IMPORTANCE OF WEED INFESTATION IN RICE IN THE FUNCTIONING OF AGRICULTURAL PRODUCTION SYSTEMS : CASE STUDY OF A RAINFED PADDIES AREA IN PHATTHALUNG PROVINCE, SOUTHERN THAILAND[1/]

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Abstract

Research work was carried out during the year 1989 in one dry-seeded rainfed paddies area in Amphoe Khao Chaison, Phatthalung Province, in order to analyse the weed problem in rice in a comprehensive way and to bring out and test the inner coherence of the existing cropping systems towards weed management. This allowed standard data and tresholds to be generated as references in the area.

The farmers were found to manage weeds mainly by land preparation until rice sowing. Analysis of available and necessary days for land preparation, as well as farmers' interviews, allowed to determine three types of cropping systems corresponding to low, medium and high ratio land/work, leading to three defferent types of land preparation. The implementation of those cropping systems could be linked with the objectives of the farmers and the functioning of the agricultural production systems.

Farmers appeared not to weed their paddies because of labor constraints at the weeding period, mainly due to cattle breeding activities. In this context, weeds were found to be also an important source of forage for cattle during the rice cultivation. The collection of rice weeds as forage for cattle was found to range from 8 to 100 % of the total paddies' weed infestation, but can not be considered as part of the farmers' weed control strategy, for it is made at random in anyone's paddies.

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บทคัดย่อ

งานวิจัยนี้ทำที่พื้นที่นาอาศัยน้ำฝนในอำเภอเขาชัยสน จังหวัดพัทลุงในปี 1989 โดยมีวัตถุประสงค์ที่จะวิเคราะห์ปัญหาวัชพืชอย่างละเอียด ตลอดจนอิทธิพลของระบบการปลูกพืชต่อการจัดการวัชพืช เพื่อจะได้ข้อมูลมาตรฐานในการอ้างอิงในพื้นที่ดังกล่าว

จากการศึกษาพบว่าเกษตรกรจัดการวัชพืชโดยการเตรียมดินจนกระทั่งการปักดำ จากการวิเคราะห์ข้อมูลจำนวนวันที่ใช้เตรียมดิน และการสัมภาษณ์เกษตรกรพบว่ามีระบบการปลูกพืช 3 ระบบที่เกี่ยวข้องกันกับอัตราส่วนของพื้นที่/งาน ต่ำ ปานกลาง และสูง ตามลำดับ ซึ่งจะสัมพันธ์กับวัตถุประสงค์ของเกษตรกรและระบบการเกษตร

เกษตรกรส่วนใหญ่ไม่กำจัดวัชพืชในนาเพราะขาดแรงงานในช่วงที่ควรมีการกำจัดวัชพืช เนื่องจากตรงกับช่วงระยะเวลาผสมพันธุ์ของโค กระบือ วัชพืชในกรณีนี้มีบทบาทเป็นอาหารสัตว์อีกด้วย พบว่ามีการเก็บเกี่ยววัชพืช 8-100% มาใช้เลี้ยงสัตว์ แต่ไม่อาจถือว่าเป็นการกำจัดวัชพืชได้ เนื่องจากเกษตรกรจะสุ่มเก็บเกี่ยวจากแปลงนาของใครก็ได้

บทความนี้ได้เสนอแนะวิธีการปรับปรุงการผลิตด้วย

INTRODUCTION

Previous diagnosis on rice cropping systems in Phatthalung Province and especially in the Ta Chiat irrigation area of Amphoe Khao Chaison, assumed that an important limiting condition of rice cultivation in the nonirrigated rainfed paddies agro-ecological unit (unit 4-2) was weed infestation in the paddy fields (5).

At the plot level, the weed infestation results from the interaction between the characteristics of the environment and the climate on one hand, and the cropping system performed on the plot on the other hand (9).

The cropping system concept is here defined as, a set of techniques performed on plots which are handled in an identical way, Each cropping system is defined by :

- the kind of crops and their succession order,
- the itineraries of techniques applied to these several crops, including the choice of the varieties for the selected crops. "(adapted from 9).

