PN-AAX-076

Cropping Systems Trial Results from the Northeast Rainfed Agricultural Development (NERAD) Project.

Iain A. Craig

Paper presented at the International Dryland Soils/Water Management Workshop.

February 24 - March 1, 1985,

Khon Kaen University, Thailand.

Appendix 6

Cropping Systems Trial Results from the Northeast Rainfed Agricultural Development (NERAD) Project[1/]

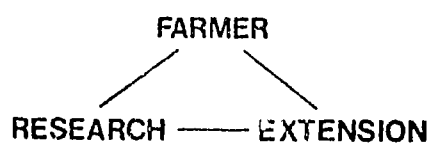
Iain A. Craig[2/]

Introduction

NERAD is developing a farming systems research and extension (FSRE) approach appropriate for agricultural development in Northeast Thailand. FSRE has different meanings to different people but as far as the cropping systems component of NERAD is concerned the major elements of such an approach are (Panothai, 1986):

* An FSRE approach is an integrated effort by research and extension personnel who should be jointly involved during all phases of the work.

INTEGRATED:

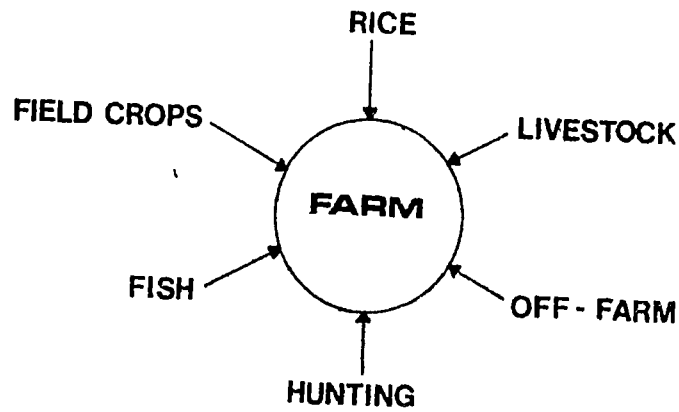


1/ Paper presented at the Lowland Soil/Water Management Workshop, February 25 - March 1, 1985 held at Khon Kaen University, Thailand.

2/ Farming Systems Specialist, University of Kentucky Technical Assistance Team, NERAD Project, Northeast Regional Office of Agriculture, Tha Phra, Khon Kaen, Thailand.

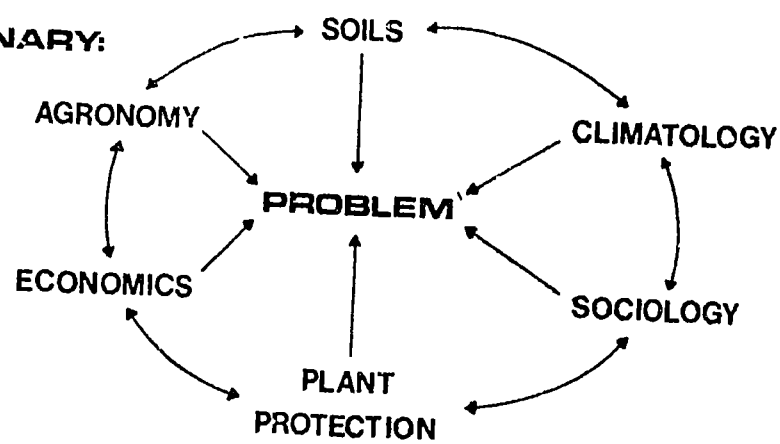
* FSRE is an holistic approach which should consider all important interactions within the farm-family system.

HOLISTIC:



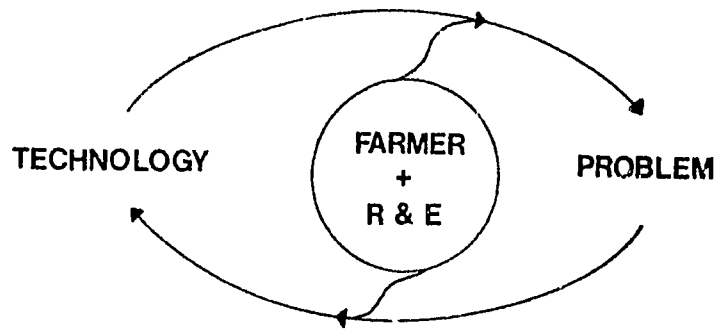
* FSRE work should be conducted in an interdisciplinary manner that cuts across departmental and divisional boundaries. It does not replace specific, single discipline research, however, but should complement it especially in the area of assisting in the definition of research priorities.

