

NOTA PENYELIDIKAN/RESEARCH NOTES

WEED AND WEALTH IN MUDA.*

Capital intensive weed management - a growing problem for resource-poor farmers in Muda, Malaysia.

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ABSTRACT

The shift in crop establishment method from transplanted to direct seeded rice culture taking place in many parts of Asia has resulted in growing problems of weed infestations. This paper discusses the problems of weed infestations experienced by farmers in five villages within the Muda Irrigation Scheme. It argues that the problems of weeds - reducing yield and increasing the cost of production - is unevenly spread among farmers and villages. Whereas the weed problem could be described as insignificant in two of the villages studied, it was found to be a serious problem in two other villages leaving one village with a moderate weed problem. The study shows that within village areas, which experience high levels of weed infestations, there is an uneven distribution of the problem among different farm categories. More well-to-do farmers experience less problems of weed infestations. On the other hand, the resource-poor farmers are seriously affected. The findings imply that small-scale and less well-to-do farmers, who traditionally have been able to substitute labour for capital, presently, are the losers under the new conditions of cultivation.

Stated differently, the findings suggest that the new need for weed suppressing cultivation techniques implies an increasing dependency on access to farm equipment such as tractors and water pumps. Thus, direct seeding offers a satisfactory solution to farmers who no longer can afford to hire labour for transplanting, only if they have timely and sufficient access to necessary farm equipment.

INTRODUCTION

Plant protection is of tremendous importance in accelerating usable crop production in developing countries. Losses from pests and

diseases in the field have been estimated at 20-40% of the crop, world-wide, and may be higher in developing countries (FAO 1981). In the case of rice, insects, diseases, nematodes, and weeds together regularly cause losses of 15-30% of the attainable rice yield and are major constraints to increased, stable rice yields (Teng 1994).

One area of concern is the growing problems of weed infestations in areas that have experienced a shift in crop establishment method from transplanted to direct seeded rice culture. Since the late 1970's, direct seeded rice has gained importance in several countries of South-East Asia, for example, Malaysia, the Philippines, Sri Lanka, Thailand, and Vietnam (Moody 1993). Major reasons for this expansion are: increasing labour costs and labour shortage, improvement and expansion of irrigation systems, and the development of agrochemicals, especially for weed control.

The above described development can be observed in the Muda Irrigation Scheme, located in the traditional "rice-bowl" area of northwest Peninsular Malaysia. The project area straddles the States of Kedah and Perlis and occupies a flat marine alluvial plain, approximately 96,000 hectares, between the foothills of the Main Range and the Straits of Malacca. Being the nation's single largest agricultural development project, it can be characterized as a typical large scale Green Revolution project formed around the basic ingredients: new, fertilizer responsive, short-term seed varieties which, in combination with irrigation development, could increase cropping intensity and yields. Prior to the introduction of irrigation in 1970, when only rainfed single cropping had been possible, the approximately 50,000 farm families with an estimated on-farm population of 325,000 persons had been basically subsistence oriented and had long been among the poorest in Malaysia (Afifuddin 1978).

During its first ten years of operation, 1970-1980, production increased dramatically and the Muda project was often referred to as a Green Revolution success story. Unfortunately, the last decade has been less encouraging, and a pattern of growing yield instability has developed (Vokes & Wong 1993, Jirstrom 1993). Since the early 1980s, there has been a series of outbreaks of pests and diseases and since the mid-1980s, the shift from transplanting to direct seeding has resulted in increasing problems of weed infestations (Jegatheesan 1987, Ho *et al.* 1989).

These serious problems not only affect the nation's rice supply,¹ but they also have an adverse impact on the economic stability of Muda farm households. Questions that arise in connection with the weed problem are:

- * Is the problem evenly spread or is it possible to identify some patterns of distribution?
- * If such patterns can be identified, what are the explaining factors?
- * What is the economic impact of weeds on the farm household?
- * Are farmers aware of the economic impact of weeds?

As evident from the list of questions, this study attempts to view the weed problem in its social and economic context. Although we will point at some of the important economic impacts of weed infestations in this paper, our main focus is set on the first two rather explorative questions concerning some aspects of distribution. It is a basic assumption that any attempt to understand farmers' weed problems must incorporate social and economic data in the analysis.

A CASE STUDY OF FIVE VILLAGES IN THE MUDA SCHEME.²

The Sample

The five villages selected are all situated in district 4 (Figure 1). This district, one of four which together constitute the Muda irrigation area, was selected because of the relatively early adoption of direct seeding, 1977, by farmers there (Ho 1982). This fact is of importance as it implies that the weed problems have had time to develop, for example, time for weed seeds to multiply in the fields. Furthermore, farmers in this district have had longer experience from weed management under direct seeded conditions and their practices can be assumed to be more developed and refined.

The villages can all be found within a radius of 20 km. In this way, the probability of differences in occurrence and levels of rainfall, which can be significant in the Muda area, was minimized in order to avoid disturbances to the comparative parts of the study. The selection of a

small number of villages all concentrated to a small part of the Muda area results in limited possibilities to use the findings for generalisations about the entire Muda area.

