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Manuring of paddy in relation to the present food crisis in India*

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Introduction: Rice is supposed to represent the staple food of the greatest number of people in the world and being comparatively a safer and more regular crop than other food-grains, its cultivation is practised on a very wide scale in various countries in the world. According to the estimates published by United States Department of Agriculture (2) in 1946, the world acreage and production of this crop in 1945–46 came approximately to 197 million acres, and 6,300 million bushels of paddy as against 382 million acres and 5,200 million bushels for wheat. These figures also show that the average world production of clean rice and wheat was of the order of 960 and 816 lbs. per acre respectively.

The position of rice vis-a-vis other food crops in India, including Indian States prior to partition, according to the Agricultural Statistics of India, 1938–39 was approximately as follows:—

	Area in million acres.	Approximate production in million tons.
Total food grains	234	
Rice	74	25·0
Wheat	34	9·8
Millets		
(Jowar, bajra, maize and ragi)	68	18·5
other food grains	58	

Figures of acreages under various crops in the Indian Dominion are not available but the population figures recently published by the Statistical Office of the United Nations (18) are 331 millions as against 405 millions for the whole of India prior to partition. For purposes of calculation if we assume, for the time being, that the areas under various food crops have been reduced more or less in the same ratio as the reduction in population, the acreages in the Indian Dominion would be as follows:—

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	Area in million acres.	Percentage of the total area under food crops
Total food grains.	193	
Rice	61	32·0
Wheat	28	14·0
Millets (jowar, maize, bajra, and ragi)	56	29
Other food crops.	48	25

From the figures given above, it will be seen that rice occupies a high place in Indian Agriculture. From the point of food resources of the country, rice also occupies a unique position, as the average outturn of this crop is estimated to be 700 to 750 lbs. of clean rice per acre, as against the averages for wheat, and other millets like jowar, maize, and ragi, of 650 to 700 lbs. and 400 to 700 lbs. per acre respectively (19). Rice not only produces a better average outturn per acre, but its calorific value is also comparatively higher than those of other cereals, 100 grams of rice producing 350 calories as against 340, 342 and 345 for wheat maize, and ragi respectively (4). According to the average figures for the years 1935 to 1940 rice average in India was 73 millions or 35% of the world acreage of 206 millions (2). Although in respect of acreage, India occupies the first place in the rice producing countries of the world, the average yield per acre is the lowest as compared to the yields obtained in other countries, like China, U.S.A., Japan, etc., A comparative statement (2) of average yields of clean rice per acre of certain countries for the years 1935 to 1940 is given below :—

	Clean rice per acre in lbs.
Italy	3120
Japan	2280
Egypt	2160
China	1560
U.S.A.	1500
Siam	900
Burma	825
India	780

Factors affecting rice production in India. The very low yields in India may be attributed to the following factors :— (i) The erratic nature of the monsoon, (ii) lack of irrigation facilities in most of the rice-growing tracts, as only about 48% of the area under rice is irrigated. (iii) inadequate supply of seed of improved

varieties, and (iv) a stationary state of soil fertility at a low yield level, as a result of cultivation over many centuries without adequate returns to the soil of organic matter, and nitrogen (9). Although this paper is intended to deal specifically with the aspect of manuring in relation to rice, a brief reference to the effect of other factors on the production of rice will not be out of place.

It is well known that the most important factor involved in the successful growth of paddy is water (20,13). It is not enough merely to provide the total quantity of water required for this purpose, but it is essential to be able to supply water as and when required, and particularly at the time of sowing, and at transplantation in the case of transplanted paddy. Delays in sowing due to late monsoon, or in the case of transplantation due to lack of water in canals, results in reducing the outturns very markedly.

In this connection the following selected figures from those given by Viswanath-30 will be found interesting :—

Station.	Date of planting.	Yield of paddy per acre in lbs.
Samalkot	15th July	3935
,,	7th August	2048
,,	21st August	1505
Godavari dalta (East)	upto 15th July	1739
,,	,, 15th Augut	1279

Results from other experimental stations in South India as well as those recorded by Copeland (14) for U.S.A. were found to be similar to those given above. In view of the fact that out of the total area under paddy, only 28% is irrigated, the adverse effects produced on the outturns of paddy by inadequate irrigation water supply and capricious nature of the monsoon, cannot therefore, be over-emphasized. They also further point to the immediate need to augment the water resources to the maximum extent possible.

