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The Role of Organic Manures and Inorganic Fertilisers in Soil Fertility

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In old-time agriculture the only method of increasing soil fertility and crop yields was by stirring the soil with manual labour, to produce a pulverised condition of the soil. It was observed by experience that a similar increase in crop yield could be obtained by the application of cattle dung. Cattle manure was the earliest ingredient known to increase the productive capacity of soil. Subsequently other plant and animal materials were known to have a similar property. During the earlier period when the science of plant nutrition had not developed so much as now, the function of manures was considered to be merely supplying humus, which could be taken up by the plants directly for their growth. This humus theory of plant nutrition held the field for a long time and retarded the progress in the fields of both plant physiology and agriculture. It was by the work of Liebig in Germany, his contemporaries Boussingault in France and Lawes in England, that the humus theory of plant nutrition was replaced by the "mineral" theory. These epoch-making discoveries laid the foundation of agricultural science in general and agricultural chemistry in particular. Liebig stated that plants could take up nutrients in mineral and soluble form. Insoluble substances should be converted into a soluble form to be assimilable by plants. An artificial manure known as Liebig's patent manure was prepared by him and put in the market. This manure failed, because it contained only alkalies (potassium) phosphates and sulphates There was no nitrogen in it, because Liebig considered that it was not needed, as he thought that plants could assimilate nitrogen in the form of ammonia from the atmosphere through the leaves. Lawes, on testing the recommendations of Liebig found them to be erroneous. The mineral theory was in turn criticised by others. There was nothing wrong with the theory, but there were two pitfalls: i. e., (i) omission of nitrogen and (ii) conversion of soluble potash and phosphorus compounds into an insoluble state by fusion with lime to prevent them from being leached out with drainage water.

Lawes, the founder of the world-famous agricultural research institute at Rothamsted, in England, started the preparation of superphosphate as a cottage industry by the addition of sulphuric acid to rock phosphate. This process was patented and subsequently developed into a large-scale industry all over the world. Other fertilisers, supplying nitrogen and potash were soon manufactured and put in the market. All the inorganic nutrients prepared commonly are known as fertilizers. They are generally inorganic compounds containing large proportions of plant nutrients in a water-soluble state. Manures on other hand are naturally occurring substances containing a low percentage of plant nutrients mostly in organic forms insoluble in water. Thus it can be seen that the inorganic fertilizers and organic manures are more or

less opposite in their characteristics. This leads people to think that they are antagonistic and act in an opposing manner in crop production and on the fertility of soil. The present controversy of organic manures versus inorganic fertilisers is due to this wrong notion.

Some think that fertilisers, though they contain plant nutrients in readily available and concentrated form, spoil the land and make it unproductive for a long time to come. They, therefore advocate the use of only organic manures. In the absence of manure they prefer to leave the land unmanured. This is a most suicidal policy to adopt when the fertility of our soils is low and the supply of indigenous manures is inadequate to satisfy our needs. We are not using much of inorganic fertilisers in India, as revealed by the statistics for 1949—'50.

The following table illustrates this fact:

	Total area (million acres)	Area under crops (million acres)	Total fertilisers imported (tons)	Quantity used per area	
				Total area basis (lb.)	Cultivable area basis (lb.)
India	581	81	145,490	0·56	0·89
Madras State	81	35*	76,102	2.1	4·87

* including double-cropped area.

The fertilisers are not used for all lands and for all crops. The commercial crop receive the best attention. Madras leads other States in the use of fertilisers in India.

There are several difficulties in importing more fertilisers into India, chief among which are (1) internal consumption in U. S. A. and Canada; (2) scarcity of foreign exchange resources in India. The annual production of ammonium sulphate in India is only 50 to 60 thousand tons. The Sindri factory in Bihar is expected to produce 3·5 lakhs of tons of this fertiliser from 1951, against an annual requirement of 4 to 5 lakhs of tons.

The following table gives the manure problem of our State:

	Removed by crops tons	Supplied as organic manures (tons*)	Deficit (tons)	% total removed
Nitrogen	887,000	280,000	607,000	68
Phosphoric acid	372,000	170,000	201,000	54
Potash	894,000	252,000	642,000	72

* As farmyard manure, compost, oil-cakes, bone meal, fish manure, fish guano and wood ash available in the State.

This deficit should be met by the application of green manures composts and chemical fertilisers. Besides these principal plant nutrients, the food for soil organisms is also to be considered seriously for replenishment. Unless we utilise every possible source to build up our rapidly declining soil fertility and equally rapidly increasing population, we will not be able to solve the national food problem.