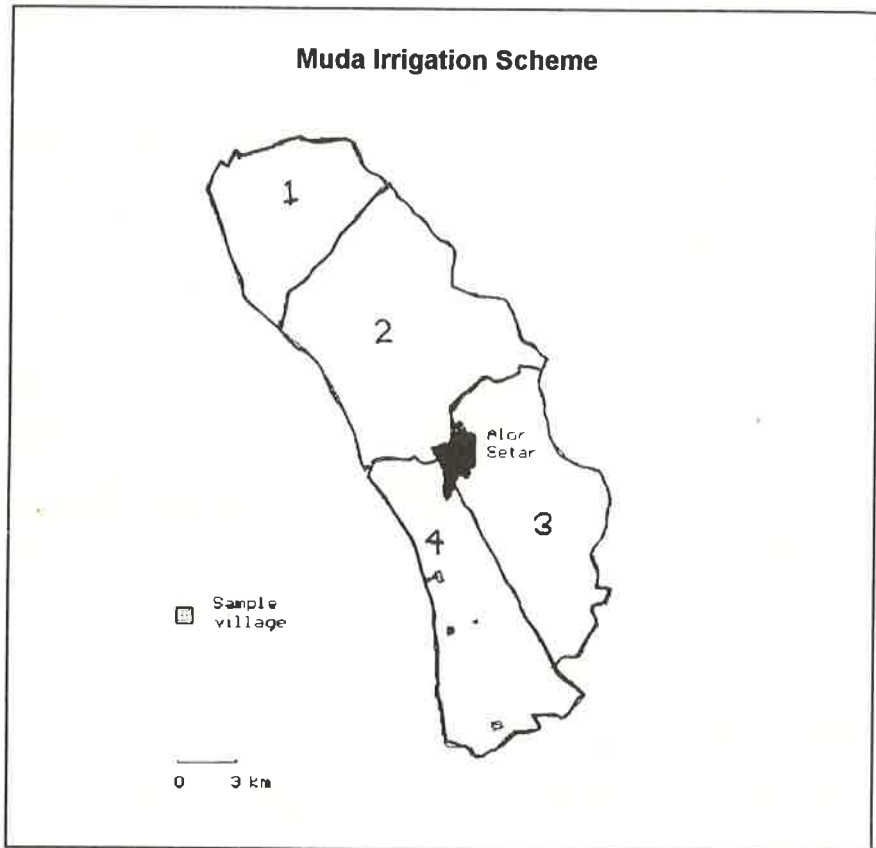


Figure 1: The Muda Irrigation Scheme and the sample villages

Selection criteria

Selection criteria for the villages were based on the identification of two factors assumed to affect the over-all level of pest/weed problems within a village, namely: (a) canal density, (b) the existence of a group farming project (Jirstrom 1993). As supplement, a village with a long period of direct seeding experiences was sought for.

From a stratified sample frame based on the above criteria, five villages were selected randomly:

Permatang Kangkong: Non-group farming village in a low canal density area.

Permatang Ibus: Group farming village in a low canal density area.

Kampung Bahagia: Non-group farming village in a high canal density area.

Kampung Gelam 111: Group farming village in a high canal density area.

Kampung Batas Ubi: Village among the first (1977) to adopt the direct seeding technique (group farming, low canal density area).

The definition of a village area, a rather difficult task in Muda, was made simple thanks to the selection criteria. In three of the villages, the group farming project defines the physical boundaries of the village. In the case of Kampung Bahagia, the villagers all perceived a certain area surrounded by irrigation canals as their village area. In Permatang Kangkong, finally, the village area was defined by asking villagers to which village they belonged. In each village the name of farmers operating land within the defined areas were listed and included in the total sample frame. From the sample frame for each village, a stratified random sampling according to wealth groups (see section below) of 20 farmers was made. After drop-outs the sample breakdown for the season 1992:1 was:

Village	Sample Frame Total No. Operators	Sample No. For Intensive Study
Pmt. Kangkong	88	18
Pmt. Ibus	104	18
Gelam III	23	19
Kg. Bahagia	77	18
Batas Ubi	26	20
Total	318	93

Figure 2: Sample 1992:1 (Dry season)

Wealth Ranking

One of the assumptions made in this study is that the economic resources of a farm household affect its pest/weed management (Jirstrom 1993). Therefore, the 20 farmers selected in each village represent a stratified sample selected according to wealth. The technique of wealth ranking is a simple way of obtaining data about the economic resources of farm households (Grandin 1988). It is based on a card sorting technique in which the name of each household is written on a small card and several informants (7-8 in each village) are asked to place the cards in piles according to the wealth of each household. As the initial ranking sessions showed that most informants, independently, chose to divide farmers into four wealth categories, this number of categories was decided on for the study. From each category, five farmers were randomly selected. Rank 1 refers to the most well to-do farmers and rank 4, accordingly, refers to the poorest segment (Figure 3).