INTERDISCIPLINARY:



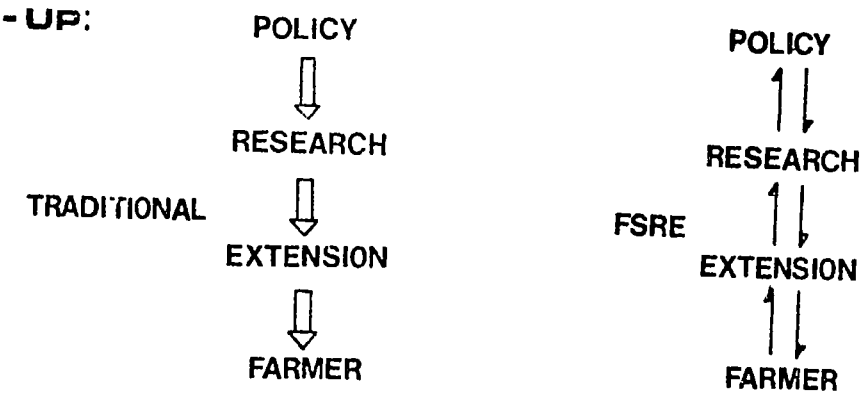
* It focuses at the farm level and should include 'on-farm' trials and research, where relevant, to gain a better understanding of real problems and of the performance of new technologies under actual farm conditions. The farmer should be considered a partner in this phase of the research and should be actively involved throughout.

ON-FARM:



* It has a stronger 'bottom-up' orientation than the traditional technology-based approach to development and thus requires a greater delegation of responsibility to junior scientists and technicians.

BOTTOM-UP:



Earlier papers in this workshop have stressed a number of key characteristics of agriculture in the Northeast that have important implications for cropping systems development programs in the region. Some consideration of how these implications are translated into strategic and tactical responses within NERAD's cropping systems component will be made here.

First, it has been stressed that the subsistence rice crop is the key to cropping systems development in the Northeast. If improvements can be made to the rice crop, then constraints will be removed enabling farmers to diversify their cropping activities. Conversely, any cropping system technology which interferes with the subsistence rice crop is unlikely to be successful (Craig and Pisone, 1985). Most of the major advances in rice-based cropping systems development throughout the world have come through the introduction of new rice varieties. In most cases these have been short duration, non-photoperiod-sensitive varieties enabling planting of rice to be adjusted for timely planting of pre or post-rice crops (Dalrymple, 1971; Carangal, 1977). However, in rainfed environments such as the Northeast, the flexibility of photoperiod sensitive rice is essential to ensure a crop and thus this type of breakthrough is unlikely. NERAD's focus has been moving more towards component technology work on rice itself and exploring the potential for stabilizing and increasing rice yields by selective pre and post rice crops.

Secondly, it would appear that northeastern farmers are highly skilled and their traditional practices are already well tuned to local agro-ecological conditions (KKU, 1982, a). The

implication here is that rapid, revolutionary breakthroughs in cropping systems development are unlikely. NERAD's approach has been more of attempting to make small improvements to the farmers traditional practices in each locality based on the farmers' problems and taking account of the constraints facing them.

Many papers have stressed the extreme variability of agro-ecological and economic conditions over both time and space in the Northeast (KKU, 1982, b). It is therefore unlikely that cropping systems can be developed which will give optimal returns every year or will be suitable for the entire region. Rather, the approach should attempt to identify for each specific location a series of low-risk, 'robust' technologies which give at least adequate returns all years. These technologies will have to be low-cost and purchased-input levels should be adjusted towards risk minimization rather than yield maximization.

