2. FERTILIZER RESPONSE OF NEW RICE VARIETIES IN MALAYSIA

CHEE SEK PAN*

Introduction

Up till about 1960, with the popular traditional varieties, the position of rice yield responses to fertilizer applications was a rather perplexing matter in west Malaysia to the agricultral workers (both local and overseas) then working on the problem. The knowledge for tropical conditions was, of course, very much lacking at that time compared to what is known today. With present day knowledge this rather perplexing state of affairs is now quite understandable. This is so, because it has now become clear that although the performance of yield response to fertilizer application is a complex matter governed by a number of requirements, the first requirement that must be satisfied is that the plant has the genetical potential to respond with high yield before other input requirements can be effective in playing their role.

Background

Among the rice growing countries in South East Asia, the yearly average rice yields in West Malaysia were reported by F.A.O. to be about the highest in the region. These yields referred to the popular traditional varieties. In the major good rice areas of the conutry, many of these varieties have consistently been producing an average yield of around 2,500 to 3,000 lb./ac. without the use of any fertilizers. But it was observed that these popular traditional varieties in West Malaysia had, in general, given rather disappointing yield responses when fertilizers were used.

This position was of much concern in the early years following 1960 to both local and overseas workers tackling the problem when the country started to embark on programmes of utilizing more fertilizers in rice production. Consequently, there was much speculation as to what was really responsible for holding back the performance. Without the knowledge and eventually the new varieties we have to-day, it was not surprising that the majority of workers attributed the cause more towards problems connected principally with management practices of soil/water/fertilizer rather than towards problems of the genetical potential of the varieties then available.

With such an interpretation strongly argued by some quarters, the important issue as to what direction research work should be emphasized was brought to the forefront. It was not easy to sort out the position at once because of the many gaps of knowledge still existing then. Nevertheless, the facts had to be settled before the country could be certain of the research emphasis to which the limited resources could be utilized to the best advantage.

Research Results Uncovering Low Potential of Popular Traditional Varieties

In the next few years that followed from 1960, research work in West Malaysia concentrated on resolving the issue of the disappointing yield response to fertilizer application. The work that was done over this period gradually unfolded the position. It

* Senior Agronomist and Head of Rice Research Unit, Rice Research Centre, Bumbong Lima Department of Agriculture, Penang, Ministry of Agriculture, West Malaysia

Table 1. Relation between fertilizer level and varietal response of 4 popular traditional varieties.

Fertilizer level (lb/ac)	Average grain yield lb/ac (3 seasons 1960/62)			
	Siam 25	Subang Intan 117	Radin China 4	Radin Ebos 33
0 : 0 : 0	2,645	3,298	3,075	3,097
45 : 45 : 45	2,704	2,978	2,854	2,780
90 : 90 : 90	1,949	2,687	2,356	2,056

became more and more definite that what was principally responsible for limiting yield response to fertilizer yields in West Malaysia was a varietal limitation rather than the question of improper management practices of soil/water/fertilizer. Nevertheless, the question of management has always been recognized as being important and will be more and more so as the genetical potential for high yields keeps improving.

Among the many research findings, a typical example of varietal limitation is given in Table 1 and illustrated in Figure 1. Here 4 popular traditional varieties under 3 levels of fertilizer treatment were grown in a relatively good class of soil generally found in the west coastal plain of West Malaysia. From the graph, it can be seen that all the 4 varieties gave relatively good yields at the O fertilizer level. But when fertilizer levels were

