FARMER PARTICIPATORY RESEARCH IN CASSAVA SOIL MANAGEMENT AND VARIETAL DISSEMINATION IN VIETNAM – RESULTS OF PHASE 1 AND PLANS FOR PHASE 2 OF THE NIPPON FOUNDATION PROJECT

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ABSTRACT

Farmer participatory research (FPR) in Vietnam has been carried out since 1994 as part of the Nippon Foundation project. This is a collaborative project between Thai Nguyen University of Agriculture and Forestry (TNUAF), the National Institute for Soils and Fertilizers (NISF) and the Centro Internacional de Agricultura Tropical (CIAT). The objective of the project is to enhance the adoption of soil conservation practices and improved cultural techniques in cassava fields. Two villages in Pho Yen district, Thai Nguyen province, one in Thanh Ba district, Phu Tho province, and one in Luong Son district, Hoa Binh province, were selected as pilot sites for implementing the FPR methodology in phase 1 (1994-1998). By using RRA and PRA methods in conducting the participatory diagnosis some limiting factors in cassava production were identified. Demonstration plots with 16 treatments on different ways to improve soil fertility and methods to control soil erosion were also established at Thai Nguyen University.

Based on the results of the RRA and discussion, farmers selected four technical options, i.e. the use of contour hedgerows to control soil erosion, intercropping, application of fertilizers and new varieties, to test in FPR trials on their own fields.

Result of the FPR trials on farmers fields indicate that the combination of intercropping with peanut, planting of contour hedgerows of vetiver grass or *Tephrosia candida*, and the use of a well-balanced NPK application were considered as the most promising practices at both pilot sites; these practices not only increased farmers' income but also reduced soil erosion by 20-40% in comparison with the check plot of monocropping and without hedgerows. The results of the FPR trials were evaluated each year by the farmers during the field days at time of harvest and were used to plan the trials for the next year.

After four years of research, farmers have adopted the application of balanced NPK fertilizers and some are establishing contour hedgerows of *Tephrosia candida* or vetiver grass. However, the widespread adoption of new cassava varieties by the farmers was the best result of the first phase of the project. New cassava varieties, such as KM60, KM94, KM95-3, and KM98-7, are now planted extensively, not only by farmers that participated in the research program but also by other farmers. FPR is the best method to develop and transfer technologies with farmers. The number of farmers that wanted to participate increased from 1994 to 1998, indicating the effectiveness of the participatory research approach.

The main objectives in the second phase are:

- To develop new and innovative FPR methodologies by using various methods of participatory research at about 20 pilot sites in Vietnam, in order to overcome constraints identified at the farm level.
- To disseminate new technologies that increase income and help to conserve soil productivity, identified by farmers, to at least 3000 other cassava farmers.
- To build and strengthen the capacity of researchers, extensionists and cassava farmers in using participatory approaches for self-development.

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INTRODUCTION

Cassava is a traditional crop within the tropical world in general, and in Vietnam in particular. Therefore, farmers have a lot of experience in cultivating this crop. However, they have not yet adopted new technologies to increase their cassava yields, especially to maintain stable cassava production. During the past decade some serious cassava research has been undertaken by various universities and research institutions. This work has resulted in good results, but very few of these have been applied in practice. The main reason for the above situation is that there are major differences in environmental and practical conditions between research stations and farmers' fields. For that reason, improved techniques are not readily adopted by farmers. In addition, various limitations faced by farmers, as well as a lack of awareness, are also factors that contribute to the limited adoption of advanced technologies by farmers.

Because of this situation, a new research approach need to be developed that can combine careful on-station research with on-farms trials with participation from farmers. Farmer Participatory Research (FPR) methodologies can better meet the needs of farmers. For that reason, an FPR project, funded by the Nippon Foundation, has been implemented in close collaboration with CIAT. This includes a first phase from 1994 to 1998, and a second phase from 1999-2003. The first phase of the project has been implemented in four pilot sites: in two villages of Pho Yen district, Thai Nguyen province; in Thanh Ba district, Phu Tho province, and in Luong Son district, Hoa Binh province.

1. FPR Methodologies Used

The FPR project was divided into five steps:

- Conduct Rapid Rural Appraisals (RRA) to evaluate the current agricultural practices, the constraints in cassava production in the pilot sites, and potential solution to these problems.
- Identify with farmers research topics that deal with these problems, and plan FPR trials that test potential solutions.
- Conduct demonstration plots on experiment stations on various topics, such as new varieties and fertilization.
- Conduct FPR trials with farmers on their own fields with the following components:
  - Control of soil erosion by evaluating various soil/crop management practices
  - Cassava intercropping with grain legumes
  - Cassava fertilization
  - New cassava varieties.
- Organize farmers' field days to harvest and evaluate the FPR trials, present and discuss the results and decide further research needs.

