SOME METHODOLOGICAL FEATURES AND RECENT ADVENCES IN THE THAI-FRENCH FARMING SYSTEMS RESEARCH PROJECT CARRIED OUT IN THE SONGKHLA LAKE BASIN SOUTHERN THAILAND

Prasert Chitapong and Yves Crozat[1]

SUMMARY

The songkhla Lake basin is the largest rice producing area in Southern Thailand. Farmers in the area depend primarily on rice cultivation for their income. The secondary sources of income are fisheries and livestock raising. In some areas of the basin such as Sathing Phra and Ranot, the production and processing of sugar from palm trees (Borassus flabellifer) is the major alternative sources of income. The agrarian system in these particular areas needs improvement due to unbalances recently arising in rice based cropping system and to the ineffective methods of sugar palm production and processing. Prince of Songkla Univer-sity, with the assistance from French Government, initiated the farming system research project in the Sathing Phra area in 1982. Since then to the end of 1983, the problems in the area have been diagnosed and the area as well as the existing farming systems have been classified into 3 agro-ecological units and 3 types of farming systems. The problems are mainly concerned with the constraints of the rice-based cropping system and palm sugar processing. The main problems of the cropping systems are declining soil fertility, wild rice infestation, soil preparation, and implantation techniques. For sugar processing, the use of furnace with low heat efficiency and the preservation of fresh sap are the major limitations. Methods

---

[1] Head, Department of Plant Science and Agronomist, respectively, coordinators of the thai-French Farming System Research Project, Faculty of Natural Resources, Prince of Songkla University, Hat Yai, Songkhla 90110.

to overcome these constraints have been proposed and implemented since January 1984. Recent advances in experimentation have indicated that new cropping pattern, in which mungbeans are grown after and before rice cultivation, do not improve soil fertility or reduce the wild rice problem. The investigations on the effects of method of soil preparation on rice cultivation are now underway. The pilot furnace for sugar evaporation has been constructed and investigated. This new furnace produces higher heat efficiency than the old furnace. The use of sodium benzoate and potassium meta bisulfite shows promising results for the preservation of fresh sap as well as for sugar quality. The features of methodology used in the diagnosis and experimentation are discussed.

BACKGROUND INFORMATION

The Prince of Songkla University, with assistances from the French government, established the Thai-French Farming System Research Project in 1982 and has conducted Agricultural Research and Development in the Sathing Phra area of the Songkhla Lake basin since the inception of the project. The basin (Figure 1), consists of 1.5 million rai (240,000 ha.) of paddy and Sathing Phra is one of the main rice producing areas of the basin. The Methods of research and development which have been used can be characterized as an integrated multidisciplinary scientific approach (concepts for analysis of systems and for on-farm experiments) and a practical approach towards development (training and extension). The objectives of the project are :

1. to improve the socio-economic status and agricultural productivity of the area by using specific French methodology for Agrarian and Farming Systems Diagnoses (Trebuil, 1983) as well as for on-farm agronomic research. These methods have been demonstrated to be well adapted to agricultural development of difficult areas because they take into account a variety of socio-economic, agronomic and technological constraints found in each area.

2. to initiate within the Faculty of Natural Resources programs of interdisciplinary research which are applicable for the development of the study area as well as the training of staff members.

The Sathing Phra area was chosen as a pilot area to achieve these objectives. Although this area is the rice granary of the Songkhla Lake basin, it is classified as "poor rural" according to the Office of the National Economic and Social Development Board. A particular problem with this area has been the lack of adoption of new technical packages for rice cultivation despite the concerted efforts made by the extension services.

IMPLEMENTATION OF THE PROJECT

The project has been conducted in three stages as follows :

1. Diagnosis within the existing farming systems of the area in order to identify and understand the bottleneck problems. This stage of the study was conducted from 1982 to 1984 by a French Agro-economist in collaboration with academic staff from Department of Agricultural Development, Faculty of Natural Resources (Trebuil et al, 1983, 1984) and with extension officers and farmers of Sathing Phra district.