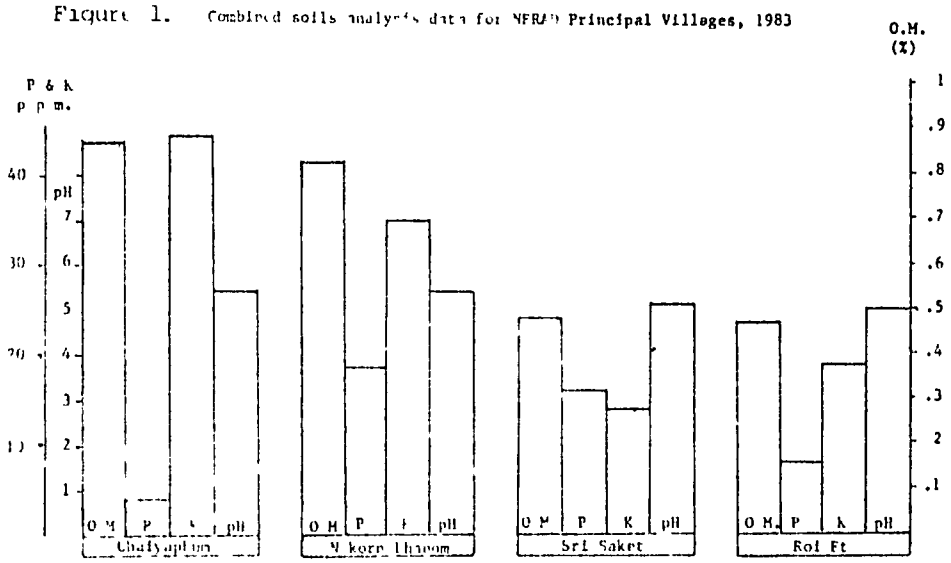
Finally, most of the cropping systems development work in the world to date has been in irrigated areas and has been synonymous with increasing cropping intensity (Andrews and Kassam, 1976; Anon., 1975; Dalrymple, 1971). There is always the danger, however, of over-emphasising cropping intensification as the major objective of this work especially in rainfed areas where the potential for more than one crop per year is often extremely limited. Previous papers have clearly shown that although there is a potential for multiple cropping in some situations in the Northeast, many of the current problems facing the traditional monocrop systems are extremely serious and warrant higher research priority than cropping intensification.

It is anticipated that NERAD's cropping systems work in the future will focus more towards tackling these problems than attempting to increase cropping intensity per se. Hopefully the results of this workshop will give the project some guidelines on how this may be done as regards soil-water management problems.

Farmer Strategies

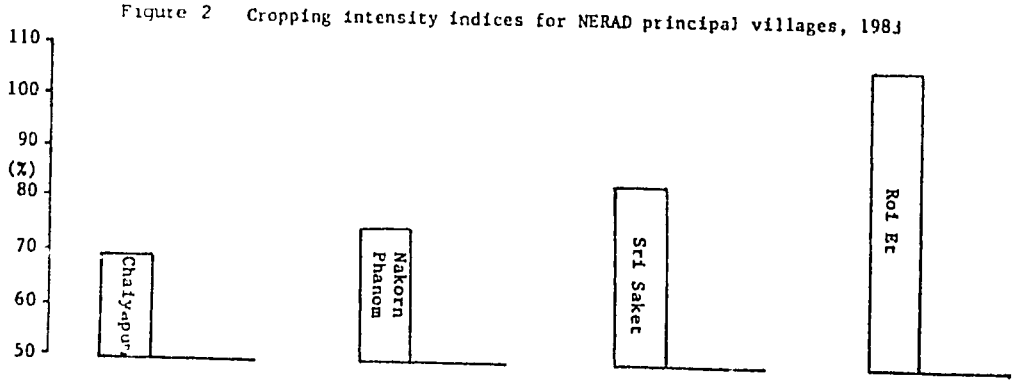
It would appear that the majority of the traditional cropping systems in the Northeast are 'exploitive' in nature and the farmers' strategy is essentially one of mining the natural soil fertility built up when the land was under forest-cover (Ragland, et al., 1983). Purchased fertilizer in the rice crop is zero or minimal and the predominant upland systems of kenaf or cassava also generally receive no fertilizer. A review of the soil fertility levels for 4 principal villages shown in Figure 1 gives some idea of how long this exploitation process has been going on in each Province.

Figure 1. Combined soils analysis data for NERAD Principal Villages, 1983



In Roi Et, where the land has been cultivated for the longest time and where soil fertility levels are the lowest, cropping intensity (Figure 2.) is surprisingly the highest of all villages. This is due to a locally evolved strategy for dealing with declining nutrient levels and decreasing rice yields. Farmers commonly plant watermelon after rice, not with the primary objective of earning cash but more as a means of 'stabilizing' rice yields through the residual fertility from the manure and fertilizer applied to the water melon plots which are rotated between fields from year to year in order to spread the benefit over all the paddy land.

