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9. ABSTRACT

Crop yields on farms surveyed in southern Karnataka State, in southern India, responded well to applications of organic manures. Paddy and sugar cane received the largest applications of organic manures. The amounts of organic manure applied to paddy fields by rice farmers varied from 2.5 to 64 one-half-ton cartloads per acre, averaging 17 cartloads for paddy and 38 cartloads for sugar cane. Maximum average yields of 14 quintals per acre for paddy were obtained with 21-30 cartloads of manures. For ragi, maximum yield was 3.4 quintals per acre with 11-20 cartloads. For jowar, maximum yields were 8.5 quintals per acre with 11-20 cartloads. For maize, maximum yields were 19 quintals per acre with 21-30 cartloads. For peanuts, maximum yields were 7.6 quintals per acre with 11-20 cartloads. For sugar cane, maximum yields were 33 tons per acre with 11-20 cartloads of organic manure. The correlation of organic manures with levels of other inputs, such as fertilizer, pesticides, and irrigation, was not known. Thus the results need to be interpreted with considerable caution. A more detailed study of farm-level yield response to organic manure is required before definite conclusions can be drawn.

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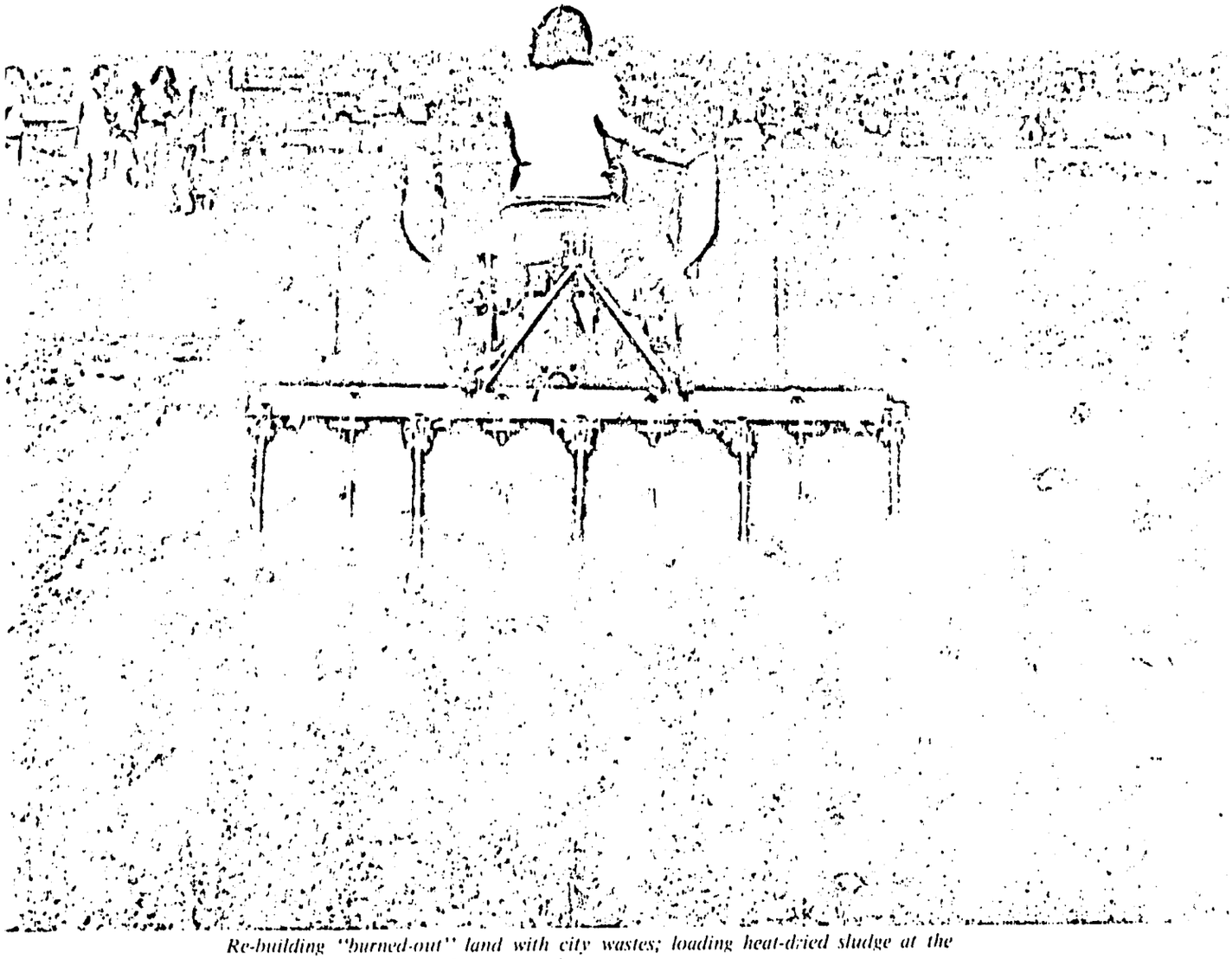

