THE NIPPON FOUNDATION PROJECT ON IMPROVING THE SUSTAINABILITY OF CASSAVA-BASED CROPPING SYSTEMS IN ASIA - A PROJECT EVALUATION REPORT[1] -

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The Problem and Context

Sustainable management of Asia's upland areas, particularly in the humid and sub-humid areas, has remained an unfulfilled development objective. The concentration of research, extension, and development resources on the more productive lowland areas, the more limited road infrastructure and greater distance to urban markets, and the more constrained crop options have limited agricultural incomes and, in turn, investments in land improvement in the upland areas. Extensive land management on gentle to steep slopes leads to significant rates of soil erosion, with Southeast Asia's rivers carrying some the highest sediment loads of any region in the world. The relatively favorable food balance, rising per capita incomes in favored agricultural areas, and increasing government budgets allow a potential shift in resources to upland areas. Moreover, such a resource shift is congruent with a potential policy objective of alleviating rural poverty, as this tends to be concentrated in upland areas.

Cassava competes with maize and to a lesser extent upland rice as the most important field crop grown in the upland areas of the tropical and sub-tropical areas of Southeast Asia (tree crops are important in humid areas with low population densities). Cassava is particularly important in more marginal areas where either drought or soil constraints limit the production of other crops. These advantages, however, result in cassava often being grown on sloping land and because of the wide plant spacing and 3-4 month period to closed canopy, soil erosion is often a significant problem if appropriate control measures are not taken. A project focusing on controlling soil erosion in cassava-based systems is a logical entry point into the problem of reducing soil loss in Asia's uplands. In fact, addressing soil erosion by linking it to broader-based crop technology allows a more direct link between productivity, soils management, erosion control, and farmer incomes.

The review team noted the extraordinary diversity in cassava production systems and the factors leading to soil erosion across the sites in the four countries. The team views this to be a very positive feature of the project in that methods and ideas are tested in very different contexts with the possibility of transfer of experience between sites. This leads to a far more robust methodology and deeper insights into the factors that condition farmers' adoption of soil erosion control techniques. However, one of the tensions in such a project structure is the balance between comparing relatively common or standardized methods or trials across different sites and within different contexts versus adapting those trials and methods to the more particular needs of each of the individual sites - especially given the range of diversity.

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Each pole of this strategic continuum has its pros and cons and one of the themes of this review will be to explore this evolving balance within the project.

Farmers' adoption of soil erosion control techniques should be viewed as an investment in land - that is a significant upfront investment which pays off over time and where tenure rights in land are important. This investment usually requires a significant application of labor and is most successful if the farmer has knowledge of the various options available - therefore, the importance of farmer participatory research (FPR). Farmers will be more interested in investing in technologies that have larger and more immediate impacts on productivity and incomes. Thus, market access and income potential of cassava are important, as is the impact of the control measures on either moisture or nutrient availability and cassava yield. When combined with technologies such as improved varieties or nutrient management, productivity effects from soil erosion control can be enhanced. Most soil erosion control projects have tended to focus on single technologies, such as live barriers on the contour or bench terraces, which have been independent of the principal crop or income source, and as a result have not been very successful or widely adopted. This project attempts to combine different options of soil erosion control with other yield increasing technology options within a farmer participatory research framework. The review team strongly endorses this approach as the way forward in developing more sustainable land management systems in Asia's uplands.

The review team visited all but one of the FPR sites in the four countries. This was essential to understanding the project, the challenges that the project has set for itself, and the diversity in both institutions and farming systems across the sites. Some of the diversity in the factors conditioning the suitability or type of erosion control technology and the potential for adoption are presented in **Table 1**. Even this table simplifies the complexity found across the sites, but the team would like to use this table as a framework to evaluate progress within the project and possible future directions for the project. What is suggested in this framework is something of a continuum in upland land use intensity across the sites, running from very intensive in Indonesia (on the left) to relatively extensive in Thailand (on the right). There is something of a divide in the table between Pho Yen village and Phong Linh village, both in Vietnam, in intensity of management of upland areas, particularly in the level of prior investment in soil erosion control. While the project has a role in the more intensive villages, the real challenges of developing appropriate soil erosion control measures are found in the villages of extensive upland land use where there has been little terrace development. By Asian standards, most of this land has been brought into cultivation relatively recently, having previously been in forest. In Thailand extensive land use is due to the relatively large size of the farms and the more constrained rural labor situation, while in China and Vietnam, there is access to communal land on steep slopes which is being brought into cassava production within an extensive slash and burn fallow system. This framework will be used to explore the impact of the project and the next steps for the project in each of the countries.

Review of Project Implementation and Impact

Each of the three principal objectives of the Nippon Foundation project is important and challenging, and meeting any one would be an achievement in and of itself. In essence, the project has addressed the following: (1) the development, testing, and extension of crop

Table 1. Upland land use intensity in FPR sites in four countries in Asia.

Village	Sumbersuko	Ringinrejo	Tien Phong/	Kieu Tung	Dong Rang	Kongba	Noon Sombuun
Municipality	Dampit	Wates	Dac Son	Phuong Linh		Shi Feng	
District/county	Malang	Blitar	Pho Yen	Thanh Ba[1)]	Luong Son	Baisha	Soeng Saang
Province	E-Java	E-Java	Thai Nguyen	Phu Tho[2)]	Hoa Binh	Hainan	Nakorn Ratchasima
Country	Indonesia	Indonesia	Vietnam	Vietnam	Vietnam	China	Thailand
Land-labor Relations							
-Upland/lowland ratio	High	High	Low	Medium	Medium	High	Very high
-Farm size (ha)	0.2-0.5	0.3-0.6	0.7-1.1	0.2-1.5	0.5-1.5	2.7-3.3	4-24
-Relative labor availability	High	High	High	Medium	Low	Low	Low
Land Tenure							
-Lease/ownership	Long-term Usufruct	Long-term Usufruct	30 year lease	30 year lease	30 year lease	Long-term lease	Quasi title
-Communal/Unassigned land	No	No	Yes	No	Yes	Yes	No
Existing Investments							
-% Uplands terraced	~70%	~70%	~70%	~50%	~40%	~20%	~10%
On-farm cassava use	High	High	High	High	High	Low	Low

[1)]formerly known as Thanh Hoa district
[2)]formerly known as Vinh Phu province

and soil management practices that both reduce erosion and increase farmers' income; (2) development of FPR methods appropriate to testing and extension of these technologies, and their institutionalization within complex organization structures, and (3) the maintenance and continued development of national cassava research capacity in Asia. The project builds on 15 years of research work within the context of CIAT's Asian Regional Cassava Program, which provided strong and necessary foundations from which the project could move forward as quickly as it did. The last objective was not explicitly stated at the initiation of the project, but it became apparent in the review team's discussions with cassava researchers in the region that the project has become by default the principal vehicle for maintenance and support of often struggling cassava research programs in the region.

Given the complexity and difficulty of the objectives, the necessary lags in project start up, the individual and institutional learning associated with new methods, and inherent constraints to rapid institutional uptake of such methods, five years seems a very short time indeed. The team therefore viewed the task as much more of a midterm review, rather than an end-of-project review. Such an approach was felt necessary not only to give an idea of what has been accomplished but also to evaluate this progress in relationship to a second generation of issues which the project has stimulated in the course of its work—which, in turn, provides opportunities to build upon for either the Nippon Foundation or another donor. Thus, this section reviews the progress and accomplishments of the project over the last five years, while the following three sections evaluate issues and opportunities that the review team felt deserved more discussion. The review team visited all but one of the FPR sites, interacted with virtually all of the national program staff, had access to and reviewed all the pertinent literature and reports, and interacted intensively with the project coordinator. As such, the review team feels that it has all the information necessary to provide an adequate and balanced report.