Without going into the theoretical aspects of the function of organic manures and inorganic fertilisers, the experimental evidence on their manurial value and their effect on pH value and microbiological activity are given below:

Permanent manurial experiments, Coimbatore. (Old Permanent Manurial Experiment):—

This experiment was started in 1909. Eightyone crops were taken so far, upto 1950. The major nutrients nitrogen, phosphoric acid and potash were applied singly and in combinations containing 60 lb. of N, 38 lb. of P_2O_5 and 90 lb. of K_2O. Cattle manure at the rate of 5 tons per acre was also included as one of the treatments. The field was originally irrigated till September 1937 and it was left fallow till November 1939 and thereafter treated as rainfed. The following amounts of chemical fertilisers were added:

	Quantity applied per acre.	lb. of ingredient supplied per acre.
Ammonium sulphate	1 cwt.	22·4 lb. (N)
Superphosphate	3 ,,	64·8 ,, P_2O_5
Potassium sulphate	1 ,,	54·0 ,, K_2O

The average yields of grain of each variety of crop grown are given in Table I.

The data presented above show that when the total yields of all the crops is taken into account the following is the descending order of treatments in their response:

N plus P plus K; N plus P, Cattle manure; K plus P. P. K. N plus K, N, No manure.

There is not much response for potash, either alone are in combination. It may be noted in this connection that the ingredients were not added on equal basis. For instances, cattle manure contains nearly 2½ times the amount of nitrogen added in the form of ammonium sulphate, only half of the phosphoric acid added in the form of superphosphate and about twice the amount of potash. Thus except for phosphoric acid, cattle manure contained double the dose of the artificials added. Yet it did not show its superiority to the inorganic fertilisers. The effect of these fertilisers on the biological population and activity is presented in Table II and III.

The results indicate that moisture is the chief factor in increasing the microbiological population of a soil by manuring. With sufficient amounts of moisture available, cattle manure nearly trebled the microbiological population of the soil. The N + P + K treatment was intermediate between the no manure and cattle manure treatments. The microbiological population and activity increased most with the application of cattle manure. Next in rank was N + P + K. Even under rainfed conditions with failure of monsoons, the complete inorganic fertiliser did not depress the biological population and activity of the soil, compared with no manure plot.

The same experiment was repeated under gardenland conditions in duplicate from the year 1925 and continued up to date. Forty crops were grown so far. One set of plots was found to be giving lower yields than others. It received therefore, a basal dressing of 2,000 lb. of cattle manure per acre since 1931. The average results of crop yields with and without basal dressing are given in table IV.

The following is the descending order of response of each treatment:

Rank	Without basal dressing of cattle manure	With basal dressing of cattle manure
1.	Cattle manure	...
2.	N + P + K	N + P + K
3.	N + P	N + P
4.	P	P
5.	K + P	K + P
6.	N + K	K
7.	No manure	N + K
8.	N	N
9.	K	Basal dressing alone

Under irrigated conditions, cattle manure responded best. The complete inorganic fertiliser closely followed cattle manure. As in the previous experiment under rainfed conditions, phosphate was the best single plant nutrient that increased the crop yield very markedly. There was little response to potash application either alone or in combinations. The application of a basal dressing of 2,000 lb. of cattle manure containing 12 lb. N, 7·5 lb. P_2O_5 18 lb. K_2O, to all except C. M. and C. M. residual per acre increased the response of inorganic fertilisers in a field of low fertility. The dosage of nitrogen in both the experiments is very low.

The analysis of soil of the permanent manurial plots (both old and new) is given in Table V.

There was a definite increase in the soil of the ingredient added as a manure, especially the available form. The percentage of nitrogen and potash were doubled in the cattle manure treatment in the old permanent manurial plots. This was due to the large supply of these ingredients as mentioned before.

There was a marked loss in total lime in the cattle manure treatment. The organic matter seems to be responsible for this mobilisation of lime and consequent loss due to leaching. There is a fall in pH from 7·9 to 7·5 in the N + P treatment. This was also noted in cattle manure treatment and the fall cannot be attributed to the evil effect of inorganic fertilisers. A loss in total calcium was also observed in the new permanent manurial plots in the cattle manure treatment. There was no fall in the pH value due to any manurial treatment in these plots. These results definitly disprove the impression many people have that inorganic fertilisers render the soil acidic and unproductive if used alone continuously for a long time. Forty-two years of experimental evidence is certainly a definite proof against such ill-founded impressions. It is true the microbiological population and activity were not as high in the N + P + K treatment as in the case of cattle manure treatment, but nevertheless, the values were far higher than those in the no manure plot. In no case did the N + P + K treatment depress either the microbial population or their activity.