Re-building "burned-out" land with city wastes; loading heat-dried sludge at the Scranton-Dunmore Waste Treatment Plant.

see p. 12: RECLAMATION OF A BURNED ANTHRACITE REFUSE BANK WITH MUNICIPAL SLUDGE

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Can Organic Manures Improve Crop Production In Southern India?

The India government is actively promoting the use of organic manures in crop production. How effective is this program in terms of crop yield under actual farm situations?

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ABSTRACT

The application of organic manures to the soil is an old practice in India. Farmers in Karnataka State, (formerly Mysore) utilize animal manure, urban compost and green cover crops on a regular basis to supplement commercially produced chemical fertilizers, to maintain soil fertility, and to increase crop yields. Application of farmyard manure, urban compost or other organic material to paddy soils will improve their physical condition and influence rice yields. Organic manures will also improve the yields of maize, jowar, sugar cane and other crops. The India government is actively promoting the use of organic manures in crop production. The objective of this article is to measure the effect of organic manures on crop yields under actual farm situations in southern Karnataka State, India.

As Indian agriculture faces limited fertilizer availability during the next decade, alternate sources of plant nutrients assume increasing importance. Bacterial fertilization, organic manuring, composting, and recycling of wastes are possible sources of additional nitrogen and other plant nutrients. Commercial development of the biological fixation of nitrogen [seed innoculant approach] may take five to ten years (7, 12). However, organic manuring offers immediate possibilities of increasing the supply of plant nutrients.

Prime Minister Indira Gandhi has told Indian farmers that they should economize on chemical fertilizer application but also explore possibilities of utilizing organic nutrients as supplements to chemical fertilizers. Fertilizer price inflation and shortages have been the major reasons behind the Indian Government's thrust to use organic manure. The Union Government has proposed a plan for the large scale use of organic manure throughout the country, with an outlay of Rs. 90 million during the Fifth Five Year Plan [1974-79]. The Agricultural Ministry expects to produce 7.5 million tons of compost annually by the end of 1978-79 (10). The bulk of the compost material will come from farmyard manure, sewage, and 300 urban compost projects. The response of crops to organic manures needs to be analyzed since government officials are supporting composting as an alternative source of plant nutrients.

Farmers in Karnataka State, as well as in other parts of India, utilize animal manure, urban compost and green cover crops on a regular basis as a useful supplement to commercially produced chemical fertilizers. Agricultural development programs in Karnataka have promoted the production and application of organic manures during the last two decades and production of organic manures has increased substantially since 1965. The Fertiliser Association of India reports that rural compost production was up 153 percent, urban compost production was up 348 percent, but the acreage green manured fell by 27 percent.

Organic manures play an important role in the maintenance of soil fertil-

Table 1: Average Chemical Composition of Some Organic Manures

Material	*Nitrogen*	*Phosphate*	*Potash*
		percent	
Bulky organic manures			
Farm yard manure	0.5-1.5	0.4-0.8	0.5-1.9
Compost (Urban)	1.2-2.0	1.0	1.5
Compost (Rural)	0.4-0.8	0.3-0.6	0.7-1.0
Green manures (various averages)	0.5-0.7	0.1-0.2	0.8-1.6
Edible oil cakes			
Coconut	3.0-3.2	1.8-1.9	1.7-1.8
Cotton seed (Decorticated)	6.4-6.5	2.8-2.9	2.1-2.2
Cotton seed (Undecorticated)	3.9-4.0	1.8-1.9	1.6-1.7
Groundnut	7.0-7.2	1.5-1.6	1.3-1.4
Manure of animal origin			
Dried blood	1.0-1.2	1.0-1.5	0.6-0.8
Fish manure	4-1.0	3-9	0.3-1.5
Bird guano	7-8	20-25	2-3
Bone meal (raw)	3-4	20-25	-
Bone meal (steamed)	1.0-2.0	25-30	-
Activated sludge (dry)	5-6	3-3.5	0.5-0.7
Settled sludge (dry)	2-2.5	1-1.2	0.4-0.5
Night soil	1.2-1.3	0.8-1.0	0.4-0.5
Human urine	1.0-1.2	0.1-0.2	0.2-0.3
Cattle dung and urine mixed	0.60	0.15	0.45
Horse dung and urine mixed	0.70	0.25	0.55
Sheep dung and urine mixed	0.95	0.35	1.00