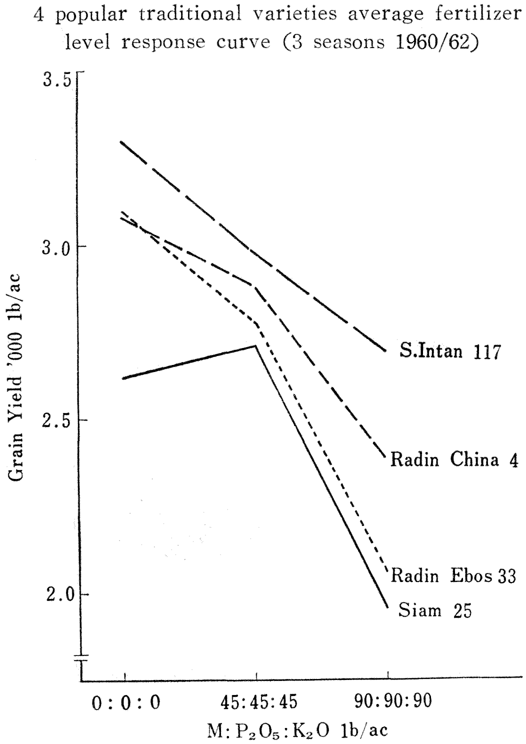


Fig. 1. Illustrating a typicul case of disappointing response to fertilizer levels with the popular traditional varieties.

Table 2. **Showing nature of varietal limitation in yield response and lodging % by a popular traditional variety under a fertility improving rotational system compared to a non-rotational system.**

Cropping system	Average grain yield (lb/ac)			
	1960	1961	1962	1963
Non-rotation padi/Padi	2,768(0%)	2,749(5%)	3,193(0%)	2,855(30%)
Rotation padi/Other crops	3,744(0%)	3,217(75%)	3,617(97%)	2,915(100%)

increased, the yields started to drop early. The explanation for this was the fact that these varieties responded with marked vegetative growth which eventually led to severe mutual shading, and finally, to heavy lodging. Unfortunately, as recently as up to about 5 years ago, such type of results by itself was not recognizable as a varietal limitation. Rather, arguments at that time, strongly attributed the situation of improper management practices of soil/water/fertilizer complex.

With management practices designed to build up soil fertility, it became obvious that after an inital increase in yield up to a certain level, a low potential variety would fail to respond further and would instead exhibit more and more lodging and eventually a tendency to decrease in yields. Such a situation is given in Table 2 and well illustrated in Figure 2, where a popular traditional variety, such as Radin China 4, was tested. Under

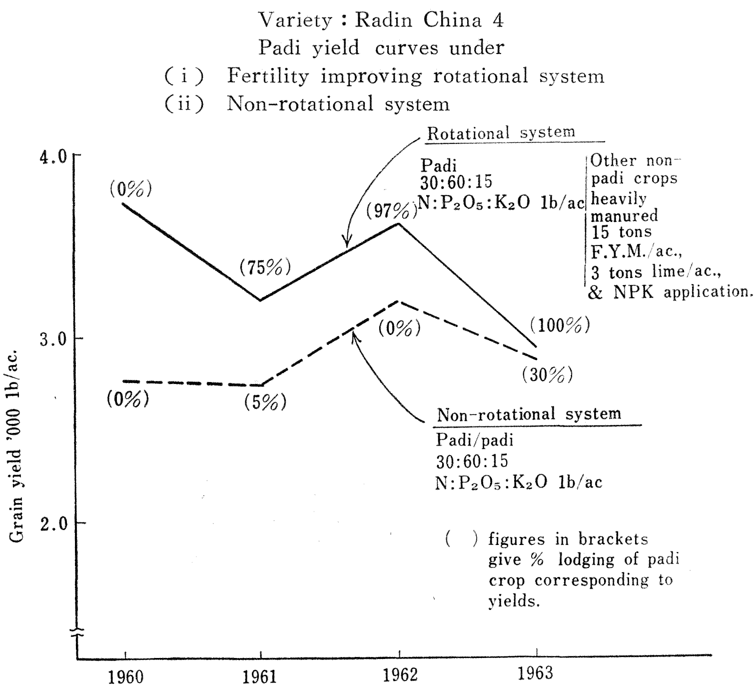


Fig. 2. **Illustrating the low potential of a popular traditional variety limiting yield increases above a certain level with soil fertility built up in a rotational system, which led to severe lodging and consequent check in yields.**

