

## Manuring Crops \*

by

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**Use of Fertilisers:** It was Dr. J. A. Voelker, consulting Chemist, Royal Agricultural Society, who, in 1889, first recommended the use of fertilisers for India. At that time only ammonium sulphate, superphosphate and sodium nitrate were known. In 1909, the first permanent Manurial experiments in India were started at Coimbatore to compare the effects of N, P and K individually and in combination with Farm Yard Manure. Later when the Council of Agricultural Research in India got interested in fertiliser studies, a number of manurial trials were initiated. At that time results had shown that nitrogen and organic matter responded to their use while response to phosphorus and potash were varying and conflicting. Meanwhile, the science of Statistics came to be well established as an adjunct to agricultural investigations and subsequent experiments on manures and fertilisers were laid out according to the requirements of this science. Many short term experiments to compare the effect of different forms of fertilisers were laid out throughout the country, particularly for the major crops like paddy, wheat, cotton and sugarcane.

All these experiments were mostly laid out in Government farms or colleges. When Dr. A. B. Stewart came out in 1945 and reviewed the manurial position in India in his report to the I. C. A. R. he was of the opinion that though much data was available in the country on manurial values, very little was known about the responses in cultivators' fields and consequently in 1949, Stewart's manurial experiments in cultivators' fields were implemented by the I. C. A. R. and in 1951, Madras, West Bengal and Bihar tried out these simple manurial trials in cultivators' fields in one district only in each of these States and in Madras, Tanjore district was the venue of these experiments.

Based on the suggestions of Dr. F. W. Parker in 1952 under the Operational Agreement No. 4 "Project for the determination of soil fertility and fertiliser use" jointly by Technical Co-operation

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Mission and Government of India, an overall project was implemented. A two fold approach was made to the manurial problem in India, viz. (1) to conduct complex replicated experiments at a few centres; and (2) to have many simple, unreplicated experiments on cultivators' fields. The planning of the experiments however was greatly influenced by the original report of Dr. A. B. Stewart in 1945. Simple experiments (with Control, N, N+P) were laid out by 1953 in about 40 locations covering the wide range of soil and climatic patterns in India. Half of the experiments were in Community Development Blocks and the rest in cultivators' fields. One such location for the erstwhile Madras State was in Mangalore for paddy with about 82 trials. The complex manurial trials were laid out in 15 acre plots in about 20 centres in India, and Aduthurai was one such centre in Madras State, wherein, levels of N and P with forms of fertilisers were tried out. Half of the centres in India were devoted to paddy and the other half to wheat.

In 1954, the free fertiliser demonstration scheme was launched on an All India basis by the Government of India with the main purpose of demonstrating the effectiveness of some of the important new commercial fertilisers, such as urea, ammonium-sulphate-nitrate etc. In Madras, over 1345 demonstrations were done in 1954-55 and with an equal number in 1955-56, under the Regional Fertiliser Officer. In the Second Five Year Plan large number of manurial experiments on a more intensive scale is planned. In Madras, the complex manurial experiments are being done in Aduthurai and Bhavanisagar on paddy, cotton and millets while the simple manurial experiments are scheduled to start off with a centre for every two districts. The free fertiliser demonstration trials are also to continue in a limited scale. Besides these experiments of all India coverage, there are not only numerous manurial experiments under way in Government farms but many manurial firms like the Potascheme are conducting demonstration experiments on their own. Thus, we are now living in an era of "fertilisers and manures" with all the commercial, agricultural and scientific minds being fully manure conscious.

