USE OF HIGH-YIELDING RICE VARIETY IN MALAYSIA

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INTRODUCTION

DEVELOPMENT OF modern high-yielding varieties (HYVs) of rice such as IR8 and IR5 from the International Rice Research Institute (IRRI), Los Banos, Philippines and Mexican wheat varieties came at a time in the mid-1960s when many developing countries particularly those in Asia, had an acute food problem. Through HYVs these nations saw a bright prospect for increasing farm income, attaining self-sufficiency in food, and even earning precious foreign exchange through food export. They also saw the clear possibility of producing food at low cost so that the cost of living could be kept at relatively low levels. These in turn, it was visualized, would greatly help economic and social development. The arrival of HYVs was proclaimed as the beginning of the "green revolution." Since then HYVs have helped to increase food production and farm income. Nevertheless, the achievements of the "revolution" fell far short of the expectations. Yield performance of HYVs on farms, for example, has generally been far below potential. Also, not all farmers have been able to adopt HYVs and benefit from them. It is now widely accepted that the opportunities offered by HYV technology for social and economic development have not been fully realized. Hence it is desirable that an attempt be made to examine and understand the causes of variations in yield performance and adoption of HYVs on farms so that it will eventually be possible to devise suitable remedies for exploitation of developmental opportunities offered by the new technology. Realizing this necessity, researchers have carried out numerous studies and from their work we are beginning to understand why HYV technology has not given its expected yielded results. But there are still large, unexplored problem areas in this field which require study. This case study from Malaysia is an attempt to move in that direction.

The paper is broadly concerned with the determinants of HYV adoption. But the emphasis is not so much on factors which lead to adoption but on factors

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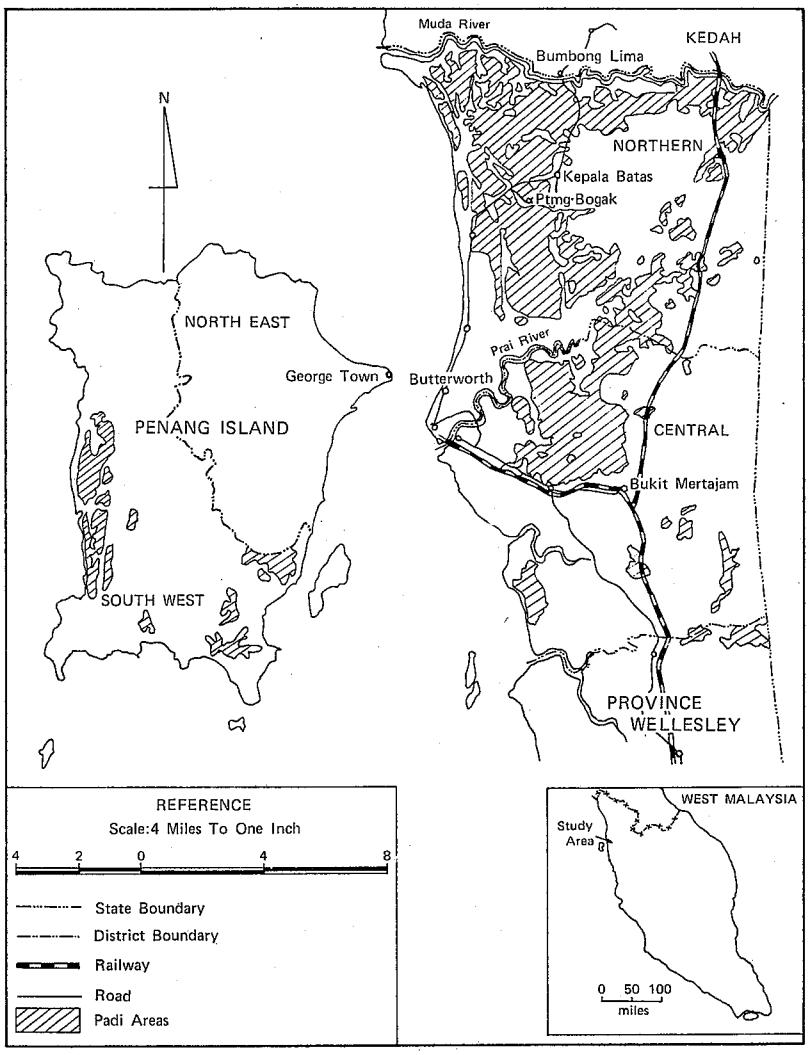
responsible for subsequent rejection or discontinuation of adopted HYV. It is based on an interesting case observed in West Malaysia where in a short period of time an overwhelming number of farmers adopted HYV for padi (paddy) cultivation but a substantial proportion soon stopped growing it and went back to old varieties. By analyzing this case we may learn some useful lessons. This study was made in Penang State, Permatang Bogak Village. Permatang Bogak is a double-cropped padi village in Province Wellesley. An evaluation made on the basis of selected key socioeconomic indicators suggests that Permatang Bogak is probably a representative village in the region. The period for the case study is from 1968 to 1972, but appropriate references are made to other years also.

Fig. 1. Penang State: Padi Areas and Permatang Bogak Village



I. THE PROBLEM

Before the arrival of modern HYVs, Mahsuri was the most popular variety of padi grown in the region. It was locally developed and was first used in early 1965. Owing to its moderate yield capacity under widely varying field conditions and good taste of the rice, Mahsuri is still popular with both producers and consumers. IR8, locally called Ria and put out for use in 1966, was the first IRRI variety in Malaysia. In spite of its high-yield, IR8 was a flop. Among other drawbacks were the fact that (1) it required more precise field conditions than were generally available, (2) made for higher labor and seed costs, and (3) low prices owing to its low quality and inferior taste. The next high-yield IRRI variety developed in late 1968 was IR5, locally called Bahagia, IR8, and IR5 have almost identical yields [6, p. 1]. However the new variety IR5, was more popular than IR8, because IR5 (1) did not require as precise field conditions as IR8 and was suitable for more farms, (2) required less seed and labor inputs, (3) was relatively easy to harvest and thresh, and (4) was long-grained and better tasting than IR8[1] As a result of these characteristics, and other factors which will be discussed later, IR5's popularity rapidly increased. Within only three years, about eleven thousand acres or 30 per cent of the total padi area in Penang State was using IR5 (Table I). During the same period in the village of Permatang Bogak, as Table II shows, 82 per cent of our sample of 44 farmers (total population: 105 farmers) had adopted HYV.[2]

TABLE I

AREA PLANTED WITH IR5 IN PENANG STATE

Crop Season and Year*	Acres	% of Total Padi Acreage
Main season 1969–70	4,836	12
Off season 1970	n.a.	—
Main season 1970–71	8,500	22
Off season 1971	10,772	29
Main season 1971–72	5,912	16
Off season 1972	4,680	14

Source: Annual reports of the Penang State Department of Agriculture.