Table 3. **Showing nature of yield decreases with 2 popular traditional varieties having limited genetical potentials with increasing N under 2 sites of fertile coastal soils.**

N Level (lb/ac) at P_2O_5 =90 lb/ac & K_2O =90 lb/ac	Average grain yield (lb/ac)	
	Radin Puteh	Pebifun
0	3, 110	3, 072
30	3, 060	2, 961
60	2, 664	2, 554
90	2, 475	2, 005

the rotational system the padi crop alternated with other non padi crops which received heavy manuring of 15 tons farmyard manure per acre plus 3 tons lime per acre plus a heavy dose of inorganic NPK fertilizers appropriate to the crop. Both the padi crops under the Rotational System and Non-Rotational System received $30N : 60P_2O_5 : 15K_2O$ lb/acre during their growth. From the graph, it can be seen that the padi crop under the rotational system where soil fertility was rapidly built up, gave an initial jump in yield, but after which severe lodging set in and further yield increases were checked in comparison to the lower yields of the padi crop under the non-rotational System. Such results

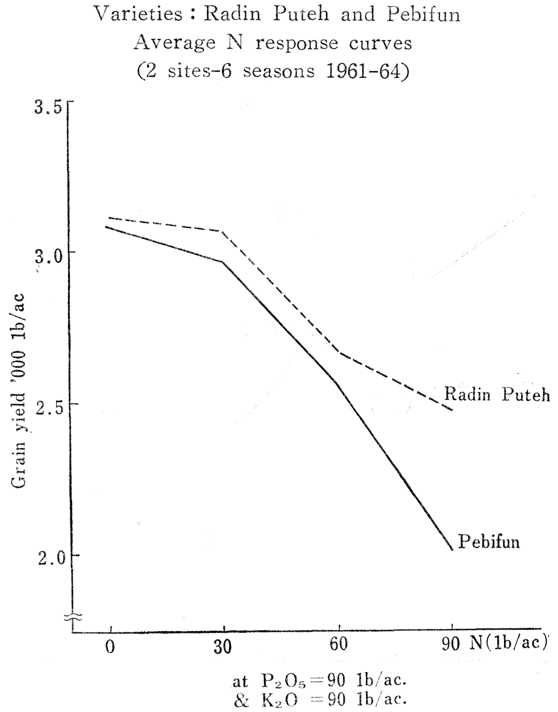


Fig. 3. **Illustrating the general trend of varietal limitations by 2 popular traditional varieties with increasing N fertilizer application under 2 fertile sites.**

as shown in Figure 2 together with those seen in Figure 1, gave the early clue that what was limiting yield response to increased fertility either through fertilizer application or a fertility improving rotational system, was in fact a varietal limitation which is characteristic of all the popular traditional varieties.

A further typical evidence of varietal limtation in yield performance with increasing levels of N fertilizer application is presented in Table 3 and illustrated in Figure 3. In

Table 4. Showing yield responses to 3 levels of N application by 3 new non-photoperiod sensitive hybrids compared to Pebifun under an average soil condition.

N level (lb/ac) at P_2O_5 =60 lb/ac & K_2O =30 lb/ac	Average grain yield (lb/ac) (5 sites-1 season 1965)			
	Malinja (DC 4)	DC 5	Mahsuri (DC 7)	Pebifun
0	2,086	2,239	2,635	2,000
30	2,565	3,084	2,869	2,400
60	2,408	3,604	2,501	2,168