Within each cropping system, the successive techniques performed by the farmer for a given plot (the "itinerary of techniques") are logically linked and result from his objectives and the functioning of the farm on one hand, and from the characteristics of the environment on the other hand (8) (Fig.1)

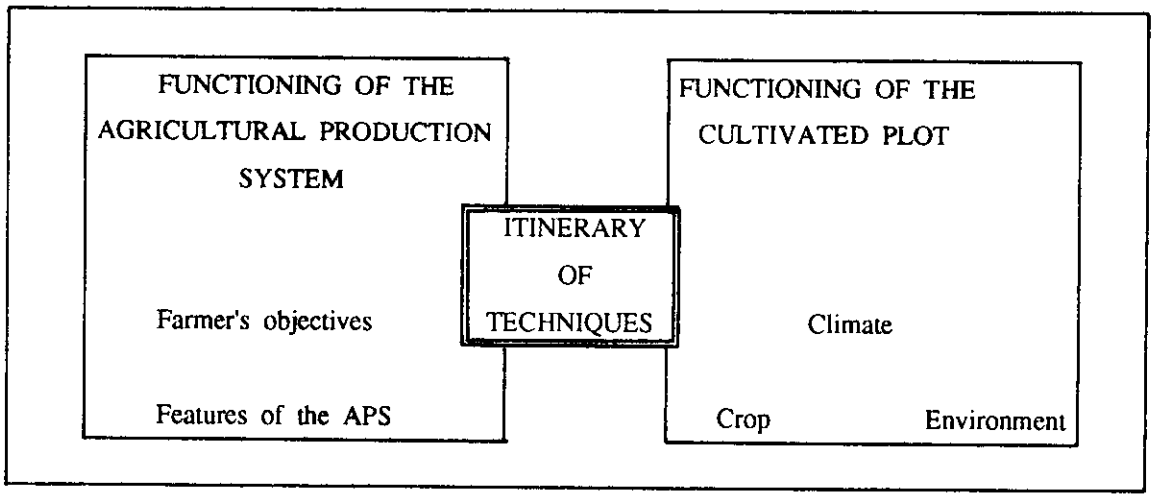

Figure 1 : The concept of itinerary of techniques, (Adapted from 4).
(The farm is here considered as and Agricultural Production System finalised by the farmer's and his family's objectives (1).)

In this perspective, the analysis of the weed management in the farmers' plots must not be performed out of context, from an "external" point of view, according to standard data which are in most cases generated in experimental stations and correspond to maximum target yields.

On the contrary, knowing that the functioning of the Agricultural Production System (APS) has an effect on the plots management, it is necessary to bring out the objectives of the plots management, it is necessary to bring out the objectives of the farmers concerning the management of their crops and to base the diagnosis on the two following questions (11) :

- did the farmer do what he wanted to do ?
- is the current situation acceptable by the farmer considering his objectives ?

Thus, the diagnosis on the weed problem in the farmers' paddy fields will be carried out in two direcions :

- what are the objectives of the farmers concerning rice weeds management, and what is the relationship between these objectives and the functioning of the APS in the studied area ?
- to what extent do the cropping systems the farmers implement on their plots allow them to reach their objectives, and for what reasons ?

I- DETERMINATION OF THE CROPPING SYSTEMS PERFORMED BY THE FARMERS.

1- Materials and method.

The determination of the existing cropping systems is made through investigations taking into account a maximum diversity of the APS (1)(14), here concerning their general features (cultivated area, labor force, equipment).

Through these investigations, the combination of the productions existing on the APS and its relationships with the environment, the labor and the equipment (1) is brought out, as well as the farmers' itineraries of techniques concerning rice cultivation. Emphasis is there laid on rice weeds management.

2- Results.

In agro-ecological unit 4-2, farmers cultivated one dry-seeded rainfed rice crop per year, from September to January. No other crop is cultivated except on some APS and on very limited area, occasional and risky rainfed cucumber crop, during the pre-humid season. Paddies remain fallow from February to June.

The farmers' itineraries of techniques in rice are very homogeneous in the studied area. Two types were recorded, consisting as follow (Fig.2) :

- in the APS equiped with oxen-draught plough (85 % of the APS), three tillages are performed before rice sowing, from June to August-September. Rice is

/June /July /August / Septemb. /October /November /December /January /February /March /Avril /May/							
ITINERARY OF TECHNIQUES TYPE A							
T1	T2	T3	S + T4	C-Tr	F	Harvest	Fallow
ITINERARY OF TECHNIQUES TYPE B							
T1	T2	S + T3	C-Tr	F	Harvest	Fallow	

T1 first tillage — T2 second tillage
T3 third tillage — S sowing of rice
T4 fourth tillage — C-Tr clearing transplanting
F fertilizer dressing

Figure 2 : The itineraries of techniques performed in the dry seeded rainfed paddies of Ta chiat irrigation area, Amphoe Khao Chaison, Phatthalung Province.

broadcast in September and the seeds are ploughed-in with a fourth tillage. One month to one month and a half after rice settlement, the poor regularity in plant stand resulting from the rough seedbed is corrected through clearing-transplanting within the same plot, until mid-November. Fertilizer dressing is then performed on some parts of the plots by the end of the same month. No other intervention takes place until harvest in January.