* There are two padi crop seasons in Penang State. The off season is from February to July, and the main season is from August to January.

[1] Padi varieties introduced in Malaysia in addition to IR5 (Bahagia) were Murni (a cross between IR8 and IR5) in March 1972, and Jaya (C4-63) in January 1973. These varieties will not be discussed here since they were introduced at times other than the period of this study.

[2] Tables I and II show that the adoption rate for IR5 followed the characteristics S-curve pattern. Ryan [16], Griliches [8], Lockwood, Mukherjee, and Shand [11], Barker and Anden [1], and others have reported similar adoption patterns from different countries for new seed varieties. Basis for such a pattern is discussed by Lionberger [10] and Rogers [14] among others.

TABLE II

RATE OF ADOPTION OF IR5 BY THE 44 SAMPLE FARMERS OF PERMATANG BOGAK VILLAGE

Crop Season and Year	Adopters	
	Number	%
Off season 1968	2	4.5
Off season 1969	18	40.9
Off season 1970	14	31.8
Off season 1971	2	4.5

Note: IR5 was not grown in main seasons.

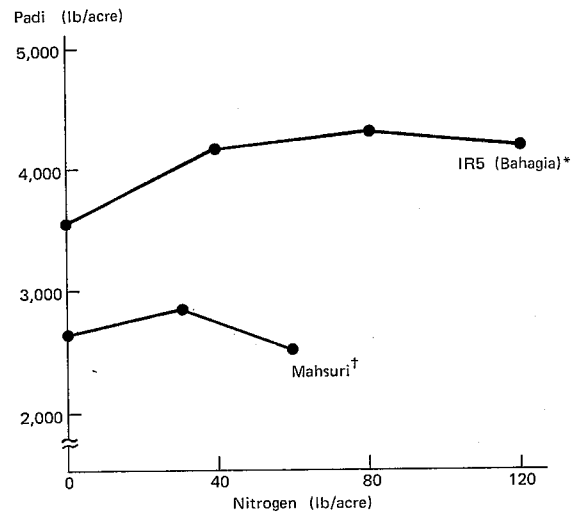
However this rapid and large-scale adoption of IR5 not only came to a halt but reversed. Soon after the off season of 1971 there occurred an absolute and proportionate reduction in IR5 acreage in the state as shown in Table I. In Permatang Bogak Village, on the other hand, by the off season of 1972 when fieldwork for this study was being carried out, 64 per cent of adopters had discontinued IR5. Only the remaining 36 per cent wished to continue growing HYV in the future. Those who discontinued HYV reverted to Mahsuri, a variety farmers used to grow, and other unofficial padi varieties which did not possess high-yielding potential of IR5.[3] Notwithstanding the fact that some IR5 adopters were still planting it, an important question was: Why did a large percentage of adopters discontinue HYV? A main objective of this paper is to answer that question.

II. ANALYTICAL FRAMEWORK

A basic assumption in analyzing the adoption and subsequent discontinuation of HYV in this study is that the farmer aims to maximize profit. He will adopt HYV if it helps him to make greater profit. Research data from West Malaysia on padi yield to fertilizer input show that the production function of IR5 is "superior" to Mahsuri (Figure 2). This means that unit cost of padi production will be low by using IR5 which, when other things remain constant, shall result in greater profit. Success in exploiting the high-yielding potential of IR5, as exemplified in Figure 1, is a key to adoption and continued use of that type. Therefore its yield performance vis-à-vis Mahsuri, will be examined. Further, relative profitability of IR5 is related not only to yield but also to changes in price of input and output. Because factor-product prices can change in a manner that may adversely affect the relative profitability of IR5, causing a discontinuation of HYV. We therefore propose to examine changes in factor-product price as well. For the sake of convenience in explaining adoption and discontinuation of IR5, it is planned to first consider factor-product prices. Next, the yield

[3] Yield data for the 1969–72 period, however, show that there was no decline in overall padi yield per acre in Penang State. In fact, main season yields remained constant and off season yields increased. If not for the abandonment of HYV, there would have been greater gains in yields in the state.

Fig. 2. Yield Responses of IR5 (Bahagia) and Mahsuri Padi Varieties, West Malaysia



Source: [5, p. 7] [10].
* P_2O_5=80 lb/acre, K_2O=60 lb/acre: 16 sites, one season 1968.
† P_2O_5=60 lb/acre, K_2O=30 lb/acre: 5 sites, one season 1965.

performance of IR5, and finally selected economic and social characteristics of farmers that affect the yield and continued adoption of HYV will be examined.