Figure 2 Cropping intensity indices for NERAD principal villages, 1983



In Sri Saket where fertility levels have also declined markedly the strategy appears to be one of spending more money on fertilizer applied directly to the rice crop (Figure 3). This has probably been made possible by the higher proportion of the rice harvest which is sold thus generating cash to purchase the fertilizer (Figure 4).

Figure 3. Money spent on fertilizer applied to rice for the NERAD principal villages, 1983

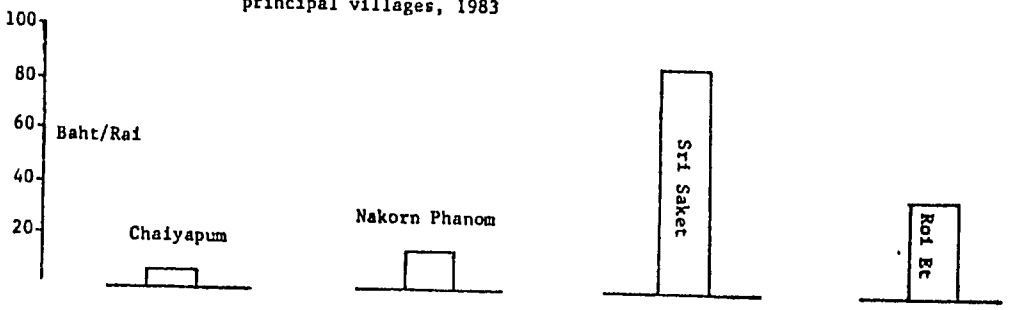
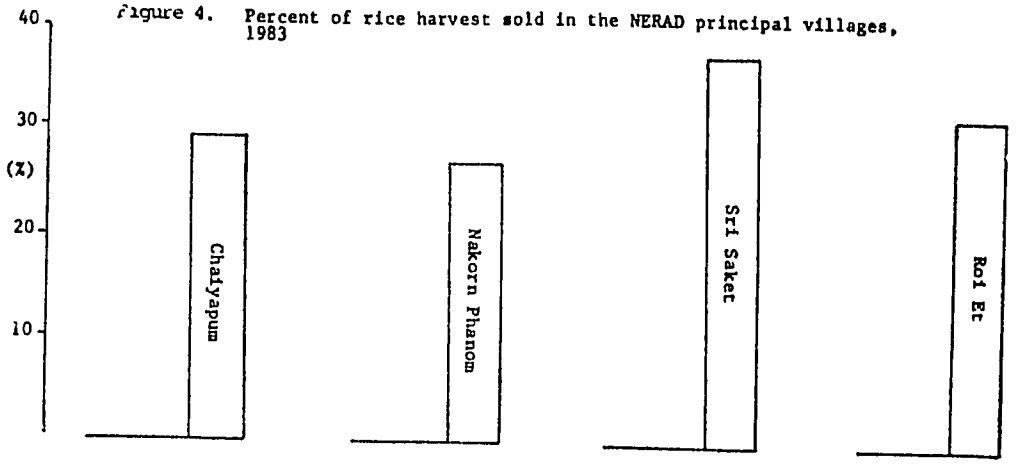
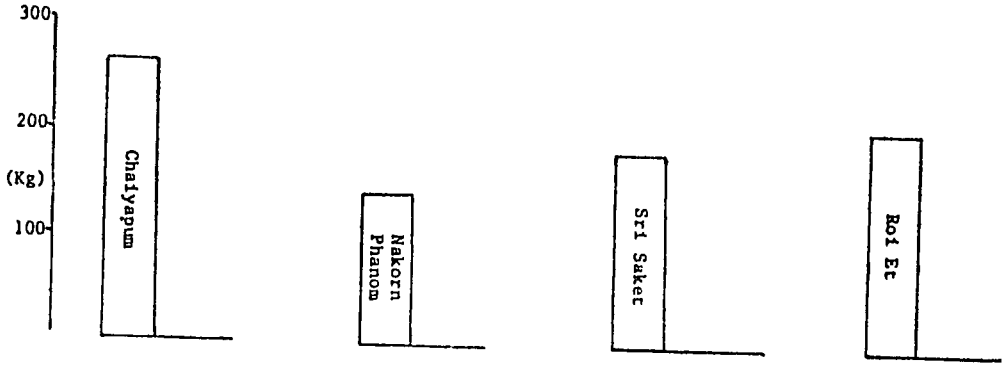