- in the APS equiped with a hand tractor (15 % of the APS), the itinerary of techniques performed is very similar, except that two tillages are performed before crop sowing instead of three.

3- Discussion.

The kind of crops and their succession order in the studied area are homogeneous and do not result from the farmers' objectives nor strategies. The environmental constraints do actually not allow other crops : plots are flooded 4 to 5 months per year which obliges rice cultivation. No irrigation water supply is performed, leading to an uncontrolled flooding during the rainy season (October to January) which makes the transplanting technique risky, and to a severe lack of water during the dry season (February to May) and the pre-humid season (June to September), this water lack being accentuated by the sandy texture of the soils (dry-season crops possible only on very limited area like 1 rai). So the only possible crop in the studied area is dry-seeded rainfed rice.

Thus, the diagnosis on weed management in the cropping systems will be made at the itinerary of techniques level. The analysis will be carried out in two steps :

- until ride sowing
- after rice sowing.

II- APPRAISAL OF THE LAND PREPARATION AND RICE SOWING ITINERARIES OF TECHNIQUES.

1- Materials and method.

In order to appraise the itinerary of techniques for land preparation performed by the farmers, several elements have to be analysed.

First, the objectives of the farmers concerning land preparation must be brough out : what modification of the environment is wanted, through what kind of techniques, in which soil moisture conditions?

Then, the question which must be considered is to what extent and in which cases these objectives can be reached. Thus, the feasibility of the itineraries of techniques of land preparation within a given range of soil moisture has to be appraised.

The concepts of "available days" and "necessary days" (4) (6) enable us to answer this question.

An "available day" is defined as a day when the achievement of a given cultivation technique is possible. It is determined according to :

- the conditions considered by the farmer as favourable to the achievement of the technique (depending on the type of tool, the type and the target state of the soil, and the technical objective of the farmer concerning the result of the cultural intervention).
- the climatic data during the considered period, which allow to determine the frequency of occurence of the favourable conditions above-mentioned. This frequency has to be defined by an average on several years in order to decrease as much as possible the "year effect".

The "necessary days" are defined as the number of days necessary to achieve the technique on a given APS. It depends on the features and functioning of each APS, such as the equipment, the available laborforce and the labor calendar during the studied period.

The assessment of the feasibility of the considered itineraries of techniques is then performed by comparing the number of availavle days (NAD) and the number of necessary days (NND).

If NND < NAD, then the farmer can reach his objectives concerning land preparation (situation 1).

If NND = NAD, the system works up to the limit. The risks linked to such full functioning must be assessed and discussed (situation 2).

If NND > NAD, the farmer can not reach his objectives (situation 3).

In the three cases, the reasons for such situation must be appraised, for it is not a conicidence but a structural characteristic of the system wich has to be linked with the whole functioning of the APS.

2- Results.

The objective of the farmers concerning the land preparation is to bury completely the weeds at rice sowing.

This objective can be reached on the condition that :

- three ploughings are actually performed before sowing in case of oxen-draught tool, and two in case of hand tractor.
- each ploughing (including the post-sowing one) is performed in favourable hydric conditions of the soil :

  tillage in very humid conditions does not allow the plough to cut the roots of the weeds, which leads to quick regrowing of the weed population,

  tillage in dry conditions generates large size and chahotic clods, which allows only partial burying of the weeds. The strength of cattle is anyway not enough to plough in very dry conditions.

The soil moisture requirements for ploughing were determined through farmers' interviews during the ploughing period of the year 1989. Thereby four classes of soil moisture where the farmers actually plough their fields could be distinguished :

- class A : low moisture conditions, between field capacity and the limit of drought allowing ploughing,
- class B : optimum moisture conditions, corresponding to field capacity,
- class C : high moisture conditions between saturation and field capacity,
- class D : very high moisture conditions corresponding to the saturation.

One must remark here that the interviews did not allow any difference to be brought out in the soil moisture requirements for hand tractor and oven-draught plough, though the available traction strength is obviously very different for these two tools.

The soil moisture during this period was assessed through a simplified model of cumulative "Rain - Evapotranspiration"