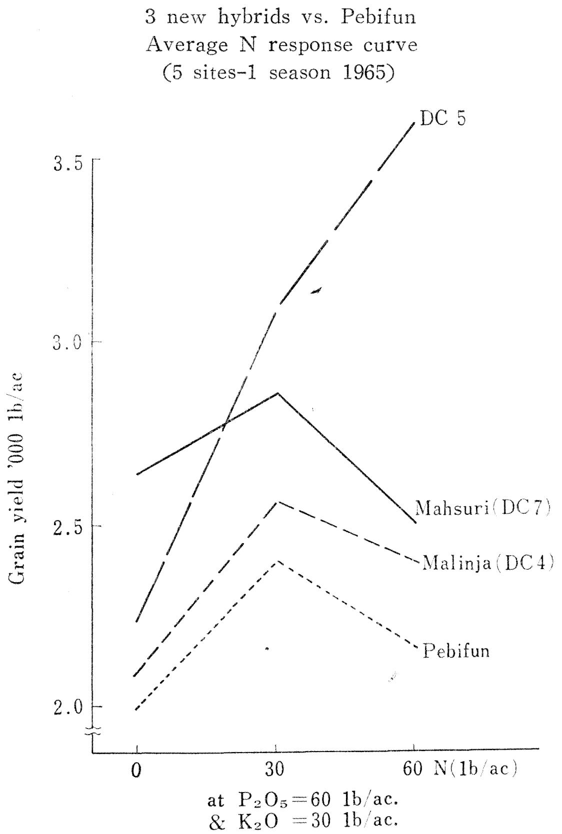


Fig. 4. Illustrating higher potential yield responses to 3 levels of N application with the new hybrid lines compared to Pebifun under an average soil condition.

this case, the popular traditional variety was Radin Puteh, and the variety Pebifun was the only non-photoperiod sensitive variety then used in the off-season double cropping areas. The story was similar to the earlier ones recounted here. From such findings, the deduction that varietal limitation was principally the cause for the disappointing yield responses to fertilizer applications, later gained support and conformation with the introduction of new hybrid varieties through Malinja, Mahsuri, Ria, and Bahagia.

Discovering Higher Potentials of New Rice Varieties

With the rapid development of more drainage and irrigation schemes in West Malaysia to increase double cropping of rice, greater attention became focussed on finding new varieties which are now season fixed and hence capable of being double cropped in order to replace the then only non-photoperiod sensitive variety, Pebifun which was the only variety used to any large extent for double cropping in the off season. The urgency to do so was due to the fact that Pebifun was not a particularly good yielder and had the added disadvantage of rather poor grain quality and developing susceptibility to blast attack.

Higher yield potentials began to show up with the first batch of new hybrid lines. The first group that was tested widely contained DC 4, DC 5, and DC 7. DC 4 was released as Malinja on 22 nd February 1964 ; DC 5 was not released because of poor grain quality ; while DC 7 was released as Mahsuri on 1st January 1965 in West Malaysia. With this new batch of hybrids yield response potentials became apparent as given in Table 4 and illustrated in Figure 4. Although a higher yield response potential was demonstrated by these hybrids, under average soil condition, these hybrids were only generally consistent up to about 30 lb.N/ac. The only exception was DC 5 which had a short stature and rather resistant to lodging, but its grain quality was unfortunately not acceptable. For reference, a summary of the characteristics of these new hybrid varieties are provided in Table 5. In respect of the DC hybrid varieties, the inintial hybridization was

Table 5. Varietal characteristics of new varieties.

Item	Malinja	Mahsuri	Ria	Bahagia
Strain	DC 4	DC 7	I R 8-288-3	I R 5 (Sister line)
Parents	Siam 29 × Pebifun	(Taichu 65 × Mayan Ebos 80) × Mayang Ebos 80	Peta × Dee-geo-woo-gen	Peta × Tangkai Rotan
Maturation	130—135 days	135—140 days	120-125 days	135-140 days
Average fertilizer	N30, P60, K25	N40, P60, K25	N90, P60, K30	N60, P60, K30
Spacing	12′′ × 12′′	12′′ × 12′′	8′′ × 8′′	12′′ × 12′′
Culm height	110cm	90—100cm	61-62cm	84cm
Panicles	15—18	15—18	20-25	14-17
Potential Yield per acre	3, 500 lbs/ac.	3, 8000 lbs/ac.	5, 000lbs/ac.	4, 500 lbs/ac.
Diseases	Blast susceptible	Blast susceptible	Moderate resistance to virus, Susceptible to blast	Moderate resistance to virus and blast
Others				
	Lodges at 45 lbs. N/ac.	Lodges at 60 lbs.N/ac.	Non-lodging	Non-lodging
	Rice-acceptable	Rice-acceptable	Rice-less preferred	Rice-acceptable

