Proceedings of the 13th ISTRC Symposium, 2007
pp. 585 - 592

Participatory approach in the development of technologies to control erosion for sustainable cassava production in Thailand

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Abstract. During the first 2-3 months of cassava canopy establishment, part of the soil remains exposed to the direct impact of rainfall, which can cause serious erosion. Complete canopy closure in a cassava crop takes a long time. If farmers do not apply fertilizer to cassava, soil fertility may decline while plant nutrients in the soil may be lost due to erosion when the crop is grown on slopes. Although nutrient extraction and removal by cassava tends to be less compared with many other crops, soil loss due to erosion may be higher because of the crop's slow initial development. Past research has shown that fertilizer application, reduced tillage, contour ridging, mulching, intercropping and the planting of contour hedgerows can greatly reduce erosion. Nevertheless, farmers seldom adopt such soil conservation practices, mainly because the recommended practices are not suitable for the local conditions. They may be too costly or require too much labor, or they may be ineffective. Moreover, farmers are often not aware of the amount of soil lost by erosion. Results of the farmer participatory research (FPR) project in various pilot sites in Thailand indicate that farmers should make their own decisions, and that they are willing to adopt soil conservation practices such as the planting of contour hedgerows of vetiver grass or legumes, if these were shown to be effective in reducing erosion. The use of a farmer participatory approach was very effective as many farmers readily adopted the selected practices and also helped disseminate these to farmers in neighboring communities. The selected practices would be well-adapted to the local conditions if the farmers made their own decisions and were directly involved in the development of new technologies by planning and implementing the trials together. This is of fundamental importance for enhancing the sustainability of cassava production.

Introduction

Most cassava in Thailand is grown by smallholders in upland areas with low fertility soils and frequent drought conditions. In the northeastern and eastern regions, cassava is often grown on gentle slopes; nevertheless, soil erosion may be quite serious. Since most cassava farmers are poor, they do not apply much fertilizer to cassava and this may lead to a decline in soil fertility which in turn causes low yields.

Past research by Kasetsart University has shown that cultivation of cassava may cause twice as much soil erosion as that of mungbean, and three times as much as that caused by maize, sorghum and peanut (Puttacharoen *et al.*, 1998).

Research on erosion control practices indicate that soil losses due to erosion can be markedly reduced by various agronomic practices combined with simple soil conservation practices. This includes agronomic practices such as minimum or zero tillage, mulching, contour ridging, intercropping, fertilizer or manure application, and planting at close plant spacing. Soil conservation practices include terracing, hillside ditches and planting contour hedgerows of grasses or legumes. But these latter practices are seldom adopted by farmers because they may not be appropriate for the specific circumstances of the farmers, either from an agronomic or a socio-economic standpoint (Howeler, 2001).

Since 1994, the Nippon Foundation in Tokyo, Japan, has supported the project "Integrated Cassava-based Cropping Systems in Asia: Farming Practices to Enhance Sustainability". This project has developed and used a farmer participatory research (FPR) and extension (FPE) methodologies to achieve widespread adoption of soil conservation practices.

Materials and Methods

First Phase (1994-1998). The following institutions collaborated in the project.

1. The Department of Agriculture (DOA)
2. The Department of Agricultural Extension (DOAE)
3. The Land Development Department (LDD)
4. Kasetsart University (KU)
5. The Thai Tapioca Development Institute (TTDI)
6. The Centro International de Agricultural Tropical (CIAT)

Activities. During this first phase a Farmer Participatory Research (FPR) methodology was developed and included the following activities:

Selection of suitable pilot sites. These were selected in cassava growing areas, with at least 5% slope, and where farmers and local extension staff were interested in joining the project. In each site, Rapid Rural Appraisals (RRA) were conducted to gather information about the local situation and identify the major problems (Howeler, 2001; Watananonta *et al.*, 2002).

Preparation of field staff. Courses in FPR and RRA methodologies as well as in cassava production technologies were held to train field staff that collaborated in the project.

Demonstration plots. Demonstration plots were established by DOA, KU, LDD or TTDI in areas not too far from the pilot sites. They had a large number of treatments, including application of chemical fertilizers, green manures, closer plant spacing, intercropping with different crops and contour hedgerows of different grasses or legume species. Farmers from new sites visited these demonstration plots and selected treatments to test on their own fields.

