WEED PROBLEMS AND FARMERS'WEED MANAGEMENT STRATEGIES IN RAINFED PADDY AGROECOSYSTEMS OF SATHING – PHRA, SOUTHERN THAILAND

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ABSTRACT

A study of the agrarian system of Sathing Phra area, started in 1982, has pointed out that weed problems faced by all types of farmers were one of the three main "bottlenecks" of rainfed rice based cropping systems. Weed types and their degree of infestation in rice fields depend on the characteristics of the agro-ecological units indentified in the area. Among weeds identified, "wild rice" is the most dreaded by farmers. It's increasing infestation appears to be linked with the recent changes in the system of land use.

Very few rice fields can be replanted by farmers since the impossibility of control of water level in paddies creates too high a manpower demand over a short duration. The technique of dryseeded broadcasting allows farmers to plant all their fields. But in this case weed competition is a serious limiting factor of rice yields. The highly time consuming technique of hand weeding generally combined with thinning-replanting technique can only be performed during a short duration defined by agro-ecological constraints. Therefore, only part of the paddies can be completely hand weeded. Added to ecological constraints, specific constraints of the three types of farming systems indentified in the area have to be taken into account. Although numerous weed management strategies, especially wild rice ones, are employed, weeds cannot be properly control on all paddies. These observations provide basic information necessary for the launching of on-farm research on wild rice ecology and control in a cropping system perspective.

INTRODUCTION

Many weed-control measures in rice have been reported according to type of rice culture (De Datta, 1980). But the final choice of any weed-control measure will depend largely on farmer's resources and constraints (De Datta and Baker, 1977).

From 1982 to 1984, the Thai-French Farming System Research Project, based at the

Faculty of Natural Resources, Prince of Songkla University, has undertaken a detailed analysis of the agrarian system of Sathing Phra area, Southern Thailand (Trébuil, 1982; Trébuil et al 1983; 1984). This phase of diagnosis first consisted in identifying the agro-ecological units of the area and understanding the present system and recent changes in land use (Trébuil et al, 1983). It ended on a functioning typology of farming systems, based on their respective socio-economic strategies (Trébuil et al, 1984, Trébuil, 1984). Constrainsts and bottlenecks faced by each farming system type were well identified (Trébuil et al, 1984).

In rainfed rice based cropping systems, weed problems, especially those of wild rice, together with land preparation and soil fertility were found to be the three limiting factors.

This paper aims at presenting the relative importance of weeds in rice based cropping systems of Sathing Phra area, and at reporting farmers' weed management strategies.

MATERIAL AND METHODS

a) Identification of the regional agro-ecological zones and weed infestation.

Five-line transects were selected for field-runs according to the geomorphology of the area, soil series, type of habitat and the repartition of the sugar palm tree *(Borassus flabellifer)* plantations in order to cover the maximum variety of the human and physical environment (Trébuil et al, 1983). During these field-runs, the following information was recorded for each crossed plot:

- soil characteristics
- relative topographic situation and drainage channels
- existing flora, on the plot itself as well as in the hedges or on the paddy bunds
- in case where the plot was under cultivation at the time of the field-run a rapid enquiry was made into the cultivation techniques employed, especially for rice.

These latter observations were used to define agro-ecological units. As part of agro-ecological characteristics, weed types and infestation were evaluated in the different agro-ecological units.

b) Relative importance of weed control and famers'weed management strategies.

A deeper agro-ecological diagnosis helped to indentify the ecosystem determinant variables, at the same time taking into account both historically and dialectically, the agricultural activity (on the basis of the mode of ecosystem artificialisation) and the natural resources (their nature, state of reproducibility) (Trébuil, 1982; Trébuil, et al, 1983). Relevant criteria for the definition of a reasoned and restricted sample of farming systems have been chosen on the basis of this agro-ecological diagnosis. Farming system functioning, farmer strategies and technical choices, as well as their consequences on cropping systems have been studied on this sample throughout an annual cultivation cycle.

During this latter study, relative importance of weed control and farmers' weed management strategies, especially of wild rice, were evaluated according to agro-ecological units and farming system functionings.

RESULTS AND DISCUSSION

a) Weed infestation in the agro-ecological units of the area.

Figure 1 shows topographical profile and the distribution of agroecological zones along one of the five line-transects periodically covered.

From a rice based cropping systems point of view the numerous agroecological zones could be gathered into three main agroecological units. Some of their characteristics as well as the principal types of weeds and their level of infestation in paddy fields are given in table A.

