Working with Farmers: The Key to Achieving Adoption of More Sustainable Cassava Production Practices on Sloping Land in Asia

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Abstract

In order to enhance the adoption of soil conserving practices and improve the sustainability of cassava production under a wide range of socio-economic and bio-physical conditions, a farmer participatory research (FPR) approach was used to develop not only the most suitable soil conservation practices, but also to test new cassava cultivars, fertilization practices and cropping systems that tend to produce greater short-term benefits. The FPR methodology was initially developed in 2-3 sites each in China, Indonesia, Thailand and Vietnam. The methodology includes the conducting of Rapid Rural Appraisals (RRAs) in each site, farmer evaluation of a wide range of practices shown in demonstration plots, FPR trials with farmer-selected treatments on their own fields, field days with discussions to select the best among the tested practices, scaling-up of selected practices to larger fields, and farmer participatory dissemination to neighbors and neighboring communities. Based on the results of these trials, farmers in the pilot sites have readily adopted better cultivars, fertilization and intercropping practices, and many farmers have adopted the planting of contour hedgerows to control erosion. In the second phase of this Nippon Foundation supported project, the farmer participatory approach for technology development and dissemination was further developed in a total of 99 pilot sites in Thailand, Vietnam and China. The testing by farmers on their own fields of new cassava cultivars and fertilization practices in addition to soil conservation practices was found to be of crucial importance for the adoption of more sustainable production practices. The resulting increases in cassava yields over the past 10 years have increased the annual gross income of cassava farmers in Asia by an estimated 325 million US dollars.

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is the third most important food crop (after rice and maize) grown in Southeast Asia and is used for human consumption, animal feed and for industrial purposes. It is usually grown by smallholders in upland areas with poor soils and low or unpredictable rainfall. In some countries, the crop is grown on steep slopes, but in others it is grown mainly on gentle slopes; in both cases, soil erosion can be serious. Moreover, cassava farmers seldom apply adequate amounts of fertilizers or manure to replace the nutrients removed in the harvested products. Thus, both erosion and nutrient extraction can result in a decline in soil fertility and a gradual degradation of the soil resource.

Research has shown many ways to maintain or improve soil fertility and reduce erosion, but farmers usually consider these practices too costly or requiring too much labor. To overcome these obstacles to adoption, it is necessary to develop simple practices that are suitable for the local situation and that provide short-term benefits to the farmer, as well as long-term benefits in terms of resource conservation. Being highly site-specific, these practices can best be developed by the farmers themselves, on their own fields, in collaboration with research and extension personnel. Thus, a project was initiated to develop a farmer participatory methodology for the selection and dissemination of more sustainable production practices in cassava-based cropping systems, that will benefit a large number of poor farmers in the uplands of Asia.

MATERIALS AND METHODS

First Phase (1994-1998)

The first phase of the project was conducted in China, Indonesia, Thailand and Vietnam. The project was coordinated by CIAT and implemented in collaboration with research and extension organizations in each of the four countries. During an initial training course on farmer participatory research (FPR) methodologies, a general framework for the implementation of the FPR approach was developed. The steps in the process, from diagnosing the problem to adoption of suitable solutions, are shown in Fig. 1. The outstanding feature of this approach is that farmers participate in every step and make all important decisions.

1. Pilot Site Selection. Suitable pilot sites (villages) were pre-selected in areas where cassava is an important crop, where it is grown on slopes and erosion is a serious problem. Detailed information about the bio-physical and socio-economic conditions in each site, as well as the commonly used cassava production practices was obtained through Rapid Rural Appraisals (RRAs).

2. Demonstration Plots. Each year, demonstration plots were laid out on an experiment station or a farmer's field to show the effect of many alternative treatments on yield, income and soil erosion. Farmers from the selected pilot sites visiting the trial were asked to score the usefulness of each treatment. From this range of many options, farmers usually selected 3-4 treatments that they considered most useful for their own conditions.