Farmers meetings. Farmers in each new site who were interested in participating in the project joined a training course whose objectives were 1) to increase the farmers' knowledge and understanding of soil conservation in cassava growing areas; and 2) to equip farmers with techniques of conducting trials on their own fields.

FPR trials. After farmers had decided to conduct FPR trials, researchers and extensionists discussed the trials with collaborating farmers and provided the necessary materials. During the crop season, researchers and extensionists visited the farmers several times to discuss and solve their problems. At harvest, collaborating farmers and project staff harvested all the cassava trials together, recorded all data. Data on soil loss from every treatment was also presented to the participating farmers and others interested. The meeting then discussed the results of each trial and selected the best treatments either for adoption or for retesting in next year's trials (Howeler, 2001; Watananonta *et al.*, 2002).

Scaling-up and adoption. After 2-3 years of conducting FPR trials, farmers usually would be able to select the most suitable treatments to test and then adopt in larger areas of their production fields.

Second Phase (1999-2003). After having developed and tested the farmer participatory research (FPR) methodology in a few sites during the first phase, the project rapidly expanded to more sites during the second phase. These include sites in:

1. Nakhon Ratchasima province in the lower Northeastern region
2. Kalasin province in the Upper Northeastern region
3. Prachinburi province in the Eastern region
4. Chachoengsao province in the Eastern region
5. Chaiyaphum province in the Northeastern region
6. Kamphaengpet province in the lower Northern region
7. Kanchanaburi province in the Western region
8. Roi-Et province in the Upper Northeastern region
9. Ratchaburi province in the Western region
10. Chonburi province in the Eastern region

By 2003, the project had expanded to 33 sites in 21 districts of 11 provinces.

Activities. During the second phase of the project, additional Farmer Participatory Extension (FPE) methodologies were developed with the objective of reaching a large number of farmers. These include:

Cross-site visits. Farmers from new sites visited villages where the project had been conducted before and where new technologies had already been adopted.

Farmer field days at harvest. Local officials and farmers from the village and surrounding communities were invited to evaluate each treatment in the FPR trials, including root yield and the amount of soil sediments eroded from each plot. This way, farmers learned and obtained information to make decisions about technologies suitable for their own conditions. They then discussed and planned for action in the following year.

District level field days. The purpose of these large-scale field days was to disseminate the selected technologies to nearby villages and sub-districts. During the field day, the experienced farmers shared their knowledge with other farmers.

Provincial level field day. At this level, approximately 1,000-1,500 farmers and officials from nearby provinces were invited to attend the field day. Reporters from newspapers and television stations were also invited in order to report the project activities through the wider mass media.

FPR training courses. Initial courses were organized by CIAT to train project staff of DOA, DOAE, LDD and TTDI in FPR methodologies. Additional courses were organized to train local extension workers and key farmers in cassava technologies and farmer participatory approaches. Furthermore, CIAT also supported the training of trainers in advanced courses abroad.

Technology transfer through farmer participatory extension. In order to enhance the transfer of technologies through farmers' participation, a budget was allocated to support 4-6 farmers' meetings annually. The topics included discussions on the problems of project implementation and the possible solutions for both project management and crop production. Local extension workers acted as the coordinators; they sometimes invited outside experts to discuss specific topics according to farmers' needs.

Cassava development villages. Starting in 2000, DOAE further assisted the project implementation by setting up so-called "Cassava Development Villages". DOAE provided the farmers with various materials such as fertilizers, which they had to return to the village– revolving fund after harvest. A specific interest payment was agreed upon by the villagers. Furthermore, the members voted to elect the "Fund Administration Committee" which comprises at least a president, a vice- president, a treasurer, and a secretary. Members also discussed and decided on the rules and regulations of their community-based self- help group.

Results and Discussion

The data in Table 1 show that most of the hedgerow treatments (T_{12}- T_{18}) as well as contour ridging (T_3) and closer plant spacing (T_8) were very effective in reducing soil loss by erosion. Some of the intercrops (T_9 and T_{11}) and one of the three vetiver grass varieties (T_{16}) competed strongly with nearby cassava, causing a reduced yield. Farmers from several new sites visited these plots. Farmers evaluated the treatments and selected 3-4 treatments that they considered most effective and wanted to try out in FPR erosion control trials on their own fields. Most farmers selected vetiver grass hedgerows as the most suitable practice, followed by closer spacing, the combined application of fertilizers and chicken manure, contour ridging, and intercropping with pumpkin.