SOURCE: Fertiliser Association of India, *Fertiliser Statistics 1973-74*, (New Delhi: Fertiliser Association of India, December 1974), p. 1-141.

ity and soil structure. Puddling is a *sine qua non* for most paddy soils in Asian countries since it causes the disintegration of soil aggregates. The result is a soft and easily penetrable medium which the rice plant needs for proper root development and assures water availability. Certain soil types may be soft, directly after puddling but may afterwards become hard and compact, thereby impeding percolation of water and oxygen. The application of farmyard manure, compost or other organic material to paddy soils will improve their physical condition and influence productivity.

Organic manures are expected to improve yields; however, it is entirely possible that excessively large applications of organic manures on some crops could reduce yields. Use of adequate amounts of organic material in combination with fertilizer responsive varieties of paddy and other crops, improved cultivation practices, and adequate and timely supplies of fertilizer, pesticides and irrigation are critical to increasing food supplies in India and other developing countries.

DATA AND METHODOLOGY

Data used in this analysis were derived from a survey of 136 farms in three districts of Karnataka State, India, conducted in the summer of 1972. The sample of farms was restricted to 1) membership in cooperative societies and 2) use of crop production loans. They were also classified according to farm size and financial status in the local cooperative. Although the data were originally collected for a study of crop production loans from cooperatives, they were also a satisfactory measure for this analysis. The focus here will be on the use of organic manure in paddy (rice) production and other production inputs.

The actual chemical composition of the organic manure was unknown but the average chemical composition of some organic manures in India is presented in Table 1. Accordingly, the nitrogen, phosphate and potassium content of rural and urban compost could vary substantially but the value of organic manure as a soil conditioner may be even more important (6). The common soil types in southern Karnataka are red loans, light in texture and porus in nature, either gravelly, sandy, or clay loam. The

Table 2: Average Crop Production Costs and Yield Per Acre - 136 Farms - Karnataka State, India, 1972.[1]

Costs	Paddy	Ragi (millet)	Jowar (sorghum)	Maize	Sugar Cane	Ground-nut (peanut)
	Crops					
	Rupees[2] per acre					
Labor[3]	93.01	60.14	50.32	113.85	255.60	55.40
Seed	13.07	.48	7.35	32.84	90.41	27.07
Water	16.72	.36	0	0	0	0
Farmyard manure Urban Compst & Green Manure	75.06	44.35	29.42	57.56	157.96	21.70
Fertilizers	130.48	27.04	83.58	105.46	302.89	24.51
Plant protection (pesticide)	29.93	0	0	0	5.10	0
Total costs of purchased inputs	358.27	132.37	170.67	309.71	811.96	128.68
	yield					
Total yield in quintals[4]	11.61	2.88	4.99	10.91	35.55	4.17
Percent of crop consumed on farm	60%	84.3%	55.5%	10.0%	0.0%	9.1%

[1]*Survey conducted in Bangalore, Mandya and Mysore districts, 1972.*

[2]*One rupee equals about $.13.*

[3]*Labor costs include only hired labor.*

[4]*Quintals equals 100 kilograms or 220 pounds, sugar cane was measured in tons.*

SOURCE: Unpublished survey data from Karnataka State, India 1972.

Table 3. Organic Manure and Fertilizer as a Percent of Average Crop Production Costs Per Acre - 136 Farms - Karnataka State, India, 1972[1]

Costs	Paddy	Ragi (millet)	Jowar (sorghum)	Maize	Ground-nut (peanut)	Sugar Cane
	Crops					
	Percent					
Farmyard manure Urban Compost & Green Manure	21	34	17	19	19	19
Fertilizer	40	20	49	34	19	37
All other inputs (Labor, seed pesticides and water)	39	46	34	47	62	44
Total cost of purchased inputs	358	132	171	310	129	812

[1]*Survey conducted in Bangalore, Mandya and Mysore districts, 1972.*

SOURCE: Unpublished survey data from Karnataka State, India 1972.

depth varies from a few inches to several feet (2).