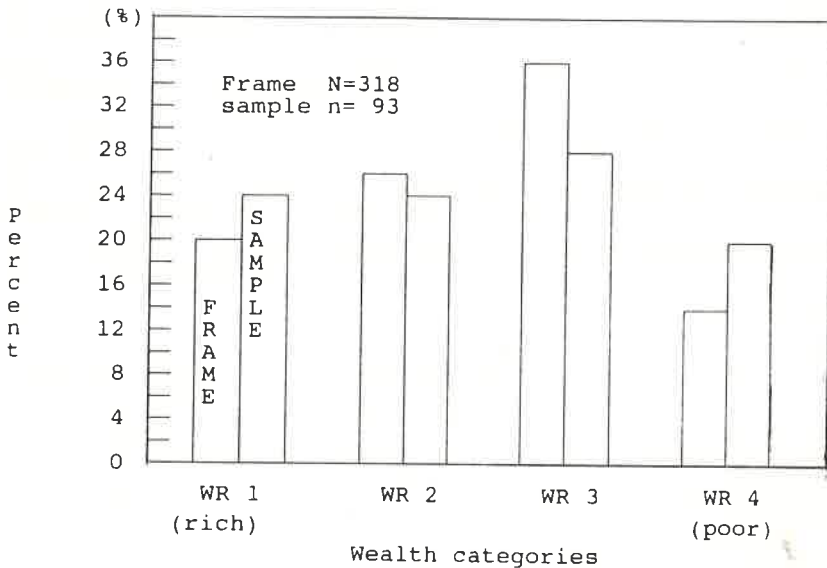


Figure 3: Breakdown of sample in wealth categories

Data collection

Data for the village study was collected at two levels. For all farmers in the sample frame (N=318) data on weed infestations in the fields, wealth rank of the households, distance between farm houses and fields and tenure status were gathered through field surveys (weed assessment) and through the above mentioned use of informants.

For the sample selected for intensive study (n=93), the data was collected through:

- (i) Two rounds of structured interviews based on questionnaires, covering the following topics: demography and farm economy, land preparation, planting/seeding, pest and weed management, water management, affiliations to local organizations, and forms for farmers' cooperation. During the rounds of interviews, a knowledge test on weed species, a knowledge test on herbicide application, and an attitude test regarding pest and weed management were also conducted.
- (ii) Daily keeping of farm diaries by farmers during two crop seasons.
- (iii) Organised workshops in two villages.
- (iv) A great number of informal interviews in connection with weekly checks of diaries and frequent visits to farmers' fields.

DISCUSSION OF FINDINGS

The following discussion of findings is organized along the principal research questions so that each question or group of questions is treated in a separate section. The discussion will, however, sometimes refer to maps, tables and diagrams in which a combination of data is presented.

The importance of the weed problem

Using a modified weed assessment scale based on the Braun Blanquet scale (cf. Ho 1991, Kershaw 1973), the weed scores of 318 farmers' fields were assessed for both the wet and dry seasons of 1992. The percentage of weed coverage above the rice canopy was based on scanning of the whole field. This was done approximately 70-80 days after crop establishment, which means that farmers no longer can control weeds through herbicide application.

The modified Brown Blanquet scale was chosen for practical reasons. It is a comprehensive measurement for quick assessment of weed coverage over an extensive area. Its relative advantage compared to other more sophisticated scales, is its ease of application when the researcher is constrained by the lack of well-trained and experienced field staff.

The modified scale uses 6 grades where:

- 0 = no or only rare existence of weeds.
- 1 = light infestation with less than 5 % cover.
- 2 = moderate infestation with a cover of 5-25 %.
- 3 = moderately serious infestation, cover 26-50%.
- 4 = serious infestation, cover 51-75 %.
- 5 = very serious infestation, cover more than 75 %.

Figure 4 is a sample breakdown in weed score categories. From the diagram we can see that 36% of the farmers in the total population experienced a weed cover of 26% or more. For the sample, the share having a high weed density coverage (grade 3 or higher) was 35%. For both groups then, more than one third of the farmers are experiencing serious weed infestations.

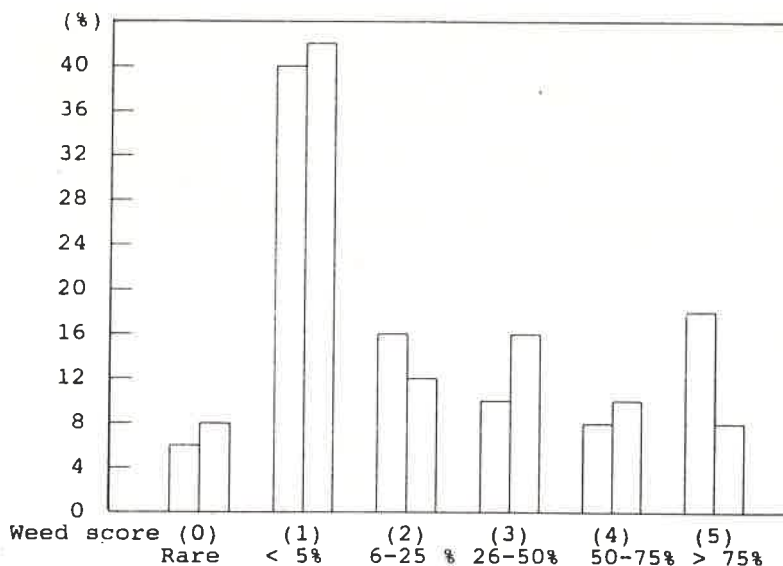


Figure 4: Sample breakdown in weed categories
 Left bars: total sample, n=318
 Right bars: sample for intensive study, n=93