A. Applied Research Trials

As noted, the project builds on and supports continuing applied research on soils and crop management in cassava-based systems. This research is carried out by national program or university staff, with backstopping from the project coordinator. The trials are organized around three principal areas, namely soil fertility maintenance in cassava systems, soil erosion control in cassava-based systems, and intercropping trials. These are usually carried out on existing experimental stations in the region, although sometimes are executed as researcher-managed trials on farmers' fields. There is a large, but not complete, degree of standardization of objective and design to these trials across sites and countries, which provides a comparative basis for evaluation of results across the region.

These trials serve dual functions within the framework of the project. They serve their traditional role of testing research hypotheses or answering questions. Also, they provide a core set of technologies from which alternatives can be drawn for testing on farm, either by researchers or by farmers. In terms of the latter function, the trials were necessary to the start of the project, giving researchers some confidence in their understanding of the techniques and options, and providing farmers from the FPR sites with an array of options which they could visually evaluate in selecting a reduced set for testing on their own farms. A relatively standardized array of trials was therefore appropriate to the initiation of the FPR project. However, as the project has moved on farm, in many instances reproducing the on-station trial as a researcher-managed, demonstration trial in the FPR site, a certain amount of duplication becomes apparent, with a reduced need for the on-station trials. Accordingly, the number of on-station trials has been declining over the project period, as much of the applied research has shifted to on-farm sites. This trend is natural and to be commended, with the on-station trials reserved for long-term experiments or for questions that require better control over inter-plot variation and/or more intensive monitoring.

In terms of the more traditional objective, the on-station trials have also produced a comparative set of data, both on plant nutrition and fertilizer response and on yield and soil loss under varying treatments involving live barriers, fertility, intercropping and ridging, as well as across different soil types and rainfall regimes. Virtually all of these trials are well designed, executed and maintained. The soil fertility trials are long-term in nature, many having continued for up to nine seasons. These trials were designed to answer research questions dominant at the start of the project. Having now developed a solid set of trials and data on these questions as well as having identified new questions arising in the application of these techniques on-farm, the project has in many respects reached a point where the research questions driving the on-station research should be more critically evaluated. The recent trials on evaluation of competition effects of various live barriers on cassava is a good example of movement in this direction. The project, probably through the Asian Cassava Research Network, could now usefully explore a possible mechanism by which new ideas arise from the research sites for experimental evaluation. This would lead to some greater diversity across research groups in the types of applied research trials. A possible mechanism for this could be a competitive, small grants program run by the network.

B. FPR Methods and Team Development

Most of the activities of the project revolved around training in FPR methods and their application in selected sites to the problems of soil erosion and crop management in cassava-based systems. Training in new methods such as FPR is best reinforced and internalized by their application to particular problems, such as soil erosion. The review team endorses the project view that FPR is a methodology that has particular relevance in its application to the problem of developing and disseminating soil erosion control techniques, with the corollary that the methods should be designed to suit the problem. The project organized its FPR activities as follows: (1) a joint FPR methods course for 30 research and extension personnel drawn from all participating countries; (2) an RRA of the target areas and selection of 1 to 2 project villages in each country; (3) farmer selection from demonstration plots of a set of possible techniques, followed by testing these within a set of farmer-managed FPR trials; (4) farmer evaluation of trial results and joint planning of succeeding season's trials; and (5) a Training-of-trainers course in each of the four countries to expand the pool of personnel with FPR skills- 27 in China, 31 in Indonesia, 28 in Vietnam and 27 in Thailand.

The review team was impressed by the progress achieved in the establishment of FPR research within the national teams and sites. From very much a perspective of hindsight, the team would make the following observations, none of which detract from the progress achieved in the project. First, much of the material in all the FPR courses focused on diagnostic FPR tools, but there was not much evidence that they were applied in the project. Given the technological and cropping systems' focus of the project and the reliance on participatory research trials, there in fact was little need for application of these tools. This is standard FPR course material and the project provided effective training in this material.

However, any future courses should attempt to achieve a better congruence between course material and project activities - this will be discussed in more detail in the succeeding section on FPR methods.

Second, the result of the RRAs are presented in the Fifth Regional Workshop Proceedings. They were effectively carried out, building on previous RRAs and surveys conducted in China and Vietnam, respectively. While they obviously gave the researchers a more in-depth understanding of the farming systems, they were only utilized in either selecting or rejecting the sites, providing little input into trial selection or design. While RRAs are standard FPR procedure, there is a question for future projects of the value of the exercise in relation to both costs and project design and objectives. Finally, the trials involved not only erosion control, but also varieties, fertilization, and intercropping. These were relatively standardized across the sites, and like the applied research trials were a logical and necessary starting point. It was useful for the review team to view these trials in the different sites and the comparative references or adoption of alternatives between the sites. The succeeding FPR methods section will review this very useful experience and make recommendations on future directions for trial design.

C. Institutionalization of FPR

The organizational locus of the project was cassava research programs and capacity within both NARS and universities in the region. As mentioned above, the project initiated its FPR activities by drawing on ongoing cassava research trials on experiment stations in the region. These researchers also provided the core personnel in the initial training course. There was a tendency in the project for universities and NARS programs to implement their own independent FPR sites, particularly in Vietnam and Indonesia. Given that both universities and NARS offered very similar capacity - for example, universities in both Vietnam and Indonesia have cassava breeding program - there in fact was little scope for collaboration and different sites offered the most logical division of labor. As the FPR sites were established, researchers began to see the gains to collaboration with other institutes, particularly extenstion, and in Thailand, the Thai Tapioca Development Institute. Indonesia was the only case where there were not good interactions with extension, and this limited the effectiveness of a local supervisory capacity in the FPR sites.

D. Farm-Level Impact

In order to reach the goal of increased income and agricultural sustainability, the project conducted research and technology development in four general themes – reducing soil erosion, improving or maintaining soil fertility, intercropping, and varietal improvement. These themes are not independent. Improved soil fertility, intercropping, and improved varieties can all contribute to reducing soil erosion. Strategic research conducted before this project had identified many technological options in the four thematic areas. Particularly, previous research had established a strong foundation of knowledge on soil fertility and cropping systems, and cassava breeding programs had developed many improved clones. At every pilot site that the team visited, farmers had adopted at least one method to control erosion in their fourth year of participating in the FOR project (**Table 2**). Although farmers in all pilot sites adopted some technologies for erosion control, technologies adopted differed widely among sites.

Table 2. Technologies that farmers have adopted at the pilot sites visited in 1998. Level of adoption: * = little, <10%; ** = moderate, 10-25%; * = rapidly growing, 25-80%; **** = high, adoption by >80% of farmers; FP = farmer practice before FPR project.**

Pilot site[1)]	Erosion control	Fertilizer	Intercrop	New varieties
China, Hainan, Kongba	Contour hedgerows -Sugarcane*** -Vetiver**	NPK mix *	Peanut *	**
Indonesia, Malang, Dampit	Contour ridges***	N, P, K (FP)*	Maize (FP)	Undecided
Indonesia, Blitar, Ringinrejo	Contour hedgerows -Elephant grass** -Gliricidia*** -Leucena**	N, P, K (FP)*	Maize (FP)	Undecided
Thailand, Soeng Saang	Contour hedgerows -Vetiver** -Sugarcane*	N, P, K ***		****
Vietnam, Luong Son, Dong Rang	Rice straw mulching (FP) Contour hedgerows -Tephrosia***	FYM[2)] (FP) N, P, K ** Green manure*** Split applications**	Taro (FP) Peanut **	*
Vietnam, Thanh Ba, Phuong Linh	Contour hedgerows -Tephrosia*** -Vetiver ** -Pineapple*	FYM[2)] (FP) Green manure*** N, P, K**	Peanut **	*
Vietnam, Pho Yen, Tien Phong/Dac Son	Contour ridges (FP) Contour hedgerows -Tephrosia** -Vetiver**	FYM2) (FP) N, P, K*** Green manure*** Ca for peanut (FP)	Peanut ***	*** 25 farmers doing own variety testing outside of project

[1)]The pilot site in Kalasin, Thailand, is not included because it is only in its first year of FPR trials
[2)]FYM = farm-yard manure

1. Soil erosion: Most demonstration, on-station, and FPR trials on erosion control methods were very well conducted. Farmers at most sites are adopting contour hedgerows, and a few farmers have adopted contour ridging as well. In two locations, Playen, Yogyakarta, Indonesia and Phuong Linh, Thanh Ba, Vietnam, farmers said that during the dry season they physically moved soil from drainage ditches or from lowland fields back to the upland fields. In addition to reducing soil loss and improving crop productivity, erosion control technologies may reduce labor requirements.