Farmers purchase bullock cart loads of urban compost, usually decomposed urban garbage, and spread it on their fields before planting. Farmyard manure was applied in the same manner. Sewage sludge was not used by farmers although the Indian government plans to make it available to farmers in the future.

Organic manure was a major cost item in crop production according to the survey data (Table 2). On the average, organic manures accounted for about 19 percent of the cost of purchased inputs for paddy, jowar, sugar cane, and peanuts. Organic manure accounted for about 34 percent of the cost of purchased inputs for *ragi* (millet) (Table 3).

APPLICATIONS OF ORGANIC MANURES AND CROP YIELDS

Application of organic manures resulted in significant increase in yields of paddy, ragi, jowar, maize, and sugar cane of farms in southern Karnataka (Table 4). Groundnuts apparently did not respond consistently to applications of organic manures. This may have been the result of the dry land conditions under which groundnuts were grown and from the small number of observations, only 17 farmers planted groundnuts.

Farmers applied 17 cart loads of organic manure, on the average, per acre for paddy, with a range of 2.5 to 64 cart loads per acre (Table 5). The *Farm Planning Manual* recommended 10 cart loads, and 10 percent of the farmers applied organic manure at that rate. Twenty percent applied exactly twice the recommended amount and 25 percent applied more than 20 cart loads per acre. A few farmers did not apply organic manures although they used other purchased inputs such as fertilizer.

Excessive amounts of organic matter were not recommended for paddy under certain soil conditions (6). The data indicated that about 30 cart loads resulted in the maximum product of 14 quintals of paddy per acre. Paddy yields then declined when greater amounts of organic manure were applied. The reason for the decline in yields may be related to poor soil drainage, interaction of decomposed organic matter and soil reducing conditions, and the occurrence of related physiological disease symptoms.

In the case of groundnuts and jowar, organic manure applications were very low. This situation was expected since both crops were grown on dry land, in most cases subject to limited rainfall and received few other inputs. Ragi was also grown under dry land conditions or occasionally light irrigation. Applications of organic manures were slightly higher than on the other dry land crops. Actual applications of organic manures were within the range recommended in the *Farm Planning Manual*.

Maize was grown mainly for green fodder and sold to stockmen with milch cows. On the average, farms applied 12.5 cart loads of organic manure per acre on maize.

Sugar cane received the largest amount of organic manure. Heavy soils may be improved by organic matter and it may increase the efficiency of N, P, and K fertilizers (6). Cane mill trash was often burned in the evaporators rather than being returned to the soil. Other sources of organic manures were utilized and, on the average, farmers applied 38 cart loads; about three times the recommended amount in *Farm Planning Manual*.

Although the results of the farm survey concerning compost use were compared with the *Farm Planning Manual*, the *Manual's* recommenda-

Table 4. Organic Manure Applications and Average Crop Yield Per Acre - Southern Karnataka State, India, 1972

Organic manures[1]	Average Yields					
	Paddy	Ragi	Jowar	Maize	Groundnuts (Peanuts)	Sugar Cane
Cartloads of manure	Quintals[2]					Tons
less than 1	-[3]	2.88	.4	6	3.6	7
1 - 10	9.5	3.3	3.8	9.9	2.8[4]	15
11 - 20	10.0	3.4	8.5	12.1	7.6	33
21 - 30	14.0	3.2	-	19.0	-	32.3
31 - 40	13.0	-	-	-	-	28.4
41 - 50	11.5	1.2	-	-	-	-
51 and above	10.0	-	-	-	-	-

[1]*One cartload was equal to about one-half ton. Farmers used the cartload as a standard measure when purchasing organic manures.*

[2]*One quintal equals 100 kilograms.*

[3]*Seventeen farmers did not purchase any organic manures and obtained an average yield of 10.6 quintals.*

[4]*Erratic groundnut yield results may have resulted from dry conditions under which groundnuts were grown and from the small number of observations.*