**Food Production:** In the First Five Year Plan, the Agricultural production of the four principal crops grown in the Madras State shows an overall increase in production of 40% as will be seen from the following figures :—

	Production in 1951—52 Tons	Production in 1955—56 Tons	Increase
Rice	2,163,000	3,063,000	40%
Millets (of all kinds)	843,000	1,338,000	45%
Oilseeds	802,500	893,000	11%
Cotton	227,280 bales	284,000 bales	25%

*Average production per acre.*

	In 1951—52 lb.	In 1955—56 lb.	Increase lb.
Rice	800	1,033	233
Millets (of all kinds)	565	718	153
Oilseeds	855	1,036	181
Cotton	120	122	2

**Our Targets of Food Production:** More food will have to be produced if we are to feed the 50 million additional people who are expected to make up India's population in 1961. The Second Five Year Plan as programmed at present envisages a gross increase of 28% in Agricultural production. But the target to be aimed at is still higher according to the National Development Council and for Madras it is stated that if the consumption of cereals is to be maintained at the level of 18·3 oz. fixed by the Planning Commission, the present total production of 44 lakh tons should increase by 20% so that nearly 52·5 lakh of tons of cereals are available to feed the population of 38 millions. This increase of 20% is not going to be easy, particularly after the initial increase shown in the First Five Year Plan.

**Importance of Fertilisers:** Better seeds, more irrigation facilities, freedom from pests and diseases would all contribute a little towards this increase in production but the main solution lies in scientific manuring. Average rice yields of the State as a whole in comparison with the yields in Government farms is given below:—

State	Average yield of State as a whole lb./acre.	Average yield of experimental station lb./acre.
Assam	772	1644
Bihar	623	1194
Bombay	883	2138
Madras	1020	2025
Madhya Pradesh	580	1224
Mysore	682	1998
Orissa	600	1951
Uttar Pradesh	584	1151
West Bengal	841	2087

From this it is seen that the yields in the State as a whole can be reasonably doubled by adopting suitable manurial and agronomical practices as in the Government farms. By bringing more and more land under fertilisers, the consumption of fertilisers is also expected to go up as shown below in the Second Five Year Plan (From Dr. Ward, H. Sach, Fertiliser Consultant to the T. C. M. as per his report to the Government).

*Targets for consumption of commercial plant foods*

Year	Nitrogen	Phosphoric acid	Potash
1956—57	150,000	40,000	12,000
1957—58	190,000	50,000	15,000
1958—59	240,000	70,000	20,000
1959—60	300,000	90,000	25,000
1960—61	370,000	120,000	30,000

Towards this consumption of fertilisers, Government have taken steps to step up production of fertilisers through local production and by imports. But the more important problem is how best to utilise them to get the maximum benefit.

**Scientific use of Fertilisers:** We hear not only farmers but also the specialists in the different crops asking the question "How many pounds of N, P and K and in what form should one apply per acre". The answer is not easy to give as the soils vary; climate of the country is not uniform and crop requirements are different.

One and the same crop needs more food at one time than at another. Some crops are voracious in their feeding habits while some are frugal. However, factual information developed by the various experiments conducted in the country and in particular in Madras State will be presented here so that the farmers' requirements for N, P and K in relation to the main crops of the State could be broadly indicated for adoption.

**A. Paddy:** Manurial experiments on paddy have been conducted from very early days by the Madras Department of Agriculture but, as the modern field experimentation technique came to be adopted only after 1930, the experiments from that year to the present date is reviewed here. The experiments done under the auspices of the T. C. M. and I. C. A. R. since 1945 are also reviewed.

**Chemical Fertilisers: Nitrogenous Manures:** (i) *Ammonium Sulphate:* There has been an universal response to application of ammonium sulphate. The maximum response was at Pattambi (laterite soil) and the minimum response at Samalkot (heavy clay) in the erstwhile Madras State. The response was also at a minimum in Aduthurai (Cauvery alluvium) compared to Pattambi, when the fertiliser was applied singly. The response to increased doses of N as ammonium sulphate was low at Palur (Alluvium). The mixed black and red soils at Coimbatore indicated graded response up to 80 lb. N but on the light sandy soils of Tirurkuppam 20 lb. and 30 lb. N as Ammonium sulphate were on a par. In regard to the time of application, results indicate that one month after planting was suitable. The optimum dose would appear to be 30 lb. N.

(ii) *Ammonium nitrate:* Generally, on the same levels of N, it was equal to ammonium sulphate as the yields were on a par at Tirurkuppam, while at Palur and Aduthurai the results were not significant.