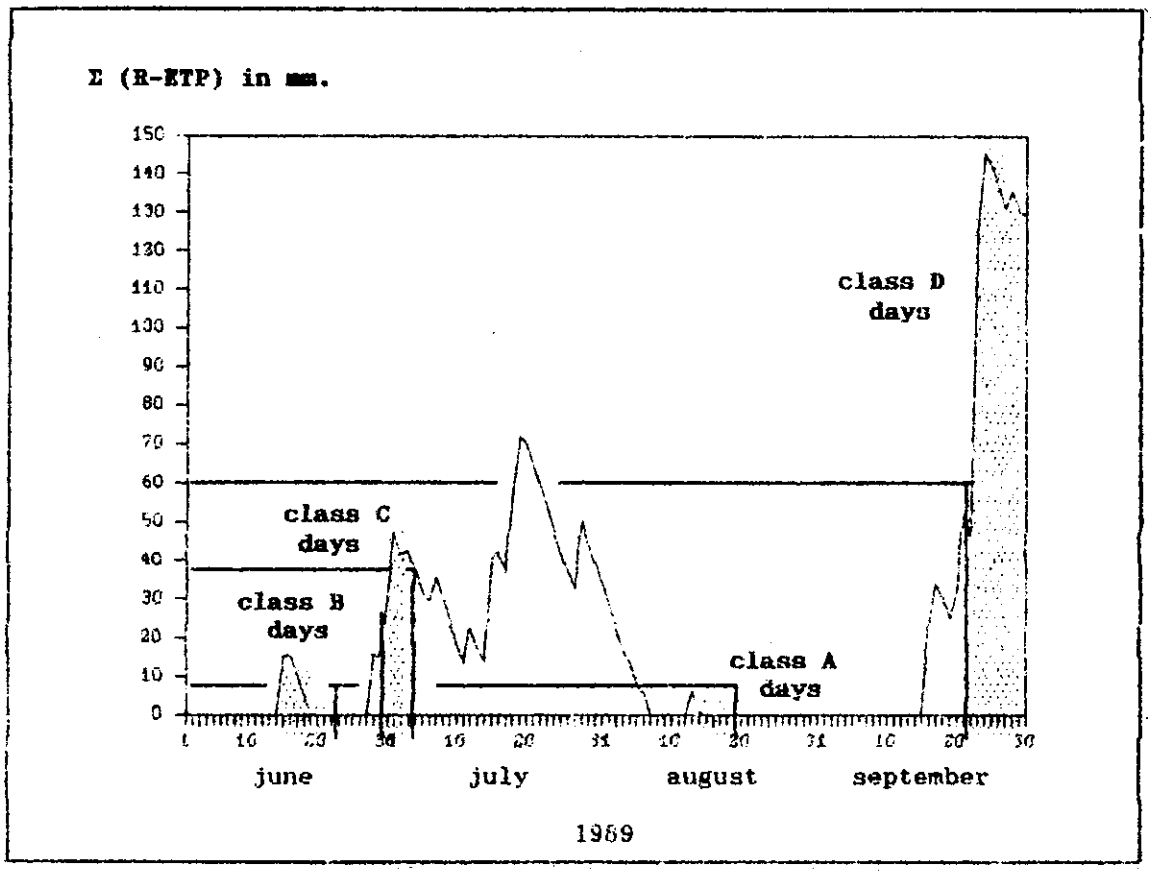

Figure 3 : Example of the determination through farmers' statements of available days for ploughing, made during the 1989 ploughing period.

(R-ETP) balance.

The confrontation between the farmers' statements and the model of soil moisture during the ploughing period gives the following results (Fig. 3) :

- class A : 10 mm > (R-ETP) > 0 mm plus 3 days in case of initial balance under 10 mm
- class B : 40 mm > (R-ETP) > 10 mm plus 3 day in case of initial balance above 10 mm,
- class C : 40 mm < (R-ETP) < 60 mm,
- class D : (R-ETP) > 60 mm.

The same assessment of the soil moisture during the ploughing period was made over 13 years, allowing the assessment of an average number of the available days of classes A B C D, over 13 years.

Fig. 4 and Tab.1 display the results of this assessment.

The number of necessary days are assessed as follows :

- in case of ploughing with a hand tractor, one day is necessary to perform one tillage on 3 rais (1 rai = 0.16 ha),
- in case of ploughing with an oxen - draught plough, on day is necessary per tillage and per rai (oxen can actually plough two rais per day, but usually work half of the day).

The balance of necessary and available days (Tab.2) shows that :

- on the APS equiped with a hand - tractor, 41 rais can be ploughed in optimum conditions, and 67 if the farmer accepts dry and humid soil moisture conditions
- on the APS equiped with oxen - draught ploughs. each team can plough 11 rais in optimum conditions and 17 if dry and humid conditions are accepted.

These theoretical results fit with the farmers' statements about land preparation and sowing :

- the farmers equiped with a hand tractor say they never have any problem to perform the land preparation and sowing in "good conditions" (situation 1).
- the farmers equiped with oxen - draught ploughs

  with a ratio land/team inferior to 10 say they can perform 4 tillages in optimum conditions (situation 1),

  with a ratio land/team between 10 and 16/17 say they can perform 4 tellages on all their plots, but only part of them in good conditions (situation 2),

  with a ratio land/team above 20 say they can not perform 4 tillages on all their plots and have to plough part of them in bad conditions (situation 3).