carried out in Cuttack, India, under the International Rice Commission Hybridization Project. The second generation seeds were received in West Malaysia in 1956. The selection and testing until their release were carried out in West Malaysia by Japanese Colombo Plan Experts and their Malaysian counterparts.

In view of the developments that had taken place so far, Malaysian workers had become fully aware that although the performance of yield response to fertiliser application was a complex matter governed by a number of requirements, the first requisite that must be present was that the variety had the genetical potential to respond with high yield before other input requirements could be effective in playing their part. At this stage, the country had been receving many breeding lines from the International Rice Research Institute, Philippines, and subjecting them to selection and yield performance trials.

The IRRI line IR 8-288-3 was soon identified in West Malaysia to have outstanding genetical potential to respond with high yields when it was grown under good agronomic

Table 6. Showing the yield performance by Ria under different levels of fertilizer application at the Field Day to mark its release on 12th August 1966.

$N : P_2O_5 : K_2O$ (lb/ac)	Grain yield (lb/ac)
60 : 30 : 15	4, 505
90 : 30 : 15	5, 315
120 : 60 : 30	6, 018
180 : 60 : 30	6, 074
180 : 120 : 60	6, 725

Table 7. Showing high average grain yields to application of NPK by the variety Ria averaging over 27 sites for 3 seasons 1967/68.

N(lb/ac) at P_2O_5 =120 lb/ac & K_2O = 90 lb/ac	Average yield (lb/ac)
0	3, 137
60	3, 969
120	4, 322
180	4, 255
P_2O_5 (lb/ac) at N =120 lb/ac & K_2O = 90 lb/ac	
0	4, 199
60	4, 295
120	4, 322
at N =120 lb/ac & P_2O_5 =120 lb/ac	
0	4, 001
45	4, 197
90	4, 322

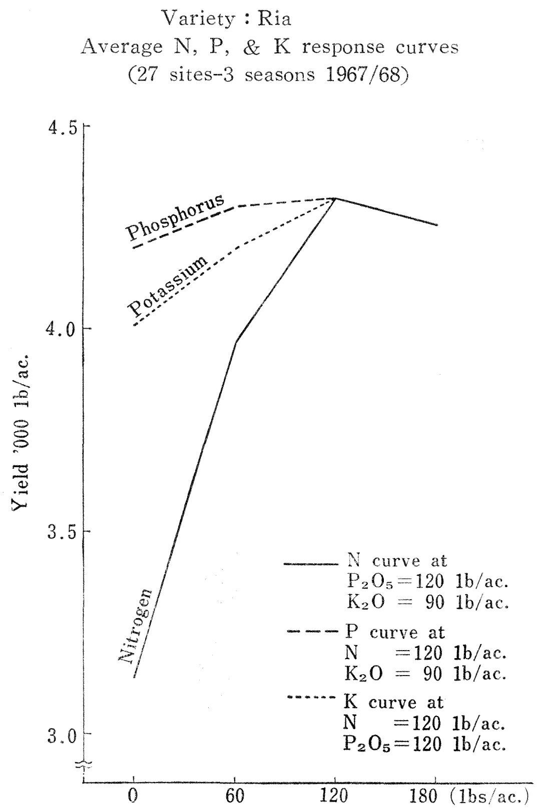


Fig. 5. Illustrating the high average grain yield response curves of NPK by the variety Ria which has shown to have a high genetical potential yield performance under good growing conditions in West Malaysian conditions.

conditions with all the necessary inputs. Owing to the exceptional performance of this IRRI line, a decision was taken to release it as a variety before it even became a variety in the Philippines. On 12th August 1966, the release was made in the presence of the Director of IRRI, Dr. F. Chandler, and the Breeder, Mr. H. M. Beachell. The line became known in Malaysia as Ria. From the field demonstration on the day of the release, the public witnessed the harvest and measurement of the yield of the crop. Table 6 gives the results at this field demonstration.

