12. PRESENT SITUATION OF FERTILIZER USE IN INDONESIA

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The amount of food that plants can produce is influenced by climatical factors over which man so far has been able to exert little control, and by a series of other factors that he has learned to control to a considerable degree. The latter include the genetic character to the plant, the protection of the plant against diseases and insects, the conservation and utilization of water, and the amount and availability of mineral nutrients.

Progress in manipulating the genetic characteristics and the control of pest in Asia has been so great that the yield potential is increasing and the gap between national average yields and potential yields is becoming larger. Water supply, however, is not the major factor limiting production in the large areas having a rainfall of 80 or more inches. Its efficiency of use needs to be increased by a combination of soil, water, and crop management practices.

Considering the fourth controllable factor influencing the plant as an energy-converting organism, we will discuss the following topics : limiting of yields by plant nutrients ; requirements for fertilizer ; consumption and production ; fertilization and management practices ; regional trials.

Limiting of Yields by Plant Nutrients.

Most of our rice soils are low to very low in one or more of the major plant nutrients. Many of the arable soils have been cultivated a long time with only small additions of plant nutrients in farm manures. Therefore, we would expect a good response of crops to chemical fertilizers. That such is the case has been widely demonstrated in field experiments, fertilizer demonstrations and in farm practice.

Data on fertilizer response for rice from 300 experiments on farmers fields in Java show a good response to nitrogen, an average return of 13 kg of milled rice per kilogram of nitrogen when applied at a rate of 30 kilogram per hectare. On the average, a good response to phosphate, 7.8 kg of milled rice per kilogram of phosphate, when applied at a rate of 30 kg P_2O_5 per hectare was obtained. The effectivenss of fertilizer in crop production is confirmed by statistics on fertilizer consumption. From 1951/1952 to 1961/1962 total fertilizer consumption increased from about 20,000 metric tons of plant nutrients to 150,000 tons, an increase of 750% in 10 years.

Research and farmer experience has shown that best returns are only obtained when fertilizers are used along with improved crop varieties, pest control and adequate soil moisture. Recent data show that at 60 kg per ha N, IR 5 gave almost 160% the response of the local variety. Furthermore, IR 5 responded to 120 kg of N, where as the local variety did not respond to more than 60 kg N per hectare.

It is utmost importance to recognize that high production requires the proper combination of input factors. A package of practices should be used including improved inputs. However, appropriate adjustments should be made as to kind of crops, sequence of crops and kind of soil. Since adequate moisture supply is essential for maxium benefits from the better varieties, heavier fertilization, and appropriate application of insecticides, the first areas selected should be served by good irrigation systems. Poor irrigation stimulates

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growth of weed, offering greater competition to the rice crop and reduce yield. The depressing effect of weeds on rice yield was demonstrated by one of the results of weed control experiments. Compared with the yield of unweeded plots which averaged about 2.3 ton milled rice per ha, an increase in yield of about 1.3 ton milled rice was obtained from plots where weed was controlled. The soil should be those deemed highly responsive to good management. The areas should be strategically allocated for the improved technology to other areas.

The following conclusions can be drawn from the agronomic data that has developed through previous research.

(1) Plant nutrients are one of the major limiting factor in agricultural production.

(2) A moderate rate of fertilization, 60 kg N or 60 kg N+30 kg P_2O_5 per hectare depending on fertilizer need of the soil will usually increase the yield of rice about 40 per cent.

(3) Improved varieties, pest control and good soil and water management practices will again increase yield by 40% with this fertilizer.

(4) High levels of fertilization, 100-180 kg nutrients per hectare, and high yields are only possible when the fertilizer is used on crops bred for use at high levels of fertility and disease and insect resistance.

(5) With the current varieties used where lodging, disease and insects are the limiting factors, 60 kg nitrogen per hectare will be the optimum rate. Data from insect control trials indicate that the controlled plots yielded 1.6 ton milled rice per hectare, plots which received poor spray yielded 2.7 ton per hectare while plots which received best protection yielded 3.8 ton milled rice per hectare.