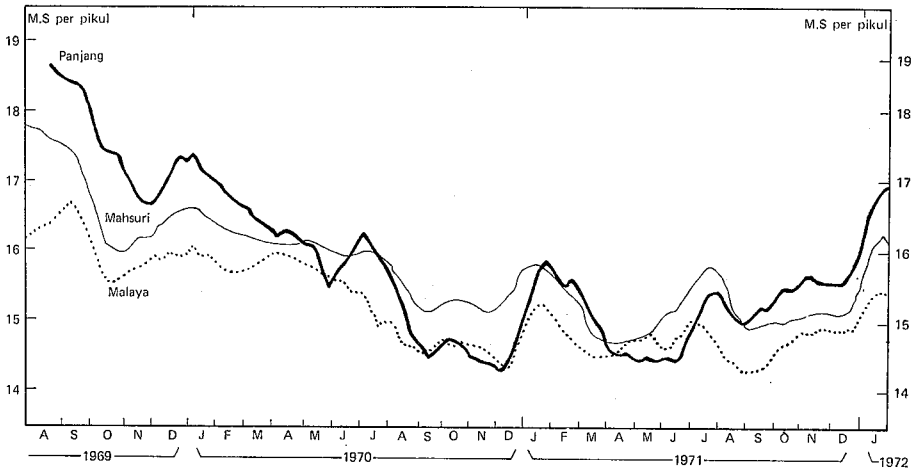
Terminology: Any farmer who planted IR5 on whole or part of his farm is called an *adopter* in this study. The adopter who discontinued HYV will be called a *discontinuer,* and the one who continued to grow it will be called a *continuer.* The farmer who never took to IR5 will be referred to as a *non-adopter.*

III. PADI PRICES

Figure 3 shows the average weekly farmers' prices for padi during 1969–72 in Penang State. It is based on data compiled by the Federal Agricultural Marketing Authority: National Padi and Rice Authority.[4] Price data were available separately for three varietal types of padi, namely, padi *panjang,* padi Mahsuri, and padi Malaya. IR5 being a long-grained variety, it falls in the *panjang*

[4] The monetary unit in this study is the Malaysian dollar (M$), and weight of rice is expressed in pikul which is a local unit of weight equal to 133.33 lb. During the period of this study, the government guaranteed a minimum price (GMP) scheme for padi. Under the scheme a farmer with "padi not more than 13 per cent moisture content, free of dirt, empty grains, husk, straw or other foreign matter, and having the grains fully matured," and delivering it at a government authorized rice mill will receive GMP of M$16 a pikul. But if padi supplied by a farmer did not meet specifications GMP is appropriately lowered. This accounts for padi prices being below M$16 in part of Figure 3.

Fig. 3. Average Weekly Padi Prices Received by Farmers in Penang State, 1969–72 (Five-Week Moving Average)



("long") category. During 1969–72, according to officials who compiled price data, IR5 padi constituted a dominant component of *panjang* group. Hence, price of *panjang* are considered here as IR5 prices. The second variety obviously refers to Mahsuri only. But the third type called padi Malaya refers to a number of local varieties with relatively low-yield. Price data are compiled for the state as a whole and not by village or district. It is therefore further assumed that farmers' padi prices depicted in Figure 3 represent the prices received by Permatang Bogak sample farmers too. This assumption by officials is sufficiently realistic on the grounds that northern Province Wellesley District, where Permatang Bogak is located, is the foremost rice producing district of the state. From the viewpoint of this study important facts from an examination of Figure 3 are:

(1) Prices of IR5, as represented by padi *panjang,* where highest among the three types when padi produced in off season 1969 was sold by farmers in the latter half of 1969. Even if all IR5 users did not get high yields, its distinctly high prices during the initial period of introduction may have contributed positively to the relative profitability of HYV and thus to the "snowballing process" in adoption as seen in Tables I and II.

(2) Wide price differentials favorable to IR5 narrowed considerably later. Further, prices of all padi varieties showed a continuously declining trend from 1969 until mid-1971. But more importantly, during the period of declining prices, IR5 padi prices were not always above the prices of other padi varieties. Indeed, on several occasions IR5 prices were lowest. Thus prices of IR5 declined much more relatively than prices of other padi varieties. In a competitive product-product relationship model, a relative change in price of a product alters the slope of iso-revenue curve thereby indicating a different product-mix along the production possibility curve for a profit-maximizing farm. Thus on theoretical grounds, it is reasonable to expect that a relative decline in IR5 padi

prices will eventually result in a change in the slope of the iso-revenue curve so as to cause a reduction or complete abandonment of HYV production in favor of other varieties such as Mahsuri. This seems to be a principal cause for a decline in IR5 acreage in Penang State (Table I) and also for the abandonment of IR5 by a large proportion of Permatang Bogak adopters (Table II). In fact, thirteen out of twenty-three discontinuers in the sample mentioned relatively low prices of IR5 padi as their main reason for abandoning HYV. Obviously, the farmers' behavior was economically rational.

(3) In addition to the above-mentioned points, the issue of price variation magnitude for IR5 is also important. It is clearly seen in Figure 3 that compared to prices of other varieties, price variation for IR5 is much greater, and the difference between high and low prices is greatest. Also, IR5 prices moved up and down more abruptly. Such price variations obviously accentuate uncertainty. Coefficients of variation were computed for actual prices of each of the three varietal groups of padi to ascertain the magnitude of variation. The coefficients of variation expressed as per cent, with respective arithmetic means of prices in dollars per pikul in parentheses, turned out to be: 7.0 (M$15.75) for IR5, 4.8 (M$15.74) for Mahsuri, and 4.5 (M$15.20) for Malaya. Thus price uncertainty, being a major uncertainty, tended to be notably high for IR5 and low for Mahsuri and other varieties. A large proportion of farm in Penang and in the sample are small scale with low income. Such farmers can be expected to have a greater aversion to risk and uncertainty. In view of the relatively more uncertain behavior of IR5 prices, adopters with particularly low incomes and greater dependence on padi for their livelihood are likely to switch over to other padi varieties having less price uncertainty. Farm data for other crop seasons were unavailable, but if the data for the main season of 1971–72 for sample farmers are any indication of farmers' general economic conditions at the time of their decision to abandon the HYV, support for the above proposition is furnished by Table III. It is clearly seen in the table that the average income of discontinuers is much less than that of continuers, and padi production plays a more important role in total income of discontinuers than it does for continuers.