Among weeds identified, wild rice is the most dreaded by farmers. Data concerning the recent technical and socio-economic transformations of the agrarian system (through guided interviews with local old people) showed an increasing infestation of paddy fields by wild rice. Wild rice, identified as *Oryza perennis* by N W S R project (1984) and *Oryza barthii* (J.DEUSE pers comm.), was reported to be initially present in the uncultivated land on which the conquest for rice cultivation ended 40 to 50 years ago. Natural hybridization, by which wild rice phenotype becomes closer to the of cultivated rice, make its control by farmers more and more difficult.

Weed problems and control have been deeply modified by the recent changes of the agrarian system. The expansion of rice cultivation has occured principally under the effect of demorgraphic expansion (297 persons/km^2 in 1960, 372 in 1981). It has in time condemned the traditional way of maintaining fertility in the rice fields, based on the grazing of grass borders by cattle and the concentration of organic manure on the rice plots. These changes mark the penetration of the market economy into the zone in the form of an expansion of the rice sugar palm combination and the decrease of livestock, the organic manure from which is now concentrated on market gardens situated on the sand ridges. These imbalances have been only partially solved by the recent use of motorization of ploughing and the use of chemical fertilizers, as yet still little employed.

Within this new context, weed control measure are largely affected by agro-ecological constraints and the socio-economic strategies which characterize nowadays farming systems.

b) Relative importance of weed control in rainfed based cropping systems.

As a general rule, the first constraint of rice based cropping systems of the area is the impossibility of control of water in paddies, whether excess or lack. One rice crop a year is then the most frequent. Transplanting technique is very limited (15% of the rice fields cultivated by our sample of farmers in 1983) since the impossiblilty of control of water level in rice fields

Zones	Characteristics	
1	Sand dunes on present existing coast.	
2	Uninhabitated coastal land	
4	Type A village on sand ridge, with many gardens.....	AGRO-ECOLOGICAL UNIT I
5	Type B village on narrow sand ridge, with few gardens.....	
6	Type C village beside the lagoon	
7	Sugar palm trees closely associated with rice.....	AGRO-ECOLOGICAL UNIT II
8	Sugar palm trees loosely associated with rice.....	
9	Rice field without sugar palm tree.....	AGRO-ECOLOGICAL UNIT III
10	Grassland beside the lagoon	
	0 = drainage canal	