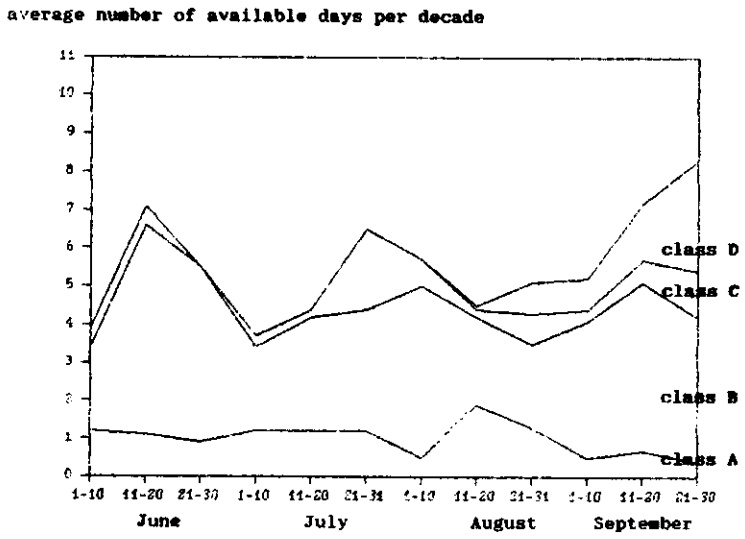

Figure 4 : Modelization over 13 years (1977-1989) of the average available days for ploughing, in dry seeded rainfed paddies area of Amphoe Khao Chaison, Phatthalung Province.

Table 1 : Average number over 13 years of available days for ploughin in dry seeded rainfed paddied rainfed paddies of Ta Chiat irrigation area, Phatthalung Province.

	NUMBER OF AVAILANBE DAYS				
	Calss A	Class B	Class C	Class D	Total
June	3.2	12.3	1	0	16.5
July	3.6	8.4	2.6	0	14.6
August	3.7	9	1.7	0.9	15.3
September	1.6	11.8	2.1	5.2	20.7
Total	12.1	41.5	7.4	6.1	67.1

Table 2 : Number of rais that can be ploughed and sowed during the available days assessed in Table 1 (1 rai = 0.16 ha).

	Calss A	Class B	Class C	Class D	Total
Hand tractor	12	41	8	6	67
Oxen-draught plough	3	11	2	2	17

3- Discussion.

More precise investigations on the farmers' practices show the three situations above-mentioned often don't concern the whole cultivated area of the APS, but only some groups of plots. In APS corresponding to situations 2 and 3, some groups of plots have priority concerning land preparation and rice sowing, and are always cultivated in conformity to the farmers' objectives, whereas the rest of the cultivated area is managed in function of the remaining available days. The plots having priority are the ones that have the most important water supply in quantity and in duration (low ground level plots) and /or are the nearest from the household and so receive regular manure dressing : they are the plots with highest cultural potentialities on the APS.

Thus, the recorded situations actually correspond to different cropping systems performed by the farmers on some pre-selected groups of plots, in function of the environmental characteristics and the objectives that they have : they reflect the different farmers' strategies concerning rice cultivation.

Three cropping systems can eventually be defined, corresponding to the three situations above-mentioned

- cropping - system 1 (C1) : the land preparation is always performed in optimum hydric conditions of the soil and the number of ploughings before rice sowing corresponds to the farmers' objectives (equal to 3 in case of oxen-draught plough and 2 in case of hand tractor).
- cropping - system 2 (C2) : the land preparation is performed in non optimum hydric conditions of the soil but the number of ploughings corresponds to the farmers' objectives.
- cropping - system 3 (C3) : the land preparation is performed in non optimum hydric conditions of the soil and the number of ploughings does not correspond to the farmers' objectives.

A methodological problem frequently faced in such diagnosis made through farmers' interviews (3) is to be pointed out here : during first interviews, farmers only gave **average informations** about the itineraries of techniques they perform on their plots. Only further analysis and checking of the collected data through appropriate concepts could enable to bring out the different kinds of cropping systems actually performed.