Many results of the FPR trials conducted by farmers in Thailand have already been published (Howeler, 2001; Howeler *et al.*, 2002). Tables 2 and 3 are a few examples of FPR trials conducted by farmers in Kalasin and Chayaphum provinces. They show that both vetiver grass and lemon grass hedgerows were very effective in reducing soil loss by erosion; in some (but not all) cases they also increased yields and net income. Most farmers selected vetiver grass over lemon grass hedgerows because of the former's tolerance to drought and poor soils, and for its ease of planting and maintenance. In addition, farmers observed that contour

Table1: Results of the FPR demonstration plots at TTDI, Huay Bong, Nakhon Ratchasima, Thailand, in 2001/02.

Treatments[1)]	Soil loss (t/ha)	Dry cassava yield (t/ha)	Intercrop yield (t/ha)	Starch content (%)	Gross income[2)]	Prod. costs	Net income
					——('000 B/ha)		——
1. farmers' practice: up/down ridges, no fertilizers	10.50	44.12	-	25.4	53.74	17.59	36.15
2. up/down ridges; 50 kg/rai 15-15-15 fertilizers	37.68	43.51	-	30.9	57.78	20.93	36.85
3. contour ridges; 50 kg/rai 15-15-15 fertilizers	5.86	40.28	-	28.0	51.16	20.06	13.10
4. no ridges; 50 kg/rai 15-15-15 fertilizers	12.06	48.68	-	25.5	59.39	21.51	37.88
5. no ridges; 25 kg/rai 15-15-15 fertilizers	12.70	46.96	-	28.7	60.30	19.42	40.88
6. no ridges; 25 kg/rai fertilizer+125 kg/rai chicken manure	10.83	45.36	-	24.5	54.43	19.85	34.58
7. no ridges; 25 kg/rai fertilizer+1,000 kg/rai compost	13.09	45.63	-	29.0	58.86	20.16	38.70
8. no ridges; closer spacing (0.8 x 0.8 m)	4.52	49.27	-	31.6	66.12	21.98	44.14
9. no ridges; peanut intercrop	11.70	27.00	2.00	26.1	53.26	18.66	34.60
10. no ridges; pumpkin intercrop	5.53	40.41	3.80	23.5	85.68	23.28	62.40
11. no ridges; sweet corn intercrop	16.70	17.80[3)]	7.10	25.7	57.29	18.18	39.11
12. no ridges; *Leucaena leucocephela* hedgerows	5.28	33.80	-	25.4	41.17	18.50	22.67
13. no ridges; sugarcane (for chewing) hedgerows	7.51	44.01	-	23.0	51.49	21.25	30.24
14. no ridges; lemon grass hedgerows	6.51	42.09	0.65	27.2	52.78	20.73	32.05
15. no ridges; *Paspalum atratum* hedgerows	14.24	39.09	-	23.3	45.97	19.92	26.05
16. no ridges; vetiver (from TTDI) hedgerows	4.69	25.46[4)]	-	22.0	29.28	16.24	13.04
17. no ridges; vetiver Songkla-3 hedgerows	6.24	46.10	-	26.0	56.70	21.82	34.88
18. no ridges; vetiver from Vietnam hedgerows	8.25	41.68	-	24.6	50.10	20.62	29.48

[1)] Variety KU-50; treatments 8-18 were all fertilized with 50/kg rai of 15-15-15 fertilizers, and all treatments except T_8 were planted at 0.8 x 1.25 m spacing; 1 ha = 6.25 rai.

[2)] Prices: cassava baht 1.31/ kg fresh roots at 30% starch; 0.02 baht reduction for every 1% lower starch content; peanut 10.0/ kg dry pods; pumpkin 10.0/ kg; sweet corn 5.0/ kg; lemon grass 5.0/ kg.

[3)] Low yield due to strong intercrop competition and poor drainage.

[4)] Low yield due to competition from very vigorous vetiver grass hedgerow.

Table 2: Average results of seven[1)] FPR erosion control trials conducted by cassava farmers in Sahatsakhan district, Kalasin, Thailand in 1999/2000.