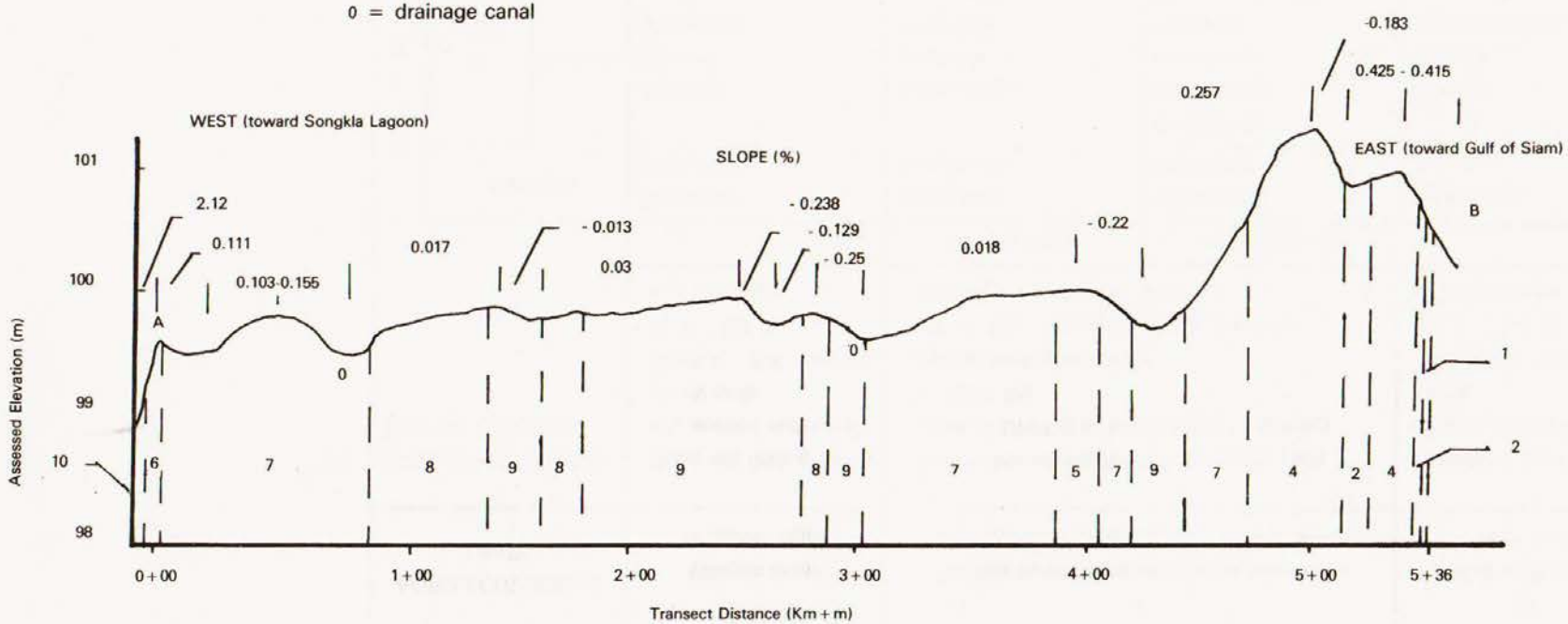


Figure 1 Topographical profile and distribution of agro-ecological zones along a transect line (Ran Ro Daeng to Ban Tha Hin)

Table 4 Main weeds of rice fields and their degree of infestation according to agro-ecological characteristics

AGRO-ECOLOGICAL UNITS			I Villages areas on sand ridges	II Paddies surrounded with sugar palm trees *(Borassus flabellifer)* planted on the bunds		III Paddies without sugar palm trees
MAIN CHARACTERISTICS OF THE UNIT			- Upper rice fields generally dry-seeded nurseries - sandy soils - pH<5.1; - P.K. very low - % C < 0.7 % - fast drainage	- Succession of rice fields from upper parts (limit of UNIT I) to lower parts 1 begining of UNIT III) - Sandy clay to clayey soils - pH ≤ 5.5; - P.very low; - % C < 1 % - Drainage : medium to slow		- Lowland rice fields - Clayey to heavy clayey soils - pH ≤ 5.2; - P.very low - % C < 1.2 % - Drainage very slow
				UPPER PART	LOWER PART	
MAIN WEEDS	FAMILY		Gramineae Mimosaceae	Gramineae Cyperaceae	Cyperaceae Gramineae	Cyperaceae
	Genus	frequent	Digitaria Mimosa Bulbostylis	Echinochloa Cyanotis Paspalum Fimbristylis Oryza (wild rice)	Fimbristylis Echinochloa Ischaemum Paspalum Oryza (wild rice) Cyanotis Ipomoea	Cyperus Scirpus Aeschynomene
		common	Dactyloctenium Heliotropium	Mimosa Heliotropium Chrysopogon	Cyperus Scirpus Altlernanthera Jussiaca	Oryza (wild rice) Jussiaca Monochoria Scleria
DEGREE OF INFESTATION			very high	high	high	low

creates too high a manpower demand over a short period. In order to plant all their ricefields, farmers employ dryseeded broadcasting technique and various methods such as minimum land preparation and early sowing which on the contrary facilitate weed infestation. After only one ploughing, weeds of fallows are only partly buried. Competition between rice and weeds is then generally high, especially during years caracterized by a late onset of the first heavy rain (late flooding) and drought periods during the rice cultivation.

Hand weeding is always combined with the anti-aleatory technique of thinning-replanting within a plot which aims at homogenizing rice population over the field. The opportunity to complete hand weeding-thinning-replanting technique usually affects fertilizer use by farmers as well as the yield of rice fields. If hand weeding-thinning-replanting is not achieved before complete flooding of a field, the second application of fertilizers is not performed by farmers and yields are strongly affected. Figure 2 illustrates the interdependance between the hand-weeding technique and fertilizers use by farmers in the case of broadcasting. Figure 3 shows significant correlation between yield of broadcasted paddies and the amount of fertilizers employed; this latter itself strongly linked with hand weeding. Table B summarizes this combined effect of hand weeding-fertilization interaction on yields of broadcasted paddies. These data demonstrate the importance of a good weed control in dryseeded paddies.