(6) Under optimum condition during the dry season, IR 8 as well as IR 5 yielded more than 4.9 ton milled rice per hectare. However, the heavy incidence of bacterial leaf blight during the wet season prevented IR 8 to show its yield potential and yielded only 2.5 ton milled rice per hectare. Syntha, the local improved variety yielded 2.9 ton milled rice per hectare.

(7) Where phosphate is needed, one kilogram nitrogen only produce 10 kg milled rice. When phosphate is added, the response become 15 kg milled rice. For the local varieties the figures are respectively 7 kg and 10 kg milled rice per kg nitrogen, when applied at the rate of 60 kg nitrogen per hectare.

One ton of plant nutrients will produce about 5 tons of rice 18 million calories, enough to provide 20 people with 2400 calories per year. A fertilizer plant producing 2000 tons of nutrients per day would therefore provide about 15 million people with 2400 calories per capita per year.

Requirements for fertilizer.

Population projection indicate that the population is increasing at about 2.5 per cent per year and may increase by about 15 million people over the next five years. Table 1 shows the fertilizer needs for such a population increase.

The additional 750,000 tons of nutrients is about five times the maximum amount that has been available for use in Indonesia in any one year exclusive of plantation usage. The maximum fertilizer usage occured in 1962 which is about 150,000 tons nutrients. Indonesia has started indigenous fertilizer production in its ammonia urea complex located at Palembang, Sumatra with a rated capacity of the plant of about 50,000 tons of nitrogen per year. Assumed that in 1973 the acreage covered by rice is 7.5 milion hectare and 50 % of the area will be planted with improved varieties, the total need for fertilizers will be 375,000×100 kg is 375,000 ton nutrient.

Table 1. **Population increase and fertilizer needs over 1967-1968**

Year	Population increase over 1967-1968 in millions	Fertilizer needs over 1967-1968 level of consumption in tons nutrient
1967—1968	—	—
1968—1969	2. 9	145, 000
1969—1970	5. 8	290, 000
1970—1971	8. 8	440, 000
1971—1972	11. 9	595, 000
1972—1973	15. 0	750, 000

The estimated needs for the next five years would indicate that a ratio of 2 : 1 : 0 would be best for fertilizer needs for rice. By 1972 the total nitrogen required will be approximately 550, 000 tons of N, exclusive of plantation use.

Consumption and production.

Fertilizer consumption, excluded for plantation use increased from about 20, 000 tons of nutrients in 1951/1952 to about 150, 000 tons in 1961/1962 and decreased during the economic crisis in 1964/1965. Fertilizer usage in 1966/1967 of about 50, 000 tons nutrients has not as yet returned to its formal level. The Palembang Urea plant rated capacity is about 50, 000 tons per annum of nitrogen. It supplied about 25, 000 tons nitrogen in 1966/ 1967. With the 1972 total nitrogen requirement of 550, 000 tons of nitrogen, exclusive of plantation use, a deficit of 500, 000 tons will exist. To meet this needs, about 1, 000 tons per day additional urea production capacity could be justified, exploring the natural gas available in 40 oil fields spread in North Sumatra, Djambi, South Sumatra, West Java, Central Java, North East Kalimantan and the Western part of West Irian.

Planning should begin immediately to furnish phosphatic materials for production of phosphorus, which comprises one-third of the total fertilizer need. It could be accomplished by exploration of about 20, 000 tons of indigenous and importing phosphatic fertilizers either bagged or bulk.

Although no significant potassium deposits are known in the country, rocks containing mineral jarosite near Bandung gave a possible future source of potassium phosphate.

Fertilization and management practices.

The new high yielding rice varieties now coming into use gain more popularity among farmers. These, however, need different fertilization and management practices than those appropriate to the tall, late maturing local varieties. The fall, late maturing local varietes, bred at a rather low fertility level, they are suited for nitrogen application to a maximum of 30 kg/ha. Higher nitrogen application tends to cause severe lodging and reduce yield.