In both the demonstration plots and FPR erosion control trials on farmers' fields, a simple methodology was used to measure soil loss due to erosion in each treatment. Plots were laid out exactly along the contour on a uniform slope. Along the lower side of each plot, a ditch was dug and covered with plastic; small holes in the plastic allowed runoff water to seep away, while eroded sediments remained on the plastic. These sediments were collected and weighed 2-3 times during the cropping cycle. After correcting for moisture content, the amount of dry soil loss per hectare was calculated for each treatment. This simple methodology gives both a visual as well as a quantitative indication of the effectiveness of the various practices in controlling erosion (Howeler, 2001; 2002).

3. FPR Trials. The FPR trials did not only involve soil conservation practices, but also new cultivars, intercropping systems and fertilization, with the objective of developing a combination of practices that would increase farmers' income, reduce erosion and improve soil fertility. The FPR trials usually had 4-6 treatments, with one treatment representing the farmer's traditional cultivar or practice.

During the first phase of the project, farmers in the four countries conducted a total of 177 FPR erosion control trials, 157 cultivar trials, 98 fertilizer trials and 35 intercropping trials – a total of 467 trials. At time of harvest, field days were organized in each site to harvest the various trials by the participating farmers and their neighbors. The yields of cassava and intercrops, the dry soil loss due to erosion, as well as the gross income, production costs and net income were calculated for each treatment and presented to the farmers. Farmers and extension workers from the area discussed the results and then indicated their preferences for a particular treatment or production practice by raising their hands.

Second Phase (1999-2003)

The second phase of the project was conducted in collaboration with five institutions in Thailand, six in Vietnam and three in China (Howeler et al., 2004). During the second phase the emphasis shifted from the development and use of farmer participatory research (FPR) methodologies to farmer participatory extension (FPE) in order to reach more farmers and achieve more widespread adoption.

RESULTS AND DISCUSSION

First Phase: Farmer Participatory Research (FPR)

Table 1 shows a typical example of an FPR erosion control trial conducted by six farmers having adjacent plots on about 40% slope. Contour hedgerows of vetiver grass, *Tephrosia candida* or pineapple reduced erosion to about 30% of that in the check plot, while intercropping with peanut and planting vetiver hedgerows also markedly increased net income. Farmers clearly preferred those treatments that were most effective in both increasing net income and reducing soil erosion, such as hedgerows of vetiver grass or pineapple.

Second Phase: Farmer Participatory Research (FPR) and Extension (FPE)

Since the objective of the second phase was to achieve widespread adoption of more sustainable production practices by as large a number of farmers as possible, it was necessary to markedly expand the number of pilot sites and to develop farmer participatory extension (FPE) methodologies to disseminate the selected practices and cultivars to many more farmers.

1. Farmer Participatory Research. Implementing the project in collaboration with many different institutions in China, Thailand and Vietnam, and with generous financial support from the Nippon Foundation, it was possible to expand the number of pilot sites each year. In 2001, the project was working in about 50 sites, and this further increased to 99 sites by the end of the project in 2003. Once the benefits of the new technologies became clear, the number of sites increased automatically, as neighboring villages also wanted to participate in order to increase their yields and income.

Whenever the project extended to a "new" site, the process outlined above was re-initiated, i.e. an RRA was conducted, interested farmers visited demonstration plots and/or made a cross-visit to an already established site; they conducted FPR trials, discussed results and eventually adopted those cultivars or practices they had selected as most suitable for their own conditions. Table 2 shows the number and type of FPR trials conducted during the second phase of the project. While initially farmers were mainly interested in testing new cultivars, fertilization, intercropping and erosion control practices, during the later part of the project they also wanted to test the use of organic or green manures, weed control, plant spacing and even leaf production and pig feeding. During the five years of the second phase of the project a total of 1,154 FPR trials were conducted by farmers on their own fields.