2. A stage of research and experimentation with the farmers to overcome the bottleneck problems. The main purpose of this stage was to improve the efficiency and reproducibility of rice cropping systems and to perfect the harvesting and producing techniques of sugar from palm tree (Borassus flabellifer) (Trebuil et al, 1983, Crozat and Chitapong, 1984). This program which has been carried out since January 1984 has involved one long-term French Agronomist, one short-term French specialist in palm sugar production and ten academic staffs from the Faculty of Natural Resources.

3. A stage for the diffusion and evaluation of technical improvement developed from stage 2. It is anticipated that this stage will commence in 1986. The project is expected to be continued through the establishment of Thai-French Farming System Research Center. This center will form the base for collaborative research programs between Thai and French researchers concerned with farming system research and development.

FROM DIAGNOSIS TO THE DEFINITION OF KEY PROBLEMS TO BE SOLVED

The diagnosis phase consisted of identifying the various agroecological zones, the type of existing farming systems and recent changes in land use in the Sathing Phra area (Trebuil et al, 1983). The results from this phase are useful not only to explain the nature of the zone and the type of farming systems but also to identify the function and methodological strategies necessary for the development of Sathing Phra Agrarian System.

1. An agricultural region is not homogenous; the usage and history of ecological units are the revealing elements of the systems.

From the east coast to the lagoon in the west, ten agroecological zones were identified along the peninsula (Figure 2). Identification was performed using aerial photographs, soil maps and field surveys. The line-transect sampling technique was used in the field survey so that the maximum variables of human and physical environments within each zone were intensively investigated (Trebuil et al, 1983). These zones represent three main agro-ecological units. The salient features and agronomic constraints of the three units are summarized in Table 1.

Except for unit I, which represents less than 5% of the cultivated area, rice-based cropping systems are situated on clay-textured soils with low fertility and poor drainage. The drainage problems are immense since the area is situated between the sea and the lagoons. The erratic rainfall distribution together with the lack of control of water levels in paddy fields due to poor drainage and no irrigation facilities are the key to an understanding of the existing cropping systems of Sathing Phra area (Crozat et al, 1985). These problems limit rice cultivation to only one crop a year from mid August to February. The limitation is seriously involved with the transplanting techniques of rice implantation (15 to 30% of total area) because the water level and conditions suitable for transplanting prevail for only a short time, creating a high manpower demand over a short period. Therefore, farmer management strategies are primarily based on security techniques to avoid the hazards of sudden flooding followed by period of drought during grain filling or ripening. These phenomena are not uncommon during rice cultivation in Sathing Phra area because the area experience a short rainy season (3 to 4 months) with intense rainfall (up to 1300 mm). The following management strategies illustrate the security techniques used by farmers :

a. Dispatching of the paddy in all units

b. The use of a wide range of local rice varieties chosen according to the maximum water level (20-120 cm) and the duration of flooding expected in the paddy.

c. Broadcasting dry-seeded rice after a single ploughing under dry conditions. This should be done early in the season before sudden submersion.

d. Thinning out areas where the rice population is dense and transplanting into sparsely populated areas in the same plot in order to palliate problems of space emergence of dry-seeded rice.

The Earliest ploughing and broadcasting occurs in the lower paddies of units III and II where a sudden flooding can be expected. In unit III, seedbed quality has a major influence on rice yields because it directly affects the plant population and weed growth. Weeds are seldom a serious problem here as flooding occurs early. In contrast, in unit II, flooding usually occurs later and early intermittant rain allows the drying of the fields and high weed infestation to occur, especially wild rice (Oryza perennis). Therefore, the quality of land preparation and weed control are major determinants of rice yields in unit II. Complete control of wild rice by hand-weeding requires about 150 man-day/ha. In fact, this high labor requirement and ecological constraints restrict most types of farming systems to only partial weed control (Trebuil et al, 1984). This partial weed control reduces fertilizer usage because the farmer often use less amount of fertilizer if the field receives less intensity of weed control. However, chemical fertilizers are not commonly used regardless of the intensity of weed control. Consequently, soil fertility becomes another major constraint because chemical fertilizers are presently the only option to maintain soil fertility. In addition, the recent decrease in livestock numbers together with the development of home gardens, now the main area where animal manure is used, has led to the end in the use of manure fertilizer in paddies.