Experiments were conducted from 1929—'26 to 1932—'33 in the Central Farm, Coimbatore to find out the effect of application of Chilean nitrate (sodium nitrate) alone and in combination with organic nitrogen on paddy. The total dosage of nitrogen applied was 50 lb. per acre. Daincha and cattle manure formed the source of organic nitrogen. The results indicate that Chilean nitrate in combination with cattle manure in a ratio of 3 : 2 gave the best results. The wetlands never became unproductive by the use of Chilean nitrate.

A report from the Tocklai Experiment Station of the Indian Tea Association 1949, (2) show that Chilean nitrate when applied to sandy well-drained soils initially produced increased yields but spoiled the tilth on continuous application for a number of years. This can be corrected by applying 3 parts of ammonium sulphate to 2 parts of sodium nitrate. On heavy soils sodium nitrate produced harmful effects in the year of application itself. Ammonium sulphate was found to give twice the yield given by oil-cakes.

Another experiment was conducted at the Central Farm, Coimbatore to determine the manurial value of calcium cyanamide at the rate of 2 cwts. per acre, alone and in combination with 1½ cwts. of superphosphate. The calcium cyanamide in combination with superphosphate gave better results than the others.

An experiment to find out the effect of ammonium phosphate on paddy as compared with that of ammonium sulphate at 50 lb. of N. level was conducted on the Central Farm, Coimbatore, for two years from 1924. Only ammonium sulphate gave conclusive results.

A field trial on the dose of ammonium sulphate required for paddy alone and in combination with superphosphate, started in 1925—'26 and continued up to 1928—'29 proved that 2 cwts. of ammonium sulphate in combination with 1½ cwts. of super gave the best results consistently

The results obtained so far establish the superiority of ammonium sulphate to the other forms of inorganic nitrogenous fertilisers commonly used in our State. Niciphos II was also found to be good. Among phosphates, superphosphate was found to be the best for ordinary soils, though their response is poor.

Potassium sulphate was found to be better than muriate of potash.

Though some workers claim that produce obtain by the application of organic manures like cattle manure have higher biological value in proteins and are richer in vitamin content, there is no conclusive evidence in support of this claim.

Total production of cattle manure

		1940	1945
Bovine population (millions):			
Adult cattle		97	99
Adult buffaloes		25	26
Young stock		55	52
Estimated daily production of manure (in lb.):			
Per adult cattle		40	40
Per adult buffaloes		50	50
Per young stock		20	20
Total production of raw manure (Million tons per annum):			
Adult cattle		632	645
Adult buffaloes		204	212
Young stock		179	169
Total ...		1,015	1,026
Estimated proportion used as fuel ...		66·6%	66·6%
Balance available as raw manure (Million tons per annum) ...		339·0	342·7

(Agricultural Situation, India, April, 1950)

From the results of our manurial experiments we find that we have to supply a normal dose of 30 lb. of nitrogen and 30 lb. of prosphoric acid per acre over a basal dressing of 2 tons of green leaf or cattle manure for our paddy crop alone. At this rate, we require the following quantities of manures and fertilizers to manure 11 million acres of paddy area :

Ammonium sulphate ...	733,000	tons
Superphosphate ...	923,000	,,
Green leaf manure or cattle manure ...	22,000,000	,,

The available stock of fertilizers are only 59,952 tons of ammonium sulphate and 16,210 tons of super phosphate and assuming that the whole quantity is used only for paddy crop we have a deficit of

Ammonium sulphate	...	roughly	673,000 tons
Superphosphate	...	,,	907,000 ,,

We have no data to show the availability of cattle manure in our State. If we assume that all the dung is fully utilised as manure and the urine carefully preserved, we can expect about 2½ tons of manure per head of cattle per annum. This works out to 56·5 million tons of cattle manure for the State per annum and it supplies 418,100 tons of nitrogen per acre, when the average percentages of a good manure is taken as 0·75% nitrogen This is never realised in actual practice as nearly ⅔ of the dung is utilised as fuel and most of urine runs to waste. It is the urine which is the most important source of nitrogen in a readily available form. Thus the superiority of sheep or cattle penning is attributed to the urine added to the soil. The following table gives the quantity of dung and urine voided by 22·6 million heads of cattle per annum on the presumption that 1/3 of our cattle population are young calves and left out of account. Our data at Coimbatore show that adult cattle void daily 35 lb. of dung and 25 lb. of urine per head.