It can be said then that high prices for IR5 in early stage of its introduction account for the HYV's adoption. But an absolute as well as a relative decline in IR5 prices in the later period, together with higher price uncertainty caused

TABLE III

FARM SIZE, INCOME, AND CONTRIBUTION OF PADI TO INCOME

(Main Season 1971–72)

Adopter Category	No. of Farmers	Operated Area of Farm (Acres)	Net Income (M$)	Gross Income (M$)	% Contribution of Padi to Gross Income
Continuers	13	4.12	1,244	1,900	78
Discontinuers	23	2.89	647	1,128	87

by greater magnitude of variations in price, were responsible for subsequent lage-scale abandonment of HYV.

IV. INPUT COSTS

Prices of all inputs used in padi production began rising even before IR5 appeared on the scene. But increase in prices of some critical inputs such as fertilizer were more important for continued adoption of HYV. Reviewing general trends in increase of input costs, we find that the annual fixed cash rent per acre in Permatang Bogak was about M$38 in 1963 and M$150 in 1972. Wages for contract labor to transplant and harvest padi in 1972 were as much as two and a half times greater than what they were ten years before. Regarding inputs such as fertilizer, its price was relatively low and fairly stable at the time of IR5's introduction which may have facilitated adoption of HYV. But soon after 1970 there were marked increases in prices for practically all capital inputs (Table IV). Even if other things remained constant, such increases in capital

TABLE IV
CHANGES IN RETAIL PRICE OF SELECTED INPUTS, PENANG

	Year	Price (M$)	Remarks
(1) Urea fertilizer, 55 lb bag	1969–70	3.64	Subsidized price under the padi fertilizer subsidy scheme
	1971	5.28	Farmer's association price
	1972	5.70	Same
	1973 (March)	7.95	Same
(2) Basal mixture fertilizer, 55.7 lb bag	1969–70	3.01	Subsidized price under the padi fertilizer subsidy scheme
	1971	4.18	Farmer's association price
	1972	4.80	Same
	1973 (March)	5.50	Same
(3) "Agroxone 4" herbicide, one pint tin	1969	2.40	
	1973 (April)	2.75	
(4) Two-wheel tractor (power tiller) Kubota	1969–71	3,620	Excluding attachments
	1972–73	4,150	Excluding attachments, prices of which have remained unchanged

Sources: (1) and (2), Penang State Department of Agriculture; (3), Ministry of Agriculture and Imperial Chemical Industry (Butterworth); (4), Kubota Agent (Bukit Mertajam).
Note: Price paid by individual farmers may vary from those stated above.

input costs alone would adversely effect continued adoption of IR5 much more because HYV requires more fertilizers, pesticides, and other chemical input. Also, there are usually imperfections in factor and product markets in economies of the type discussed in this paper [13, p. 3]. It was found during fieldwork in Permatang Bogak that prices paid by individual farmers were *not* the same for the same type and weight fertilizer bought at about the same time. A num-

ber of observers believe that market imperfections are likely to be biased in favor of large farmers [7]. Hence, changes in input (as well as in output) prices discussed above may have been much more unfavorable for such HYV adopters who have relatively small farms. And, Table III does show that discontinuers indeed have small farms compared to continuers. It is therefore possible that market imperfections may have also played some role in the abandonment of IR5.

Increase in input prices can be largely due to changes in usual conditions of demand and supply. But a particular government policy was also partly, yet notably, responsible for the increase in fertilizer price. Until the end of 1970 a 30 per cent government price subsidy for fertilizer was in operation. But from January 1, 1971, the first day of the Second Malaysia Plan (1971–75), the subsidy was scrapped in West Malaysia's double-cropped padi areas including of course Permatang Bogak and Penang State. The subsidy scheme was terminated because the government had realized, and correctly too, that the scheme had succeeded in its primary goal of popularizing fertilizer use among padi farmers. But unwittingly the timing for scrapping the subsidy scheme from 1971 coincided with very low padi prices, particularly for the IR5 variety (Figure 3). Since IR5 requires more fertilizer for exploiting its high-yield potential, abolition of the fertilizer subsidy scheme would reduce profitability thus endangering continued adoption of HYV.

V. PADI YIELD PER ACRE

Cost-price squeeze, that is, rising factor costs and declining product prices for IR5 are major factors in explaining the large-scale abandonment of HYV. In fact by using the cost-price squeeze argument one can say that the discontinuers were only behaving rationally. But the interesting thing is that continuers may also have been behaving rationally. Because, in contrast to the failure by the discontinuers, continuers succeeded in exploiting high-yield potential of IR5. Thus they kept their unit padi production costs sufficiently low to overcome the cost-price squeeze and to maximize profits. Padi yield data for Permatang Bogak sample farmers show that discontinuers did not succeed in obtaining high yields from HYV.

To ascertain success or otherwise in exploiting the high-yielding potentials of IR5 for the sample farmers of Permatang Bogak, each adopter was asked whether, compared to the average Mahsuri yield he used to get, IR5 yield he obtained was less, the same, or more. This rather simple question was asked because farmers were unable to recall exact padi yields obtained for crops for several past seasons. The farmers' answers to the question are summarized in Table V. Only 8 per cent of continuers obtained "less" yield from IR5 compared to 35 per cent of discontinuers. On the other extreme, greater yield from IR5 was reported by 54 per cent continuers compared to only 17 per cent of the discontinuers. This suggests that the continuers generally succeeded in extracting high yields from the HYV while discontinuers failed. To complement

TABLE V
COMPARISON OF PADI YIELDS FOR IR5 AND MAHSURI VARIETIES

Adopter Category	Total	Adopters Reporting IR5 Yield Compared to Mahsuri Yield, as (Per Cent of Total)			Main Season 1971–72	
		Less	Same	More	Average Yield/Acre (Pikul)*	Average Operating Cost/Pikul (M$)
Continuers	100 (13)	8	38	54	23.11	4.69
Discontinuers	100 (23)	35	48	17	21.47	5.14
All adopters	100 (36)	25 (9)	44 (16)	31 (11)	22.21	4.93

Note: In this and the following tables, the figures in parentheses given below percentages is the absolute number of farmers.
* One pikul = 133.33 lb.

the findings on yield differences between continuers and discontinuers, data on padi yield per acre and unit cost of padi production for the main season 1971–72, the latest crop season of our fieldwork in the village, have also been presented in Table V. From the data there is an indication, as may be expected, of a negative correlation between yield and unit cost of padi production. It is also seen that even during the main season 1971–72 when HYVs were not planted in Permatang Bogak (as pointed out in note to Table II), all farmers planted more or less identical local padi varieties, and continuers on the average tended to have a higher padi yield per acre together with a lower padi production unit cost. From the main season 1971–72 data it seems that similar differences in yield rates and unit costs of production prevailed between continuers and discontinuers when both groups were planting IR5 in the past.