2. Farmer Participatory Extension. The following FPE methods were found to be very effective in raising farmers' interest in soil conservation, in disseminating information about improved cultivars and cultural practices, and in enhancing adoption of soil conserving practices:

Cross-Visits. Farmers from new sites were usually taken to visit older sites that had already conducted FPR trials and had adopted some soil conserving technologies. These cross-visits, in which farmers from the older site could explain their reasons for adopting new technologies, was a very effective way of farmer-to-farmer extension.

Field Days. At time of harvest, field days were organized at the site in order to harvest the trials and discuss the results. Farmers from neighboring villages were usually invited to participate in these field days, to evaluate each treatment in the various trials and to discuss the pros and cons of the various practices or cultivars tested. In a few cases, large field days were also organized with participation from hundreds of neighboring farmers, school children, local and high-level officials, as well as representatives of the press and TV. The broadcasting or reporting of such events also helped to disseminate information about suitable technologies.

Training. Research and extension staff involved in the project had previously participated in Training-of-Trainers courses in FPR methodologies, including practical training sessions with farmers in some of the pilot sites. In addition, 2-3 key farmers from each site together with their local extension agent were invited to participate in FPR training courses. The objective was to learn about the various FPR methodologies, the basics of doing experiments as well as the implementation of commonly selected technologies, such as setting out contour lines or the planting, maintenance and multiplication of hedgerow species.

Community-Based Self-Help Groups. Realizing that effective soil conservation practices, such as planting of contour hedgerows, can best be done as a group, farmers from some sites decided to form their own "soil conservation group". Subsequently, the Department of Agricultural Extension in Thailand encouraged farmers to set up these groups as a way of organizing themselves, to conduct FPR trials, to implement the selected practices, and to manage a rotating credit fund, from which members of the group can borrow money for production inputs. Thus, by 2003, a total of 21 "Cassava Development Villages" had been set up in the pilot sites in Thailand.

ADOPTION AND IMPACT

In order to determine the effect of this project on adoption of new technologies, an impact assessment was made by an outside consultant at the end of the project in Nov/Dec 2003. He organized focus group discussions and collected data from farmers in eight representative project sites – four sites in Thailand and four in Vietnam – as well as from farmers living within 10 km of those sites, who had not participated in the project. Table 3 shows the percent of households (out of 767) who had adopted various technologies. New cultivars were adopted by nearly all cassava farmers in the eight sites in Thailand and by 70% of farmers in Vietnam; the use of chemical fertilizers had been adopted by 85-90% of households in the eight sites in each country; intercropping by nearly 60% of households in Vietnam, but by only 13% in Thailand. Contour ridging was adopted by about 30% of households, while contour hedgerows were adopted by about 25% of households in both Vietnam and Thailand; in Thailand these hedgerows were almost exclusively vetiver grass, while in Vietnam most farmers preferred the planting of *Tephrosia candida* or *Paspalum atratum*, as these are easier to plant (from seed) and can also serve as a green manure and animal feed, respectively. Thus, it is clear that adoption of specific practices varies from site to site, depending on local conditions and traditional practices. Table 3 also shows that there were highly significant differences in the adoption of almost all the technologies between participating and non-participating farmers (with the exception of contour ridging and the use of chemical fertilizers in Vietnam), with participating farmers having a greater extent of adoption than non-participating farmers. In this case, "participants" were defined as farmers who had conducted at least one FPR trial and/or had participated in an FPR training course, while "non-participants" had done neither, but may have attended a farmer field day organized by the project. It can be seen that new cultivars and the use of chemical fertilizers were readily adopted by both participants and non-participants, while, adoption of soil conservation practices and intercropping was both less widespread and largely limited to participating farmers. This clearly points to the difficulty of achieving spontaneous and widespread adoption of soil conservation practices.