	Quantity mil. tons	% Nitrogen	Total nitrogen tons	P_2O_5	Total tons
Dung	78·54	0·33	259,182	0·10	78,540
Urine	33·79	0·60	202,740	0·02	6,758
Total	102·33		461,922		85,298

During decomposition and dryage half the quantity of dung and urine will be lost. It can be seen from the data, that the amount of phosphoric present is only about 1/5 of the total nitrogen present. Cattle manure is thus an ill-balanced manure, and is deficient in phosphates. If cattle manure is used as a source of nitrogen, phosphatic fertilizers have to be added to supply all the necessary plant nutrients. The condition of manure pits in villages is very deplorable. They are exposed to sun and rain and water accumulates during the rainy season. The surface gets so dry that the top surface remains unfermented. The litter also remains in a raw state. It is a very common feature to find as low a value as 0·3% nitrogen in most samples of village cattle manure. The urine is also lost. If we can preserve this source of manure, which is a by-product of agricultural industry it can go a long way towards meeting our manurial deficiency. As it stands at present, the quantity available is so small that the ryot applies cattle manure to his commercial crops and nurseries every year and to some important dry lands only once in 3 or 4 years, at 10 cartloads per acre. The data available from the permanent manurial experiments at Coimbatore and green manure experiments at Anakapalle show that a basal dressing of about 1 ton green manure or cattle manure cannot satisfy the organic matter demand of our soils. Let us take necessary steps to improve the preservation of cattle manure.

Another important source of organic matter is compost. The present drive for compost making has enabled us to conserve a portion of nightsoil from urban areas which used to be wasted hitherto. We have not succeeded much as yet. Only 44,441 tons of compost was made last year in this State. The bulk of population on our country live only in rural areas and the utilisation of nightsoil in rural areas for compost making is not possible for want of conservancy service. The prejudice of the local population and social stigma attached to the handling of nightsoil is another major handicap. From the present population of 54·8 millions, we may expect roughly four million tons of nightsoil per annum available for compost making. It is well known to every student of agriculture that the high fertility of the lands in the Far East is due to the systematic use of nightsoil as a manure. The manurial value of compost prepared from nightsoil with municipal rubbish, and farm waste compost with cattle dung were compared with cattle manure alone on equal nitrogen basis, on selected Agricultural Research Stations of the State, during the years 1949 – '50 and 1950 – '51. The results of these experiments are given in tables VII, VII(a) and VII(b).

In some Stations both nightsoil and farm waste composts gave significantly higher yields than no manure.

In other cases, though increased yields were obtained by the applications of compost over no manure plots, the data were not significant.

In a few cases, compost proved superior to farmyard manure.

Oil cakes which are intermediate in action between fertilizers and manures are very valuable as sources of food to higher plant and bacteria, but they are available only to a limited extent. In the year 1949—'50, 135, 185 tons of groundnut cake was produced. The edible cakes serve as an excellent feed for cattle. In 1948—'49, 29,627 tons of groundnut seeds have been exported from this State which is detrimental to the interests of the State as the cake would have been useful as cattle feed or manure. All the cakes are almost equal in their manurial value on equal nitrogen basis.

Even if ideal methods of preserving all the sources of manures mentioned above are adopted, our manurial needs cannot be met unless we tap the unlimited source, namely, green manures and green leaf manures. Of course, there are limiting factors such as moisture, cattle trespass etc., but these obstacles have to be overcome.

Green leaf available from uncropped lands can best be utilised as manures. Their decomposability is in the following descending order:

Calotropis,
Gliricidia
Pungam
Cassia
Croton sparsiflorus
Delonix
Poovarasu
Datura
Sesbanea speciosa

The results of experiments conducted at the Paddy Breeding Station, Coimbatore show that daincha, wild indigo and Sesbanea speciosa when applied on equal nitrogen basis, have the same effect on paddy (Table VIII.)

Under ideal conditions about 20,000 lb. of green manure can be produced per acre and 75 to 130 lb. of nitrogen can be fixed from the atmosphere. This will be equivalent to 3½ to 5¾ cwts. of ammonium sulphate. Experiments at Coimbatore have shown that the following is the descending order of merit of the common green manures grown in this State: Daincha, pillipesara, sunnhemp and cowpea. The yield of paddy grain can be increased from 30 to 100% by the application of green manures. The availability of nitrogen contained in green manures like pillipesara is equivalent to ⅔ of that of the ammonium sulphate. We can utilise inorganic fertilizers for building up soil humus, if superphosphate is applied to the preceding leguminous green manure crop at the time of sowing. This practice increases the amount of green matter production and nitrogen fixation from the atmosphere and ultimately solves both the problems of soil humus and nitrogen.