(iii) *Nitrate of Soda:* This fertiliser recorded lower yields than ammonium sulphate on Cauvery alluvium in Tanjore district, in the mixed black and red soils of Coimbatore and in the laterite soil of South Malabar.

**Oil Cakes:** Good response to oil cakes in general with the maximum at Maruteru (for 48 lb. N as groundnut cake) was noted. When the level of application was at 30 lb. N, the maximum yield was obtained at Pattambi. These results are similar to those obtained for ammonium sulphate. No consistent difference was

noticed between the different cakes at Aduthurai, Pattukottai, Tirurkuppam and Pattambi. But there was some indication to show that neem cake was more suited in seasons of drought than the other common oil cakes like groundnut cake and castor cake at Coimbatore. The levels of N tried in relation to crop response showed the yield to increase up to 60 lb. N in earlier experiments in almost all the places but in some centres the yields due to 60 lb. N and 40 lb. N as cakes were on a par. The experiments to study the time of application of oil cakes indicated that 4 weeks after planting in the case of long duration and 3 weeks after planting for short duration varieties was best at Maruteru, while at Pattambi, application at planting or 3 weeks after planting was the best. In the case of combined application of oil cakes and ammonium sulphate, application of the latter either at planting time in a single dose or in two doses (half at planting and the rest 2 months after planting) was best at Pattambi, while no difference was noticed at Coimbatore between the applications made 30 days and 45 days after planting. Experiments at Aduthurai on the other hand, indicated that groundnut cake or ammonium sulphate applied at planting or a month after planting to the first crop was the best. For the second crop at the same place, groundnut cake at first weeding or a week after planting and ammonium sulphate at second weeding or two months after planting appeared to be optimum.

**Green Manures:** Trials with green manure showed that at Coimbatore (mixed black and red soils) 4000 lb. was the best in the ranges tried from 2000 to 12,000 lb. At Pattambi (laterite soil) progressive increase in the yield up to 8000 lb. were obtained, when green manure from 2000 to 10,000 lb. were applied along with bone meal. At Pattambi (laterite soil) the optimum dose was 5000 lb. while in Palur (Alluvium) 6000 lb. (for *Kar*) and 9000 lb. (for *Samba*) appeared to be suitable. Between the different forms of green manure tried, there was no marked difference in general but the common weed *Croton sparsiflorus* was inferior to pungam leaves on equal weight basis. No advantage was seen by the use of processed leaf over green leaf. Nor was any cumulative effect found by continuous green manuring for 20 years in Anakapalle. In Pattambi, for broadcast paddy and for semi-dry paddy in Tirurkuppam, green manuring was profitable. In Aduthurai, a combination of 200 lb. of groundnut cake, 100 lb. ammonium sulphate and 4000 lb. of green leaf gave the best yield in one year and 4000 lb. leaf plus 100 lb. ammonium sulphate in another year.

*Different forms of N:* (both artificial and organic manures) Ammonium sulphate gave the best response at Buchireddipalayam while the differences were not consistent at Aduthurai.

**Phosphatic Manures:** Early experiments did not give consistent results as the increase in the dosage of  $P_2O_5$  did not show higher yields. In the later experiments no significant difference was noticed between calcined bone, bone meal and superphosphate at the Paddy Breeding Station, Coimbatore, Ambasamudram and Buchireddipalayam. Similarly, there was no difference between calcined and raw bone meal at Aduthurai, Pattukottai and Palur. It can be said in general that response to phosphatic manures was good at Maruteru, while it was absent at Samalkot, Aduthurai, Pattambi, Tirurkuppam and Ambasamudram.

*Forms of Phosphates:* Among the different forms, Ammonium phosphate gave the maximum yield followed by bonesuper at Aduthurai and Pattukottai. On the laterite soils of Mangalore, bone meal was superior to super and fused phosphate was superior to bone meal. No special benefit due to other forms like hyperphosphate etc. was noticed.

*Time and method of application:* As regards the optimum time of application, consistent results were not obtained at Coimbatore but application before planting appeared to be suitable. No advantage with reference to grain yield was noticed by the indirect application of phosphate to paddy (through application to green manure) at Palur, Tirurkuppam and Pattambi, even though increased yields of green manure were got at Palur and Pattambi. It was only at Maruteru that 10% more grain was obtained due to indirect application of phosphate.