Economic consequences of weeds

Yield

As the presence of weeds only is one out of several yield suppressing factors, we must be cautious in the analysis of the weed problem. Based on the modified Brown Blanquet scale, farmers' fields in this study were divided into two groups. Fields with weed scores below grade 3 were considered 'low weed density fields' and those of grade 3 and above were categorized as 'high weed density fields'. Weed infestations in 'high weed density fields' will have a distinct impact on yields. There will, however, also be fields in the low weed density group in which weeds will have a marked impact on yields. This is because the weed score 2, i.e. a coverage of 6-25%, includes fields with a relatively high weed infestation. A weed coverage of, for example, 20% may indeed affect yield. By setting the line at score 3, we do not suggest that weed infestations in fields assessed lower will not have any impact on yield. Rather it is set at score 3 in order to create certainty that all fields in the high weed density group are negatively affected in terms of yield.

By comparing yield data for the sample (n=93) with weed levels, we discover a relationship. The strong correlation between weed scores and yields (Figure 5) does, however, not imply that weed infestations alone explain the lower yield. A serious weed infestation not only depresses the yield in its own capacity but also seems to be a good indicator of other problems in the field such as poor water management and insufficient land preparation, all having a negative impact on yields.

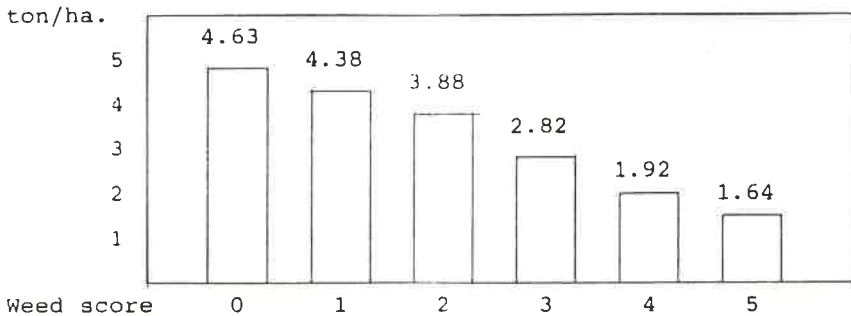


Figure 5: Average yield 1992:1 farmers/felds in different weed score categories, (n =93)

Cost of herbicides

Another serious consequence of the growing problems of weeds is that the cost of herbicides has risen dramatically during the last decade. Findings from the village study during the dry season 1992:1, show a weighted average herbicide expenditure of RM151.00 per hectare (Appendix 1). Although this figure does not include the cost of Paraquat³, it is more than four times as high as the figure (RM 33.19/ha.) presented in a recent production cost surveys carried out by Muda Agricultural Development Authority (MADA) (Wong 1992:41). Partly the discrepancy can be explained by the fact that in two of the five villages studied, farmers seem to be spending very high amounts on agrochemicals.

Taking this into account, a more representative figure would probably come close to the weighted average of herbicide expenditure of the three remaining villages, that is approximately RM125.00 per hectare. Still the

difference is significant. Apart from the herbicide survey, in which each chemical brand used was discussed, farmers have been asked, at two different occasions, about their herbicide cost per hectare. The results confirm the more detailed herbicide survey and show that, on the average, herbicide cost per *relong* exceeds RM125.00.

One factor that could have had an impact on farmers herbicide use was that many farmers were experiencing serious weed infestations in the dry season of 1992. However, further evidence supporting the findings of increasing herbicide costs has been obtained through a questionnaire survey conducted by MADA on behalf of the author. Data pertaining to the wet season of 1992 was collected in association with the authorities' seasonal crop cutting survey. According to the findings of this survey, which covers some 500 randomly selected farms in the whole Muda area (i.e. approximately one percent of the total number of Muda farm households), farmers reported an average expenditure on herbicides of RM107.00 per hectare - a figure still more than three times higher than MADA's.

These findings imply that the cost of herbicides has become an important part of the total cost of production for farmers. The frequent complaints by farmers about increasing herbicide costs should therefore be taken seriously.

Farmers opinions and awareness of the weed problem?

By asking farmers in the sample about the impact of weed infestation on yield, we discover an interesting relationship (Figure 6). More poor farmers reported more serious weed problems and bigger losses.