In this connection it may be mentioned that constant submergence of the soil under water does not appear to be beneficial in the case of heavy soils as in the case of lighter types (11). This observation is particularly important from the point of utilising available water supplies in relation to soil types, economically and efficiently, so as to ensure maximum production.

Experiments carried out by a number of research workers have shown that the existing yields of field crops can be increased by

10 to 20% if improved varieties are grown in place of local ones. Since only a small fraction of the area under rice is, at present, covered with improved varieties, the paramount need to immediately increase seed multiplication centres by increasing the number of seed farms, plots, and growers' societies, with suitable organisations for seed distribution to the required extent, is quite obvious.

General experience of various countries shows that clay loams, silt loams, sandy loam, and marshy soils fairly free from stagnant water, are suitable for paddy. Where irrigation facilities are not available heavier soils with high waterholding capacity are particularly suited to this crop, which is semi-aquatic in character. Results of analyses of various soils from India, Ceylon, and other eastern countries have shown that rice soils of these countries fall mainly under the four categories mentioned above (12), with a large number of short, medium, and long duration varieties being available, rice can thus be successfully grown in a variety of soils under varying conditions of climate, and it is chiefly this aspect of rice culture which makes it a safer and surer crop than other field crops.

Studies on the effect of soil reaction on the growth of paddy, show that a slightly acidic reaction, i.e., about pH 6·5 is definitely more beneficial than an alkaline reaction (10). Analyses of rice soils from Malaya, Japan, Philippines and Central Provinces in India show that the reaction of the soils is between pH 4.4 and 7.6. Soils of Burma, Ceylon, and South India, however, show a slightly alkaline reaction, the pH value varying between 7.8 and 8.7 although some soils in Ceylon are acidic having a pH value of 4.5. to 6.9.

Fertility status of rice soils: In regard to the fertility status of the soils from India and other eastern countries, it is seen that the percentages of chief fertilising constituents and organic matter in these soils, leaving exceptional cases, are generally of the following order (6,12).

Loss in ignition (Organic matter and combined water)	1.0 to 10.0%
Nitrogen	0.94 to 0.10%
Total $P_2 O_5$	0-05 to 0.4%
Total $K_2 O$	0.40 to 1.00%

The following limits have been suggested by Jack, quoted by Copeland (14) regarding the suitability of various soils for rice production :—

	1st class soils.	2nd class soils.
Nitrogen	0.24%	0.15%
Total $P_2 O_5$	0.07%	0.04%
Total $K_2 O$	0.51%	0.18%

If we take into consideration the average figures of soils from India and other eastern countries given above the standard suggested by Jack would appear to be very high, particularly in respect of nitrogen. Taking the yields of paddy per acre, as are at present being obtained, the following standards appear to represent the upper and lower limits according to the analyses of soils from Bombay Province given by Sahasrabuddhe :— (22)

	Good soils	Poor soils
Nitrogen	0.05% and above	Below 0.04%
Total $P_2 O_5$	0.10% and above	Below 0.10%
Total $K_2 O$	0·40% and above	Below 0.40%

It may be particularly noted that in accordance with the standard suggested by Jack, the majority of our rice soils fulfil the requirements in respect of $P_2 O_5$ and $K_2 O$, a point to which a reference will be made later while considering the question of manuring of rice.

Manurial experiments conducted in foreign countries: Results of various experiments carried out in U.S.A., Italy, Egypt, and other countries to study the effect of the three important fertilizing constitutents, N,P. and K on the growth of rice, show the following :—

(1) Nitrogen plays a very important role in the fertilization of rice crop, large quantities of nitrogen being required even in the early stages of growth. The form of nitrogen most suitable has been found to be the ammonium sulphate. Generally speaking, nitrate manures are not considered to be satisfactory for rice and may even have toxic effects on this cereal (15). The dose of ammonium sulphate recommended (16) is about 100 to 150 lbs. per acre and 300 to 400 lbs. where rice is cultivated on intensive lines.