However, the average yield responses for Ria is given in Table 7 and illustrated in Figure 5. It is obvious with this variety that it has a high genetical potential in yield response and, therefore, confirms that all previous varieties were rather low in this respect. Its varietal characteristics are given in Table 5. The variety serves its best purpose in re-orientating the thinking of all those concerned with improving rice yields, although it is by no means a perfect variety as it can still be improved on, particularly, in rice quality and more resistance to insect pests and diseases.

The latest variety released in West Malaysia on 5th September 1968 is known as

Table 8. Showing high average grain yields to application of NPK by the variety Bahagia averaging over 16 sites for 1 season 1968.

N (lb/ac) at P_2O_5 =80 lb/ac & K_2O =60 lb/ac	Average yield (lb/ac)
0	3, 559
40	4, 147
80	4, 298
120	4, 227
P_2O_5 (lb/ac) at N =80 lb/ac & K_2O =60 lb/ac	
0	4, 215
40	4, 314
80	4, 298
K_2O(lb/ac) at N =80 lb/ac & P_2O_5 =80 lb/ac	
0	4, 209
30	4, 299
60	4, 298

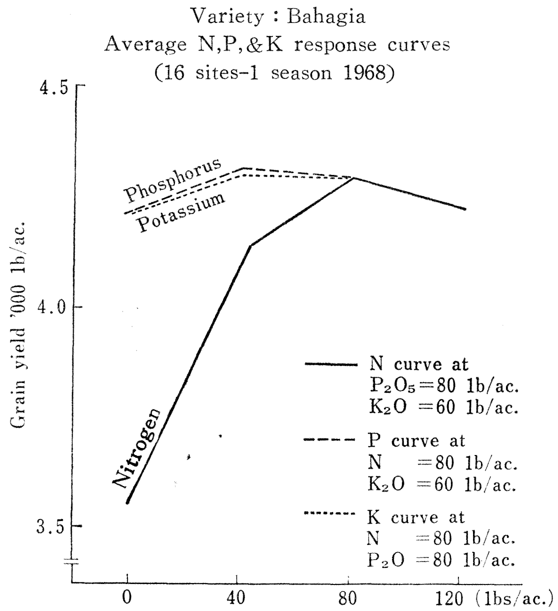
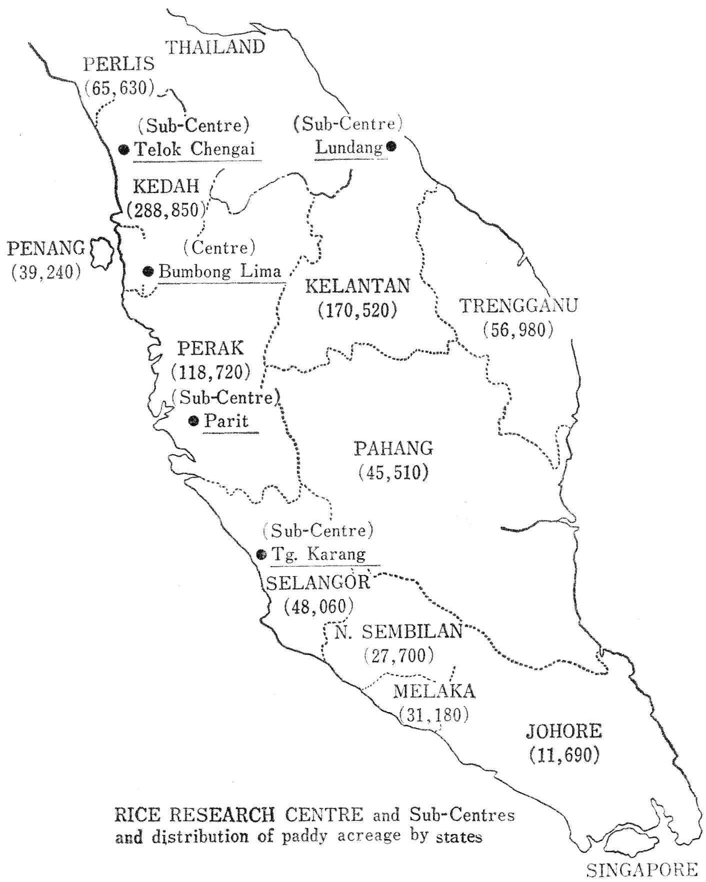