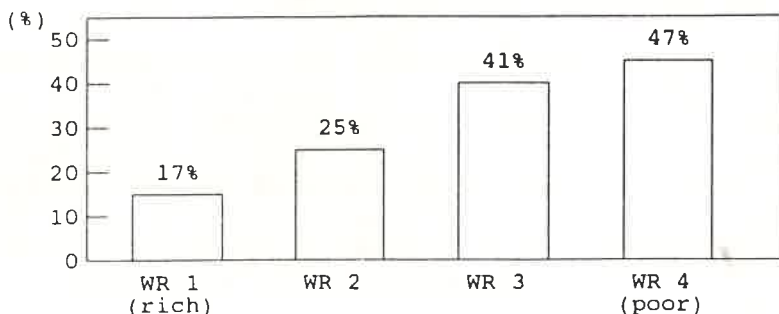


Figure 6: Farmers who estimate yield losses due to weeds at 20% or more a normal season

An important issue when discussing farmers' problems with weeds is the awareness of farmers of the weed coverage in the fields. By using a set of photographs depicting the different grades of weed infestations, farmers were asked to assess their own fields. The outcome shows that in most cases (74%) there is a discrepancy of zero or 1 grade between the farmers own assessment and the assessment made for the study⁴. In other words, farmers in the sample are relatively well aware of the weed situation in the field. It is of interest, however, that seven out of the eight farmers who underestimated the weed density in their fields by two grades or more, belong to the relatively less well-to-do (Figure 7).

(Wealth Rank)	WR 1	WR 2	WR 3	WR 4	ALL
Farmers ' assessment equals project assessment	9	8	11	7	35
Discrepancy by 1 weed density grade (-1 - +1)	9	10	9	6	34
Farmers underestimating their weed coverage by 2 or more grades	1	---	3	4	8
Farmers overestimating their weed coverage by 2 or more grades	4	6	4	2	16
	23	24	27	19	93

Figure 7: Farmers' weed assessment compared to actual score.

THE DISTRIBUTION OF THE WEED PROBLEM

Having briefly discussed the magnitude of the weed problem, the next question that arises is the distribution of the problem. There is a great variation between villages. In two of the villages, Batas Ubi and Kampung Gelam III, farmers do not experience any serious problem with weeds. In two other villages, Permatang Ibus and Permatang Kangkong, however, the situation must be described as serious. This inter-village difference will be discussed in the final section of the paper which compares the two villages - Batas Ubi and Permatang Ibus.

First, however, we need to examine the spread of the weed problem within those villages experiencing high weed density scores. By using maps from the two most seriously affected villages, we can study the

distribution in detail and obtain important spatial information (Figure 8-9). The maps clearly show that the distribution of weed infestations do not follow any physical features like proximity to canals or farm roads. There is a significant number of cases in which fields with light weed infestations are neighbouring fields with serious levels of infestation. Common assumptions that farmers having their fields next to or close to rivers and canals will perform better in terms of weed control than those farming far away from the water source do not seem to hold true in these two villages.

Intra-village differences

Mainly two factors that could explain the intra-village differences have been analysed. These are (1) the level of knowledge of weed management and (2) the economic resources of the farm household that could have an impact on agricultural practices.

Before turning to the first of these, we can briefly state that data collected about farmers' age and formal education show no correlation with levels of weed infestation. In other words, old or young, low or high formal education, does not seem to matter in this context.

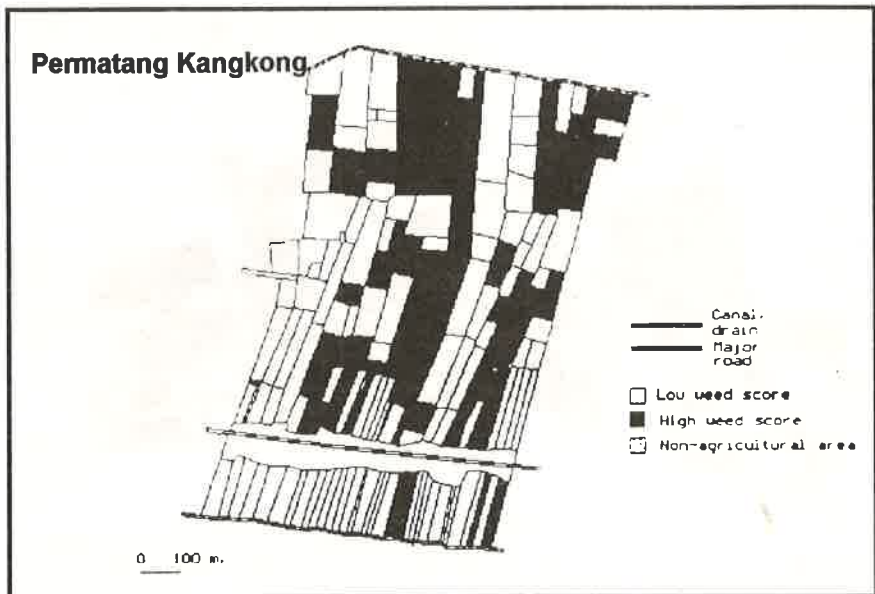


Figure 8: Weed infestations in Permatang Kangkong, dry season 1992.