2. Problems to solve are different according to the type of farming system.

From an understanding of the socio-economic strategies and the capabilities of farmers to utilize existing resources determined in the diagnosis phase, the existing farming sytems were classified as type A,B and C (Trebuil, 1984). The main characteristics of each type of farming system are summarized in Table 2. It would appear that not all the rice growing strategies and techniques amenable to the region are utilized uniformly by the farmers. The diversity of techniques used for plot situated in the same area demonstrates the constraints of individual socio-economic strategies.

For farmers of type B and C, whose income depends mainly on rice, the problems to be overcome are largely associated with the availability of manpower. The recent change caused by demographic growth (nearly 400 inhabitants per square kilometer) as well as the orientation of the people in the region toward the towns of Songkhla and Hat Yai may eventually endanger the present rice-based agricultural system of the Sathing Phra area. In addition, the progressive abandonment of traditional draught ploughing has reduced the amount of organic manure available and stopped its use on paddies as well as the small amount of chemical fertilizer presently used as a substitute in rice fields can not arrest the decline in soil fertility. The use of tractor to replace animal power often results in low quality soil preparation which potentiates the problem of rice field becoming infested with wild rice.

On the other hand, the farmers of type A and some of those in type B earn most of their income from activities other than growing rice, in particalar from the extraction of sugar from sugar palm trees. The problems of these farmer, who only own small plots (approximately 0.5 ha of cultivated land), are mainly the irregularity of production and the poor quality of sugar produced. These problems are exacerbated by the increasing cost of fuel for the furnaces used in the evaporation of palm sap.

FROM THE KEY PROBLEMS TO THE ELABORATION OF TECHNICAL ITINERARIES SUITABLE FOR EACH TYPE OF FARM AND ECOLOGICAL UNIT

In 1984, a cropping system research program was initiated in an attempt to overcome the interrelated problems of soil structure, wild rice control and chemical fertility in rice cultivation. The general methodology and the program used in this cropping system have been reported by Crozat and Chitapong (1984).

The target area is mainly unit II paddies, especially dryseeded cultivation area as they represent the majority of paddies with the largest variation in yield (500-3,600 kg/ha in 1982).

Target farmers are those belonging to farming system type B (0.5 to 0.8 ha per economic active person) and type C (more than 0.8 ha per economic active person) because rice is their principal income. For type A farmers (approximately 50% of households), and improvement in farming system efficiency requires specific research on the processing of palm sugar. This is because most of the family workforce in this type of farming system is engaged in this activity, making rice cultivation difficult or often only of secondary importance.

Research is now underway covering aspects on both cropping system and palm sugar processing. Details of the methods used and progress with aspects of the work on cropping systems conducted during February 1984 to January 1985;have been reported (Crozat,1985;Crozal et al,1985). The relevant results for each research program have been summaeized and recently used to make changes in the research programs.

1. Cropping system aspect

Crozat and chitapong (1984) initially hypothesised that the cultivation of legume crops [especially mungbean (Vigna radiata)] between rice cultivations together with the use of technical itineraries for each crop could improve soil physical properties for land preparation, soil fertility and the control of wild rice in Sathing Phra paddies. Experimental investigations were conducted during the 1984 non-rice cultivation period and the 1984-85 dry-seeded rice cultivation period to test this hypothesis.

a. The 1984 non-rice cultivation period

On-farm trials covering 27 farmer fields and 5 research-managed fields were carried out to evaluate the potential for mungbean cultivation during two climatic seasons : (i) the dry season after rice harvest (February to May) and (ii) the pre-rainy season (May to August). Technical components such as patterns of land preparation, fertilizer usage, seed inoculation and weed control were the treatments imposed in both the farmer fields and research-managed fields. An evaluation of 6 green manure legumes was also carried out during the pre-rainy season.