Figure 4. Percent of rice harvest sold in the NERAD principal villages, 1983



In Chaiyaphum and Nakorn Phanom where the land has been cropped for a shorter period, soil [illegible]nts have not yet declined to such low levels a[illegible] are following the strategy of 'mining' soil nutrie[illegible] continuous low input mono-cropping. Figure 5 indicates [illegible]at all 3 strategies produce approximately equivalent rice yields. However, the dominant strategy in Chaiyaphum and Nakorn Phanom of mining natural fertility is not sustainable in the long term.

Figure 5. Mean rice yields - Farmer estimates (Kg rai) for NLRAD principal villages, 1983



Farmers also have various strategies for dealing with the uncertainty of rainfall in the region. For rice these include: use of photo-sensitive rice varieties; small, bunded fields; rice-storage and by following what can best be termed 'compensatory' cropping strategies. A good example of the latter also comes from Roi Et where farmers plant kenaf in the paddy before rice. In dry years the kenaf produces higher yields firstly because water-logging problems are reduced and secondly because the kenaf can be left in the field for longer as rice transplanting is either not possible or is at least delayed by lack of rain. Thus, there is some compensation for reduced rice yields in dry years by higher cash earnings from kenaf.

Results

NERAD has been running cropping system trials for 2 years in farmers fields in 9 tambons in 4 Changwats in Northeast Thailand. Two sets of trials have been conducted. Firstly, cropping intensification trials have been conducted over the entire tambon following DOA recommended practices for planting dates, fertilizer rates, etc. The second set of trials were conducted in only one principal village per tambon and were designed to solve current farmer problems identified during an interdisciplinary, needs-assessment conducted in each village. A summary of the results of last year's trials are presented in Appendix 1.

Almost 100 trials, generally replicated over 5 farmers, were conducted with varying degrees of success. Available resources, however, were over-extended causing problems of inadequate data on which to base decisions for improving the systems and a means of prioritising the trials in order to concentrate effort on the technologies with the highest potential for benefitting farmers in each tambon was needed.

To achieve this, a technical workshop was held to review the results of all the trials conducted and to classify the technologies into 3 categories

1. Successful technologies which are considered suitable for expansion through extension demonstrations.
2. Promising technologies which still require further testing or modification by component technology research.
3. Technologies which under present or expected future conditions are unlikely to significantly benefit farmers.

As a result of this 'triage' process, technologies assigned to category 1 will be demonstrated in an extension phase by DOAE with technical support from DOA. Those trials classified as category 3 will be discontinued or passed back to the research stations but regularly reviewed to determine if technological advances or economic circumstances have changed sufficiently to warrant further testing. The project's cropping system trials program will concentrate on category 2 with an intensive series of on-farm trials including superimposed, component technology work to solve the remaining problems and develop the systems until they are ready for the extension phase. The overall cropping systems strategy will be implemented according to the system summarised in Figure 6.

Instead of reviewing the results of all the trials, some examples will be chosen to illustrate the triage process, to demonstrate the importance of understanding traditional cropping strategies and to assess the potential for cropping systems development in the Northeast. These examples are presented in Tables 1-3.

A green manure trial was implemented in Sri Saket to address the problems of low soil fertility and the high cost and associated risk of applying fertilizer to rice. Both the objectives of increasing rice yield and reducing fertilizer requirements were met by the trial. Although yield increases were only moderate, the farmers' response was extremely enthusiastic and the technology is already being rapidly adopted in the area. It is believed that the reason for this is that it satisfies the farmers' rice yield stabilization objective but