The question which must be considered here is : how do the objectives of the farmers and the functioning of the APS play upon the choice and the implementation of the latter cropping systems ?
Considering this criterium and the features of the APS (Tab.3), two types of APS Could Be bruought out :

- Type 1 (APS 1, 2 & 3) : APS having a high level of capitalization (cattle, land or equipment). Farmers aim at maximizing their incomes through diversification of the in-season productions (i.e. at the same time as dry-seeded rice cultivation). The necessary flexibility in calendar is made possible by high level of equipment, either handtractor or number of cattle teams for ploughing This enables implementation of cropping systems C1 and C2.
- Type 2 (APS 4 to 8) : Farmers aim at optimizing their incomes through dry-seeded rice and cattle breeding during in-season, and sometimes with other crops in dry-season. Three sub-types can be defined :

Table 3 : Features of 8 Agricultural Production Systems investigated during the year 1898 in dry seeded rainfed paddies area of Amphoe Khao Chaison, and their cropping systems in dry seeded rice.

APS	Area (Rais)	Combination of the productions			Labor force	Equi-pement	CS
		% GM dur to d.s. rice	% GM due to cattle	% GM due to other activity.			
1	36	75	0	25 (fruits, RS/DS)	4	HT	C1
2	70	35	33	31 (irr. rice RS)	5	Ox	C1
3	45	36	39	25 (irr. rice RS)	3	Ox	C1 C2
4	60	75	25	0	3	HT	C1 C2
5	50	75	25	0	5	Ox	C1 C2
6	30	85	0	15 (chilis DS)	2	Ox	C2 C3
7	30	100	0	0	1.5	Ox	C2 C3
8	30	37	34	29 (chilis DS)	1.5	Ox	C2 C3

HT hand tractor
d.s. dry-seeded
Ox oxen-draught plough
Ds during dry-season
RS during rainy-season
GM total gross margin of the APS

- 2a (APS 4&5) : all the incomes are made through dry-seeded rice and cattle breeding. The emphasis is laid on rice cultivation with a high level of equipment. This enables implementation of cropping systems C1 and C2.
- 2b (APS 6&7) : APS at the beginning of the process of capital (land and cattle accumulation, where the low number of bovines on APS limit the number of teams for ploughing, leading to high ratio land/team (implementation of C2 and C3).
- 2c (APS 8) : low availability of labor force, limiting the number of teams preparing land (implementation of C2 and C3).

B- APPRAISAL OF THE POST-SOWING ITINERARIES OF TECHNIQUES IN RICE.

1- Material.

The record of the itineraries of techniques performed by the farmers show that they never weed their paddies, neither chemically nor mechanically.

Yet, weed infestation in the paddies can be very high (12). This will depend on :

- the cropping systems performed on the plot,
- the importance of the flooding linked to the ground level in the plot (in many cases, due to poor land planning, the ground level is very uneven wihtin the same plot). (Tab. 4).

Table 4 : Importance of weeds infestation in the dry seeded rainfed paddies due to the cropping systems performed on the plots.

	Cropping system performed on the plot		
	C1	C2	C3
Low ground level	-/*	*/**	**/***
High ground level	**/***	***	***

The question which must be then considered is : why don't the farmers perform any weeding ?

This question has to be analysed in link with the functioning of the APS in interaction with the management of the crops : the labor calendar of the farmers at the period which would be suitable for weeding will be analysed.

2 - Results.

According to former research work carried out in neighbouring area of Sathing Phra peninsula (13), farmers hand-weed their plots when weeds are big enough to allow the work, and not too big so that their eradication should not destroy rice. Moreover, this practice is performed just before or at the beginning of the flooding of the paddies, due to the difficulty in pulling up the weeds when soil is dry (13), This corresponds to the period of mid-October until mid-November.

Reconstitution of the labor calendar of the APS at this time shows that (Fig. 5 & 6) :

- on APS type 1, 10 to 30 % of the total labor force available on farm is devoted to the productions different from dry-seeded rice and cattle (such as orchard, irrigated rice in other agro-ecological units).
- 50% on APS type 2 and 20 to 40 % on APS type 1 is deveoted to the clearing-transplanting technique aiming at obtaining a more regular plant stand of the dry-seeded rice crop.
- 40 % is devoted to guarding the cattle on both types of APS : all the plots are cultivated in rice from September on, So cattle have no place where to graze anymore, This obliges the farmers to go daily either on fallowes located near the Songkla laguna, 2-3 km. far from the village, or on the road edges or largest paddies bunds.
- the remaining time is devoted to forage collection in order to complete the food for cattle.