Data on the effect of nitrogen fertilization on grain yield show, that the yield of the new variety was essentially doubled by the use of 120 kg of nitrogen. In the dry season of 1967, with proper fertilization and management it gave yield of 7600-7800 kg/ha. To take full advantage of the yield potential of the new varieties, other management practices must be revised and adjusted. Transplanting at an earlier stage : 15—20 days is required for the new varieties. Weeding should be done early to avoid growth competition at early stage. To induce early tillering and rapid growth part of the nitrogen fertilizer should be applied prior to planting.

Time of application of insecticide is extremely critical and may represent the difference between adequate yield and serious damage. Bacterial blight was serious during the wet season, especially in plots which received high doses of nitrogen fertilizer. However, there is hope, that this disease can eventually be substantially controlled through the development of varieties with higher levels of resistance. The use of granular insecticides to control insect pest : stem borer, appears to offer good promise. No special equipment is required and application may be more rapid. Steep scopes or terraces need a special water management.

Regional trials.

The possibility of increasing the yield by the use of inorganic fertilizers has been under investigation from 1929. In addition to trials in the experimental stations, a number of trials were conducted in the farmers' fields over almost all soil types in which rice is cultivated. The results of such experiments for the year 1957/1958 give useful information regarding response to nitogen and phosphate individually and the increase in yield obtained by the application of both these nutrients. The abstracts of the results is given in the following table.

Table 2. Fertilizer response on the variety Bengawan in different soil types of Java during the wet season 1957/1958

Soil tyhe	Number of experiments	Yield unfertilized plots t/ha unhusked rice	Response kg/ha unhusked rice per kg nutrient at an application of :		
			40N	$20P_2O_5$	$40N+20P_2O_5$
Alluvial	8	2. 8	14. 0	19. 5	12. 5
Latosol	6	2. 0	12. 5	13. 0	12. 0
Grumusol	2	1. 9	10. 5	18. 0	11. 0
Podsolic	3	2. 6	10. 3	26. 0	9. 2
Regosol	4	3. 0	14. 0	8. 5	13. 1
Andosol	2	3. 4	13. 8	16. 0	13. 1
Average		2. 6	12. 5	16. 8	11. 8

Limited data on 1959/58 experiments gire the following indications :

Except in Regosol (young volcanic ash), where phosphate did not give as high response as nitrogen, in other major rice areas comprising the alluvial, latosol, podsolic and andosol, significant responses to both nitrogen and phosphate individually are obtained indicating that both these nutrients are necessary for fertility requiremets. Previously it was considered certain large areas covering more than one million hectares were only deficient in phosphate and the addition of only phosphate fertilizers were necessary for these areas. From the table it is clear that in no soil type, phosphate alone is needed. Later data show that in latosol, regosol, alluvial and low humic gley, nitrogen give a significant increase in yield. On latosol, addition of P_2O_5 increase the response to nitrogen.

In this connection it is important to relate the results of these trials to the type of soil. Soil survey work was first started in Indonesia as early as 1927. In view of the recent advances in the field of soil survey, the whole basis of earlier classification was revised according to the recent International Nomenclature.

Considering the urgency of the food position, the results are of sufficient value for practical application to enhance the rice production in the country. On the basis of 300 experiments conducted during 1957 untill 1965, it is seen that the addition of 30 kg nitrogen, (30 kg $N+30$ kg P_2O_5) and (60 kg $N+30$ kg P_2O_5) give an increase of 22 kg, 13 kg

Table 3. **Increase of unhusked rice in Kg per Kg nutrient and price of nutrient*)**

Fertilizer applied (kg/ha)	Increase kg unhusked rice per kg nutrient	Price of nutrient :	
		Average kg nutrient Rp	Total Rp
30—0—0	22	60	1, 800
30—30—0	13	57	3, 420
60—30—0	13	58	5, 200