(2) Applications of phosphates are attended by beneficial effects to the rice crop. On an average a dressing of 200 lbs. of superphosphate per acre is recommended and about 300 to 350 lbs. per acre where cultivation of paddy is done on intensive lines.

(3) Potash is important in the earlier months, while towards the end of growing period, absorption of nitrogen is greater.

It is recommended to apply potassic fertilisers two to four weeks before planting. Ordinarily a dressing of 53 to 100 lbs. potassium sulphate per acre is recommended and 100 to 200 lbs. per acre where rice is cultivated on intensive lines.

Results of various experiments briefly summarized by Copeland are as follows :—

"It can be stated as a general conclusion from such experiments, that for continuous rice culture it pays to use phosphatic fertilisers freely, the best form depending upon soil conditions and the immediacy of the results desired; that a liberal addition of nitrogen is also profitable, whether as a green manure or in some other organic from, or as ammonium sulphate; that it usually pays to apply potassium and that the most generally satisfactory inorganic form is the sulphate."

It has also been mentioned by him, that the quantities of various fertilizers to be used will have to be modified in accordance with the local needs of different places, based on the physical composition and fertility status of the soils and availability of water. Chemical analysis of the soils should be a better guide to the choice of fertilizers for rice than for most crops.

Experiments at the Texas Experiment station (27) during 1934–40, to determine the effect of ammonium sulphate on paddy, show the following :—

Quantity of Ammonium sulphate added in lbs. per acre.	Percentage increases in yields over control.
100	About 15 to 20%
290	About 39 to 48%

Manurial experiments conducted in India : Results of manurial experiments on paddy in India have been summarized and published from time to time by Vaidyanathan (29) Allan (5) Sethi (24) Burns, (13) and recently by Stewart (25). As various workers in India are acquainted with these publications it does not appear necessary to deal with them in any great detail, and our purpose will be served if a reference is made only to the following salient points therefrom, which are intimately connected with the objective in view of increased agricultural production :—

(1) A great majority of the experimental results show that nitrogen deficiency is extremely widespread in the soils of India. Applications of ammonium sulphate to paddy at the rate of 20 to

40 lbs. nitrogen per acre, have given profitable responses, and increases in yields of the order of 20 to 60% have generally been obtained.

Organic nitrogen in the form of oil-cakes and green manure (8) has also been found to increase the yields very considerably. It has been observed (17) that if the green manure is applied one or preferably two weeks before the date of transplantation, the yield obtained is considerably higher than that obtained when the green manure is incorporated with the soil at the time of transplantation.

(2) In regard to the applications of phosphatic manures, the general result has been that there is either no response, or where some response has been observed, it has not been high enough. In some exceptional cases, however, where the soils are deficent in phosphoric acid. e. g. some of the light soils of Central Provinces, phosphatic fertilisers have given positive responses, and the responses have been on definitely higher order where phosphatic fertilisers are applied in combination with nitrogenous manures and fertilisers.

In the case of phosphate deficient soils it is important to use phosphate fertilisers both from the point of obtaining higher yields and also from the point of nutrition, as applications of nitrogenous manures alone reduce the percentage of $P_2 O_5$ in the seed (1).

(3) General experimental results show that most Indian soils are relatively well supplied with potash, and for most crops there is, therefore, little need for potassic fertilisers. Experiments with paddy confirm this general observation and show that the need for supplying potash to this crop is comparatively unimportant except in the case of some few soils known to be deficient in potash. Potash deficiency symptoms in the case of paddy do not appear to have been so far recorded in India. The above findings are in agreement with the results of analyses of a large number of rice soils from different parts of India.

Various manurial experiments conducted all over India have shown that, out of the various field crops, paddy gives the highest response to nitrogenous manures and gives an extra yield of 10 to 20 lb. of paddy for every 1 lb. of nitrogen added to the soil per acre. The range of responses of some cereal crops, when manures are applied at the rate of 10 to 20 lb. of nitrogen per acre, are given below:— Response per lb. of nitrogen per acre. Paddy 10 to 20 lb. Wheat 8 lb. Jowar 8 to 13 lb. Bajra 8 to 12 lb.