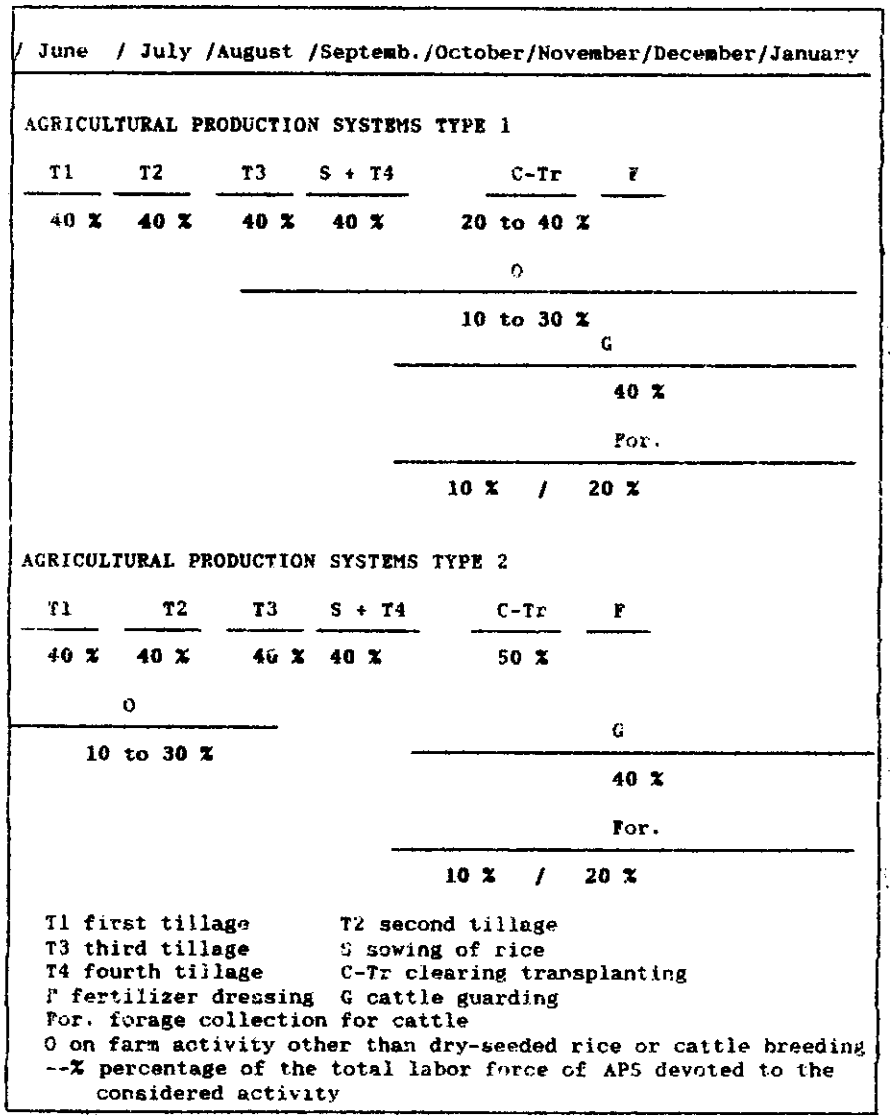

Figure 5 : Average labor calendar of the APS of dry-seeded rainfed paddies agro-ecological unit in Ta Chiat irrigation area druing rice cultivation.

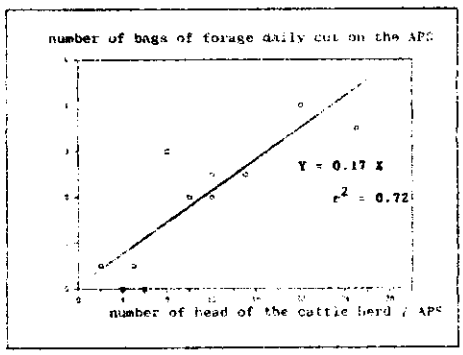

Figure 6 : Relationship between the forage collection by the farmers in the paddies during rice cultivation and the importance of the cattle herd on the APS.

Those results demonstrate that the farmers have no time for weeding their dry-seeded paddies because of their cattle on one hand, and of other productions for APS type 1 on the other hand.

Yet, according to farmers' interviews, part of the forage collection for cattle abovementioned is performed in the dry-seeded paddies : when rice weeds are big enough to be easily cut (about the middle of the rice tillering process), they are daily collected as a forage

The amount collected per APS depends on the number of head of cattle on APS (Fig.6).

Three classes of weed collection as forage and three classes of weed infestation were defined (low, medium and high) (12). The comparison during the second half of rice tillering between the as a forage for cattle and weed infestation in the plots showed that 8% to 100% of the weeds are taken away this way (Tab.5) (12).

Thus, forage collection in the paddies has an effect on the weed population in many cases. Yet it can not be considered as part of a weed control strategy, for the farmers cut the paddies weeds at random, in their own plots as well as in the neighbouring ones.

3 - Discussion.

The results above mentioned show that the farmers have no time for weeding their paddies. They show also that weeding is not considered as useful by the farmers, otherwise forage collection in the paddies would be performed in a coherent way as part of weed control straegy.

On the other hand, because of the use of the rice weeds for feeding cattle, farmers won't be likely to spray herbicides.