How does adoption of these new technologies translate into higher yields and income? Fig. 2 shows the cassava yields that farmers reported before and after the project. In Thailand, the average yields of farmers who had participated in the project by conducting FPR trials or by attending training courses increased from 19.4 to 25.8 t/ha (33%), while those of non-participating farmers increased from 15.5 to 20.3 t/ha (31%); in Vietnam, project participants increased their yields from 13.7 to 28.2 t/ha (106%), while non-participants increased their yields from 14.3 to 23.9 t/ha (67%) (Lilja et al., 2005). Thus, in both countries, yields increased very markedly, but these increases were greater for participants than for non-participants, especially in Vietnam. For comparison,

Fig. 3 also shows the increase in yield for the whole country, as reported by FAO (FAO, 2005), during approximately the same time period. Yields for the whole of Vietnam are considerably below those reported by the farmers in the focus groups; but the yield increases are similar to those reported by the non-participants. In Thailand, the initial yields in the country were similar to those of non-participating farmers, but after-project yields were much higher for participants as well as nearby non-participants than for the country as a whole. This indicates that participating farmers benefited most from their experiences but that nearby farmers also benefited indirectly from the project.

Table 4 shows that during the past ten years the average cassava yields in all three countries increased, ranging from 1.03 t/ha in China to 6.05 t/ha in Vietnam. The increased yields resulted in annual increases in gross income received by farmers of about 210 million US dollars in the three countries, and about 325 million US dollars in all of Asia. In addition, farmers in Thailand received higher prices due to the higher starch content of the new cultivars. This was achieved not only by this project, but by the collaborative effort of many researchers, extensionists, factory owners and farmers, with strong support from national governments.

CONCLUSIONS

Research on sustainable land use conducted in the past has mainly concentrated on finding solutions to the bio-physical constraints, and many solutions have been proposed for improving the long-term sustainability of the system. Still, few of these solutions have actually been adopted by farmers, mainly because they ignored the human dimension of sustainability. For new technologies to be truly sustainable, they must not only maintain the productivity of the land and water resources, but they must also be economically viable and acceptable to farmers and the community. To achieve those latter objectives farmers must be directly involved in the development, adaptation and dissemination of these technologies. A farmer participatory approach to technology development was found to be the key to the development of locally appropriate and economically viable technologies, which in turn enhances their acceptance and adoption by farmers.

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Tables

Table 1. Effect of various crop management treatments on the yield of cassava and intercropped peanut as well as the gross and net income and soil loss due to erosion in a FPR erosion control trial conducted by six farmers in Kieu Tung village of Thanh Ba district, Phu Tho province, Vietnam in 1997 (3rd year).

Treatment[1]	Slope (%)	Dry soil loss (t/ha)	Yield (t/ha) cassava	Yield (t/ha) peanut[1]	Gross income[2]	Product. costs	Net income	Farmers' ranking
					(mil. dong/ha)			
1. C monocult., with fertilizer, no hedgerows	40.5	106.1	19.17	-	9.58	3.72	5.86	6
2. C+P, no fertilizer, no hedgerows	45.0	103.9	13.08	0.70	10.04	5.13	4.91	5
3. C+P, with fertilizer, no hedgerows	42.7	64.8	19.23	0.97	14.47	5.95	8.52	-
4. C+P, with fertilizer, *Tephrosia* hedgerows	39.7	40.1	14.67	0.85	11.58	5.95	5.63	3
5. C+P, with fertilizer, pineapple hedgerows	32.2	32.2	19.39	0.97	14.55	5.95	8.60	2
6. C+P, with fertilizer, vetiver hedgerows	37.7	32.0	23.71	0.85	16.10	5.95	10.15	1
7. C monocult, with fert., *Tephrosia* hedgerows	40.0	32.5	23.33	-	11.66	4.54	7.12	4

[1] Fertilizers = 60 kg N + 40 P_2O_5, + 120 K_2O/ha; all plots received 10 t/ha pig manure
[2] Prices: cassava (C) : 500 dong/kg fresh roots; peanut (P) : 5,000 dong/kg dry pods
Exchange rate: 1 US$ = 12,000 dong

Table 2. Number and type of FPR trials conducted in the 2nd phase of the Nippon Foundation Project (1999-2003) in China, Thailand and Vietnam.