The results with regard to mangbean yields were extremely disapointing regardless of the cultivation techniques used. During the dry season after rice harvest, the grain yield of all 11 research-managed fields was lower than the seeding rate. During the pre-rainy season only 5 of the 22 fields yielded more than 100 kg/ha. No harvest was possible in 29 % of the fields and with 77 % of the fields, the farmers lost income (Crozat, 1985).

There was up to 100 % mortality of mungbean plants in earily flooded fields due to waterlogging. This occurred as much in the dry season as in the pre-rainy season. In other fields, low mungbean yields were attributed to periods of flooding interrupted by drought. The flooding problems were aggravated by poor soil drainage. These conditions seriously affected the development of the mungbean plants and there was a highly significant negative relationship between yield components and the degree of waterlogging, especially with regard to pod number (Crozat et al, 1985).

In term of probability, waterlogging of mungbean crops was shown to occur at least once in two year, irrespective of the planting date used (Crozat et al, 1985). Thus, waterlogging is such a major constraint of the Sathing Phra peninsula that intensification techniques, such as multiple tillage, fertilizer use and weed control should not be recommended for mungbean except for those fields with a low risk of flooding. In such fields, mungbean produces optimum yield under the condition of either 5 weeks weed-free duration or 2 weeks weed competition duration after emergence. (Chitapong et al, 1985).

In addition, mungbeans had no specific residual effects in terms of either residual nitrogen and soil organic matter levels or the yield of the following rice crop (Crozat, 1985; Crozat et al, 1985).

On the other hand, Sesbania rostrata and Aeschynomene indica showed considerable promise as green manure crops. Soil incorporation of these crops contributed 130 and 40 kg N and 7.7 and 1.6 tones of dry matter per ha, respectively (Crozat,1985).

b. The 1984-85 dry-seeded rice cultivation period.

The detailed analysis of soil structure created by various tillages have shown to affect rice emergence and growth as well as weed infestation (Crozat et al, 1985). These analyses included (i) effect of various seedbed clod sizes, number of ploughing, and rice seeding rates on emergence, spatial distribution, yield, and yield components of both rice and wild rice, and (ii) effect of ploughing depth (from 0 or non-tillage to 15 cm) on drought resistance of rice during grain formation (leaf water potential, percentage of filled spikelets). Once the optimum soil structure is defined, the reccomendation for tillage according to soil type and for seeding rate relevant to wild rice competition will then be possible. Data from these investigations are presently being analysed.

In conclusion for cropping systems, the initial hypothesis of multiplecropping as a mean for improving rice-based cropping system efficiency and reproducibility has not been confirmed. Although the major constraints of the system were identified at an early stage, at present these need to be redefined more closely. Promising research programs can be elaborated in order to propose technical improvements for the 1985-86 rice growing season. This process is illustrated in Figure 3 and can be summarized as follows:

1.1 The existing association of rice with perennial plant like sugar palm trees is an optimum multiple cropping system, which needs to be improved.

1.2 With regard to soil fertility, nitrogen is the primary limiting factor for rice production, and with clay-textured soils. attempts to increase organic matter content through the growing of leguminous crops must be considered as questionalble practice. The screening of green manure legume having high biological nitrogen fixation under successive waterlogging and drought periods, therefore, may help improve nitrogen availability with low cost.

1.3 Improving of land preparation quality (either non-tillage or finer seedbeds) is a suitable means to increase emergence and erratic spatial distribution of rice. Minimum tillage also limits wild rice infestation.

1.4 The infestation of rice crops with wild rice can be largely attributed to large banks of wild rice seed in the paddy soils and to the genetical contamination of rice seed used for broadcasting. Physical contamination at the time of harvest does not appear to be a problem since seed of wild rice drops to the ground prior to the rice harvest and all farmers harvest rice by the panicle to panicle method. The development of better methods for the sorting of rice seeds for planting and studies to delineate the optimum time for wild rice control need to be given high priority.

1.5 More appropriate zonation of unit II according to the risk of temporary flooding and soil properties is necessary before attempting to implement specific technical recommendations.