Generally, contour hedgerows have led to gradual terracing of fields. Terrace formation is probably more a function of soil movement during land preparation rather than erosion. Nonetheless, contour hedgerows have resulted in terraces of 15-40 cm over three to four years. Terraces both reduce erosion and conserve soil moisture. Terrace formation was not an explicit treatment in FPR trials. Most farmers reject terrace construction because of high labor demands or costs. Contour hedgerows provide a low cost, relatively low labor alternative to terrace construction and lead to terrace formation over a relatively short time.

The only site where contour hedgerows did not lead to terrace formation was Soeng Saang, Thailand, where fields are plowed by tractors. Special concerns arise for farms that contract mechanical tillage for land preparation. Tractor drivers may not be aware of the need for contour plowing or field shape may prohibit contour plowing. Some contract drivers have destroyed contour hedgerows.

Selection criteria for hedgerow species differed among locations. Although vetiver grass is probably the best species for erosion control and competes little with the crop, it cannot be fed to livestock. Where farmers had livestock, farmers preferred species that could be cut and fed to livestock. Some farmers want a hedgerow species that would also provide fuel, cash income, or green manure.

In most locations, availability of planting material or seed of hedgerow species was a problem. Sometimes farmers' selection of hedgerow species depends more on availability of seed than on the erosion controlling features or other uses of the species. Farmers rely heavily on researchers or extensionists to provide the planting material or seed. To become a self sustaining technology, and for continued adoption of these technologies beyond the project locations, either farmers need the ability to maintain or increase planting materials for hedgerows, or extension services should multiply and distribute planting materials, as is done by the Department of Land Development in Thailand and the National Institute for Soils and Fertilizers in Vietnam.

2. Soil fertility: Native soil fertility varies greatly among project sites. Initial soil fertility levels are relatively high in Kongba, China, where farmers rotate cassava with fallow. Greater use of inorganic fertilizers may increase sustainability of cassava yields and reduce the need for expanding cassava cultivation into steeply sloping lands.

Indonesian farmers say that they do not want to purchase fertilizers for cassava because they grow cassava for home consumption, not for sale. On the other hand, they apply fertilizers to intercropped maize in East Java, or soybean at the on-farm research site in Playen.

Cassava benefits from fertilizers applied to intercrop species, so responses to fertilizers applied to cassava are relatively small. Still, farmers in Dampit cited the value of applying potassium fertilizers to cassava, although the current economic crisis has led to rapid increases in costs and reduced availability of imported KCl in Indonesia.

In Thailand it was shown that yields of cassava had declined gradually over 25 years of cultivation if no fertilizers were applied. Through this and other projects farmers have learned the value of fertilizer application in sustaining cassava productivity. Because most Thai farmers cultivate cassava to sell to livestock feed or starch factories rather than for home consumption, they are willing to purchase fertilizer's and to re-incorporate crop residues to improve yields.

Vietnamese farmers applied pig manure to cassava and other crops before the project began, but only the wealthiest Vietnamese farmers applied fertilizers to cassava before this project. Now many more farmers are aware of the advantages of fertilizer application, and have either improved fertilizer management through split application or increased levels of applied fertilizer, especially K. They have also increased the use of green manure produced from contour hedgerow or intercrop species, mainly *Tephrosia candida* and peanut, respectively.

From our short review we could not determine whether farmers outside the project had adopted fertilizer application technologies. Furhtermore, the application of inorganic fertilizers by farmers in the project may reflect project participation more than true adoption, because in some sites farmers receive a bag of fertilizer as an incentive to participate in the project.

3. Intercropping: Cassava canopy growth is relatively slow. It takes several months for cassava to completely cover the soil. Intercropping reduces erosion because plants more quickly protect the ground from the direct impact of rain. Farmers in Indonesia and Vietnam practiced intercropping before the project. In Vietnam, however, farmers have increased the area of cassava intercropped with peanut as a result of the project. Through FPR, farmers learned that their traditional planting density for cassava was too high. By spacing cassava plants farther apart, stems were thicker, roots bigger, and yields increased. Wider spacing also provided the opportunity to increase peanut intercropping, so that now, about 50% of the cassava has a peanut intercrop.

Farmers' choice of intercrop reflected either a need for quick cash or need for livestock feed. In Pho Yen district, Vietnam, where farmers grow rice for home consumption and cassava for swine feeding, a peanut intercrop has become the principal source of cash income. They also incorporate leaves and stems in contour ridges as a green manure for cassava. In Dong Rang, Vietnam, farmers grow a taro intercrop on more sloping lands farther from the household and a peanut intercrop on more level land near the household. These farmers traditionally apply rice straw mulch to intercropped taro, but now also apply to cassava grown in monoculture to reduce erosion, conserve soil moisture and facilitate land preparation by hand.

4. Improved varieties: Most farmers quickly accept improved varieties. In many cases, farmers' interest in participating in the project was initially through their interest in new varieties. In Soeng Saang, Thailand, farmers completely changed to new varieties. In Vietnam, though farmers are still undecided as to the best variety, many farmers outside of the project have planted one or more new varieties in their fields on their own initiative. Adoption of new high-yielding varieties by farmers is slow only in Indonesia, where traditional varieties are well adapted to ecological niches and are often preferred for home consumption.

Cassava variety selection programs appear to be well established in all locations. Only the pilot sites managed by the National Institute for Soils and Fertilizers of Vietnam does not have a breeder on the team, but this team received cassava varieties from Thai Nguyen University and from the nearby Vietnam Agric. Science Institute.

E. Conclusions and Next Steps

It is the assessment of the review team that the project has met the objectives as set out in the initial project proposal and that the results obtained represent a very worthwhile investment by the Nippon Foundation. The review team was impressed by the progress made in institutionalizing new FPR methods into existing research programs in the region, the obvious value of the methods in very diverse village situations, the technological possibilities for reducing soil erosion in Asia's upland cropping areas, and the benefits of linking yield increasing technological options with soil conservation options. The problem on which the project worked is important to the sustainability of agriculture in the region, often for some of the poorest households and regions in Southeast Asia.

The review team would like to stress the potential that the project has as a real innovator in a challenging field and we will devote the rest of the report to reviewing how the project might think about organizing itself to realize that potential. After virtually a decade of development and evolution, FPR methods are at something of an impasse. They are widely applied but primarily in diagnosis and small plot experimentation. This project has the potential to go beyond that in the exploration and development of new methods, based on problems that now present themselves in the project. Secondly, the real potential of FPR rests on how it is replicated from a few sites to thousands of sites, and therefore in how institutional structures are formed around FPR methods. The project as well offers the potential to explore this critical issue. Finally, the real test of the project is the impact it will have on soil erosion control and farmer welfare. Farmers are exploring these options in the FPR villages and there are initial signs of adoption. Such sites now provide the potential to test the validity of new approaches and techniques and form a possible nucleus for more widespread diffusion of these technologies.