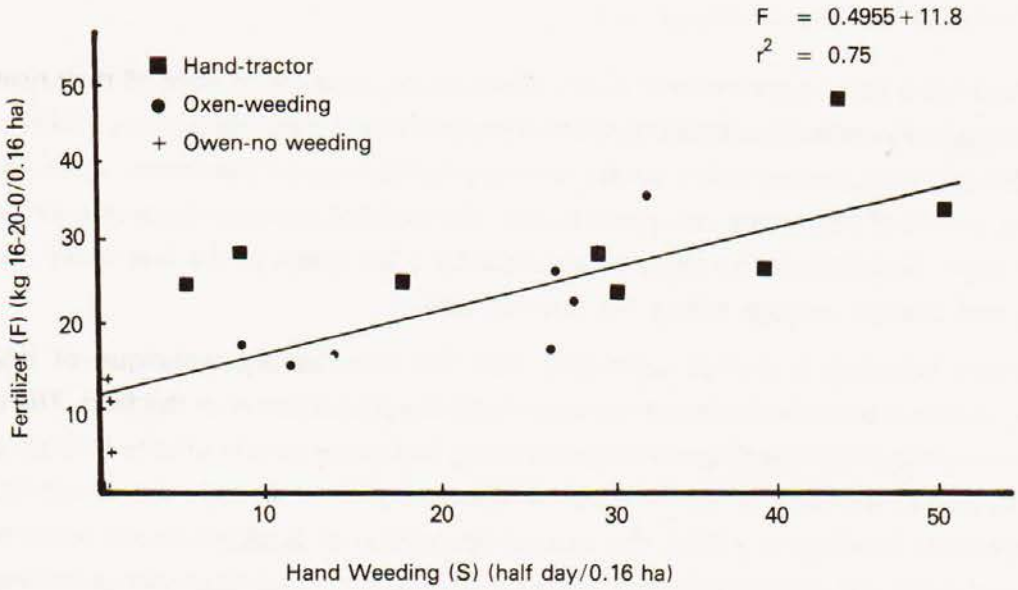
Unfortunately nowadays agro-ecological constraints allow a only partial hand weeding of paddies. On sand bar units, weed infestation is often serious but as fields are used primarily as rice-bed nurseries hand weeding is almost nonexistant. On the contrary in the two others units whose soils are mainly clayed textured ones hand-weeding can begin only when soil moisture is high enough (≥ field capacity). Hand-weeding start first in the lowest plots (unit III) which are also the first to be flooded. In this unit, hand-weeding is often less determinant than land preparation quality, because of the short time available before flooding for hand-weeding-thinning-replanting technique. In unit II hand-weeding stops with the complete flooding of paddy fields.

Due to those latter constraints, hand-weeding often take place more than two months after sowing. In addition, the degree of hand-weeding and application of weed management strategies largely depend on farming systems constraints which differ among farming system types identified.

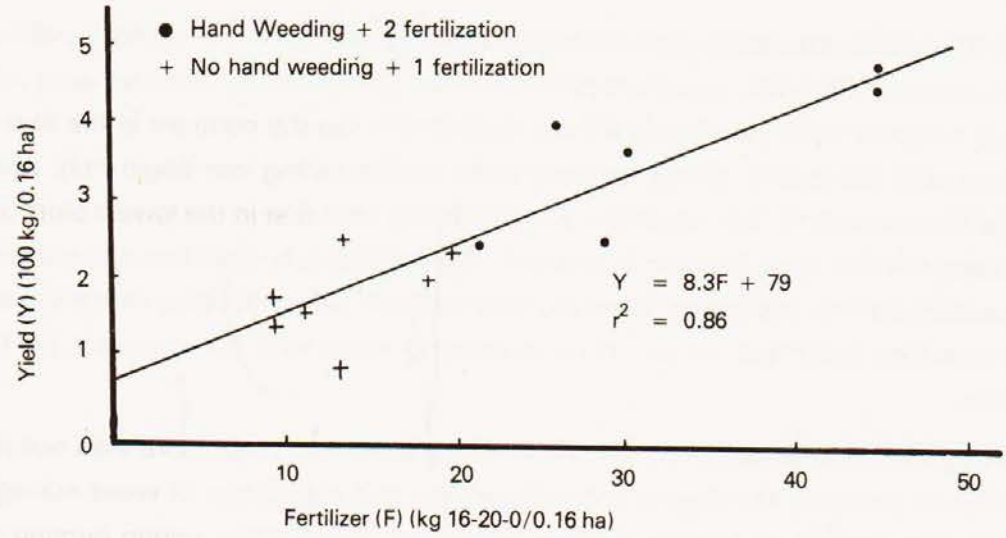
c) Weed management strategies used by farmers and differences between farming system types.

Beside hand-weeding techniques, farmers use various strategies to limit weed infestation in paddies. The most important is rotation in fields to be transplanted. Priority for replanting is given to plots highly infested during the previous rice cultivation and fallow; especially for wild rice infestation.