2. Sugar processing aspect.

Two research programs have been given priority for 1984-85. The first is concerned with improving the efficiency of open pan evaporators used to evaporate the water from palm sap. The primary objective is to reduce the cost of the fuel component since the price of wood has increased substantially and now represents 30 % of the total cost of inputs. This program also aims at improving the sugar crystallization process. Eight farmers were trained in Petchaburi province with the result that new furnances were built by some of them as their return. At present, a total of 50 households have built new furnaces and some of which are modified and investigated. Tests to compare the efficiency (heat balance) of local and new evaporators operating under farm condition are now in progress. Preliminary data indicates that, for each kilogram of fuel from palm petiole, the new evaporators can produce 2.8 kilogram of 65° Brix concentrate sugar, whereas the old evaporators can only produce 1.8 kilograms of sugar of the same quality. The heat efficiency (heat used/heat produced) for the new and the old evaporators is 34.4 and 24.4 %, respectively. The new type of evaporator not only reduces the time and fuel required for evaperation, but also shorten the waiting time for fresh sap to be evaporated. This reduction in time is important in order to prevent fermentation of fresh sap before being evaporated.

The objective of the second research program is to improve the methods used by farmers for the collection and preservation of sugar palm sap in order to avoid spoilage through fermentation prior to evaporation. Since fermented sap produces low quality sugar, farmers try to delay fermentation by putting a piece of plant locally called "kiam" (Shorea henryana) in to the fresh sap. This practice, although, is fairy effective but its propor use is technically defficult and, therefore, alternative methods need to be investigated. Studies conducted by staff of the Department of Agro-industry of Faculty of Natural Resources using sodium benzoate and potassium meta bisulfite have shown promising results.

It is now apparent that information on the amount of sap produced by each household annually and on sugar marketing organization are also a priority for further research. Consequently a survey on sugar production was recently commenced involving farmers of types A and B, along with study on sugar marketing organization.

The research on sugar processing is very encouraging since farmers have adopted our new techniques faster than expected. Within 3 months, 50 households have built new evaporators, with the problem of irregular quality and mastering.

CONCLUDING REMARKS

Previous considerations show to which extent Farming System Research is a complex process. The notion of standard technical package or standard cropping pattern even highly efficient on experimental fields is often useless because of a lack of understanding of the existing environmental and socio-economic constraints of farmers. Most agricultural regions consist of a range of agro-ecosystem where all farmers do not have the same needs. To different types of farms, different technical solutions must be elaborated according to each agro-ecological units and farmers' socio-economic strategies. Therefore, before on-farm experiments, a detailed zonation and characterization of the environment as well as a typology of farming system are the necessary step. Once constraints are identified, target areas and target farmers may be chosen as a frame-work for experimentations. This logical process is not static but dynamic. It was shown previously that during experimentation, constraints initially identified are continuously redifined closer and classified by order of priority. Surprisingly, the most relevant data was not revealed by conventional experimental designs (split-plot, RBD etc.) but from specific designs using the existing variability found within farmers' fields. These specific designs were developed for on-farm research by French agronomists (Sebillotte, 1978a; Boiffen et al. 1981). Variability in seedbeds, plant density, and levels of inputs generally found within one farmer's field and between farmers' fields were found to constitute the most complete experimental system to study. For example, to study the effect of waterlogging on the reduction in yield of mungbeans, relevant data was obtained by comparing part of a mungbean field where the topography resulted in different waterlogging intensities and duration (Figure 4a). Statistical methods could also be used to compare the yield and yield components of mungbean from each homogenous part of the field (Table 3). Results could then be confirmed by considering the variability between farmers' fields (Figure 4b). Similar designs have been used to study the effects of clod size and depth of ploughing on rice establishment and the ability of rice to compete with wild rice. This is often variable in the quality of land preparation even within the same farmer's field. Such methods, not well known in Asia, require detailed observations and measures on both the environment and the yield elaboration proeess of the crops. It is necessary to establish an association between the variability of the factors studied (e.g.waterlogging, size of clods in the seedbeds, ploughing depth) to that of other environmental factors and growth parameter (e.g. rainfall, microtopography, soil porosity, root distribution) and to understanding their consequences all along the yield elaboration process. Only where these interactions are understood, will it be possible to implement new technology which is appropriate for each kind of environment (Sebillotte, 1978b)