STRATEGIC AND APPLIED RESEARCH NEEDS

As cassava FPR projects disseminate technologies identified for adoption in the first phase of this project, there will be an increasing demand for new technologies (**Table 3**). At the same time, there appears to be a reduced or more diffuse effort in cassava research outside of the project. In other words, demand for research results within the project is increasing while generation of those results outside of the project is decreasing. This situation is exacerbated by the economic decline in the countries of the project partners, which has already resulted in reduction of national program support to cassava activities. Given the importance of a good research base to support FPR, and the fact that one of the benefits of FPR is from its feedback from farmers to researchers in identification of research needs, allocation of project resources to strategic and applied research is a necessary and appropriate component of the project. During its first phase the project allocated about 30% of its resources to conducting strategic and applied research on-station and in farmers fields. In the next project phase, the allocation of resources between strategic-applied research and FPR activities should remain about the same. On the other hand, researchers should be encouraged to reduce redundancy between on-station research and demonstration plots in farmers fields, and shift the resources for on-station research to new areas of strategic research, as discussed below.

Some of the strategic and applied research conducted during the first phase of this project should be continued. Long-term fertility trials give valuable information on the long-term sustainability of cassava production. While the number of long-term fertility trials may be reduced to allow resources to be used for other activities, several of the trials should be continued. Breeding and selection of improved cassava varieties is fundamental to any cassava program. Whether farmer participation earlier in the selection process would benefit cassava improvement is a question that may be addressed in the next phase of the project.

Strategic and applied research needs identified through FPR during the first phase of this project include:

1. Competition between cassava and hedgerow species. Effectiveness in controlling erosion is only one of the critera farmers use when selecting species for contour hedgerows. They also consider ease of establishment, availability of planting material, alternate uses as green manure, fuel, fodder, or cash sales, and competition between the hedgerow and crop. Of these concerns, hedgerow selection and management to minimize competition between the hedgerow and crop for light, nutrients, and water may require strategic research with levels of control and measurement precision that can best be achieved through on-station research.

2. Nutrient cycling and transfers. Sustainable agricultural systems require soils that continue to provide nutrients needed by the crop through time. Much of the research on nutrient cycling and transfers in cassava based systems have been conducted under conditions of ongoing soil erosion, use of traditional varieties, minimal fertilizer inputs, and monoculture. As farmers adopt improved technologies, research is needed to understand the impacts of those technologies on nutrient cycling and transfers.

Table 3. Research and training need for the second phase of the project as identified through feedback from FPR trials. Research needs include strategic and adaptive research.

Pilot site	Research need	Training needs/Community action
China, Hainan, Kongba	Drought tolerant intercrop	Vetiver use for other crops
	Pineapple in contour hedgerows	Farmer-to-farmer extension
	Fertilizer management in crop-fallow rotation	Vetiver multiplication
	Cassava variety selection	
	Improving sugarcane hedgerows for erosion control	
	Tree legumes as hedgerows	
Indonesia, Malang, Dampit	K fertilizer options to replace imported KCl	Farmer-to-farmer extension
	Hedgerows suitable for cut-and-carry feed	Contouring across farm boundaries
Indonesia, Blitar, Ringinrejo	Hedgerow-cassava competition	Farmer-to-farmer extension
	Effect of rotating cassava varieties	Contouring across farm boundaries
	Short duration, drought tolerant cassava	
Thailand, Soeng Saang	Drought tolerant intercrops	Tractor driving for contour plowing
	Hedgerow-cassava competition	Vetiver multiplication
	Chemical or mechanical weed control	Farmer-to-farmer extension
	Minimum tillage	
Vietnam, Luong Son, Dong Rang	Peanut varieties for intercropping with cassava	*Tephrosia* seed production
	Cassava variety selection	Vetiver multiplication
	Combined vetiver and *Tephrosia* hedgerows	Farmer-to-farmer extension
Vietnam, Thanh Ba, Phuong Linh	Hedgerow-cassava competition	*Tephrosia* seed production
	Soil liming	Vetiver multiplication
	Soil fertility in relation to position on hill	Farmer-to-farmer extension
	Mutual benefits of cassava-peanut intercrop	
Vietnam, Pho Yen, Tien Phong/Dac Son	Why have farmers adopted variety testing here on their own, when none of the other villages have done so?	*Tephrosia* seed production
		Vetiver multiplication
	Peanut-cassava intercropping patterns	Farmer-to-farmer extension
	Peanut-cassava competition	
	Livestock feeding of cassava roots and leaves	
	Mg fertility	

3. Socio-economic issues. Farmers in Thailand identified cassava marketing and processing as a major concern. Such issues are important where cassava is grown for sale, whether most or part of the crop is sold. Marketing issues, price fluctuations, and weather can have a major impact on production stability. Farmers are generally more willing to purchase inputs when they have access to markets for cassava sales. They increase or decrease area planted and input use based on market price. Farmers may consume more of their cassava crop if bad weather affects other crops in their agricultural system. How these factors interact in their influence on farmer adoption of new technologies and sustainability of cassava-based systems is an important research area.

4. Soil-water balance. Low or poorly distributed rainfall affects adoption of intercrop technologies in most cassava growing areas. Technologies that reduce erosion should increase both soil water holding capacity and the fraction of rainfall that is retained in cassava fields. Research on soil-water balance should be conducted to verify and quantify these benefits and to ascertain whether farmers adopting technologies that reduce erosion will sufficiently improve soil moisture status to allow intercropping, crop rotation, or cultivation of a more desirable hedgerow species.

NEW DIRECTIONS AND DIVERSITY IN FPR METHODS

The project had used a relatively standardized methodology of FPR introduction across the various sites, consisting of demonstration trials from which farmers chose a more limited set of options to be established as trials on their own farm. These FPR trials consist of four principal technological options, namely varieties, fertilization, intercropping and soil erosion control. These trials are continued for two to three years, with farmers evaluating the results at the end of each harvest.. This was a reasonable approach for the first phase and provided a very successful strategy for introduction of FPR methods into both institutions and village sites, as well as providing a useful comparative set of data for evaluation across sites. However, the team noted differences across sites in adaptation by farmers of these trials and results, and most importantly very different needs for a second generation of methods to take the technologies and approach to scale in the various countries. This section will first review these different needs by country and then explore a few project-wide issues in the evolution of FPR methods.

Country-Specific FPR Strategies

Thailand : Cassava is a priority crop in Thailand. There is a well developed structure for developing and disseminating new varieties to farmers. Much of the land planted to cassava has been opened only within the last 20 to 30 years, and only within the last 5 to 10 years have soil nutrient levels declined to the point where farmers have started applying fertilizer to cassava. There is some scope for improving fertilizer use efficiency, requiring a cassava-specific, compound fertilizer rather than the 15-15-15 currently utilized. Intercropping potential is limited by the large field size and the lack of good drought tolerant legumes. Thus, the FPR results of most interest to farmers have been the erosion control measures, and farmers generally have tended to prefer the vetiver barrier as showing the most potential. The central issue in Thailand is how to scale up this technology from its evaluation in small plots.

There are three strategic issues in the next steps of this scaling up process. The first is how to scale up the technology from a small plot to its application at a whole farm level. There is a range of issues here. The most important issue for vetiver technology is the production of sufficient planting material for farm level application. To be effective the vetiver hills have to be planted closely. Once a live barrier is established, farmers are not willing to disturb it for planting material. Efficient transfer of vetiver to the field and establishment on the contour are issues, compounded by the tendency for fields to be narrow and run up the slope or hill (a general tendency in land allocation during the land reform). There is very little, if any, work on participatory methods for scaling up technologies - compost and agroforestry technologies have similar difficulties. This may involve community-based nurseries, joint contour development across farms based on community-developed land-use maps, farmer research committees for community based planning, and testing of different methods of large scale establishment. Scaling up problems were apparent in the field sites and new methods will have to be developed to tackle what is the central problem to effective adoption of vetiver technology.

Second, land is prepared by hired tractor services. Tractor drivers prefer to plow the length of the field, which tends to be up and down the slope. They view both contour plowing and live barriers to be nuisances. Tractor drivers must become participants in the testing and application of the technology, as they are central to its application. How to do this remains a question, but one which will have to be addressed in the project.