From the foregoing arguments and evidence, it can be inferred that farmers' success in exploiting high-yielding potentials of IR5 is a principal determinant in sustained adoption of HYV technology. It is also seen in Table V that IR5 yields obtained on farms were not always higher than those of Mahsuri. From Figure 2 one would expect that IR5 will always give higher yield; but it appears that yield differences between IR5 and Mahsuri on farms are not as dramatic as on research stations. It is also seen that IR5 yield response has not been uniform between continuers and discontinuers. This may be due to physical differences in farm conditions (e.g., soil, water, etc.) and in economic and social constraints.

VI. SELECTED ECONOMIC AND SOCIAL CHARACTERISTICS OF FARMERS

This includes farmers' age, education, tenure status, farm size, income level, resource constraints, and the like. Changes in these factors may be responsible for adoption and subsequent discontinuation of IR5 among Permatang Bogak

farmers. Within the short period from 1968 to 1972 not much change seems to have occurred in these characteristics which may explain the adoption and discontinuation of HYV. However certain characteristics in conjunction with other variables such as cost-price squeeze and associated uncertainties, even if static, will hinder or facilitate the sustained use of IR5. Discontinuation of HYV may thus be linked to these factors. For the purpose of analysis, the adopters shall be categorized as continuers and discontinuers, then differing social and economic characteristics of the two groups will be examined. First we take up the variation in quality of HYV seeds used by sample farmers and its relation to continued use of HYV.

A. *Quality of IR5 Seeds*

Quality of seeds is important in using IR5. Admixtured or degenerated seeds are of course no longer HYVs. From analysis of data gathered, it appears that discontinuers used relatively poor quality seeds. Consequently, they did not obtain high yields.

Before examining the data on quality of HYV seeds, the process of distributing new seeds such as IR5 may be briefly described for clarification. After a variety has been officially approved, Penang State Agriculture Department acquires the seeds from research stations. The seeds are then distributed free to a few chosen farmers but most are sold at concessional prices to some leading farmers. These farmers are usually large, innovative, and influential members of elite, forming a small fraction of the total number of padi farmers. Other farmers interested in pure seeds are likely to buy them at usual prices from the department. However in some places if there is a research station nearby (as was the case in Permatang Bogak), farmers can buy pure seeds there also. Pure seeds thus acquired are multiplied by farmers and subsequently sold by them to interested farmers in the village; the process continues down to the next level of farmers. In absence of any seed certification authority in the state as well as in whole of West Malaysia, and due to lack of any official supervision of the seed multiplication process in farmers' fields, there is a progressive deterioration in quality of seeds as they pass from one level of farmer to the next, and also from one crop season to the next for the same farmer. Deterioration in seed quality occurs in two aspects. First, through admixtures with other varieties in farmers' fields and homes, and second, by the setting in depressions of inbreeding in varieties such as IR5 which are developed by pedigree selection method. In the light of this seed distribution process, if a farmer obtains seeds directly from official sources, quality is likely to be better than those obtained from farmers within the village. It may be pointed out that usually farmers do not obtain a fresh stock of pure seeds every season; they generally keep on using the previous seasons' padi as seeds for the next season. Also, if a farmer purchases his seeds instead of obtaining them by barter, it is likely that he will get seeds of superior quality. Traditionally farmers in Permatang Bogak exchange padi seeds of varieties on equal quantity or volume basis (i.e., a unit of variety A for a unit of variety

B) even if the two varieties exchanged command different market prices. But if a farmer makes a cash purchase of seeds from another farmer in the village, the price is determined by factors such as quality and variety of the seeds. Hence the exchange system for seeds operates in such a way that it is reasonable to expect purchased seeds to be superior to bartered ones. In short, (1) HYV seeds obtained from official sources will be better than those from farmers within the village; and (2) within the village itself, seeds bought will be better than seed obtained by barter. With this background, Table VI may be considered as showing where sources and methods of obtaining the first lot of IR5 seeds are summarized.

TABLE VI

SOURCES AND METHODS OF OBTAINING THE FIRST LOT OF IR5 SEEDS (%)

Adopter Category	Total	Source of Seeds		Method of Obtaining Seeds	
		Villagers	Agriculture Department	Barter	Cash Purchase
Continuers	100 (13)*	69	31	15	85
Discontinuers	100 (23)*	83	17	30	70
All adoptors	100 (36)*	78	22	25	75

* Number of farmers.

Table VI clearly shows that a relatively inferior quality of IR5 seeds were used by discontinuers. As many as 83 per cent of the discontinuers obtained IR5 seeds from within the village compared to 69 per cent of continuers. Thus both sources and methods of obtaining the first lot of IR5 seeds suggest that a poor quality of HYV seeds were used by discontinuers. These facts reveal that discontinuers started with a relatively inferior quality of IR5 seeds which did not allow the expected high yield from HYV, thus eventually making them discontinue use.