**Ash:** Ash by itself gave a good response at Pattambi, while combinations of wood ash either with groundnut cake or green leaf gave the maximum yield.

**Lime:** A dose of 1500 lb. of lime at Ambasamudram (alluvial soil deficient in lime) did not give significant increase in yield. Lime was found beneficial at Pattambi (3000 lb. per acre) and Mangalore (1000 to 3000 lb.).

**Optimum dosage experiment:** A combination of 5000 lb. leaf, 250 lb. of groundnut cake and 100 lb. ammonium sulphate and 25 lb. of  $P_2O_5$  was the best at Pattukottai. Groundnut cake and

ammonium sulphate in the ratio of 2:1 N to give a total of 60 lb. N over a basal dressing of green manure (2000 lb.) appeared to be the best at Aduthurai. The balanced manure experiment at Ambasamudram did not indicate the utility of  $K_2O$ . Groundnut cake (48 lb. N.) gave the maximum yield.

**Maximum Potentiality Experiment:** At Maruteru, growth was proportional to N but the yields at 60 and 90 lb. N were on a par and 30 lb.  $P_2O_5$  seemed to be the optimum. The influence of  $K_2O$  was not felt. At Buchireddypalayam N up to 60 lbs. increased the yield, combination of smaller  $P_2O_5$  doses of N upto 60 lbs. with  $P_2O_5$  and  $K_2O$  contributed to increase the yield. At Tirurkuppam, all the three primary nutrients contributed to the yield. 90 lb. N appeared to be optimum. Application of  $K_2O$  at the rate of 60 lb. depressed the yield. At Palur, a combination of 30 lb. N, 10 lb.  $P_2O_5$  and 20 lb.  $K_2O$  appeared to be optimum and increase in the dosages of manures lowered the yield. At Aduthurai, N contributed to the yield and  $K_2O$  and  $P_2O_5$  did not increase the yield even though a combination of 120 lb. N and 30 lb.  $P_2O_5$  over the basal dressing of leaf gave the maximum yield in one year. At Pattukottai  $K_2O$  did not increase the yield and only slight increase was got with 30 lb.  $P_2O_5$ . Progressive increase in yield for application of N up to 60 lb. was obtained. At Coimbatore  $P_2O_5$  and  $K_2O$  at any level did not materially increase the yield even though combinations of 120 lb. N and 30 lb.  $P_2O_5$  in one year and 60 lb. N, 30 lb.  $P_2O_5$  and 60 lb.  $K_2O$  in another year gave maximum yields. The addition of  $K_2O$  to N at higher doses somewhat depressed the yield. At Pattambi also N was the only element that contributed to increase in yield. The favourable influence of  $K_2O$  was felt in the absence of leaf only.

Thus, even though the high dose of 120 lb. N in combination with other nutrients gave the highest yield at Coimbatore, Aduthurai and Pattukottai, generally the yields of treatments 60, 90 and 120 lb. N have been on a par. The higher dosage of N (120 lb.) resulted also in lodging of the crop indicating that 60 lb. N is the highest that can be profitably adopted.

**Placement of Fertilisers:** Experiments conducted after 1950 indicated that ammonium sulphate at the rate of 45 lb. and 30 lb. per acre deeply placed in 2 doses two-thirds at planting and one-third a month later with 10"×10" spacing was better than broadcast application, while, with 6"×6" spacing, placement of 45 lb. N gave better yields than broadcast application. No significant difference was noticed in the case of phosphate application.



**Stewart's Manurial Experiments in Tanjore District:** Manurial experiments were conducted in various parts of Tanjore District (1952—'55) on farmers' lands to find out the effect of application of 5000 lb. of green leaf, 30 lb. N as ammonium sulphate and 30 lb.  $P_2O_5$  as superphosphate. The ryots method gave on the average 2027 lb. while the green manure (5000 lb.) gave 2183 lb. The increase in yield per lb. of N over the basal application of green manure was 7.4 lb. The application of  $P_2O_5$  resulted in 7.2 lb. per lb. of  $P_2O_5$  over that of N application indicating the need for both  $P_2O_5$  and N for Tanjore soils in farmers lands, though the experiments conducted at the Research Station at Aduthurai and Pattukottai do not bring out the same.