Only with successful resolution of these issues - and this reviewer is of the opinion that other live barrier options based on seed establishment should be kept open - is there a basis for applying the methodology in other locations, either districts or provinces. As will be discussed in the next section, Thailand has an institutional structure for efficient dissemination of proven technologies, and given the relative homogeneity in cassava-based production systems, the project has the potential of moving to a nationwide dissemination mode, building on the structures put in place to quickly extend new varieties.

China: A 1990 RRA of cassava production and utilization in China found that much of the crop is grown on sloping land, often very steep, which is also apparent in the FPR site. Of the four countries the problem of soil erosion in cassava production systems in China is probably the most extensive and faces the greatest challenges to overcoming the problem. The Chinese program is still identifying a technology for erosion control that is both effective and acceptable by farmers. Research on live barriers has tended to concentrate on forages - the research institute at CATAS has a mandate for both field crops and forages - which have either not established well or excessively compete with cassava. Vetiver is a possibility, but with the same problems as for Thailand. More tree species need to be evaluated as possible live barriers and some consideration might be given to tree-based, improved fallows, which ICRAF has found successful in Kenya and Zambia.

The technology problem is compounded by a land use issue. Individual usu rights in land were allocated about 20 years ago on a long-term lease basis. Some of these upland areas had been terraced during the collective period and tend to be closer to the village. These tend to be more intensively managed, and in Kongba village, many are going from cassava to rubber. However, farmers also cultivate unallocated lands that, because of their steepness, are ostensibly illegal to cultivate. Nonetheless farmers are shifting their cassava cultivation to these areas. Erosion control measures under this system must be very low cost. Future FPR trials might best be designed around different land use categories, for example in Kongba, terraced land in permanent cultivation, terraced land in a fallowing system, unterraced with usu rights, and unterraced without usu rights. The hypothesis here is that farmers will choose different technologies for these different land form types. A village mapping of these land forms would be done during the characterization and trial planning process.

Given the limited capacity in the research teams, it may be useful to explore these technology questions in other sites in other provinces, such as Guangxi Province. Nevertheless, the point here is that a useful technology is the essential first step in moving forward, and working with a number of research teams in different sites increases the chances of progress in this important dimension.

Vietnam: According to the 1991/92 nationwide survey of cassava production and utilization in Vietnam, 89% of cassava produced in the northern region is grown on sloping land, compared to only 29% in the southern region. The focus of the project on the northern region is, therefore, appropriate. However, the three sites reflect markedly different situations, with very different implications for next steps. Vietnam has been most successful at introducing a broader spectrum of technologies of interest to the farmer. This is partly due to the much shorter research history for cassava in Vietnam, as compared with Thailand or Indonesia, and partly to the intensity of management of these upland systems where cassava is the dominent crop. An erosion control technology based on *Tephrosia candida* live barriers has emerged from the FPR trials as an acceptable technology, at least in Dong Rang and Phong Linh villages. Vietnam is in many ways a composite of expansion paths in the other three countries, and like China ash gone through a relatively recent process (1990) of allocating lowlands through long-term leases, and is still in the process of allocating uplands.

In Dong Rang and Phong Linh villages, which are managed by the Soils and Fertilizer Research Institute, there are questions of how to scale up the *Tephrosia candida* technology within the village - although not nearly so challenging a technology as vetiver in Thailand. In Dong Rang village there is evidence of illegal expansion onto steep slopes that by law should be left fallow or in forest. Some discrimination of technology by land forms might be useful in planning for scaling up. There has already been significant adoption of *Tephrosia candida* barriers based on seed supplied by NISF. Integrating this process into community structures might be useful, as well as some monitoring and evaluation of this scaling up. When this process is well underway-varietal adoption and *Tephrosia candida* multiplication is also advanced - the site could serve as a demonstration site for extension of technologies and methods to other villages in the district or province. This is already planned by NISF and the institute might usefully consider alternative dissemination modes, such as the village as a demonstration site for both these methods and technologies, farmer-to-farmer extension methods, Farmer Field Schools or alternative farmer training models, and video techniques. Within the overall Nippon Foundation project, the NISF sites offer the greatest potential for exploring efficient dissemination models where access to a well developed extension system is not possible. The Phong Linh site offers similar potential without access to unallocated steep land; like Thailand, land has been mostly allocated in narrow fields up and down the slope.

This provides another avenue for exploring community-based scaling up methods, which the farmers indicated they were interested in trying.

The Pho Yen sites are managed by Thai Nguyen University, and represent areas similar to Indonesia where upland areas are already largely terraced and are quite intensively managed, with intercropping predominating. New varieties have been the primary source of farmer adoption in this area and the site is interesting in terms of the movement by farmers to farmer designed varietal evaluation (and multiplication) trials established independently of the researchers. This is a useful process to monitor and evaluate within the overall scope of the Nippon Foundation project. There may be some scope for expanding FPR to other components in the system such as peanut intercropping, although the potential gains here remained unclear. Given the committed team at the university, another site more typical of the conditions in the NISF sites, would be recommended.

The Vietnam program offers the potential for methodological innovation in a number of directions, with potential for spillover into each of the other three countries. However, this will require increasing the exposure of the relatively small teams to relevant FPR experience in other projects and to a broader base of literature - also a problem given the constraints on language capability, especially for the younger researchers. Donors such as Ford Foundation, that has an office in Vietnam, support work in just this area and might augment project resources. There are possible linkages to the CIP program in Vietnam, which is staffed by an agricultural economist.

Indonesia: Cassava has been an integral part of the upland cropping systems in Indonesia for far longer than any other part of Asia. A wider range of varieties and cropping systems are found there, along with a higher degree of heterogeneity in how cassava is integrated into production systems. This diversity exists within some of the most intensive cropping systems in the region. Most of the upland areas are already terraced, agroforestry is integrated into more marginal upland niches and cassava's relative role in the cropping system depends partly on food preferences and partly on market opportunities and profitability relative to other crops. In such a context, any technology that provides a productivity or profitability advantage is rapidly adopted.

The FPR methodology that worked so well in the other countries was least effective for upland conditions on Java. The erosion trials obviously depend on a minimum slope and in many instances these trials were either unrepresentative of principal land forms in the site or were created by actually taking out existing bunds. Farmers rapidly perceived the advantage of potassium fertilization of cassava, unfortunately made unprofitable or unavailable by the rapid price change of imported commodities with the precipitate devaluation of the rupiah. Live barriers, in fact, compete with other commodities on terrace borders, including cassava. Thus, *Gliricidia,* elephant grass, and *Leucaena* offered some advantages as a dry season forage, although cassava leaves provide a similar fodder resource. Finally, new varieties in Indonesia must compete with indigenous clones that have a long history of selection for particular ecological niches. While farmers are keenly interested in new varieties, it is far more difficult to compete with these well-adapted indigenous clones.

These particular features of Javanese upland systems define three critical features of an FPR program. First, unlike the other countries the approach should be based on production systems rather than just a singular focus on cassava. However, this requires efficient and accurate methods of site characterization, access to and knowledge about a broad range of possible technological interventions, and methods for testing production systems - all three issues are at or beyond the cutting edge of FPR methods. Second, given the rapid uptake of useful technologies, the FPR strategy should be to rapidly test any particularly suitable technologies in any particular village or site and then move to another site. Recommendation domains are probably quite narrow in the Javanese uplands and the trick is to develop rapid FPR methods that allow efficient coverage of mandate areas - again a cutting edge issue in FPR. Finally, the institution should have a mandate and capacity for adaptive research. Such an institute, the Assessment Institute for Agricultural Technology (BPTP), was recently created within AARD and depending on its capacity (not assessed by the review team), provides the logical vehicle for FPR research.

Fostering Diversity in FPR Methods

As implied by the country summaries above, the review team recommends developing a second generation of FPR tools, moving from a standardized methodology across countries to one that develops methods most needed within the countries and sites. The overall project should be a vehicle for developing and testing an interacting body of FPR methods that meets the needs of taking the project to scale. As such this project offers the opportunity to move FPR methods out of the diagnostic strait jacket in which most FPR work is currently concentrated. We see this as the logical evolution of the very solid foundations that have been developed during the first phase of the project, and as providing innovation in FPR methods in response to very clear and different needs in the project sites. Such a division of labor is sketched in **Table 4**.