There are certain manures like tank silt, earth from old village sites which are used as manures successfully. The amounts available are however, dwindling. Experiments were started in the Central Farm, in 1908—'09 to 1914—15 to find out a suitable manure mixture to replace *Pattimannu*. Nitrogen, phosphoric acid and potash were applied singly and in combination and in double doses. Nitrogen as supplied as 3,000 lb. of sunnhemp; Phosphoric acid as superphosphate 1 and 2 cwts. per acre; Potash as potassium sulphate 1 and 2 cwts. per acre.

The following conclusions were obtained:

Bulky organic nitrogenous manures such as green leaf was found to be quite necessary;

Phosphatic manures when used to supplement the bulky organic manures, slightly improved yields;

No increase in yields was obtained by the application of potassic manures.

At the present market rates, the following is the cost of 1 lb. of nitrogen from the following sources:

	Rs.	A.	P.
Groundnut cake	1	12	9
Ammonium sulphate	0	13	6
Chilean nitrate	0	13	5
Ammophos	0	13	6
Green manure	0	8	0
Cattle manure	0	12	10

The following table gives an idea of manurial values of different fertilizers and manures on paddy crop at different levels (Mitra and Gupta.)

Manures and Fertilisers	Level lb. of N per acre	Extra yield per lb. of N. applied
Ammonium sulphate (20% N)	30	11·4
	60	11·4
Niciphos II (contains 17·3% N and 17·4% P_2O_5)	25	16·6
	30	13·0
Oil-cakes (groundnut, neem or castor)	20	8·9
	40	7·2
	60	6·0
Farmyard manure	25	6·0
	50	6·7
Green manure	50	21·0
Town compost	50	5·3
	100	5·0
	150	4·0
Mixed Manuring; Niciphos + Farmyard manure	25	3·8
	50	11·0

The largest increase in the yield of paddy was obtained when green manures were used as a source of nitrogen. Next in rank was Niciphos followed by ammonium sulphate, oil cakes, farmyard manure and lastly compost.

It can be seen from the above that the green manures are not only the cheapest but also the most effective in increasing crop yields. Next in rank is ammonium sulphate and no indication was obtained on the deleterious effect of the latter on soil fertility. A combination of green manure and ammonium sulphate and superphosphate or an application of Niciphos in conjunction with green manure would give the best results on paddy.

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TABLE I.

Showing the average yield of crops in Old Permanent Manurial Plots (O. P. M.)

	Name of the crops	Number of crops	No. M	N	N+K	N+P	N+K+P	K+P	K	P	C. M.
			(Average yield in lb. grain per acre)								
(1)	Ragi	15 crops (1910–51)	474	552	601	1500	1546	1314	733	907	1331
	% on control		100	116	127	316	326	277	154	191	281
(2)	Cholam	15 crops (1910–51)	716	790	820	1886	1877	1617	855	1069	1980
	% on control		100	110	115	263	262	226	119	149	277
(3)	Wheat	6 crops (1910–51)	372	514	536	908	1021	769	514	564	806
	% on control		100	138	144	244	274	207	138	152	217
(4)	Panivaragu	7 crops (1910–51)	861	671	596	1119	1023	980	682	927	1070
	% on control		100	78	69	130	119	114	79	108	124
(5)	Cumbu	3 crops (1910-51)	140	185	221	319	311	211	168	146	271
	% on control		100	132	158	228	222	150	120	104	194
		Total of yield for all crops:	2563	2712	2774	5732	5778	4891	2952	3613	5458
		For single crops:	513	542	555	1146	1156	978	590	723	1092

TABLE II.

Showing the microbiological population of permanent manurial plots (under irrigated conditions) (N. P. M.)

Year	Bacteria			Fungi		
	No manure	NPK	CM	No manure	NPK	CM
May 1927 to January 1928 (Average)	1,255,000	2,093,000	3,205,000	2,000	5,000	6,000

TABLE III.

Showing the microbiological population and activity under rainfed conditions (O. P. M.)

Year	Population			Activity					
	No manure	N+P+K	C.M.	No manure		N+P+K		C. M.	
				With dextrose	Without dextrose	With dextrose	Without dextrose	With dextrose	Without dextrose
1947–48	11,40,000	11,70,000	32,05,000	12·84	4·60	14·90	10·83	29·18	14·01
1948–49	4,20,000	6,50,000	6,40,000	16·15	7·82	27·19	15·33	15·93	15·14
1949–50	3,59,300	7,81,600	9,64,700						
1950–51	15,09,000	14,98,000	19,27,000	10·472	6·644	24·024	16·786	15·884	16·192

TABLE IV.

Showing the average yield of crops in permanent manurial plots under irrigated conditions (N. P. M.)