Famers knowledge of weeds and herbicides - two tests

One assumption of the study was that the knowledge level of weed management may differ among farmers and that such differences could have explanatory value in the analyses of intra-village differences. In order to examine farmers' knowledge, two tests were constructed. Data about farmers knowledge of weed species and herbicide use was collected (Appendix 1 and 2).

The result of the weed test showed that farmers knowledge of weeds is quite high (Appendix 1). Out of 14 weed species, farmers, on the average, recognized 10. (Here it should be underlined that three of the weed species in the test can be considered as relatively new and not yet common in the fields). Farmers know the name of approximately 7-8 weed species. They report that they can identify an average of 8 weeds within 10 days after germination.

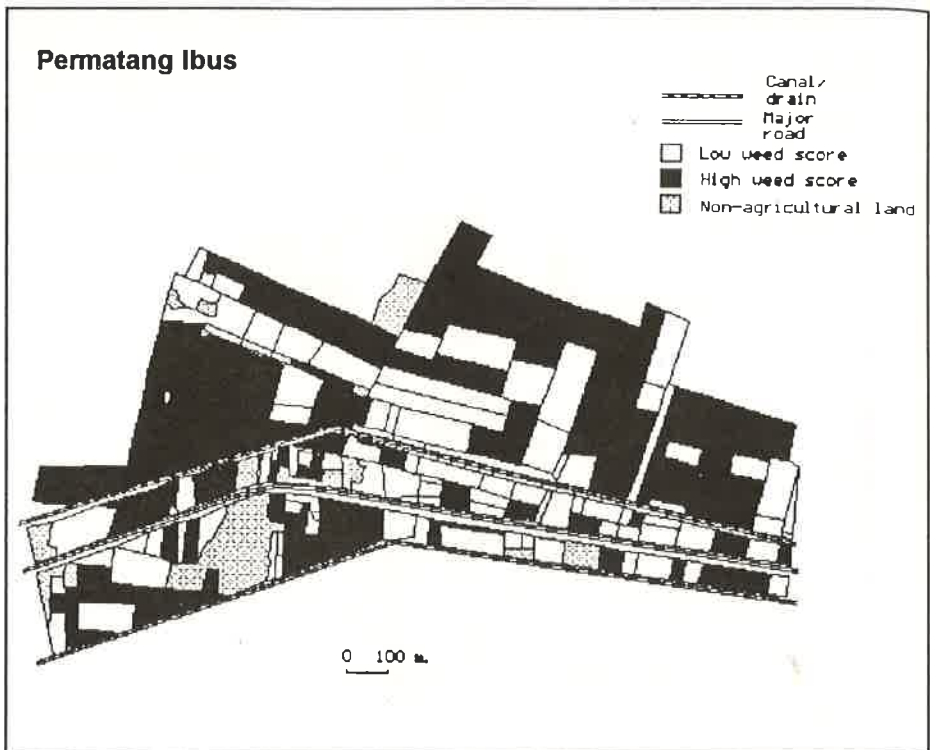


Figure 9: Weed infestations in Permatang Ibus dry season 1992.

When cross-tabled with data on weed levels we can see that farmers having fields with low weed scores, report about the same weed knowledge as those experiencing high scores. In other words, and perhaps a little surprising, no correlation was found between the weed cover of farmers' field on the one hand, and knowledge of weed species, on the other.

The herbicide test also indicated a high knowledge among farmers (Appendix 2). In short, farmers knowledge of application of the most common brands used is high. Mistakes in application - wrong chemical used, wrong amount used or wrong time of application - due to lack of knowledge can be assumed to be few. The fact that knowledge and practice do not always correlate is, however, an important issue that will be addressed in a coming paper presenting findings based on farmers agricultural diaries. As for now, we can report that that farmers reporting no mistakes in application (38%) have weed density scores which are higher than the average for the whole population. In other words, it is not possible to identify any positive relationship between good results in the herbicide knowledge tests and successful weed control.

Weed and wealth

Having shown that poor farmers report higher yield losses due to weeds (Figure 6), we now focus on the relationship between weed cover and the economic resources of the farm household. In order to compare wealth ranks and weed covers for the sample, the following table has been produced (figure 11):

Wealth rank	1(Rich)	2	3	4(Poor)	All
No. of farmers	23	24	27	19	93
No. of farmers with a low weed score	18 (78%)	15 (62%)	18 (50%)	9 (47%)	60 (65%)
No. of farmers with a high weed score	5 (25%)	9 (38%)	9 (50%)	10 (53%)	33 (35%)

Figure 11: The relationship between weed cover and wealth.

Using a non-traditional measurement like that of wealth rank calls for a comparison with other common economic parameters. The table below indicates a strong correlation between traditional parameters such as land size, ownership of farm equipment and total household income on the one hand and the wealth rank on the other (see Figure 12).

Wealth Rank Economic Parameter	1 (Rich)	2	3	4 (Poor)
Average land size operated (ha.)	5.0	2.6	1.8	0.8
Total income RM	18,800	10,000	6,100	4,100
Owners of pedestr. tractors (%)	74%	37%	18%	10%
Owners of small-scale water pumps	87%	37%	15%	5%

Figure 12: Wealth rank compared to other economic parameters

In order to further analyse the relationship between wealth and weed levels the sample is again divided into two groups according to weed coverage. For the two groups, data concerning agricultural practices related to economic resources and the ownership of farm equipment is presented in figure 13.