The lack of objectives of the farmers' regarding weed control after rice settlement lays the two following questions :

Table 5 : Percentage of the rice weeds of the paddyfields of agro-ecological unit 4-2 (5) taken away by the farmers as a forage for cattle during the second half of rice tillering.

		FORAGE COLLECTION		
		F1 (8 kg/rai)	F2 (36 kg/rai)	F3 (55 kg/rai)
WEED INFES-TATION	W1 (11 kg/rai)	72 %	100 %	100 %
	W2 (47 kg/rai)	21 %	75 %	100 %
	W3 (96 kg/rai)	8 %	36 %	57 %

- what would be the efficiency of weed control practices in the paddies,
- what can be the effect of possible other limiting factors or conditions on the yield elaboration process in the rice crop.

To answer these questions, farmers' plots surveys have been launched in the studied area, aiming at assessing :

- the effect of a hand weeding and of the environment (here ground level) on the weed population,
- the effect of weeds and of other elements (pests and diseases) on the yield elaboration process in rice.

References

1. CAPILLON, A., 1985.
Connaitre la diversite des exploitations : unprealable a la recherche de references techniques regionales. in Agriscope no 6, 1985.

3. CROZAT, Y., CHITAPONG P., 1988.
The on-farm agronomical survey : a tool for grading limiting factors of a crop and designing new technologies. in "PRINCE OF SONGKSA UNIVERSITY. 1988. Farming Systems Research and Development in Thailand : Illustrated Methododlogical Considerations and Recent Advances. Hat Yai, Thailand : The Thai-French F.S.R. Project."

4. MOREAU, D., KAEW-VONGSRI, P., TREBUIL, G.
KAMNALRUT, A., THONGKUM, P. 1988.
Testing a new itinerary of techniques : case-study of the introduction of a row-seeder in dry-seeded paddies in Sathing-Phra area. Presented at the 5 th Thailand National Farming Systems Seminar, Kasetsart University, Thailand. April 1988.

5. MOREAU, D., KAMNALRUT, A., THONGKUM, P., BOONVANNO S. 1988.
Cultural diagnosis on rice cropping systems in Phatthalung Province Southern Thailand. Thai-French F.S.R. Project, Faculty of Natural Resources, Prince of Songkla University-Thailand, Publication No 8. Presented at the 2 nd Seminar on Rice in Southern Thailand, Phatthalung-Thailand. 1988.

6. PAPY, F. 1982.
Praticabilite du milieu et itineraires techniques, In : Bulletin technique d' information 370/372. pp 375-381.

7. REBOUL, C. 1969.
Meteorologie et jours disponibles pour les travaux agricoles. In : Bulletin technique d' information 238, pp 309-320.

8. SEBILLOTTE, M. 1978.
Itineraires techniques et evolution de la pensee agronomique. CR. Acad. Agr. de France 11. Quoted in (9).

9. SEBILLOTTE, M. 1988

Systemes de culture, un concept operatoire pour les agronomes. Conseil Scientifique du Department d' Agronomie de l' INRA. Grignon-France.

10. SEBILLOTTE, M. 1989.

Approaches of the on-farm agronomist : illustrated methodological considerations, Development Oriented Research on Agrarian Systems Project, Kasetsart University Kamphaengsaen Campus-Thailand. Presented at the 4 the Thailand National Farming ystems Seminar< Prince of Songkla University, Haad Yai-Thailand. 1987.

11. SEBILLOTTE, M., SOLER, L.G., 1989.

Les processus de decision des agriculteurs. Under publication.

12. THONGKUM, P., DUPOND-LE GOUIS, G., 1990.

Weed infestation and collection as a forage in dry-seeded rainfed paddies of Amphoe Khao Cahison, Phatthalung Province, Presented at the Third Seminar on Rice Cultivation in Southern Thailand, Hat Yai, Thailand, February 1990.

13. TREBUIL, G., CROZAT, Y., THUNGWA, S., CHITAPONG, F. 1984.

Weed problems and farmers' management strategies in rainfed paddy agroecosystems of Sathing -Phra, Southern Thailand. Presented at the First Tropical Weed Science Conference, Hat Yai, Thailand. Ocober 1984.

14. TREBUIL, G., 1988.

Principles and steps of the method of diagnosis on agrarian systems : a case study from Sathing Phra area - Southern Thailand. in "PRINCE OF SONGKLA UNIVERSITY. 1988. Farming Systems Research and Development in Thailand : Illustrated Methodological Considerations and Recent Advances. Hat Yai, Thailand : Illustrated Methodological Considerations and Recent Advances. Hat Yai, Thailand : The Thai-French F.S.R. Project."