Table 5. Average Organic Manure Applications for Major Crops

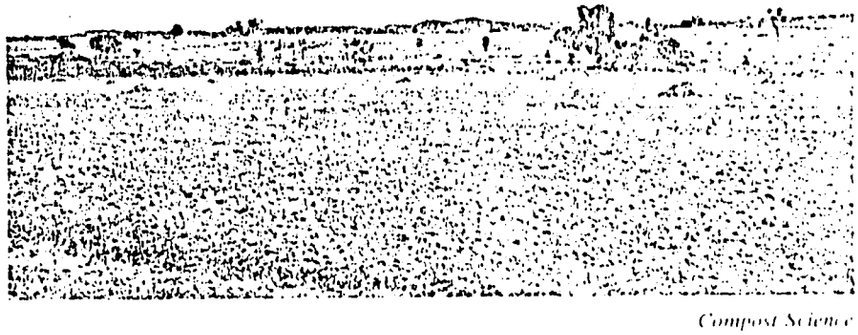
Value	Paddy	Ragi	Jowar	Maize	Groundnut	Sugar Cane
	cart load[1]					
Average	17	9.4	6.4	12.5	5.5	38
Standard deviation	14	9	9	9	6.4	35.5

[1]*One cart load was standard measure farmers used in purchasing organic manures and was equal to one-half ton.*

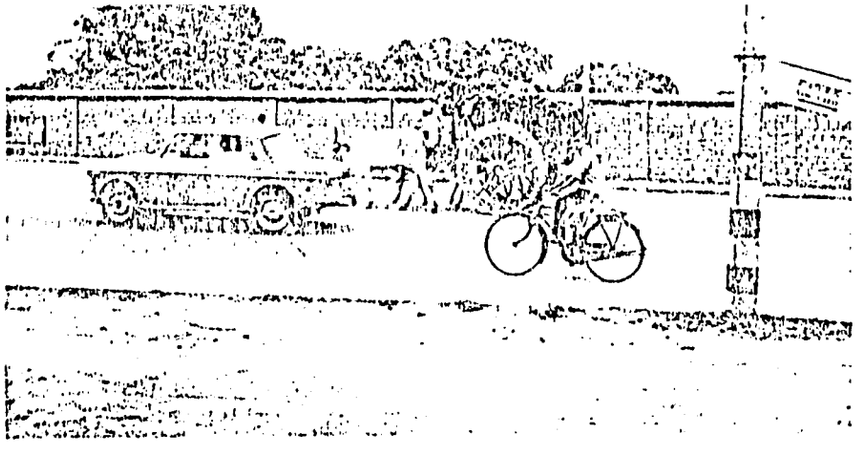
Production of organic matter is vitally important to Indian agriculture. This is a rural compost pit outside a village 18 miles east of Bangalore.

Below: These compost piles have been dumped in a field before they are distributed by hand.

Right: A close-up of one of the piles shown above. Each pile represents an average bullock cart load of compost. These piles will be spread on the fields just before plowing.



A bullock cart loaded with urban compost and trash competes with motorized traffic on the outskirts of Bangalore, India.



tion for application of organic manures on some crops, such as sugar cane, were much lower than other studies have recommended. In addition, the *Manual's* recommendations were subject to revision. Input requirements change as new crop varieties are planted, soil conditions improve, irrigation becomes available, and other biological factors change.

CONCLUSIONS

Crop yields on farms surveyed in southern Karnataka State responded well to applications of organic manures. On the average, paddy and sugar cane received the largest applications of organic manures, 17 and 38 cart loads respectively. There was some evidence that excessively large applications of organic manures reduced paddy yields in a few cases. However, the correlation of organic manures with levels of other inputs, such as fertilizer, pesticides, and irrigation were not known. The results need to be interpreted with considerable caution. There are several logical explanations as to why these farm level results may correctly identify a problem of low yield response to organic manures on annual crops in southern Karnataka State. First, the nutrient content of organic manures obviously varies greatly from rural and urban locations. Second, the response of local improved varieties of rice to compost and fertilizer applications is limited and where these varieties are still grown, losses due to lodging are still common. Third, high yielding varieties of crops associated with the Green Revolution may have different response functions to organic manures. Finally, soil analysis, as presently conducted, may not provide accurate recommendations on the quantity of organic manures.

A more detailed study of farm level yield response to organic manure is required before definite conclusions can be drawn. Such a study should carefully account for initial soil fertility; rainfall and irrigation; variety and quantity of seed; formulas, quantity, timing and method of fertilizer application; quantity and nutrient content of organic manures; and careful measurement of yields. This data would help Indian farmers allocate scarce resources in a more efficient manner. Government officials would also benefit from such information in the distribution and allocation of organic manures from the proposed compost projects.

Prime Minister Indira Gandhi has responded to the fertilizer dilemma by asking farmers to economize on fertilizer applications and to utilize organic manure as a source of plant nutrients. Compost can never replace the large amounts of nutrients required to sustain the Green Revolution; however, compost production and utilization can make a contribution to the total resource package available for agricultural production.

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