing nitrogen from the atmosphere and improving the physical condition of soil, green manures also release locked phosphates (19). Crops raised for green manuring also serve other useful purposes with certain other objects, i. e., they act as catch crops, shade crops, cover crops or forage crops (12). Appendix D explains the culture of legumes like green manures. Although rich in N green manures also supply sufficient quantities of P_2O_5 and K_2O (Table 4) on air dry basis (11).

TABLE 4.

Constituents of some important green manures.

Materials	Composition		
	N.	P_2O_5	K_2O
		(Percent)	
Dhaincha	3·5	0·6	1·2
Sunnhemp	2·3	0·5	1·8
Wild indigo plant	1·8	0·2	0·6
Leaves	3·2	0·3	1·3
Tephrosia Candida	2·0	0·7	1·0
Prickly pear	0·3	1·2	1·1
Rain tree leaves	3·3	1·3	1·1
Forest leaves	1·2	0·6	0·4
Tea prunings	2·4	0·5	1·3
Green weeds	0·8	0·3	0·2
Sea weeds	1·1	0·3	3·0
Fern weeds	3·1	0·5	3·0
Redgram plant	2·8	0·4	2·0

The Technique: Maximum benefit from green manuring cannot be derived without knowing when to grow and when to burry the green matter under the top soil. There is a great need for providing correct time gap between burying a green manure crop and sowing the next crop. Otherwise nourishment provided by the manure would not be available in full, and there may be competition between soil microbes of the crop for nutrients and moisture. This period may be about eight weeks in the case of wheat and barley and less than a week in the case of paddy.

Limitations: With all the advantages of green manuring, there are some limitations which must be given due consideration.

1. It is not possible to green manure dry lands. A minimum of 30 inches of rainfall or irrigation is necessary (10).
2. It has also been stated that the question of growing green manure crops on the field and burying it into the soil was rather impossible in many localities in Kerala because of the very heavy rainfall which begins from early June to the middle of September; total rainfall being about 80 to 90 inches on an average.
3. Availability of seed at the proper time. Some of these problems are now being satisfactorily solved (1). Orissa Government, for example, launched a very comprehensive scheme for the supply of *Dhaincha* seed packets to each of the cultivator. The two ounce seed packet sufficient for sowing one acre is sown on the borders. This is capable of providing sufficient seed for 3 acres at the end of the crop. Supply of seeds having been assured, area under green manuring in Orissa has gone up from a thousand acres in 1957–'58 to million acres in 1959–'60.

Green manuring is already very popular in Andhra and Madras. If Orissa also demonstrates its feasibility, we would be in a better position to gauge the potentialities of green manuring.

Potentialities of green manuring: Since rainfall in India is not well distributed and there are surprisingly large variations in the amount of precipitation received from year to year, we would be restricting ourselves to only those areas where annual rainfall is round about 50 inches and above. With about 72 million acres of unirrigated assured rainfall area and 135 million acres of other irrigated areas, green manuring should technically be possible on 207 million acres of cropped area.

In a perspective of 20 years it can be assumed that many changes may take place in rural India. We may under the circumstances fix a target of about 80 million acres which may be green manured and at the rate of 25–30 lbs per acre, it would release a minimum of nearly one million tons of nitrogen. Another 0.6 million tons can be assumed to be the supply from green manure leafing. A major portion of this may be done by sowing special types of plants on borders of the fields. But such trees can even be grown in any waste land away from the field and green leaf put in the desired field.

Total organic sources : Table 5 summarises total additional potentialities from organic sources, which work out to about 4 million tons of N. With 2 million tons of additional supply from the existing invisible sources, total supply of Nitrogen from organic sources, can be of the order of 6 million tons.

TABLE 5.

Total organic sources (Thousand tons).

Source	N	P_2O_5
Dung etc. from stabled livestock	2000	1000
Sewage and Sullage compost	160	1160
Sewage and sullage water	160	160
Other waste products	80	50
Green manure proper	1000	100
Green leaf manure	600	100
Total	4000	2570

Summary : Level of agricultural productivity in India has more or loss remained stationary over a number of years. In any programme of agricultural development crop nutrients - NPK - will have to play an important role. As against the present availability of about 3 million tons of Nitrogen from all the organic and inorganic sources, the requirements of the country at the end of coming two decades are likely to be of the order of 8 million tons.

The maximum contribution of organic sources (visiblo and invisible) can be about 6 million tons in terms of Nitrogen. But to get this quantity a programme of a minimum of 10–12 million acres of new village plantations with quick growing species will be extremely necessary. Our administrative machinery will have to be

geared to the responsibility of saving all the wastage in cowdung. City compost programme will need a top priority and green manuring will have to be taken up at a national scale. The task, no doubt tough, is all the same possible and rewarding.

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