If the project adopts this course - and by no means is this the only option - there are certain implications in how the project organizes itself. First, there will be a shift in focus of project and field level activities from the current concentration on research trials to research on methods, although within the context of application to problems arising in the FPR sites. This is an organizational and conceptual shift. The national FPR teams would have to understand and agree to such a shift, particularly as it moves them from an area where they feel comfortable to one which requires a large degree of learning by doing. Second, the project would have to access and assess a wider range of FPR experience than is available in the region. Much of this experience is not published and requires interaction with FPR practitioners - one vehicle for this would be the list server for the CG system-wide initiative on FPR. Third, the backstopping required from the coordination office would certainly increase, especially in conceptualizing and planning project activities. More flexibility would also be required, as the set of activities organized around crop calendars is much easier to plan. In this regard, a strong socio-economics input into project backstopping would be important. There are options in how this might be done, from a project staff position to collaborative activities with the two CIP socio-economists in the region to consulting contracts with those FPR experts working in the different areas - each of these obviously having different cost implications.

Table 4. FPR methods development.

FPR Method	China	Indonesia	Thailand	Vietnam
Characterization				
-Regional RRA and site selection	+++	+++		++
-Site characterization	++	++		+
Diagnosis in complex production systems		+++		
Farmer experiments	++			+++
Within-farm technology scaling up[1)]			+++	++
Farmer Research Coordinating Committees[2)]			+++	++
Technology dissemination and farmer training			+++	+++
Monitoring and evaluation				
-Technology/Trials	+++	++	++	++
-FPR methods		++	+++	+++

[1)] mainly for hedgerow technologies
[2)] community nurseries, research planning and execution, across-farms contouring

The project should not underestimate what is required in terms of this conceptual shift in the FPR teams. The research teams' experience with FPR methods is limited and primarily defined in terms of the different categories of trials in the current FPR approach. Researchers see the advantages of providing farmers with more choice, rather than the traditional approach of prescribing a new variety, an improved fertilizer recommendation, or even a soil conservation technique, for example vetiver. The introduction of farmer choice plays out in terms of key distinctions between types of trials. Thus, there are on-farm trials managed by researchers - for example, the RILET trials in Malang - demonstration trials managed by researchers from which farmers make selections, and FPR trials incorporating these selections and under farmer management, but with a significant involvement of researchers in their design and data collection. This has been an effective way of changing traditional researcher practice, but researchers' understanding of FPR largely ends there. Researchers noted the expansion of farmer designed and managed varietal trials in Pho Yen, Vietnam, but did not know how to incorporate such trials into their FPR activities, or how to build upon this process of farmer experimentation. The project iss now at a stage where researchers should be encouraged to move to a wider conceptualization of what constitutes FPR practice.

The real test of soil conservation technologies comes in their application at a whole-farm scale. There is little FPR experience and therefore virtually no methodology to guide this work, yet the FPR projects in both Thailand and Vietnam now must address this issue. Application at higher scales tests such issues as labor constraints, provision of planting or seed materials, establishment problems where management is much less intensive, and capital constraints. Whether alternatives can be experimented with at this scale is an issue, possibly comparing different methods between farms. Joint action is often a feature of some of the problems and constraints, e.g. village level nurseries or contour formation across farm borders. Understanding farmers' choice and decision-making becomes more relevant at this scale, and because experimentation potential is reduced, other avenues of learning and evaluation must be pursued. How FPR research teams think through and plan this next set of activities will test the validity of combining FPR trials with methods development.

Cross Cutting Issues for FPR

Models to extend technologies developed through FPR

All pilot sites began their FPR with the same process. First a training for research and extension personnel. Next diagnosis and site selection. Then demonstration trials in farmers fields. And finally, design of FPR trials by cassava team members and farmers. In all cases, FPR led to the identification of superior technologies and combinations of technologies, and at least initial stages of farmer adoption of selected technologies. At this stage, the most critical issue is how to increase the numbers of farmers that are able to benefit from the technological packages developed through FPR, which is one of the targets for the next phase of the project.

Integrated agricultural systems

As farmers become more familiar with the activities and scope of FPR, a natural extension of this project is to shift from a strict cassava-based approach to broader components of agricultural systems. Farmers in Vietnam expressed a desire to conduct FPR on pigs and chickens, to which they feed much of the cassava they produce. Farmers in Thailand mentioned that one of their biggest problems is marketing and pre-sale processing.

The challenge with any integrated systems approach is that financial and other resources limit the extent to which it is possible to study different components of the integrated. Some teams may find it important to conduct FPR on variety selection for intercrops to be grown with cassava, cassava utilization, or other components of the system. Teams may need to seek inputs from other experts. To the extent possible, the project should encourage FPR teams to address important components of their agricultural systems in addition to cassava.

Institutionalization of FPR

In addition to developing technologies that improve agricultural sustainability, the project can have a major impact if it contributes to the institutional adoption of FPR as a standard tool for technology development and dissemination. Many researchers remain skeptical of FPR's value. Through continued technological impacts, the project may teach researchers, extensionists, and administrators of the appropriate use of FPR, which problems FPR can solve, and how to extend technologies developed through FPR. Project leaders should explicitly encourage participating researchers and extensionists to promote FPR at their own institutions through presentation of seminars and publishing scientific papers outside of the traditional FPR literature.

Research balance

FPR does not stand alone. The approximate allocation of resources in this project is 70% for FPR and 30% for on-station or on-farm strategic and applied research, which we agree is the proper allocation for this project. As institutions assimilate FPP into their overall portfolio of activities, they need to consider the best balance between different research modes. The balance should not be static, but clearly they should allocate resources to FPR to solve problems for which researchers claim to have developed adequate knowledge and technology without commensurate farmer adoption of technologies.

Gender equity

Farmer participants in this project included nearly equal numbers of men and women. Except in Indonesia where only men participated in discussion, we observed no gender bias for either the project activities or suitability of adopted technologies.

From FPR to FPIDT

Active participation of extension personnel is essential and will become more essential as the next phase of the project shifts its emphasis from developing FPR methods to extending FPR methods and results. To attract greater participation of extension personnel, it may be worthwhile considering a more inclusive name. Some extension personnel may shy from FPR merely because of the word *Research*, which belongs in another department. Some options are Farmer Participatory Technology Development and Transfer (FPTDT), or FP Technology Development and Dissemination (FPTDD).

Models for extending FPR

The project proposal for the next phase lists as an objective that it will test various models to extend technologies developed through FPR, but the proposal does not describe those models. The following list of models is not exclusive. The project may consider testing these or other models, either singly or in combination.

1. Farmer-to-farmer extension. Pilot sites host field days at harvest and during crop season for farmers and village leaders from neighboring villages within a 25 to 50 km radius. Suitably trained farmers from the pilot site would visit other villages with research and extension personnel on request of villages that would like to adopt FPR identified technologies. Preferably farmers in the new village would develop their own FPR trials using their own resources and receiving only guidance from formal project participants. Alternately, farmers in the new village could move directly to technology adoption.

2. Establish new pilot sites. Once farmers of a particular village have adopted technologies identified through FPR, reduce FPR activities in that village and initiate new pilot sites. This model must balance the needs for long-term research on agricultural sustainability, with needs to extend technologies to as many farmers as possible.

3. Training trainers. Leverage project resources through training members of research and extension teams for other commodities, NGOs, and other institutions interested in improving agricultural sustainability or natural resource management. These trainers would use their own resources to conduct FPR.

4. Communications media. All participating countries have made video tapes of their training courses. Through appropriate editing, they may produce training videos appropriate to show to farmer groups, extension groups, or aired on television. Though beyond the scope of this project, some institutions may be able to produce such videos with their own resources and the project may encourage and guide them in this effort.