ACKNOWLEDGEMENT

The authors express their sincere gratitude to the Project Director, Dr. Sujin Jinahyon, Dean of the Faculty of Natural Resources for his encouragement and permission to use the Faculty facilities for the conduct of this project. Sincere appreciation is extended to all research personnel involved with the project including Mr. Guy Trebuil and Mr. Somyos Thungwa of farming system diagnosis aspect, Mr. Amnuay Sitticharoenchai, Mr. Rangsan Apakupakul, Mr. Chao Yongchalermchai, Miss Ratana Janjaroentham and Mr. Charnchai Saengchayoswat of cropping system aspect, and Mr. Paiboon Thamaratvasik, Miss Prapasri Pichitvorapanit, Miss Sukanya Chantachoom, Mrs. Saowaluck Jitbunjerdkul, Mr. Kanok Thirawat and Mr.Prasit Chaisiripant for their devotion to the project. Without their contribution, the information presented in this paper would have not been available. The assistance of Dr. John Milton in the preparation of this manuscript is also appreciated. Finally, we gratefully acknowledge the French Government for providing us with a grant to carry out this project.

REFERENCES

Boiffin, J., J. Caneil, J.M. Meynard and M. Sebillotte, 1981. Yield elaboration of winter wheat and nitrogen fertilization in Champagne Crayeuse : Methodology to study a technical problem in an area. Agronomie 1(7) :549-558.

Chitapong, P., Y. Crozat and C. Saengchayaswat. 1985. Weed competition with mungbean grown before rice in rice paddy. Songklanakarin J. Sci. Technol. 7: (inpress).

Crozat Y. and P. Chitapong. 1984. Proposal of methodology to improve limiting factors of rice cropping systems in Sathing Phra agrarian system. Presented at the First Nat. Conf. on Farming Systems, Surathani, Thailand, April 2-5, 1984. 11 pp.

Crozat Y. 1985. Potentialities of some legumes used as rotated crop to improve rice-based cropping systems in Sathing Phra area, Southern Thailand. Thai-French Farming system Research Project, Faculty of Natural Resources, Prince of Songkla University, Pub. No.4. 69 p.

Crozat Y., A. Sitticharoenchai and R. Apakupakul. 1985. Soil and water constraint and management in rice-base cropping systems of Songkhla Lake basin, Sathing Phra, Southern Thailand. Presented at Soil, Water and crop management systems for rainfed Agriculture in Northeast Thailand. 1st KKU-USAID International Seminar, Khon Kaen University, Khon Kaen, Thailand. February 25 - March 1, 1985. 15 p.

Sebillotte, M. 1978a. The elaboration of technical references and advances in agronomy. In exigences nouvelles pour l' agriculture. INA-PG ADEPRINA ed. PARIS. 466-495.

Sebillotte, M. 1978b. Concept of technical itineraries and advances in agronomy. C.R. Acad. Agri. Fr. 64:906-914.

Trebuil, G., S. Thungwa and I. Patamadit-Trebuil. 1983. The present system and recent change in land use in Sathing Phra district, Southern Thailand. Thai-French Farming System Research Project, Faculty of Natural Resources, Prince of Songkla University, Pub. No.2. 101 p.

Trebuil, G. 1984. A Functional typology of farming systems in Sathing Phra area, Southern Thailand. Proć. Internat. Conf. on Thai Studies. August 22-24, 1984, Bangkok, Thailand.

Trebuil, G., Y. Crozat, S. Thungwa and P. Chitapong. 1984. Weed problems and farmers' weed management strategies in rainfed paddy agro-ecosystems of Sathing Phra, Southern Thailand. Proc. 1st Tropical Weed Sci. Conf. Hat Yai, Songkhla. October 22-25, 1984. 66-76.