Fig. 6. Illustrating the high average grain yield response curves of NPK by the variety Bahagia which has shown to have a high genetical potential yield performance under good growing conditions in West Malaysian conditions.



RICE RESEARCH CENTRE and Sub-Centres and distribution of paddy acreage by states

Bahagia. This variety has better grain quality than Ria and has the further advantage that it is more adaptable to deeper fields because of its taller height, although its yield potential under good growing conditions is slightly below Ria. The variety is a sister line of IR 5 relesed in IRRI. It was selected under Malaysian conditions from the early segregating material sent over from IRRI. The selection was carried out by Japanese Colombo Plan Experts and their Malaysian counterparts. The average yield responses to NPK is given in Table 8 and illustrated in Figure 6. It is obvious from its performance, it has a similar yield potential compared to Ria. Its varietal characteristics are given in Table 5. This variety is expected to be widely grown because of its good adaptability to a wider range of soil and water conditions.

Conclusion

Yield responses to fertilizer applications in west Malaysia have made marked improvements in recent years with the use of new varieties which have much higher genetical yield potentials compared to the popular traditional varieties. This situation will no doubt keep improving with assistance from overseas organisations to the Rice Research Unit in West Malaysia. The improvements that have been obtained in Malaysia represents the cooperative efforts from both local and overseas contributions. The geographical locations of the centre and sub-centres of the Rice Research Unit are shown in the map of West Malaysia attached.

The Rice Research Unit of the Department of Agriculture, West Malaysia is responsible for research and development of rice and rotational crops in relation to the rice areas of West Malaysia. The Unit has its Coordinating Centre at Bumbong Lima in the Penang State with a double-cropping acreage of 35,000 ac. out of 40,000 ac. Linked to this Coordinating Centre are 4 major Sub-Centres located in the important rice growing areas which are concentrated towards the northern half of the country. The locations of the coordinating and the sub-centres are in the States where major infra-structures of irrigation and drainage are already provided or about to be provided to enable doubl cropping.

Discussion

Y. Murata, Japan : Do you have any experiments in which lodging was prevented by some measures and still varietal limitations for N-response of old varieties was seen?

Answer : There is no experiments in which lodging vareity is suppored to prevent lodging like what was reported by IRRI, but deductions made from seasonal lodging of varieties, together with the data reported from IRRI, indicated that these lodging varieties were limited in N-response because, even before natural lodging took place, mutual shading would have already limited the yields.

S. Matsuhima, Japan : Is there any variety which is suitable for only double cropping or any variety which is suitable for only mono-cropping?

Answer : As the short-term varieties released e.g., Mahsuri, Ria, and Bahagia, which are non-photoperiod sensitive, are suitable for double-cropping. All the varisties can be mono-cropped, but the most suitable one in a given locality depends on planting season and water-depth.

Soebijanto, Indonesia : What would be the limiting factor that your average figures on yield of Ria did not reach 6.0 ton/ha?

Answer : This average figures represent yields obtained over sites of varying soil and water conditions. Both can be limiting, but with the short stature of Ria, water depth was probably more limiting.