**Free Fertiliser Demonstration Trials (1954—'55) Farmers' fields:** The response per lb. of N when applied as ammonium sulphate at 30 lb. N level over the ryots method was 20.1 lb. at Chingleput (coastal alluvium), 7.5 lb. at South Arcot (red loam), 12.4 lb. in Tanjore and 15.4 lb. at Coimbatore (mixed black and red soil). The average for the whole state was 13.8 lb. per lb. of N (Cauvery and coastal alluvium). The difference in response between urea and ammonium sulphate was small, being only 0.8 lb. in favour of urea. In the case of phosphorus, the response was smaller than for N. The average for the whole state was 7 to 8 lb. per lb. of  $P_2O_5$  per acre. But the variation between the districts was larger. Responses were poor in Chingleput, Tanjore, Madurai and Malabar.

**Agronomical trials at Aduthurai (1954—'55):** In experiments conducted over a basal dressing of 3000 lb. to 4000 lb. leaf response per lb. of N was 6.5 lb. (at 20 lb. N level) and 4.8 lb. (at 40 lb. N level) when N was applied as ammonium sulphate. Response to  $P_2O_5$  when applied at 40 lb. per acre at different levels of N per lb. of  $P_2O_5$  were, 11.66 lb. at the rate of 20 lb. N. level, 13.2 lb. at the rate of 40 lb. N. level, 10.8 lb. at the rate of 60 lb. N. level. Response to  $P_2O_5$  at different levels was at 20 lb.  $P_2O_5$  level - 7.2 lb. per lb. of  $P_2O_5$ , and 3.7 lb. per lb. at 40 lb. level.

**Experiments conducted by Potascheme (1955-'56):** Application of 40 lb.  $K_2O$  (as  $KCl$ ) along with 40 lb. N and 40 lb.  $P_2O_5$  resulted in an extra yield of 266 lb. of paddy due to  $K_2O$  per acre. The highest response to  $K_2O$  was 437 lb. in Tiruchirapalli for the second crop paddy.

**Conclusions:** From all this factual presentation of the manurial experiments done on paddy it is clear that one uniform recommendation is not possible but one may however draw the following conclusions:

1. Manuring of seed bed alone is not sufficient. The transplanted field also should be properly manured.
2. Green manure in any form is useful and progressive yields up to 8000 lb. can be obtained even though the optimum quantity ranged round about 4000 lb. to 5000 lb. Green manure was the cheapest form of N.
3. Oil cakes are as good as artificials as suppliers of N.
4. Bulky organic manure like cattle manure, compost, synthetic farm yard manure, sheep manure, fish manure and night soil were equal in effect and similar to green manure, the optimum dose being 30 to 40 lb. N.
5. Ammonium sulphate was the best among the artificial manures. 30 lb. N as ammonium sulphate over 4000 lb. green manure was the optimum.
6. Best time to apply N fertilisers is 30 to 60 days after transplanting depending on the duration of the crop.
7. At least 2000 lb. of green leaf should be used as basal dressing for paddy in addition to top dressing with ammonium sulphate to give a total of 60 lb. N.
8. As regards phosphatic fertilisers no marked effect was noticeable but on the whole the trend seems to be in favour of a mixture of 4000 - 5000 lb. of green leaf and some form of phosphatic manure to supply 25 to 30 lb.  $P_2O_5$ . The best time of application is at the time of planting.
9. In regard to potassic manures, there was no apparent need in all the Research Stations tried, whereas a depressing effect was seen in Tirurkuppam and Coimbatore.
10. Lime was useful in the laterite soils of Pattambi and Mangalore. The residual effect was seen in the succeeding crop also.
11. Ammonium sulphate deeply placed in two doses two-thirds at planting and one-third a month later, was better than broadcasting.
12. No significant difference due to placement of phosphate manure was noticed.

[ To be Continued ]