Treatments	RAGI					CHOLAM				
	No basal dressing (Av. 13 crops)		Basal Dressing 2,000 lb. FYM (Av. 9 crops)		Difference on controldue to basal dressing (%)	No basal dressing (Av. 11 crops)		Basal Dressing 2,000 lb. FYM (Av. 6 crops)		Difference on control due to basal dressing (%)
	(a)	(b)	(a)	(b)		(a)	(b)	(a)	(b)	
No manure (Control)	1141	100	952	100	— 16	1596	100	1227	100	— 23
N	1073	94	1022	107	— 4	1600	100	1462	119	— 9
N+K	1173	103	1051	110	— 10	1665	104	1517	124	— 9
N+P	1807	158	1631	171	— 8	2093	131	2053	167	— 2
N+K+P	1842	161	1754	184	— 5	2196	138	2029	165	— 8
K+P	1661	146	1532	161	— 8	1945	122	1678	137	— 18
K	1116	98	1372	144	— 23	1651	103	1588	129	— 4
P	1677	147	1685	166	— 5	1983	124	1805	147	— 9

(a) Yield of grain per lb. per acre

(b) % on control

Cattle manure Ragi Average yield per acre (22 crops) 1827 lb.

Cholam do. (17 crops) 2108 lb.

TABLE IV.—*(Contd.)*

Treatments Control	Wheat: No basal dressing (Av. 5 crops) (a)	(b)	Wheat: Basal dressing 2,000 lbs. FYM per acre (Av. 3 crops) (a)	(b)	Difference on control due to basal dressing (%)	Panivaragu: No basal dressing (Av. 3 crops) (a)	(b)	Panivaragu: Basal dressing 2,000 lbs. FYM per acre (Av. 3 crops) (a)	(b)	Differences on cotrol due to basal dressing (%)
No manure (control)	752	100	805	100	7	797	100	354	100	— 55
N	724	96	860	107	19	754	95	496	140	— 31
N plus K	815	108	871	108	7	791	99	505	143	— 36
N plus P	971	129	899	110	—7	859	108	480	136	— 44
N+K+P	920	122	758	94	—18	857	108	541	153	— 41
K plus P	737	98	727	90	—1	717	90	532	150	— 37
K	588	78	680	85	—16	696	87	476	134	— 32
P	820	109	662	83	—19	722	92	563	159	— 22

Cattle manure Wheat: Grain: Average yield per acre 8 crops—849 lb.
Panivaraghu: do. 13 crops—731 lb.

(a) Yield of grain in lb. per acre.
(b) % on control.

N. P. M.: Cumbu

Treatments	No basal dressing (Av. 4 crops) Yield of grain in lb/acre	% on control	Basal dressing 2,000 lb. F. Y. M. per acre (Av. 3 crops) Yield of grain in lb/acre	% on control	Difference on control due to basal dressing %
No manure (control)	872	100	713	100	— 18
N	805	92	908	127	— 11
N plus K	904	104	864	111	— 4
N plus P	1216	139	916	128	— 25
N plus K plus P	1321	151	1209	170	— 9
K plus P	1149	131	1022	143	— 11
K	875	100	907	127	— 4
P	1331	153	998	140	— 25

Cattle manure: Cumbu grain yield per acre (7 crops) 1266 lb.

TABLE V.

Showing the analysis of soil from permanent manurial plots.

Treatments	O. P. M. Lime	Nitrogen	Total P_2O_5	Avail. P_2O_5	Total K_2O	Avail K_2O	pH	N. P. M. Lime	Nitrogen	Total P_2O_5	Avail P_2O_5	Total K_2O	Avail K_2O	pH
1. No manure	1·14	0 0295	0·032	0·0088	0·275	0·0198	7·9	1 975	0 060	0·083	0·0253	0·623	0 0269	8 1
2. N	1·33	0·0358	0·035	0·0099	0·303	0·0211	7·7	1·937	0·061	0·088	0·0255	0·666	0·0295	8·2
3. N plus K	1·21	0·0371	0 032	0·0096	0·331	0·0288	7·6	1·947	0 061	0 085	0·0238	0·636	0·0360	8·2
4. N plus P	1·17	0·0414	0·078	0 0544	0·286	0·0180	7·5	1·886	0·064	0·101	0·0378	0 618	0 0271	8·1
5. N+K+P	1·01	0·0367	0 109	0·0548	0·430	0·0265	7·6	1·843	0·062	0·094	0·0357	0 611	0 0275	8·2
6. K plus P	0 89	0·0349	0 098	0 0614	0·461	0 0252	7·7	1·920	0 061	0·098	0·0367	0·613	0·0316	8·2
7. K	0·95	0·0343	0 037	0·0152	0·458	0 0264	7 8	1·832	0·064	0·089	0·0277	0·596	0·0308	8·2
8. P	0·99	0·0316	0·088	0·0612	0·358	0 0160	7·6	1·795	0·087	0·094	0·0340	0·578	0·0273	8·3
9. C. M.	0·86	0·0437	0·035	0 0119	0·640	0·0348	7·6	1·730	0·100	0·088	0·0290	0·568	0·0315	8·2

TABLE VI.