Traditionally the bunds which surround paddies were hoed with a long handled hoe at the beginning of the rice-growing cycle. This technique limited weed propagation from the



Fiqure 2 Correlation between hand weeding and fertilization when ploughed in sowing



Fiqure 3 Correlation between hand-weeding and chemical fertilization and response to fertilizer application when sowed after two tillages.

Table B Fertilization and Yield of hand-weeded paddies compare to non-weeded paddies when sowed after two tillages.

	Hand-weeded Plots	Non-weeded plots
Number of field observed	6	9
Amount of 16-20-0 fertilizer used (kg/0.16 ha)		
minimum	20	10
maximum	47	18
Yield (kg/0.16 ha)		
minimum	220	90
maximum	240	250

bunds used for animal grazing during rice cultivation. Nowadays this technique which was formerly practiced during the animal rests, is slowly disappearing as animal husbandry decreases. The use of hand tractors which leaves the corners of paddies uncultivated also increased weed infestation.

Among weeds, farmers employ specific management strategies to limit wild rice infestation:

– When possible, transplanting is practiced on plots infested during the previous rice cultivation. Wild rice infestation during the year is assessed by its density in fallow fields. It can even be assessed soon after sowing as farmers have observed that wild rice germination occurs mainly inside clods while cultivated rice seeds germinate in between colds after broadcasting. When infestation is serious, if still possible, the plot will be replanted by transplanting technique, or if not, specific care is given hand-weeding.

- Varieties with specific morphological characteristics (shape and color of the leaf, distribution of tillers...) are chosen to allow early distinction between wild rice from cultivated rice.

- When hand-weeding has to be stopped after heavy rains, wild rice plants are cut by sickle for cattle feeding.

- Later, as heading of wild rice generally occurs before that of cultivated rice, panicles of wild rice are harvested by "Kae" between flowering and maturity of the rice crop to limit further infestation.

All these weed management strategies are highly time consuming. Effective hand-weeding requires around 150 days per ha. according to farmers reports. We have seen previously that agro-ecological constraints already limit considerably the possibilities for effective hand weeding of all the paddy fields. In addition new constraints must be taken into account according to farming system types, especially labor facilities and its allocation to the system of production.

More details on the three main types of farming systems identified in the area, and their functioning and socio-economic strategies have been reported elsewhere (Trebuil et al, 1984; Trebuil, 1984).

On type I farms, where all around the year, most of the family work-force is invested in non-rice economic activities (ducks and chicken raising, palm sugar making, temporary jobs...), hand-weeding in paddy fields competes with those latter activities. Although there is a low ratio of rice cultivated land per economically active person (0.27 to 0.38 ha) paddy fields are generally incompletely hand-weeded.

On the contrary the most intensive hand-weeding is usually a characteristics of type II farms where all the family workforce is mobilized on paddy fields during the wet season 0.48 to 0.8 ha/econom.activ.pers.). But still, all the paddies cannot be hand-weeded, especially plots

far from the village. During 1982-1983 rice cultivation 85% of dryseeded paddies close to the villages were hand-weeded against 16% for dryseeded paddies far from villages.

On type III farms where productivity per labour is high, either because they have adopted on some plots intensive rice production techniques (transplanting of hybrid varieties...) or because on the other hand, very extensive rice cultivation on large areas, hand weeding is limited by the lack of labour (more than 0.8 ha./econom.active. pers.). Therefore low hand-weeding is given to dryseeded paddies, especially in farms practising transplanting of hybrids in some plots.

CONCLUSION

Recent changes in the mode of artificialization of the ecosystem (cultivation of all fields for rice, abandonment of organic manure fertilization, use of mechanization and fertilizers) seem to have reached their limits. Without any possibiligy of water control and with a limited use of fertilizers traditional technical itineraires used by farmers give a paddy yield of around 1.9 T/ha. We recorded that 50 days/ha. of hand-weeding were required to give at least a yield of 2.2 T/ha. Added to ecological constraints which limit hand-weeding possibilities, not all farming systems types can allocate such high a demand in manpower.

Among weeds identified, wild rice is the most difficult to control. Farmers management strategies are not sufficient to limit its infestation, and due to its high hybridation abilities its recognition becomes more and more difficult for farmers.

These latter data have shown that weed problems cannot be isolated from the other elements of the cropping systems (land preparation...) and nor more generally from those of farming systems (socio-economic strategies...). Following this diagnosis, on farm research on "wild rice" ecology and control has been undertaken in a cropping system perspective where land preparation and crop rotation interaction are considered (Crozat and Chitapong, 1984). Whatever technical solutions may appear, they will have to fit into the respective socio-economic strategies of farming systems previously identified.

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