Besides the clear implications for adoption and discontinuation HYV, data in Table VI also shows that farmers of Permatang Bogak obtain seeds predominantly from sources within the village. This despite the fact that a padi research station where quality seeds are obtainable is only about four miles on a highway from the village. Reluctance of a large majority of farmers to use this official facility is notable and rather disturbing. Causes for reluctance must be explored so that corrective measures can be taken. Another revelation from the data is that 75 per cent farmers purchase their seeds. This is a notable departure from the traditional barter system practiced earlier. Clearly there is a demand and a necessity for supplying quality seeds more effectively than has been the case so far. Among other possible ways to improve the seed distribution process, the government should consider supplying certified seeds of approved varieties at appropriate prices in sealed packets of varying sizes through private shops, vil-

lage headmen, farmers associations, and the like. Creation of more than one seed distribution channel at village level merits attention. Encouragement to form private companies dealing in multiplication and distribution of approved seed varieties also deserves consideration.

B. *Farmers' Technical Knowledge*

The farmers' technical knowledge of production methods is an important economic resource and a productivity determinant of farm and farmer income. Recent studies of padi farmers in Southeast Asian countries such as the Philippines [12] and Malaysia [3] provide requisite evidence to show that if a farmer does not possess adequate technical know-how for growing HYVs, new varieties on his farm may yield only as much as moderate or low-yield varieties do. A farmer's technical knowledge may therefore explain whether once having used HYV, he will continue or abandon it.

One aspect of farmers' technical know-how is his knowledge of official recommendations on fertilizers, etc. for the new seed variety. To assess differences in such knowledge between continuers and discontinuers each adopter was asked a question on official fertilizer recommendations for IR5 and for Mahsuri. It is true that official fertilizer recommendations for IR5 were blanket in nature and would not suit each individual farm as well. Hence it could be argued that knowledge on official fertilizer recommendations is of little significance. But such knowledge can provide a useful starting point for a farmer to work out a rate of fertilizer application to suit his farm. In this way then, knowledge on official recommendations is relevant. Questions on fertilizers alone were asked on the grounds that fertilizers are a critical input for HYV. The question asked was: According to recommendations given by the Agriculture Department, the fertilizer requirement of IR5 is more, same, or less than for Mahsuri? Farmers' answers to the question are tabulated in Table VII.

TABLE VII

FARMERS' KNOWLEDGE ON OFFICIAL FERTILIZER RECOMMENDATION FOR IR5 (%)

Adopter Category	Total	According to the Agriculture Department, the Fertilizer Requirement of IR5 Compared to Padi Mahsuri Is ?		
		Less	Same	More
Continuers	100 (13)*	31	46	23
Discontinuers	100 (23)*	39	48	13
All adopters	100 (36)*	36	47	17

* Number of farmers.

The correct answer to the question is "more." If a farmer responds with "same," he is not hitting the bull's eye, but if the answer is "less," it shows a high level of ignorance which would keep the farmer from exploiting the

high-yield potential of IR5. Table VII shows that 39 per cent of discontinuers responded with "less" compared to 31 per cent of continuers—a difference of 8 points in favor of continuers shows that they possessed more knowledge. When the response was "same" it showed little difference between the two adopter categories. However even this little difference favors continuers. The largest difference is evidently in "more," the most adequate answer to the question. Therein the difference of 10 per cent points falls, and again, in favor of continuers. Thus the trend is consistent and clear, continuers were relatively more knowledgeable of the fertilizer requirement for HYV. If knowledge on fertilizer can be considered an indicator of overall technical know-how of the sample farmers, part of the explanation for adoption and subsequent discontinuation of HYV is clearly attributable to differences in farmers' technical knowledge.

Besides throwing light on the phenomenon of adoption and discontinuation of HYV, data in Table VII point out an important factor. Of a total of thirty-six adopters, only 17 per cent correctly knew that more fertilizers are recommended for IR5. If this is the situation of technical know-how in Permatang Bogak, one can well imagine the magnitude of ignorance in more remote villages. Ignorance is a barrier to modernizing agriculture. Hence, creation of a more effective extension service for padi farmers needs urgent attention.

C. *Tenurial Category of Farmers*

In this study three tenurial categories of farmers are assigned: (1) a farmer who operates partly owned and partly rented-in lands is termed an *owner-tenant;* (2) a farmer who operates only owned land is an *owner;* and (3) one who operates only rented land is a *tenant.* It may also be pointed out before proceeding further that tenants and owner-tenants in Permatang Bogak had full decision-making freedom in respect to farming rented land and paid fixed cash rents to landlords. From data analysis, it was found that among the three tenurial groups in the sample, on an average, tenants were characterized by farms of the smallest size (2.6 acres) and the lowest net incomes (M$590). On the other extreme were owner-tenants who had the largest farms (4.4 acres) and the highest incomes (M$1,326). Owner farmers were in between—with farms of 2.7 acres and net incomes of M$633. Interesting differences were also noticed among the three tenurial groups in respect to efficiency of padi production. Computations of average padi yield per acre and operating cost incurred per pikul of padi showed that owners had the lowest yield (21.8 pikuls) and highest costs (M$5.42), owner-tenants had the highest yield (22.3 pikuls) but second highest cost (M$5.18), and tenants had second highest yield (22.2 pikuls) and lowest cost (M$4.57). These efficiency indicators suggest that though the tenants had the smallest farms and lowest incomes, they were fairly efficient padi farmers. Keeping the above stated facts in view, we now consider the data given in Table VIII (Part I).

It is clearly seen from the table that owner-tenants are the most innovative group of farmers, for, all adopted HYV. Tenants emerge as the second most

TABLE VIII
TENURIAL CATEGORY OF FARMERS AND ADOPTION OF IR5

PART I

Adopter Category	No. of Farmers	Tenurial Category (%)		
		Owner-tenant	Owner	Tenant
Adopters	36	100	67	79
Non-adopters	8	0	33	21
Total	44	100	100	100
(No.)		(11)	(9)	(24)