In regard to the work which has so far been done in the laboratories and at agricultural research stations, there is, however, as mentioned by Russell-21 a great gulf which separates the research stations from the peasants, which needs to be bridged, and what is now immediately required is to bring effectively the improvements which can be effected in certain important directions, as indicated above, to the cultivator's door on a mass scale.

Future requirements: Although the data given above are useful in indicating to us the lines on which we can chalk a programme to immediately increase, production of rice in the country, further work in some important directions is still necessary to active maximisation of production, e.g. (1) evolution of improved varieties for certain tracts where this work has not hitherto been possible, (2) analyses of soils to determine their fertility status, and (3) manurial experiments on the basis of soil and climatic zones.

Other aspects of rice culture: In addition to the immense potentialites of increasing production of rice by using improved varieties and adequate quantities of manures and fertilisers, rice also offers an additional advantage of allowing a second or a catch crop like linseed, masoor, popat (*Dolichos* sp.) or other lugumes, in heavier soils in many areas whose average annual rainfall is about 35 40 inches and where at least one or two light winter showers are normally received during the period October-November. Where this type of double-cropping is possible, we can easily expect an outturn of at least 200 lb. per acre of pulses or linseed, over and above the yield of the main crop of paddy. This practice of double cropping is followed by cultivators in certain parts, but not in others, and there are vast undeveloped areas where this system can be profitably introduced. Assuming that out of the total area of 61 million acres under paddy at least about 10 millions can be newly brought under this system of double-cropping, the additional outturn on account of the second crop would easily come to 0·9 million tons per year. Increase in the production of pulses in rice-producing areas will also help to improve the nutrition of the people whose intake of pulses falls short of what is desirable-3. The importance of this system of double-cropping has been recently emphasised by the Board of Agriculture in India, Crops and Soils Wing at its meeting held in Madras in April 1948.

In a trial conducted at the Institute of Plant Industry, Indore, this year, to investigate the possibility of double-cropping after rainfed-transplanted paddy in an area of 1·22 acres, an outturn of 200 lb.

of linseed per acre, in addition to paddy was obtained. The total rainfall received from 1st June to 31st October 1948, was 36·7", and thereafter there was one shower of 0·9" on the 7th November and showers from 20th to 22nd November 1948, amounting 1·4".

From the point of immediate increased production of food in the country, rice which is the staple food of more than 70% of the population, thus offers the following specific advantages over other cereal crops :—

(1) Higher production of food per acre, (2) food of higher calorific value, (3) better response to manures, (4) facilities for double-cropping, and (5) safer and surer crop. Instead of attempting to manure all the cereal crops, if we were to select paddy for intensive work, in the first instance, on account of its special features given above, we shall be able to secure an increased production of at least 0·9 million tons of clean rice per year, and, in addition, about 3 million tons of other produce as a result of double-cropping, if we can manure only half the area under rice at 10 lb. nitrogen in the form of ammonium sulphate or 18 lb. of nitrogen as oil-cake or green manure per acre.

As we become able to increase our manurial resources, we can take the remaining area and other crops as well, so that our production based on very moderate estimates should progressively increase reaching the figure of about 5 million tons of extra food per year of all food grains in addition to the produce derived from areas newly brought under double-cropping.

The above estimates of increased production are on the lower side than the conservative estimates given by Burns. According to him an application of 22·4 lb. of nitrogen per acre is expected to increase the production by 5·6 million tons per year, due to manuring alone, and 8·4 million tons on account of the combined effect of the three important factors, (1) improved variety, (2) increased manuring, and (3) protection from certain pests and diseases.

Dr. Salter-23 chief of Bureau of Plant Industry and Soils, U. S. A., actually estimates an increase in the world production of cereals by 20% in 1960, by using the present cropped area more intensively. According to these estimates, the increase in rice production from 60 million area would come to 4 million tons of clean rice.