	Number of farmers (n=93)	Herbi- cide cost per rel. (RM)	No. of farmers owning both water pump and pedestr. tractor	No. of plough- ings/roto- vations (average)	Roto- vating after seeding (%)	yield 1992: 1 ton/ha
Low weed score	60 (65%)	50.85	20	3.3	52%	4.29
High weed score	33 (35%)	31.10	4	2.2	28%	2.37

Figure 13: Differences between 'high weed density' and 'low weed density farmers'

Discussion of intra-village differences

The table above points at the relationship between, on the one hand, weed levels and, on the other, (a) land preparation - number of ploughings and rotoations after seeding, (b) herbicide use, and (c)

access to farm equipment. We can assume a strong relationship between satisfactory land preparation and water management, on the one hand, and low levels of weed infestations, on the other. More well-to-do farmers owning pedestrian tractors and water pump and those who can afford to spend more money on herbicide, on the average, experience less problem with weeds.

To sum up, it can be said the differences in economic resources between farms seem to have stronger explanatory value than differences in farmers knowledge of weeds and herbicide application.

Inter-village differences - The case of Batas Ubi and Permatang Ibus.

Two villages, Batas Ubi and Gelam III, experience very low levels of weed infestation whereas two other villages, Permatang Ibus and Permatang Kangkong are seriously affected by weeds. In order to understand such distinct village differences, a comparison between the most (Permatang Ibus, figure 9) and least (Batas Ubi, figure 14) serious case will be made.

Both villages are situated in areas having low canal density. Both are group farming villages. The operated village area is approximately 105 hectares in Permatang Ibus and 78 hectares in Batas IYoi. In Batas Ubi, a mainly Chinese village, 26 farmers operate an average of 3.0 hectares each. In Permatang Fous, a mainly Malay village, some 104 farmers operate, on the average, 1.0 relong each. (In both villages many farmers operate land outside the defined village area).

From figure 9 we can see that the Permatang Ibus area is divided into 253 parcels to be compared with 67 in the case of Batas Ubi (Figure 14). The layout of fields in relation to canals and roads will be treated in a coming paper on water management and village cooperation. For now, we only use the maps for weed comparisons.

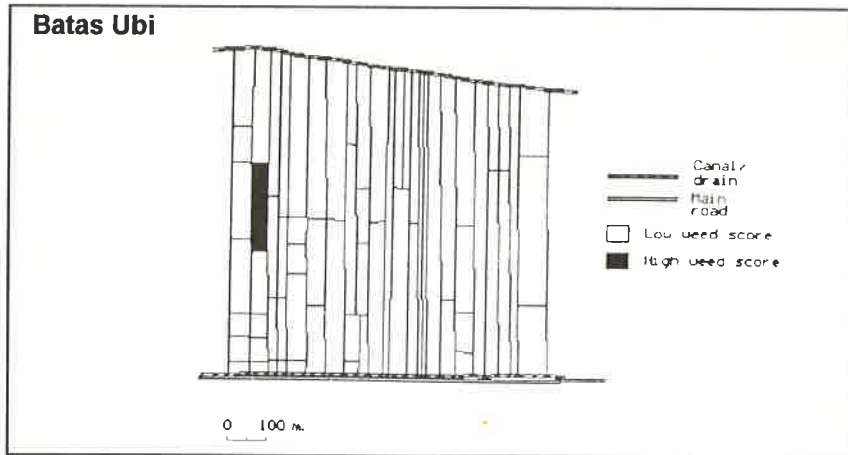


Figure 14: Weed infestations in Batas Ubi, dry season 1992

Departing from the earlier findings about intra-village differences, similar variables are used when comparing farmers' economic resources and cultural practices in the two selected villages (Figure 15).

	Batas Ubi n=20	Pmt. Ibus n=18
Number and percentage of farmers with low weed scores in 1992:1	20 (100%)	10 (56%)
Number and percentage of farmers with high weed scores 1992:1	0 (0%)	8 (44%)
Average yield 1992:1 (ton/ha)	5.42	2.49
Average land size operated (ha) (village land and outside village land)	3.5	2.28
Farmers owning both water pump and pedestr. tractor (%)	35%	5%
Herbicide expenditure/ha. 1992:1 (M\$)	174.30	122.90
Herbicide expenditure/ha. 1992:2 (M\$)	161.80	99.00
Farmers practicing seed selection (%)	75%	28%
Farmers practicing soil pressing after seeding (%)	100%	78%
Farmers rotavating after seeding (%)	100%	17%
Farmers who claim they cannot afford sufficient rotoation (%)	40%	78%

Figure 15: Comparative data for Batas Ubi and Permatang Ibus

CONCLUDING REMARKS

At this early stage of data analysis it would be pre-mature to over-emphasize any particular variable in the search for explanations to the village differences. On-going data analysis will, once completed, provide important information about variables such as cooperation levels, time-management in farming activities, water management problems faced by farmers, etc.