PART II

Adopter Category	No. of Farmers	Tenurial Category (%)		
		Owner-tenant	Owner	Tenant
Continuers	13	55	33	26
Discontinuers	23	45	67	74
Total	36	100	100	100
(No.)		(11)	(6)	(19)

innovative, since 79 per cent of them were adopters compared to only 67 per cent of owners. This innovativeness of tenants is impressive in view of the fact that (1) they had the smallest size farms and the lowest total net income, and (2) they were completely dependant on rented land. Their enthusiasm for the HYV may have been due to extra-keenness to improve their incomes. But at the same time they were unable to take big risks especially for long periods as perhaps owner and owner-tenants could, because every season the tenants have to part with considerable sums of money in land rent. This obviously leaves them with much less income as net income data in the foregoing paragraph show. Usually, low income farmers have a greater aversion to risk and uncertainty. It can be expected that the cost-price squeeze and IR5 price uncertainty discussed earlier, spanning a number of crop seasons, will affect tenants most. Under the conditions, more tenants can be expected to discontinue IR5. Data given in Part II of Table VIII substantiate this proposition. As expected, in the table the proportion of discontinuers is largest among tenants. From the same table, it is interesting to note that the proportion of discontinuers is smallest among owner-tenants. There is therefore some evidence showing that pure tenant status of a farmer influenced adoption and discontinuation of HYV. This analysis assumes that the tenurial status of sample farmers has remained unchanged since adoption of IR5. This is a realistic assumption since tenants in Permatang Bogak have a relative degree of security in tenure.[5]

The Padi Cultivators (Control of Rent and Security of Tenure) Act was passed in 1967 in Malaysia, the aim being to control rent and to provide greater security

[5] Of the total of the Permatang Bogak sample of farmers' renting land, only 6 per cent reported working the same piece of land for less than three years, but 46 per cent farmers had worked these fields for three to nine years, and the remaining 48 per cent had farmed for ten or more years.

of tenure for tenants. But the act has not yet been effectively implemented. There are various shortcomings in the act and there have been many problems in implementing it, which have been thoroughly discussed elsewhere.[6] If this situation can be overcome through amendments in the act or other appropriate means, it may be possible to check the rapid increase in land rents which in turn will help to increase tenant income and reduce their aversion associated with sustained use of HYV technology.

D. *Farm Size*

Seed and fertilizer input associated with HYV technology are infinitely divisible. Hence, theoretically the adoption of HYVs is largely free from economy of scale. In practice however, adoption of HYVs and farm size are positively correlated in some places while in others they are not [1] [17].

In the Permatang Bogak sample however there is indication of positive correlation between adoption and farm size. Average farm size, measured in terms of operational farm area was 3.3 acres for adopters and 1.8 acres for non-adopters. In regard to income, average net income for the main season of 1971–72 was M$863 for adopters and M$455 for non-adopters. Income is determined by farm size and it is positively correlated. Thus we see an indication of notable differences between adopters and non-adopters in terms of farm size and income.

Size and income differences are also large between continuers and discontinuers (Table III). Average farm size is 4.1 acres for continuers and 2.9 acres for discontinuers. Similarly, net income for the main season in 1971–72 is substantially high (M$1,244) for continuers and low (M$647) for discontinuers.

Thus in Permatang Bogak, farm size is smaller in the non-adopters than discontinuers, and with discontinuers than continuers. This is obviously contrary to the theoretically scale-free nature of HYV technology. To explain this phenomenon one has to probe into a number of factors such as (1) aversion to risk or the risk-taking ability of individual farmers, (2) imperfections in factor-product product markets, (3) extension service and distribution of government supplies such as new seeds for farmers of different scale, and (4) formal and informal institutional factors. (Participation by farmers in formal institutions will be examined in the following section.) These factors vary among farms of different size and could be responsible for the positive correlation observed between farm size and adoption of HYV. Clearly the issue of farm size and adoption or discontinuation of IR5 is not simple and deserves a separate study. Hence it would suffice here only to mention the issue and some plausible avenues for its exploration in future research.

E. *Participation in Formal Organizations*

Formal organizations referred to here are: farmers associations, cooperatives,

[6] Some of the major shortcomings and problems in implementing the act are discussed in a recent land tenure study [9].

village development committees, mosque committee, and political parties. These organizations play an important role in the village. It was realized that participation in such organizations is likely to affect a farmer's determination in adopting or discontinuing IR5. A member of these organizations is likely to have direct and better access to credit facilities, quality seeds, technical information and other resources which will allow him to realize the high-yield potential of IR5. Members of a mosque committee or a political party, for instance, will discuss religion and politics in their meetings, but as usually happens before and after the meetings, conversation is likely to be on other matters including farming. In farmers association meetings, emphasis will of course be on farming. Thus membership in farm and nonfarm organizations gives the farmer the opportunity to seek solutions to his farming problems and to compare his experiences with competent farmers who are also likely to be members. He is also likely to come in direct contact with government administrators and technical officials. A farmer thus benefits considerably through interaction with other individuals by participating in such organizations. If a farmer is member to more and a greater variety of social, economic, and political organizations, the more benefit he is likely to accrue from them. Therefore, the proposition is that adopters, who discontinued growing IR5 are likely to be members of fewer organizations than those who continued HYV. Data in Table IX support this proposition.

Table IX gives the membership in five selected formal organizations of con-

TABLE IX
MEMBERSHIP IN SELECTED FORMAL ORGANIZATIONS

Name of Organization	No. of Farmers as Members, Category			
	Adopters		Non-adopters (n=8)	All (n=44)
	Continuers (n=13)	Discontinuers (n=23)		
1. Farmers association	11	17	2	30
2. Cooperative	3	5	0	8
3. Village development committee	1	1	0	2
4. Mosque committee	1	3	0	4
5. Political party	6	8	0	14
Total of membership (m)	22	34	2	58
Organizational membership per farmer*	1.69	1.48	0.25	1.32

*. Obtained by dividing total of membership (m) with number (n) of farmers in each category.

tinuers, discontinuers, and non-adopters during the main season period, 1971–72. It is assumed that the pattern of membership shown in Table IX is more or less identical to the pattern existing prior to the main season, 1971–72. Membership is one thing, and participation is something else. Therefore it is further assumed that membership in a voluntary organization means a reasonable level of participation. Data in Table IX may be examined with this in mind. Among the forty-four sample farmers, non-adopters are members of few organizations as

indicated by the lowest average organizational membership per farmer of only 0.25. The average increases to 1.48 for discontinuers and to 1.69 for continuers. This is a positive association between membership in various organizations and the adopter category. On the basis of this evidence, it can be inferred that adoption and discontinuation of HYV is determined, among other factors, by participation in various organizations.