Figure 6. Implementation of NERAD Cropping System Trials

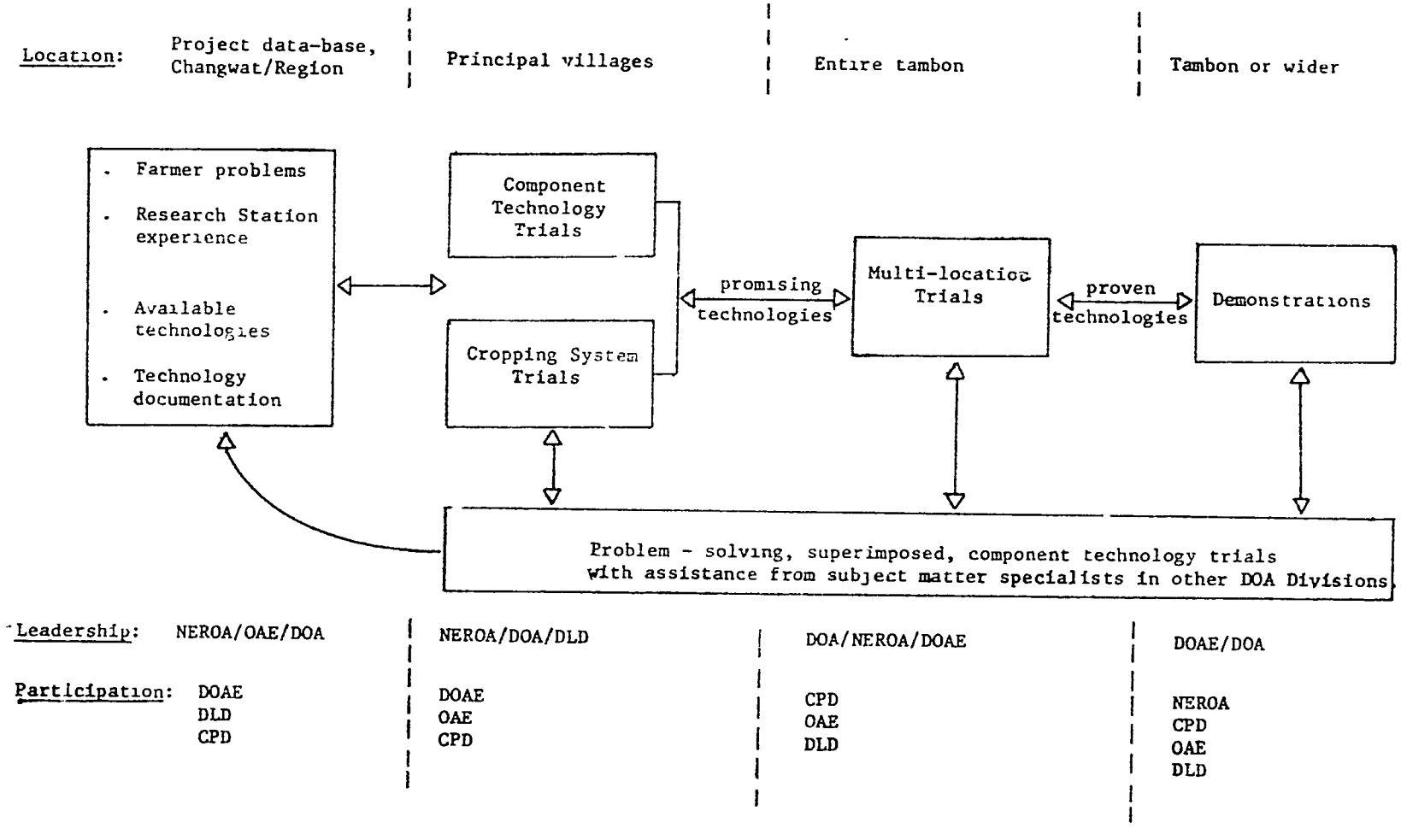


Table 1. Examples of successful technologies to be moved to the extension phase

1. COWPEA (green manure) - RICE		Sri Saket
FARMER PROBLEMS IDENTIFIED	1. Low soil fertility 2. High cost and risk of fertilizing rice 3. Pre-rice season underemployment	
OBJECTIVES OF THE TRIAL	1. Increase rice yields 2. Reduce fertilizer requirements in rice	
RESULTS (mean of 15 plots)	Cowpea-Rice (DM105) + 15-15-15 16-20-0 20kg/rai + NH_4SO_4 10kg/rai YIELD=543kg/rai Fallow-Rice (DM105) + 15-15-15 16-20-0 20kg/rai + NH_4SO_4 10kg/rai YIELD=487kg/rai Fallow-Rice+44kg(mean)fertilizer (local) YIELD=444kg/rai * -Yields are significantly different	
CONCLUSION	LOW-INPUT, LOW-RISK 'STABILIZATION' STRATEGY	