However, the above presented data do seem to point in a certain direction. Differences in weed infestations between farmers' fields, whether within in a village or between villages, seem to be strongly correlated to differences in economic resources of farmers. The Batas Ubi farmers are better equipped and are willing to incur higher costs for thorough land preparation and sufficient herbicide application. In Permatang Ibus, on the other hand, farmers operate on smaller land and often cannot afford the necessary weed controlling techniques.

A general question that arises from the presented village surveys is the following: how will small scale, resource-poor farmers (wealth rank 3 and 4), who traditionally have been able to substitute labour for capital, be able to survive economically as the changing farm environment demands an increasing input of capital? In the case of Malaysia, rice farmers belong to the relatively poor segments of the society. The resource-poor farmers in this study (wealth rank 3 and 4 account for 52% of the total sample frame, $n=318$) are presently experiencing a difficult situation. The recently adopted technique of direct seeding saves labour but demands increased access to farm equipment and expensive chemical weed control.

NOTES

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1992 - 1993. Last but not least, I would like to thank Dr. Ramli Mohamed, Associate Professor/Deputy Dean Communication Programme University of Science, Penang, who has acted as my Malaysian academic supervisor during the work.

- 1 The relative importance of the Muda area stems from the fact that it accounts for 34% of the country's double cropping area and contributes to almost 60% of national production. The second largest of Malaysia's eight granaries, the Kemubu scheme in the north-east of the peninsula, is only 28% of the size of Muda and average yields lag behind Muda's by about 20% (Wong 1993).
- 2 This paper is one in a series presenting primary data collected in connection with the on-going research project "Land Use Intensification - Social and Ecological Impacts. A case study of the Muda Irrigation Scheme, Malaysia."
- 3 Paraquat is a non-selective herbicide used mainly to control weeds on the field bunds.
- 4 The weed assessment was carried out by the author together with staff, especially trained and experienced for the purpose from the Department of Agriculture, Kedah.

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Appendix 1 - Herbicide Test

							Ringgit/rel.		
Herbicide brand	no. of users (n=83)		wrong weed match	wrong quant.	wrong timing	total sample expend MR	average cost (user)	average sample cost n=93	
Paraquat	(Not include in the study) 72 use P. on the batas.								
Rumpotox	61	66%	2	8	5	341	5.60	3.70	
Amine2,4	49	53%	-	9	4	287	5.90	3.10	
Ally	41	44%	1	2	3	149	3.60	1.60	
Whip-S	40	43%	2	7	5	940	23.50	10.10	
Ordram	35	38%	1	5	7	960	27.40	10.30	
Sindax	22	24%	1	3	6	168	7.60	1.80	
Londax	15	16%	-	1	2	193	12.90	2.10	
Nabu	14	15%	1	4	1	261	18.60	2.80	
Arosollo	11	12%	-	4	5	192	17.50	2.10	
Sofit	9	10%	3	4	6	148	16.40	1.60	
Stam F	8	8%	2	4	5	119	17.90	1.30	
Eptam D	7	8%	-	1	-	241	34.40	2.60	
Facet	3	3%	-	1	1	42	14.00	0.50	
Classic	2	2%	-	-	-	6	3.00	0.10	
Saturn1	1	1%	-	1	-	11	11.00	0.10	
Ronstar	-	-	-	-	-	-	-	-	
Satunil	-	-	-	-	-	-	-	-	

Weighted average herbicide cost per relong (n=93) MS: 43.40

Weighted average herbicide cost per hectare (n=93) MS: 151.00

10 FARMERS DID NOT APPLY HERBICIDES 1992:I

Appendix 2 - Weed Test 1992:1

Code	Types of weeds	exists in the field (%)		Farmer knows the BM name (%)		timely recognition		Intensity score 0 1 2 3 4 5
a)	Echinochloa crusgalli	91	98%	87	94%	82	88%	1.70
b)	Leptochloa chinensis	81	87%	54	58%	65	70%	1.43
c)	Scirpus grossus	44	47%	81	87%	80	86%	0.27
d)	Fimbristylis miliacea	66	71%	54	58%	54	58%	0.45
e)	Monochoria vaginalis	60	64%	72	77%	78	84%	0.40
f)	Ludwigia hyssopifolia	37	40%	33	35%	42	45%	0.16
g)	Sphenoclea zeylanica	65	70%	57	61%	64	69%	0.57
h)	Marsilea creanata	51	55%	61	66%	73	78%	0.29
i)	Cyperus difformis	65	70%	29	31%	66	71%	0.51
j)	Ludwigia adscendens	21	23%	50	54%	55	59%	0.05
k)	Cyperus Iria	44	47%	61	66%	60	64%	0.27
l)	Cyperus babakensis	24	26%	22	24%	37	40%	0.25
m)	Melochia corchorifoli	17	18%	6	6%	17	18%	0.29
n)	Scirpus juncoides	14	15%	16	17%	12	13%	0.29