Institutional Issues Within FPR

CIAT's FPR project for cassava-based systems in Asia represents a dominant trend in the CGIAR to organize and undertake research through and as partner with national institutions. CIAT facilitates and backstops the research, but local researchers within national institutions actually carry out the trials and activities. Such projects build local capacity along with the research, provide a conduct for new ideas into often isolated research institutes, and when organized within a network framework, allow for cross-country learning and innovation. The downside is that such projects require experienced researchers with a broad range of skills; there are significant time lags in project start up and institutional learning curves requiring longer project periods to meet multiple and intersecting objectives; and the project must have the capacity to develop and source new ideas, methods, and research results that makes the project attractive to Asian researchers and institutions.

A principal project objective is to strengthen national institutional capacity for generating and transferring appropriate crop/soil management practices. This is done within a context of significant institutional diversity across countries, significant organizational barriers to inter-institutional collaboration within countries – as discussed below, a necessity for successful FPR research – and an almost universal lack of capacity in socio-economic research to support the field research sites within the NARS institutions with principal responsibility for executing the project. The idea of an institutional model for both FPR and soil conservation must recognize this diversity and work within existing institutional structures – although there is a question, addressed below, of where to locate most effectively such a project. We leave open the question of whether a generalized model is in fact possible, with an alternative conception being to gauge how certain critical fractions are integrated into different institutional structures.

The challenge of institutionalizing FPR within Asian research and extension systems should not be underestimated. These systems tend to have a strong hierarchial structure. Decision-making is centralized, where information, methods, and techniques tend to flow downward, resulting in widespread replication rather than adaptation to local conditions. New technologies tend to focus on varieties that pass through restrictive testing and release systems. District or provincial capacity is structured to implement nationally designed programs and campaigns, with little capacity for lingkages or collaboration between field personnel of different institutions.

FPR as a method is designed to give farmers choice, to allow adaptation of technology to local conditions, to provide an avenue for upward flow of information from farmers and within institutions, and to decentralize decision-making to the field. As such, FPR represents a significant change in how research and extension systems undertake their work and clearly FPR programs will not be incorporated wholly or quickly within such systems. Rather, there will be a process of introduction, experimentation, and institutional change around these methods and the challenge is to guide and understand that process within any particular institutional context.

The CIAT project has adopted an appropriate and effective strategy to institutionalize FPR methods. That is, the process starts at selected district or provincial offices with training, pilot field sites, and experimenting with new methods of interaction with farmers. A focus on soil conservation moves the technology issues out of strict variety or commodity boundaries to consideration of more components and complexity within the production system. To date, the project has built on the long-term institutional and personal relationships CIAT scientists have had with cassava researchers in the region, and has started with a standardized model for all four countries. Again, this is logical and an appropriate starting point. However, the next phase should start to adapt to the institutional diversity found in each of the project countries. This section discusses some issues the project might consider in a next phase.

A. project Interaction with CIAT Headquarters

During the course of the project, program and funding structures within CIAT and within the CGIAR have changed radically. IARCs have moved from organizing and funding research around programs to projects. Projects are grouped around themes but nevertheless they function as relatively autonomous entities within relatively fixed time frames. The linkages between this project and CIAT headquarters have necessarily changed in the process. The CIAT cassava program no longer exists. The Nippon Foundation project now resides within a larger CIAT project on Small-holder Farming Systems. The positions for cassava economist and cassava physiologist/soil scientist at CIAT headquarters have been eliminated. Also, the CIAT cassava breeder based in Asia has recently resigned, with some uncertainty as to whether that position will continue with another breeder. The project acitivities have relied primarily on the senior agronomist funded within the project itself.

These changes raise a number of issues for a possible next phase. CIAT is effective in the region because of the goodwill and personal capital developed with cassava researchers and their institutes over 20 years. However, there is little sustained capacity at CIAT on which this project can draw, yet there is the need to access advances in research and methodology in FPR, soil conservation, and cassava research. The new structure of the IARCs forces projects such as this one to establish linkages with such capacities wherever they exist, most often outside of CIAT headquarters, and especially if they exist in the region. The projects' interactions with CIP's regional program is logical and has been productive. IBSRAM is a possibility, but as yet their capacity in FPR remains limited and their focus is on very steep slopes. The project could usefully review the IPM Farmer Field School experience in the region, as utilized by CIP and others.

There is an emerging body of experience applying FPR methods to soil management and soil and water conservation problems. In Latin America, especially in Honduras and Mexico, this has focused primarily on green manure cover crops. KIT has developed participatory methods to understand organic resource flows within livestock-cropping systems in Mali. CIMMYT is starting to utilize participatory methods in its soil fertility network in Southern Africa. Finally, much of CIAT's participatory research network in eastern Africa deals with soil management issues. The Nippon Foundation project could usefully exchange experience with many of these projects, particularly as a source of new ideas for what is an emergent capacity in Southeast Asia.

B. Institutionalizing FPR in Research and Extension Systems

The CIAT FPR project has been successful by applying a relatively standardized model of demonstration plots, FPR trials, and farmer evaluation in two or three pilot sites within institutions with which CIAT has had a long-term working relationship. However, as Farrington (1998) has noted, the real test of FPR methods is in how efficiently they can be scaled up and "where wide-scale replicability should be a key design criterion." Intensive interaction with farmers over extended periods of time, complemented by research trials, is expensive. It places heavy demands on researchers' time and on travel, and vehicle and operational costs. More importantly, higher costs come with direct interaction with only a limited number of farmers. The test of FPR is how to reach more farmers at significantly lower costs. How to do that is the challenge for a possible next phase. Complementing the suggestions for FPR methods, the design of institutional strategies has to take into account the large differences between countries in research and extension systems.

The project to date has been based in cassava research programs. Where cassava is a priority crop, such as in Thailand, there is a rationale for basing an FPR project focused on soil conservation within a commodity research framework. Where systems are more complex, as in Indonesia where cassava is one among three or four major crops in the system, an adaptive research unit would be more appropriate. This is possible in Indonesia where such an institutional capacity has recently been developed in BPTP. It is more difficult in China and Vietnam where there is no adaptive research capacity and extension is weak. There the work has to continue to be an extension of an on-farm research capacity within the cassava or soils research programs.

FPR is a methodological approach applicable to all-farm research. As the experience with farming systems research indicates, separate farming systems or FPR units are not the solution to institutionalization, as they tend to be staffed by junior personnel and are isolated from the on-going research of the institute. FPR methods have been particularly effective within adaptive research teams, natural resource management research, and research on particularly complex system components such as soil conservation or IPM. There is not a unique solution to where to locate FPR within research and extension systems. FPR must be adapted to the existing organizational structure and problem context – although we can expect some organic institutional change in response to incorporating these methods.

Locating FPR within national cassava research programs offers limited capacity for scaling up the number of FPR sites or the dissemination of proven technologies. Cassava research programs in Asia tend to be small and have limited transportation and operational resources. They tend to be restricted to sites relatively close to the research institute and can independently manage only a limited number of field sites, in addition to other ongoing research responsibilities. As such, any impact with FPR has to have inherent within it a strategy for replication, usually requiring linkages to other institutes. Some of the issues that influence such a strategy are found in **Table 5**, with suggestions for institutional dimensions through which to implement such a scaling up.

Central to a scaling-up mode is the decision to expand the number of FPR sites or to move to dissemination of technologies developed within FPR sites. Factors influencing this decision are the degree of cassava dominance in the system, homogeneity in land forms, and complexity and heterogeneity in the production/farming system. Significant heterogeneity between "recommendation domains" result in a strategy focused on efficient expansion in the number of FPR sites, usually combined with withdrawal from older sites. Such should be the strategy in Indonesia and eventually in China and Vietnam. When there is more homogeneity, and usually simplicity in the system, dissemination of technologies developed in FPR sites through effective linkage to extension systems is the preferred route to scaling up. This should be the strategy in Thailand, if whole-farm scale methods can be developed for hedgerow technologies.