2. CUBAN KENAF - RICE		Chaiyaphum
FARMER PROPLEMS IDENTIFIED	1. Unstable rice yields 2. Root rot disease build up on limited upland area where kenaf is continuously mono-cropped.	
OBJECTIVES OF THE TRIAL	1. Identify a pre-rice cash-crop for the paddy land. 2. Test a root-rot resistant kenaf variety	
RESULTS (mean of 5 plots)	Cuban Kenaf yield=280kg/rai net returns=747B/rai Upland Thai Kenaf (control)= 207 kg/rai Rice after Cuban Kenaf = 46 kg/rai (4 plots=0)	
CONCLUSION	IMPROVED COMPENSATORY SYSTEM	

does so in a low-cost, low-risk manner. Cuban kenaf before rice is also considered ready for extension for similar reasons as an improved compensatory system for fluctuating rice production. At present prices, the 747 Baht net returns from kenaf represents over 350 kg rice per rai which is an acceptable yield level.

Yield and returns from the direct-sown rice and the sesame before rice technologies were rather variable and well below potential. However, they represent viable compensatory and income stabilization strategies respectively with considerable potential for meeting these objectives in their respective areas. For this reason they will receive high priority for further on-farm component technology trials to overcome the remaining problems. For direct sown rice this will include planting methods to obtain better plant spacing to facilitate weeding, herbicide trials and planting date trials. For sesame the component technology work will concentrate on planting date trials in an attempt to avoid water-logging and drought.

Although net returns from sweet-corn before rice were acceptable, this trial was based on the erroneous assumption that farmers wish to increase cropping intensity on their paddy land. Farmers in Nakorn Phanom, however, have plenty of underutilized upland area which they prefer to use for cash cropping where it does not interfere with their subsistence rice production. The objectives of the mungbean-before-rice trial are considered to be valid and in line with farmers' objectives but currently the available mungbean varieties are not suitable for local conditions due to their preference for clay soils, sensitivity to water-logging and their susceptibility to common pests and

Table 2. Examples of promising technologies for intensive on farm testing and component technology trials

1. DIRECT SOWN RICE (UPPER PADDY)	Chaiyaphum
FARMER PROBLEMS IDENTIFIED	1. Unstable subsistence rice production. 2. Upper paddies planted only 1 year in 3
OBJECTIVES OF THE TRIAL	1. Produce rice in the upper paddies every year 2. Identify situations where D.S. rice will give higher or more stable yields than T.P. rice.
RESULTS (mean of 5 plots)	D.S. Rice(RD6)YIELD=154kg/rai(Rat+weed problems) Net returns = 127 Baht/rai T.P. Rice (control) YIELD=0kg/rai (Insufficient water for transplanting)
CONCLUSION	COMPENSATORY STRATEGY FOR DRY YEARS
2. SESAME - RICE	Roi Et, Sri Saket
FARMER PROBLEMS IDENTIFIED	1. Limited market and unstable prices for present cash crops(water melon and yard long bean).
OBJECTIVES OF THE TRIAL	1. Test the potential of a traditional technology successful elsewhere in a situation with similar agro-ecological conditions. 2. Identify a viable pre-rice crop with high and stable prices.
RESULTS (mean of 5 plots)	Sesame YIELD = 90 kg/rai(intermittent water logging/drought) Net cash returns = 747 Baht/rai Rice YIELD - Unaffected by sesame
CONCLUSION	PROMISING INCOME STABILIZATION STRATEGY