I have, however, based my estimate on the basis of application of lower quantities of nitrogen per acre partly because the financial

position of the average rice cultivator is not such as to permit him to invest large sums of money per acre to manure his lands, and partly because it has been the experience in Central Provinces that smaller applications of nitrogen, give a better return per rupee invested than higher applications which are profitable and give higher outturns per acre. Owing to the limitation of space, actual calculation in this behalf have not been given.

In view of what has been said above, the paramount importance of rice in the solution of the present food crisis cannot be overemphasised. From a study of this problem in so far as has been possible, it would be apparent that if the problem is tackled immediately with a realistic approach and by appreciating sympathetically the difficulties, requirements and aspirations of our cultivators, rice, if cultivated on intensive lines will very considerably help increasing the food production of the country. Increased production of rice will also incidently release equivalent quantities of wheat and other cereals for allotment to these whose staple diet consists of cereals other than rice. For this purpose, schemes for subsidised manuring of paddy lands in the hitherto comparatively undeveloped areas should, therefore, be called for and put into operation in the coming season. In so far as the newly formed Madhya Bharat, Rajasthan, and Vindhya Pradesh Unions are concerned there are, at least 1·1, 1·0, 6·6 lac acres respectively under paddy, which need adequate manuring.

According to the statement of Shri A. D. Birla(28) reported recently, Rs. 32/- crores have been spent as subsidy to foreign growers, and in addition, a substantial amount must have been spent on the maintenance of the special department of food, and other organisations. Although the total quantity of foodgrains imported against the subsidy is not nown, it is expected to be about 3 to 4 millon tons which worked out to Rs. 10·7 or Rs. 8 crores per million tons respectively.

One of the factors which limits increased food production, is lack of capital with the average Indian cultivator, and if adequate quantities of manures and fertilisers and financial help in the form of subsidies and interest-free loans are made available to him, it can be easily seen that we can increase the production at least by 1·8 million tons of clean rice from 60 millions acres, and for which purpose a sum of Rs. 15 crores only would be required on the basis of a subsidy of Rs. 2—8—0 per acre

or Rs. 8 3 crores per million tons of extra produce. The subsidy can be reduced year after year and can be stopped altogether after a period of, say, 3 years, and thereafter only interest-free or interest-bearing loans can be given.

The Hon'ble Pandit Jawaharlal Nehru (26) India's Prime Minister, has recently declared that India did not propose, after two years, to import food, no matter what happened, even if people died. In the light of the information recorded in this paper, it can be said with certainty that we can produce the increased quantity of food in the country, if a decision in this behalf is promptly taken by the Government and steps are taken to immediately implement the plans, as the monsoon is now only two months away. The most important measures capable of giving higher yields, and producing immediate results, such as seed of improved varieties, and application of manures and fertilisers, and the like, are known to Departments of Agriculture as well as to the rice growers who have been fully convinced of the importance of these as a result of the propaganda which it was possible for the departments to carry out with the help of grants and subsidies received from the Government of India under the Grow More Food Campaign. The chief difficulty has, however, been lack of full facilities for their adoption. P. M. Kharegat (28), former Vice-Chairman, Indian Council of Agricultural Reserch, and Secretary Department of Agriculture, Government of India, has recently indicated the drawbacks and impediments in the way of increasing food production, and if these are removed forthwith, we can certainly attain our goal in a period of 2 years prescribed by the Hon'ble Prime Minister.

In the light of the various points referred to in this paper, I therefore, strongly appeal to the Conference to pass a suitable resolution, urging upon the Government of India the immediate need to give their earnest consideration to the question of concentrating attention on the manuring of rice crop in view of its paramount importance in the solution of the present food crisis, by utilising all available resources of manures and fertilisers for this crop, and to take all possible steps to increase the supplies of manures for this purpose.

Conclusion: To conclude, various methods by which production of rice can be immediately increased, and the paramount importance of this crop in solving the present food crisis, have been dealt with, which indicate that if we have the will and if we

approch the problem in all earnestness, we can certainly achieve our object as mentioned by Dr. Salter, chief of the Bureau of Plant Industry and Soils, U. S. A. in the following paragraph

'If the people of the world really have the determination to give battle to the problem of hunger, if they are willing to extend a small part of the energy and capital poured into World War II, only then can we see hope of victory'.

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