Type of trial	China	Thailand	Vietnam	**Total**
Varieties	127	87	161	**375**
Erosion control	33	41	126	**200**
Chemical fertilizers	4	79	-	**83**
Chemical + organic fertilizers	-	32	108	**140**
Green manures	-	39	-	**39**
Intercropping	9	23	103	**135**
Weed control	-	32	6	**38**
Plant spacing	-	5	35	**40**
Leaf production	-	-	5	**5**
Pig feeding	59	-	40	**99**
Total	**232**	**338**	**584**	**1,154**

Table 3. Extent of adoption (% of households) of new technologies by participating and non-participating farmers in the cassava project in Thailand and Vietnam in 2003 (n=767).

Technology	Thailand			Vietnam			Full sample		
	Partic.	Non-partic.	Total	Partic.	Non-partic.	Total	Partic.	Non-partic.	Total
Cultivars									
-100% improved cultivars	100	88.0	91.1***	50.0	38.8	42.9***	73.2	67.3	69.1***[1)]
-50% improved cultivars	0	0.3	0.2	26.2	18.3	21.1	14.0	7.9	9.8
-no improved cultivars	0	0	0	14.3	30.8	24.9	7.7	13.0	11.3
Soil conservation practices									
-contour ridging	52	22	30***	35	31	33	43	26	31***
-hedgerows	60	10	23***	50	12	25***	54	11	24***
-vetiver grass	60	10	23***	10	3	5**	33	7	15***
-*Tephrosia candida*	0	0	0	38	6	18***	20	3	8***
-*Paspalum atratum*	1	0	0*	12	2	6***	7	1	3***
-other hedgerows	5	1	2*	7	1	3***	6	1	3***
-no soil conservation	21	72	59***	23	58	45***	22	67	53***
Intercropping	28	8	13***	79	49	59***	55	25	34***
-with peanut	1	1	1	47	33	38***	26	14	18***
-with beans	0	0	0	27	29	29	14	12	13
-with maize	3	10	5***	2	3	3	6	3	4*
-with green manures	19	4	8***	0	0	0	9	2	4***
-with other species	3	2	2	39	15	24***	22	7	12***
Fertilization									
-chemical fertilizers	98	86	89***	85	86	86	91	86	87***
-animal or green manures	55	25	33***	74	60	65**	65	40	48***
-no fertilizers	0	13	9***	12	8	9	6	11	9*

[1)] Significant differences between participating and non-participating farmers: * p≤0.10
** p≤0.05
*** p≤0.01

Level of significance in the case of cultivar adoption refers to differences in terms of categorical distribution, <u>not</u> the adoption levels.

Table 4. Estimation of the annual increase in gross income due to higher cassava yields resulting from the adoption of new cassava cultivars and improved practices, in China, Thailand and Vietnam, as well as in Asia as a whole.

Country	Total cassava area (ha)[1]	Cassava yield (t/ha)[2]		Yield increase (t/ha)	Cassava price ($/tonne)	Increased gross income due to higher yields (mil. US $)
		1994	2004			
China	240,115	15.22	16.25	1.03	27	6.7
Thailand	1,050,000	13.81	19.43	5.62	25	147.5[2)]
Vietnam	370,500	8.44	14.49	6.05	25	56.0
Asia total	**3,508,103**	**12.93**	**16.64**	**3.71**	**25**	**325.4**

[1]Data from FAOSTAT for 2004

[2]In addition, farmers also benefited from higher prices due to higher starch content