Showing the comparative manurial value of ammonium sulphate and groundnut cake at various doses of nitrogen on cotton crop and its residual effect on Sorghum at the Agricultural Research Station, Nandyal.

COTTON N. 14.

Year	No manure	Ammonium sulphate 20 lb. N.	40 lb. N.	60 lb. N.	Groundnut cake 20 lb. N.	40 lb. N.	60 lb. N.	Significance C. D.
1943—44	292 lb.	320	337	339	327	326	...	67
1944—45	166 ,,	165	175	151	166	171	178	Not significant
1945—46	156 ,,	158	160	161	151	184	154	,,

JONNA GRAIN.

Year	Treatments : 1	2	3	4	5	6	7
1944—45	856	841	875	839	916	951	1013
1945—46	550	543	651	711	649	664	800

TABLE VII

Showing the results of experiments where compost gave significantly increased yields

A. NIGHTSOIL COMPOST

Tirurkuppam :

	No manure	Compost	F.Y.M.
1949—50 : Paddy Co, 19	(1)	(2)	(3)
Acre yield of grain in lb.	1509	2285	1853
Percentage on control	100	151·5	122·9
Conclusion :		2,3,1	
1950-51 : Paddy Co. 19, Single crop area :			
Acre yield of grain in lb.	1284	1407	1588
Percentage on control	100	109·7	123·7
Conclusion :		3, 2, 1	
Paddy Co. 2, Double crop area :			
Acre yield of grain in lb.	984	1037	1134
Percentage on control	100	105·4	115·3
Conclusion :		3, 2, 1	

(Lam : Guntur) Chillies Crop (G-1) Dosage of manure is the amount to supply 120 lb. N. per acre.

1950-51	No manure	Farmyard Manure	Compost.
	A	B	C
Acre yield of chillies in lb.	574	787	1122
Percentage on control	100	137	195
Conclusion :		C, B, A	

Anakapalle : (Sugarcane Co. 419)

1950-51	No manure	Compost	Farmyard manure
	A	B	C
Acre yield of sugarcane in tons	41·0	53·1	52·8
Percentage on control	100	129·6	128·7
Conclusion :		B, C, A	

B. FARM WASTE COMPOST

Palur : Sugarcane Co. 449 (1949-50)

	No manure	Cattle manure	Compost
	A	B	C
Acre yield of sugarcane in tons	20·6	29·8	25·5
Percentage on control	100	139·8	123·3
Conclusion :		B, C, A	

Ragi : R. 382 (1950)

	No manure	Cattle manure	Compost
	A	B	C
Acre yield of grain in lb.	1278	1541	1516
Percentage on control	100	120·6	118·6
Conclusion :		B, C, A	

Cumbu : Co. 3 (1950-51)			
Acre yield of grain in lb.	1411	1713	1695
Percentage on control	100	121·4	120·1
	Conclusion :	B,C, A	

Aduthurai :			
	No manure	Cattle manure	Compost
(Thaladi) second crop paddy (1950-51)	A	B	C
Acre yield of grain in lb.	2097	2324	2196
Percentage on control	100	111·4	104·8
	Conclusion :	B,C, A	
Samba Paddy Co. 25 (1950-51)			
Acre yield of grain in lb.	2734	3270	3144
Percentage on control	100	120	115
	Conclusion :	B,C, A	

Maruter :			
	No manure	Compost	Farmyard manure
Paddy. MTU 5 (1950–51) Single crop area :	A	B	C
Acre yield of grain in lb.	3092	3186	3287
Percentage on control	100	103·0	106·3
	Conclusion :	C,B, A	
Double crop area, MTU. 5 (1950–51)			
	No manure	Compost	Farmyard manure
	A	B	C
Acre yield of grain in lb.	2841	2903	3173
Percentage on control	100	102·2	111·6
	Conclusion :	C,B, A	

TABLE VII—(a)

Showing the results where increased yields were not significant

A. NIGHTSOIL COMPOST :

Central Farm, Coimbatore :

1949–50. **Cholam (Co. 9)** Compost plots gave 7.8% more than No Manure while F. Y. M. yielded only 3·6% more.