Table 3. Examples of technologies unlikely to significantly benefit farmers

1. SWEET CORN - RICE		Nakorn Phanom
FARMER PROBLEMS IDENTIFIED	1. Underutilization of paddy land.	
OBJECTIVES OF THE TRIAL	1. Increase cropping intensity in the paddy	
RESULTS (mean of 13 plots)	Corn YIELD = 2924 saleable ears per rai Net returns = 476 Baht per rai Rice YIELD - no detectable effect of sweet corn on yield	
CONCLUSION	TRIAL OBJECTIVES DO NOT FIT FARMER'S STRATEGY	
2. MUNGBEAN - RICE		Roi Et
FARMER PROBLEMS IDENTIFIED	1. Declining soil fertility 2. Limited markets and unstable prices for traditional cash crop (water melon)	
OBJECTIVES OF THE TRIAL	1. Improve soil condition by incorporation of legume crop residues 2. Stabilize returns from cash crops	
RESULTS (mean of 5 plots)	Mungbean yield = 44 kg per rai Net returns = 88 Baht per rai Rice yield = 348 kg per rai) not significantly different Rice (control) = 344 kg per rai)	
CONCLUSION	STABILIZATION OBJECTIVES NOT ACHIEVED IN TRIALS	

diseases. It is therefore considered that more on-station breeding work is necessary before further on-farm trials of this technology are considered.

Major Soil/Water Management Issues

It would be appropriate to conclude with a summary of the major problems concerning soil-water and soil fertility management currently facing the cropping systems program within NERAD. Superimposed, component technology work is already planned to address some of these issues but suggestions and advice would be extremely welcome from this workshop as to how to best design and implement on farm trials to solve the following problems:

Upland Crops
- Adjustment of planting dates in accordance with local rainfall probabilities.
- Selective erosion of organic matter and clay content (Mitsuchi, 1984).
- Soil-acidity management.

Pre Rice Crops
- Planting methods and other soil management techniques to reduce the problems of water-logging.
- Adjustment of planting/harvesting dates in accordance with rainfall probabilities to avoid water-logging and drought.
- Management of soil acidity.
- Green manure management for maximum benefit to the following rice crop.

Rice Crop
- Fertilizer types/rates/timing and placement

	to reduce risk under erratic rainfall conditions.
	- Decision guidelines based on rainfall amounts and dates for when to transplant and when to direct-sow rice in the upper paddies.
	- Rice crop residue management for maintenance of soil fertility.
Post Rice Crops	- Soil moisture conservation.
	- Planting methods and other management practices to reduce crop turn-around time.
	- Fertilizer application in dry conditions.
Entire Cropping System	- Assessing trade-offs between optimal planting dates for component crops in a multiple cropping system.
	- Long term assessment of soil fertility maintenance by cropping system rotations.
	- Maximizing the utilization of residual fertility from a previous crop.

References

1. Andrews, D.J. and Kassam, A.H., 1976. The Importance of Multiple Cropping in Increasing World Food Supplies. American Society of Agronomy Special Publication Number 27, Multiple Cropping. p 1-10.

2. Anonymous, 1975. Multiple Cropping in Asian Development. The Philippine Economic Journal, XIV, (1-2). 322 pp.

3. Carangal, V.R., 1977. Asean Cropping Systems Network. Proceeding of a Synposium on 'Cropping Systems Research and Development for the Asean Rice Farmer.' IRRI, Philippines. p 31-46.

4. Craig, I. A. and Pisone, Utai (1985) Overview of rainfed agriculture in Northeast Thailand. Proceedings of a Workshop on 'Soil, Water and Crop Management Systems for Rainfed Agriculture in Northeast Thailand'. Khon Kaen University, February 25-March 1, 1985.

5. Dalrymple, D.G. 1971. Survey of Multiple Cropping in less Developed Nations. USAID/USDA, FEDR-12, 108 pp.

6. KKU, 1982 (a). An Agro-ecosystem Analysis of Northeast Thailand. KKU-Ford Cropping Systems Project, Faculty of Agriculture, Khon Kaen University, Thailand. 167 pp.

7. KKU, 1982 (b). Tambon and Village Agricultural Systems in Northeast Thailand. KKU-Ford Cropping Systems Project, Faculty of Agriculture, Khon Kaen University, Thailand. 174 pp.

8. Mitsuchi, M., 1984. Note on the Soils of Northeast Thailand. Agricultural Development Research Project in Northeast Thailand, Report of the JICA Expert Team. p 12.

9. Panothai, Aran, 1984. Issues concerning the Development of a Farming Systems Research Approach. Proceedings of the 1st National Farming Systems Conference. Surat Thani, 2-5 April, 1984, Thailand. (In Thai) 34 pp.

10. Ragland, J. L., Craig, I. A. and Infanger, C. 5th Quarterly Report. NERAD Project. Northeast Regional Office of Agriculture, Khon Kaen, Thailand. p 14-25.