Figures

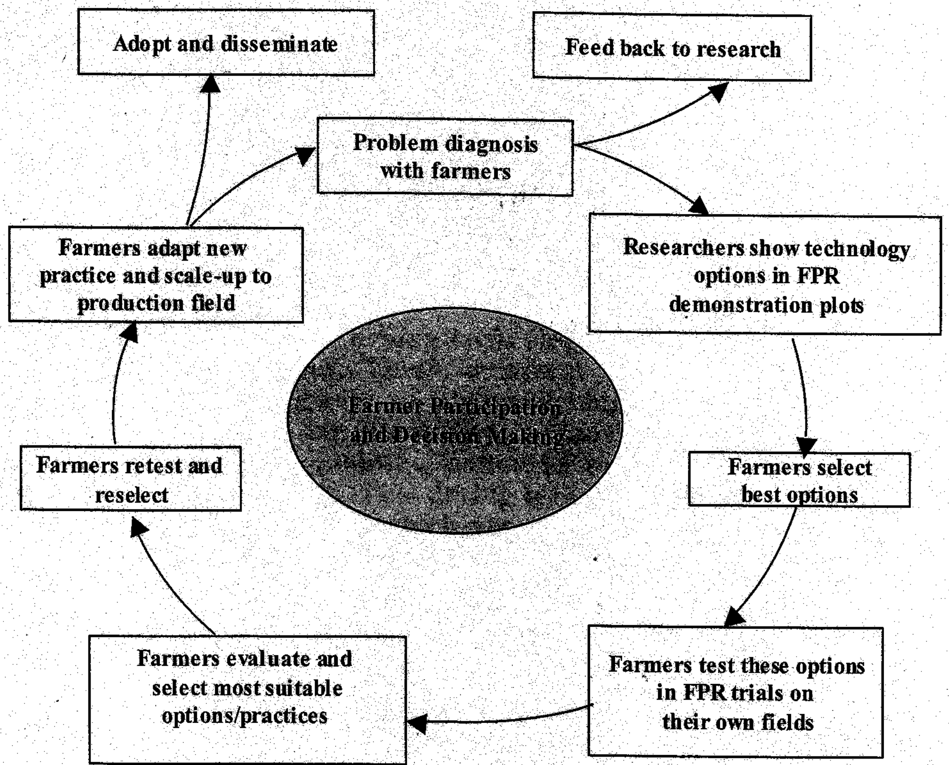

Fig. 1. Farmer participatory model used for the development of sustainable cassava-based cropping systems in Asia.

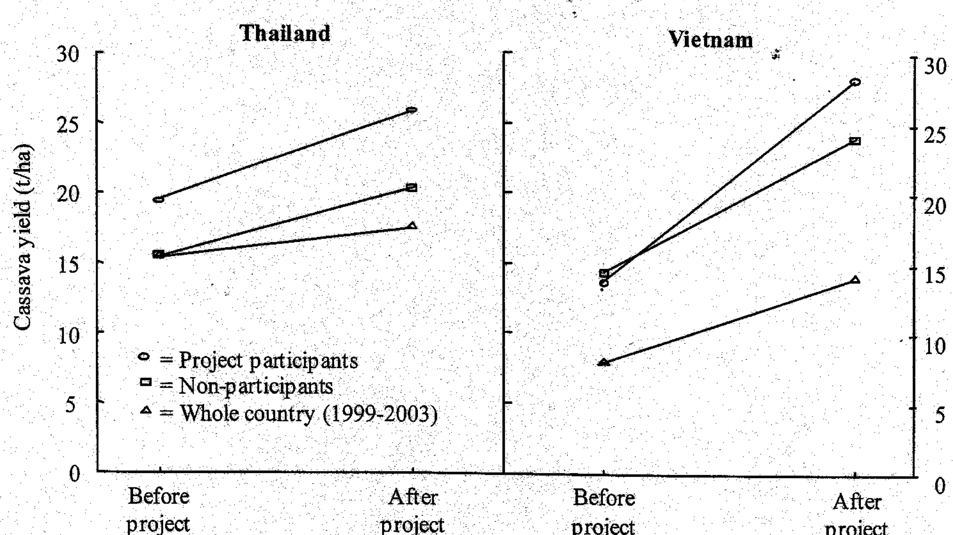

Fig. 2. Average cassava yields of farmers participating in the Nippon Foundation cassava project or of nearby but non-participating farmers, before the project started and at the end of the project. Data are from PRRA census forms collected from 417 households in Thailand and 350 households in Vietnam. For comparison the national average cassava yields in 1999 (before) and 2003 (after) are also shown.