*) One kilogram Urea, containing 46% N is Rp 27.50 and one kilogram Triple Superphosphate, containing 48% P_2O_5 is Rp 25.00

and 13 kg of unhusked rice respectively per 1 kg of nutrient applied. Based on the price of Urea which is Rp 27.50 per kg, TS is Rp 25.00 per kg and rice (milled rice) is Rp 30.00 per kg and the exchange rate of rupiah is Rp 350.00 for U. S. $1.00 or about Rp 1.00 is equal to ¥1.00. At the current price prevailing, the value of 30 kg N per ha will be Rp 1, 800 for an additional return of Rp 11, 700 as milled rice, which mean a profit of about Rp 10, 000 to the farmer. The import of the needed fertilizer would improve not only the financial resources of the farmer, but also the foreign exchange position of the Government. To meet the rice deficit in terms of import of 600, 000 tons of rice, the foreign exchange needed is equal to Rp 18,000 million. To get this increase by the use of fertilizers, it would need only Rp 4, 400 million. The Government can thus save more than 75 per cent of the foreign exchange.

If the whole harvested rice area of about 6 million hctares is to be given the fertilizer : 30 kg N+30 kg P_2O_5 per ha, it would mean an increase of production by 2. 4 million tons of rice. If also, the varietal position is improved by the spread of the new varieties, it would yield in an increase of another 1 million tons of rice. The spread of improved varieties may however take time in view of the present need for the improvement in the seed distribution program. Immediate attention is therefore required for the import of fertilizers.

To maintain and extend the current system of regional trials, experiments are underway including comparisons of standard and new varieties, as well as fertilizer response. The fertilizer response trials include a range of N applications to determine optimum response for each variety in the major production areas.

Discussion

S.P. **Chee**, Malaysia : I believe you have received the Malaysia sister of IR 5 (known as Bahagia). Have you had the opportunity to compare the Malaysian sister of IR 5 to that of the IRRI sister of IR 5 in their prformance?

Answer : It is under test. The grain quality appeared beter than that of IR 5. As soon as we find enough seed and promise, it should be put on regional adaptability test.

A. **Tanaka**, Japan : I understand that there are soils with pH above 7 in East Java. Is the effect of urea on such high pH soils as good as that on low pH soil?

Answer : If there is any indication based upon experimental results, we should like to specify.

H. **Nakayama**, Japan : You said that in page 6 transplanting at an earlier stage 15—20 days compared to 30 days is required for its early maturing period. Let me know about this reason.

Answer : What I mean is : For IR 5 with 135 days maturity period requires youngest seedlings (15-20 days), compared with the local varieties with 145-155 days maturity period.

A. Tanaka, Japan : Is there difference in phosphorus response between indicas and bulus ?

Answer : The result of one of our experiment indicated the presence of significant interaction. The Indica gives a better response to phosphate than the bulu.

A. Fujiwara, Japan : Why do you use triple superphosphate as phosphatic fertilizer? How do you think ammonium phosphate ?

Answer : Triple superphosphate has higher P_2O_5 content (48%) compared with the others. It saves cost of transportation and storage. Field trials results give the same effectiveness as the others (single superphosphate).

T. Mizukami, Japan : Did you find Bacterial Leaf Blight Diseas resistant varieties in Indonesia ? If you find them, please let me know the name of the variety.

Answer : The local varieties generally show a better tolerance. Screening tests of lines/varieties included those from IRRI are under way. We would be glad to give you the results of the varieties.

K. Kawagushi, Japan : How many per centage of rice plant residue is returned to a field now in your country ? Has it been increasing or decreasing in recent years ? How ab out in near future ?

Answer : We could not give the exact figure but as far as the mateiral is available and labor is sufficient, farmer uses organic matter (straw) into his field. There seems to be a reduction in its use, also in the near future. They rather burn the straw in the field.

S. H. Hsu, China : What is the most popular nitrogenous fertilizer of rice in your country at present ?

Answer : Urea replaced the lower nitrogen containing fertilizer ; ammonium sulfate field trials indicate the same efficiency and urea saves cost of transport and storage,

S.C. Hsu, Chin : You said that plant nutrients are the major limitimg factor in agricultural production. What kind of nutrients is most important limiting factor in your agricultural soil ?

Answer : Nutrient is one of the limiting factors. In Indonesia most soils are lacking in nitrogen. Phosphate could increase the response to nitrogen.

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