Table 5. Factors influencing FPR institutionalization strategy.

	Thailand	Indonesia	China	Vietnam
Adaptive research units	RRDO[1]	BPTP[2]	No	No
Research-extension linkages	Good with potential to be better	Ineffective outside rice	Minimal	Variable
Government priority for cassava	High	Low	Low	Low
Centralization of decision-making	National	National/ Provincial	Institute/ Provincial	Institute/ Provincial
Institutional scaling-up	RRDO or through Provincial Extension Office	BPTP	Provincial cassava research teams	Provincial cassava research teams

[1] RRDO = Regional Research and Development Office
[2] BPTP = Assessment Institute for Agric. Technology

C. Possible Country Strategies

Thailand: Thailand is probably the only country that offers the scope for rapid institutional scaling up of FPR, based on dissemination of FPR results rather than expanding the number of FPR sites. As was argued in the last section, issues in the application of live barrier, particularly vetiver, technology in their application at a whole-farm scale, need to be resolved. Given that, the project can advantageously use the hierarchical structure of both research and extension, together with the fact that cassava is a priority crop in Thailand, as a vehicle for rapid scaling up. Within the Rice and Field Crops Promotion Division of the Department of Agricultural Extension (DOAE) there is a cassava group and people directly responsible for and with a budget for the expansion of the cassava FPR program. Given the good working relations between the DOAE and the Department of Agricultural (DOA), and the number and distribution of research centers with capacity in cassava, joint research and extension FPR teams at a district or provincial level are possible. Targeting particular districts and developing a strategy and plan for farmer training – probably in association with the Thai Tapioca Development Institute – and technology dissemination through farmer-to-farmer extension would form the core of programs organized at the provincial level. The recently established Regional Research and Development Office (RRDO under DOA), may become another vehicle for participatory technology testing and dissemination.

Indonesia: The design elements for an institutional strategy in Indonesia include efficient regional and site characterization methods, FPR trials in selected villages for one to two years, and then repeating the process in other villages. Such a strategy is most logically executed by the adaptive research unit of AARD, BPTP. However, given its relatively recent formation, questions remain about its capacity. Moreover, there is a key question of how BPTP sources technology and research expertise for a range of crops and soil management problems. Building an initial linkage between BPTP and the cassava group in RILET would be the logical first step in exploring this issue.

China and Vietnam: Both countries present similar institutional constraints. Research is decentralized in universities and provincial or regional research institutes, extension is relatively weak and dependent on local government structures, and resources available to both research and extension are very limited. FPR programs are built around research capacity wherever it exists, with site selection partially dependent on the capability of local extension personnel. The balance between expanding the number of FPR sites and moving to a dissemination mode within a district (rarely a province) will be based on relative heterogeneity in production systems in the district. How many separate institutes the project can accommodate and backstop in these two countries will obviously be an issue.

CONCLUSION AND RECOMMENDATIONS

Conclusions

The project has made significant and sustained progress toward its broad goals. It has established and trained FPR teams in four countries, in itself a challenging undertaking. The FPR teams established pilot sites and implemented initial FPR methodologies within a common framework. Pilot sites and FPR teams cover a broad range of soils, slopes, history of cassava cultivation, intensity of land use, and institutional capacities. Although the FPR teams differed in effectiveness depending on levels of governmental support, inter-institutional cooperation, and availability of new cassava technologies to farmers, all FPR teams were successful in establishing demonstration plots in farmers fields. These demonstration plots included either contour ridges or contour hedgerows for soil erosion control, fertilizer and organic matter amendments, improved cassava varieties, and several intercrop species. From these demonstration plots, farmers selected treatments for FPR trials and have conducted three to four seasons of FPR. It is too early in the FPR process to assess how farmer adoption of new technologies will affect incomes or sustainability of agricultural systems, but in all pilot sites farmers had identified technologies that they adopted in at least part of their fields. In some sites, neighboring farmers were also beginning to adopt or test improved technologies.

Support from CIAT outside project funding has included support to cassava breeding through a senior scientist posted to Bangkok until March'98, and a continuing flow of seed-based crosses from CIAT/Colombia. A CIAT project on forages for small holders (FSP) has provided guidance and planting materials in the use of hedgerow species. CIAT has provided resource scientists to conduct training courses and workshops on FPR methodologies. CIAT also provides some logistical support to the project, such as performing soil and tissue analyses. CIAT's ability to support the project has been constrained by changes in its organizational structure, by declining funding levels, and by the distance of CIAT headquarters from Southeast Asia. Despite these constraints, CIAT has supported the project to the extent of its abilities.

The project has made good use of other sources of support and information. The Asian Cassava Research Network has assembled many sources of information from the region and beyond. The network facilitates communication among project participants for germplasm and information exchange. Proceedings from network workshops are a valuable resource for FPR and other cassava researchers. In Thailand, the Thai Tapioca Development Institute (TTDI) has worked closely with the project leader to establish demonstration plots for erosion control and soil management. Through TTDI, project results have gone out to about 7000 farmers each year. The project has also interacted with complementary projects in some of the sites, notably CIP in Vietnam. In the future, information may become available from new activities of IBSRAM and IRRI.

Although only one of the countries participating in the project includes cassava among their priority crops for research and extension, they all produce significant amounts of cassava, and cassava plays an important role in the disadvantaged agricultural areas. Thus, the project is highly relevant, but may not have the visibility that it merits. Cassava production in Indonesia, with its long history of cassava cultivation and research, with one of the highest levels of cassava production in the region, probably benefited least during the first phase of this project. This was because farmers already cultivated relatively high yielding varieties in an intensively managed system in which cassava was not the most important component.

Distance and communication barriers have somewhat hindered development of close collaboration among the project countries. From its regional nature, the project benefited from shared training courses, transfer of ideas and innovations among sites, and germplasm exchange. Farmers in Vietnam have begun to adopt cassava varieties developed in Thailand. Such benefits would not have accrued at nearly the same level with a bilateral project.

Cassava farmers at all pilot sites expressed great appreciation for the project. They liked the close interaction with researchers and the fact that they could see the performance of new technologies in their own fields. The level of farmer interest in the project has varied with time. In Soeng Saang, Thailand, farmers quickly selected the new technologies they wanted and converted from FPR to technology adoption. More than 125 farmers met with the review team during our visits to the pilot sites to discuss their findings and to show their FPR trials. Farmers' willingness to spend their time with us during a period of intense agricultural activity at several sites attests to a high level of farmer interest and project relevance to farmers.

Not only are farmers enthusiastic about the technologies they have selected from FPR trials, farmers in several sites reported increases in income and productivity, reduction in erosion, and increased efficiency of input use. Still, a second phase of the project is needed to build on the excellent foundation that has been established during the first phase. As future FPR continues to adapt new technologies to farmer conditions, we expect economic and environmental benefits to grow. These economic and environmental benefits should represent a highly positive return on investment in the second phase of the project.

Recommendations

1. We endorse the outstanding accomplishments of this project and strongly recommend that the Nippon Foundation support a second phase. Including start-up and development of FPR methods, five years is too short a time for a project to have significant technology adoption or environmental and economic benefits.
2. A second phase is needed to develop methods for extending or scaling up of technologies that have been adopted at pilot sites. We recommend an approach that develops methods for extending FPR research that are tailored to each of the sites, depending on the intensity of cultivation, the importance of cassava, and relative capacities of the different research teams.
3. In the second phase, the project should promote efforts to institutionalize FPR methods within the national programs. These efforts may require solicitation of support for project activities at higher administrative levels of the participating institutions.
4. Many of the FPR methods and technologies developed in the project should be suited to adoption in crops other than cassava. We recommend that FPR teams distribute their findings as widely as possible within their own and other institutions and promote the use of FPR to solve other agricultural problems for which traditional research has developed technologies that farmers do not adopt.

REFERENCE

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