Treatments[2)]	Dry soil loss (t/ha)	Yield (t/ha)		Gross income[5)] ('000 B/ha)			Production costs ('000 B/ha)	Net income ('000 B/ha)
		Cassava	Intercrop	Cassava	Intercrop	Total		
1. farmer's practice	42.5	21.91	-	14.90	-	14.90	12.73	2.17
2. closer spacing	35.3	26.06	-	17.72	-	17.72	13.87	3.85
3. contour ridging	17.2	24.04	-	16.35	-	16.35	13.78	2.57
4. sweet corn intercrop	9.6	20.28	10,830[3)]	13.79	10.83	24.62	15.41	9.21
5. pumpkin intercrop	9.8	31.87	500[4)]	21.67	1.50	23.17	16.97	6.20
6. lemon grass hedgerows	12.0	25.16	-	17.11	-	17.11	14.38	2.73
7. vetiver grass hedgerows	3.5	18.32	-	12.46	-	12.46	13.01	-0.55

1) Only four trials for treatment 7, and two for treatment 5
2) No ridging except in T3; all treatments received 312 kg 15-15-15/ha
3) Number of ears/ha
4) Number of fruits/ha
5) Prices: cassava baht 0.68/kg fresh roots (23% starch)
sweet corn 1.00/ear
pumpkin 3.0/fruit.

Table 3: Average results of two FPR erosion control trials conducted by farmers in Khook Anu village, Thep Sathit district of Chayaphum province, Thailand, in 2001/02.

Treatments	Dry soil loss (t/ha)	Yield (t/ha)		Root starch content (%)	Gross income (baht/ha)	Product. costs[2)] (baht/ha)	Net income (baht/ha)	Farmers' preference (%)
		Cassava	Intercrop					
1. farmer's practice	14.0	12.61	-	20.3	12,736	12,018	718	0
2. contour plowing	10.2	8.41	-	20.0	8,410	11,471	-3,061	100
3. up/down plowing	31.1	12.34	-	18.3	11,970	11,974	-4	0
4. mungbean intercrop	10.3	8.70	0.306	24.0	15,516	15,392	124	82
5. lemon grass hedgerows	4.5	15.94	-	21.0	16,259	13,550	2,709	0[3)]
6. vetiver grass hedgerows	8.0	13.02	-	22.3	13,619	13,083	536	100

1) Prices: cassava baht 1.20/kg fresh roots at 30% starch
mungbean 20/kg dry grain
2) Cost of cassava production without harvest 10,000/ha
Cost of C+mungbean production 14,000/ha
Extra cost of contour plowing 125/ha
Cost hedgerow planting + maintenance 1,000/ha
Harvest + transport 160/tonne
3) Although lemon grass hedgerows produced the highest net income, farmers do not like this practice because lemon grass does not tolerate drought and it is difficult to sell in large quantities.

Table 4: Location of FPR pilot sites in Thailand in 2002, and the adoption of vetiver grass for erosion control in those sites.

Province	FPR pilot sites			Adoption of erosion control practices			
	District	Subdistrict	Village	No. of farmers	Cassava area withvetiver (ha)	Vetiver(No. of plants)	Vetiver hedge rows (km)
Nakhon Ratchasima	Daan Khun Thot	Baan Kaw	Khut Dook	53	49.4	130,000	15.0
	Thephaarak	Bueng Prue	3 and 6	26	34.2	80,000	11.0
	Soeng Saang	Noon Sombuun	Sapphong Phoot	62	132.5	80,000	20.0
		Sratakhian	Sratakhian	0	4.8	20,000	2.0
	Khonburi	Tabaekbaan	Nong Phak Rai*	27	24.0	50,000	5.0
Prachinburi	Naadii	Kaeng Dinso	Aang ThongKhao Khaat}	34	27.2	60,000	4.5
Kalasin	Mueang	Phuu PoKhamin	Noon SawanKhamplaafaa	61	49.0	85,500	8.6
	Nongkungsri	Nong Bua	Khamsri	67	110.4	111,600	11.2
	Sahatsakhan	Noonburi	Noon Sawaat	63	59.2	86,170	8.6
		Noon Namkliang	Huay Suea Ten Paa Kluay}	47	40.6	128,330	12.8
	Naamon	Naamon	Noon Thiang*	50	24.0	16,000	1.6
	Don Chaan	Dong Phayung	Noon Kokchik*	50	24.0	16,000	1.6
	Huay Phueng	Nikhom	Huay Faa*	50	24.0	16,000	1.6
Chachoengsao	Sanaam Chaikhet	Thung Phrayaa	Thaa Chiwit Mai	32	10.4	50,000	2.0
	Thaa Takiab	Khlong Takraw	Nong Yai	42	27.2	100,000	5.3
Kamphaengphet	Khanuwaralakburii	Bo Tham	SiiyaekTonThoo}	42	27.2	68,000	3.0
Chaiyapuum	Thep Sathit	Naayaang Klak	Khook Anu	42	27.2	68,000	4.0
Kaanchanaburi	Law Khwan	Thung Krabam	Nong Kae	42	27.2	80,000	3.0
Srakaew	Wang Sombuun	Wang Sombuun	Baan Khlong Ruam	75	220.8	90,000	9.0
Total: 8	17	20	24	>865	943.3	1,335,600	129.8