F. *Literacy, Age, and Family Size*

Various important decisions by the typical head of a Malay household are usually arrived at by consultation with family members. Notwithstanding this, in the context of traditional Malay cultural norms the household head is dominant, and influences the decision. In view of this, it was considered appropriate to examine certain characteristics of heads of sample households, and see if those characteristics are associated with adoption and discontinuation of HYV. Literacy is a common attribute of innovators. Its connection with innovativeness in a farmer is not difficult to understand; and the variable has been the subjects of numerous adoption studies. According to other studies, innovators are usually relatively younger than non-innovators or non-adopters.

Table X shows the average age and rate of literacy at the time of interviews

TABLE X

AGE, LITERACY, AND FAMILY SIZE

Adopter Category	Total No. of Households	Head of Household		Family Size (No. of Persons)	No. of Adults in Family
		Age (Year)	Literate* (% of Total)		
Continuers	13	44.2	100	6.1	3.6
Discontinuers	23	39.9	95.7	5.3	3.1
Non-adopters	8	45.0	75.0	3.6	2.6
All	44	42.1	93.2	5.2	3.1

* A person able to read or write Malay in either Rumi or Jawi script was considered literate.

in April and May 1972. According to the table the average literacy rate is highest for continuers, and lowest for non-adopters. Evidently illiteracy is among the impediments to adoption of HYV. As far as age is concerned, there is no clear evidence available from the data to allow generalizations of its bearing on the adoption of IR5.

Table X also shows average family size and number of adults. The table shows that continuers have both the largest family size and largest number of adults. Family size and number of adults consistently decline from continuers to discontinuers, and is least with non-adopters. This indicates a positive association between adopter category and family size and number of adults. In a study of 600 Indian farmers, for example, positive association was noted between

family size and agricultural innovation [15]. This may be so because the family plays a positive role as reference group for the head of household in adopting innovation.[7] Obviously a family with more adults is a better reference group. It is also conceivable that adults in a family serve not only as a reference group but contribute positively to the family and to the farm in various ways. Risk-taking ability of a farming family may also increase as the number of adults increases, thus facilitating adoption of innovations. These are probably some reasons behind positive association observed in Table X between adopter category and family size for sample farmers.

Informal discussions with farmers during the field study revealed additional factors of interest. For example, farmers reported difficulty in germinating IR5 seeds, a high percentage of empty or unfilled grains in the IR5 crop, inferior taste of IR5 rice compared to that of Mahsuri, and lack of credit for fertilizers and other inputs. These factors may also be partly responsible for explaining adoption and discontinuation of IR5. It has not been possible to collect systematic responses on these points and therefore they cannot be examined here, but could be included in future research investigations.

SUMMARY AND CONCLUSIONS

This study on Malaysia may add to the existing literature by throwing some light on the question of why developmental opportunities offered by rice and wheat HYVs have not been fully exploited in many developing countries. The study attempts to explain the phenomenon as observed in Province Wellesley. The IR5 or padi Bahagia as it is locally called, was introduced to the area in 1968. It was planted on a large area in Province Wellesley and used, as enquiries in a chosen village showed, by a large proportion of farmers. But in about four years after introduction, there was an absolute and percentage reduction in IR5 acreage. A large number of adopters in the village discontinued growing IR5 and switched to old or unofficial varieties. But, interestingly enough a small minority of original IR5 adopters continued using it. The main objective of this study is to explain the large-scale abandonment of the HYV. With this objective, and assuming that HYV would continue to be planted as long as it helped farmers to maximize profit, the investigation was aimed at three broad areas: (1) changes in prices of padi and prices of inputs, (2) ascertaining farmers' success or failure in exploiting the high-yield potential of IR5, and (3) economic and social characteristics of individual farmers which may affect their success in obtaining high yields from HYV.

It was found that there was an absolute as well as relative decline in IR5 prices from 1969 to 1971. During the same period, there was a notable increase in prices of all inputs including fertilizer which is critical in obtaining a high yield from HYV. This cost-price squeeze reduced the profitability of IR5 es-

[7] A reference group is a group of persons to which an individual looks to when forming an opinion, making a judgment, or deciding to act [10, p. 80].

pecially for those farmers who could not get a high yield from HYV, making them discontinue use. Farmers who succeeded in getting high-yield potential from IR5, it was argued, escaped the choking effects of the cost-price squeeze on HYV's relative profitability, and continued growing IR5.

Next, an examination of selected economic and social characteristics of farmers was made to find the causes for failure of discontinuers, and success of continuers. It was discovered that discontinuers had relative poor quality seed, less technical know-how, smaller farms, lower income, a higher level of tenant status, less participation in formal village institutions, a lower level of literacy, and smaller families. Adverse effects of these interrelated characteristics on IR5 yields were discussed. However some caution is in order. Since it cannot be said that the sample area is perfectly representative of Malaysia, the findings may not be valid for the whole country. But more important, size of the sample was rather small considering the large number of economic and social characteristics chosen to explain IR5 yield differences. Consequently, various relationships observed between variables, though conforming to hypothetical tendencies, need to be viewed with reserve. Relationships of economic and social characteristics of farmers to adoption and discontinuation of HYV are tentative and must be confirmed by further research.

Based on evidence presented we can say that if opportunities offered by HYV technology are to be more fully utilized, attention should be given to removing constraints to HYV adoption and yield. Constraints on high yield are not simply those of soil, water, and other physical farm attributes. They include economic, social, and institutional factors as well which, as this study suggest, play a key role. Sustained adoption of new HYV technology is firmly linked with profitability. The profitability of HYVs depends on removing yield constraints as well as other factors such as prices. Attention must be given to all factors if the development opportunities of HYV technology are to be fully used.

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