Paddy : Co. 14 : Compost gave 2·4% more than no manure.

Sugarcane (Co. 419) : Compost yielded 27·2% more than No Manure while F.Y.M. gave only 4·8% higher yield.

Showing the results where compost gave higher yields than F.Y.M.

Station.	Year	Manure used.	Dose.	Crop.	Percentage increase in yield over No Manure Compost.	F.Y.M.
Tirurkuppam	(1949-50)	Nightsoil compost	60 lb. N/acre	Paddy Co. 19	51·5	22·9
Lam (Guntur)	1950-51	do.	120 ,,	Chillies (G.1)	95·0	37·0
Anakapalle	,,	do.	250 ,,	Sugarcane (Co. 419)	29 6	28·7

TABLE VII (b)

Showing the results of experiments where compost gave higher yields than No Manure but the increases in yield were not statistically significant

Station.	Year.	Manure used.	Dose.	Crop.	Percentage increase in yield over No Manure	
					Compost	F.Y.M
Coimbatore	1949-50	Nightsoil compost	250 lb. N/ acre	Sugarcane Co. 419	27·2	4·8
,,	,,	,,	60 ,,	Cholam Co.9	7·8	3·6
,,	1950-51	,,	60 ,,	Paddy Co. 14	15·0	11·0
Anakapalle	1949-50	,,	250 ,,	Sugarcane Co. 419	8·6	5·8
,,	,,	,,	60 ,,	Paddy BAM.3	11·9	11·0
,,	1950-51	,,	60 ,,	Paddy BAM.3	18·3	8·0
,,	,,	,,	60 ,,	do.	19·9	19·7
Lam (Guntur)	,,	,,	60 ,,	Variga	23·0	43·0
Samalkot	,,	Farmwaste compost	240 ,,	Bananas	63·0	00·0
Palur	1949-50	do.	60 ,,	Ragi R. 382	10·4	12·3
Pattambi	,,	do.	60 ,,	Modan paddy	22·7	23·7
,,	1950-51	do.	60 ,,	do.	7·9	6·3
Maruter	,,	do.	60 ,,	Paddy MTU.15	15·4	21·1

TABLE VIII

Showing the manurial value of different green leaf manures on paddy at different nitrogen levels

Year	Sesbanea speciosa A			Daincha B			Wild Indigo C			Fisher's 'Z' test satisfied or not	Critical difference (P=0·05)
	1	2	3	1	2	3	1	2	3		
1937–38	1468	1664	1687	1633	1646	1720	1500	1712	2018		
1938–39	2782	3183	3474	2384	2740	2812	2762	2801	3326	Yes	312
1939–40	2376	2537	2746	2387	2515	2632	2533	2665	2705		

(1) 15 lb . N. per acre; (2) 30 lb. N. per acre; (3) 45 lb. N. per acre.

Conclusions :—

1937–38 : C3,B3,C2,A2,B2,C1,A2,B1,A

1938–39 : $A_3,C_3,A_2,B_3,C_2,A_1,C_1,B_2,B_1$

1939–40 : A3,C3,C2,B3,A2,C1,B2,B1,A

TABLE IX

Showing the relative merits of some common green manure crops.

	Sunnhemp	Daincha	Pillipesara	Cowpea
Green matter per acre	27,790 lb.	21,131 lb.	22,337 lb.	21,055 lb.
Nitrogen added to soil	134 ,,	133 ,,	102 ,,	74 ,,
Moisture	70%	60%	80%	80%
Decomposability	Moderate	Slow	Very rapid	Rapid
Soil nitrogen due to continued application	0·109%	0·141%	0·109%	0·101%
Soil nitrogen – No manure	0·079	0·079	0·079	0·079
Bacterial population	4,000,000	4,500,000	5,300,000	4,300,000
do. No manure	3,600,000	3,600,000	3,600,000	3,600,000
Yield of paddy:				
Grain per acre	3,467 lb.	3,626 lb.	3,626 lb.	3,327
Percent over No Manure	198%	207%	207%	190%
Straw per acre	6,554 lb.	7,311 lb.	6,415 lb.	5,299 lb.
Per cent over No Manure	374%	417%	366%	302%
No Manure:				
Grain	1,753 lb.	1,753 lb.	1,753 lb.	1,753 lb.
Straw	1,753 lb.	1,753 lb.	1,753 lb.	1,753 lb.
Remarks :–	Good as green manure. Serves as fodder also. Cannot stand water-logging.	Hardy. Even under adverse conditions grows well. Gives good residual effect to soil.	Take time to grow; useful as fodder and can be cut once or twice and fed to cattle before ploughing in.	Grows thick but requires good drainage in soil.