* initiated in 2002.

Table 5: Extent of adoption[1)] of various cassava technology components in four pilot sites in Thailand in 2002.

Technology component	Baan Khlong Ruam Sra Kaew		Thaa Chiwit Mai Chachoengsao		Sapphong Phoot Nakhon Ratchasima		Huay Suea Ten Kalasin	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Varieties	480	100	469	100	396	100	228	100
Chemical fertilizers	480	100	469	100	364	92	180	79
Vetiver grass hedgerows	139	29	94	20	218	55	89	39
Green manures	72	15	0	0	0	0	114	50
Intercropping	0	0	0	0	0	0	0	0

[1)] Estimated by farmers in each site during Participatory Monitoring and Evaluation (PM&E) in Aug 2002.

plowing and ridging, closer plant spacing and adequate fertilization also contributed to reduced erosion and generally increased yields. Intercropping practices are not widely adopted in Thailand because of the high cost of labor. Similar results were obtained in many other sites. Once farmers saw the benefits of the various soil conservation practices, they adopted closer plant spacing, more balanced fertilization and the planting of contour hedgerows of vetiver grass; the latter in turn led to contour plowing and ridging in some areas.

The planting of vetiver grass hedgerows was done either by individual farmers on their own fields or as a community activity. Being one of the first groups to adopt the planting of vetiver grass hedgerows for erosion control on a large scale, farmers in Sapphong Phoot village, were visited by many other farmers to learn from them.

In 2001 the Thai government, through DOAE, set up community-based self-help groups, called "Cassava Development Villages", in 11 of the project pilot sites, providing about US$ 1,000 to each group in the form of fertilizers to initiate a revolving fund. In 2002 this was further expanded to another seven sites and in 2003 to another three sites. Table 4 shows the extent of vetiver grass growing in each of the FPR pilot sites in Thailand in 2002. By the end of 2002 nearly 900 cassava farmers in Thailand had planted about 130 km of vetiver grass hedgerows in 940 ha of cassava fields. It can be assumed that many farmers outside the pilot sites have similarly adopted this technology after hearing about it on the radio or TV, or from extensionists or other farmers through word-of-mouth. The fact that His Majesty the King promotes the use of vetiver grass, and that free planting material is available at LDD stations nation-wide are surely decisive factors favoring the rapid spread of this technology.

In addition to vetiver grass hedgerows, farmers in the FPR pilot sites also tested new varieties, chemical fertilizers and organic manures, green manures and intercropping. Results of a participatory monitoring and evaluation (PM&E) exercise with farmers in four pilot sites in 2002 (Table 5) revealed that in all sites farmers had adopted the growing of new varieties in 100% of their cassava growing area; chemical fertilizers were applied on average in 79-100% of the area, green manures were used in 0-50% of the area, and vetiver grass hedgerows had been planted in 20-55% of the area, depending on the need for soil conservation in each site; no farmers had adopted intercropping. Green manures were adopted mainly in Kalasin province where soils are extremely sandy and almost devoid of organic matter.

Conclusion

The use of a farmer participatory approach for technology development and dissemination was very effective in enhancing the adoption of soil conservation practices. Farmers are generally very interested in testing of new technologies that may produce immediate financial benefits, such as new varieties, organic and inorganic fertilizers, improved weed control etc. A combined package of suitable practices, adapted to local conditions, including soil conservation practices such as the growing of contour hedgerows, is more likely to be adopted than soil conservation practices by themselves. The growing of vetiver grass hedgerows for erosion control is a very suitable technology under the conditions cassava is grown in Thailand. The adoption of more sustainable cassava production practice is likely to improve Thai farmers' living standards.

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