2. Results of Phase I (1994-1998)

2.1 Baseline study and current cassava production evaluation

Information on bio-physical and socio-economic conditions as well as on agricultural practices in the selected pilot sites was collected by using RRA/PRA methods. Results indicate that the four pilot sites have similar natural conditions; for instance, total annual rainfall ranges from 1500 mm to 2100 mm, with more than 80% of the total rainfall concentrated during the summer months of April to Sept. Cassava is mainly grown on

sloping land, resulting in the surface soil being seriously eroded every year(Nguyen The Dang *et al*., 1998). Farmers have experience with cassava planting, but they have applied only very simple practices. The main constraints at all sites are:

- Low inputs
- Old and degraded cassava varieties
- No special practices to reduce soil erosion

The low cassava yields (8-15 t/ha) are a result of this low-input technology.

2.2 Demonstration plots on methods of erosion control in cassava

To gain an understanding of the effect of different soil/crop management practices on soil erosion and to enable farmers to select the most suitable practices to evaluate on their own farms, we have conducted demonstrations with 16 treatments at Thai Nguyen University of Agriculture and Forestry (TNUAF) from 1994 to 1997. Averaged over three years, the treatment with balanced NPK gave the highest cassava fresh root yield compared to other treatments (**Table 1**). Without fertilizer application cassava yields decreased from 8.25 t/ha in the first year to 2.65 t/ha in the fourth year. When a balanced NPK application was combined with the return of residues to the soil, stable yields were obtained during four years. The most effective way to control soil erosion was to plant contour hedgerows combined with cassava intercropping with peanut. This pattern reduced the amount of soil loss to about 20-30% of that of cassava sole cropping without hedgerows (**Table 1**).

Table 1. Results of FPR demonstration plots conducted on 18-24% slope at Agro-forestry College of Thai Nguyen University, Thai Nguyen, Vietnam. Data are average values for 1995, 1996 and 1997.

Treatments[1)]	Cassava yield (t/ha)	Net income (mil. d/ha)	Dry soil loss (t/ha)	Farmers' preference (%)
1. C monoculture, no fertilizers, no hedgerows	4.49	1.87	28.3	0
2. C, with fertilizers (60 N-40 P_2O_5-120 K_2O)	16.49	7.67	23.0	0
3. C, with FYM (10 t pig manure/ha)	17.31	7.79	25.3	10
4. C, with FYM+fertilizers	23.56	10.39	24.9	58
5. C, with fertilizers, with *Tephrosia* green manure	19.60	9.63	24.3	2
6. C+P, with fertilizers, *Tephrosia*+vetiver hedgerows	17.53	10.73	5.8	78
7. C, with fertilizers, contour ridging	20.48	9.84	12.6	49
8. C, with fertilizers, *Tephrosia* hedgerows	16.39[2)]	7.51	13.6	16
9. C, with fertilizers *Flemingia* hedgerows	16.29[2)]	7.43	8.0	22
10. C, with fertilizers, vetiver grass hedgerows	18.96[2)]	9.12	4.7	32
11. C+B, with fertilizers, *Tephrosia* hedgerows	17.93	7.93	9.0	12
12. C, with fertilizers, cassava residues incorporated	24.75	12.40	18.1	25
13. C, no fertilizers, residues incorp., *Tephrosia* hedgerows	6.52	3.26	12.8	0
14. C, with fert., *Tephrosia* intercropped+mulched at 3 MAP	18.99	8.73	18.5	0
15. C, with fertilizers, no tillage	18.92	9.29	18.1	0
16. C, with fertilizers, closer plant spacing (0.8x0.6 m)	21.66	10.58	18.5	16

[1)]C=cassava, P=peanut, B=black bean; in all treatments except T_7 and T_{15} the soil was prepared with hoe and cassava was planted without ridging; in all treatments except T_{12} and T_{13} the cassava residues were removed after harvest; in all treatments except T_{16} cassava was planted at 1.0x0.8 m;

[2)]In 1997 in T_8, T_9 and T_{10} cassava was intercropped with peanut.

Another demonstration was conducted with ten treatments from 1998 to 2000. Results confirmed that intercropping cassava with peanut and planting contour hedgerows markedly reduced soil losses, and was able to maintain cassava yields (**Table 2**).

Farmers collaborating in the project had the opportunity to visit these demonstration plots during field days each year. After evaluation, they selected the most suitable treatments to include in their FPR trials on their own fields.

2.3 Results of FPR trials

2.3.1 Pho Yen district of Thai Nguyen province

FPR trials on four research topics (soil erosion control by planting methods, intercropping systems, balanced fertilization, new varieties) have been conducted in two villages (Dac Son and Tien Phong) in Pho Yen district of Thai Nguyen province from 1995 to 1998.

Trials on planting methods for soil erosion control consisted of 4-5 treatments which were adjusted every year (**Tables 3** to **5**). These trials have shown that contour hedgerows reduced soil losses compared to planting without contour hedgerows when cassava was grown on sloping land. Treatments that combined hedgerows with intercropping with peanut maintained high cassava yields and resulted in the highest net income compared to the traditional farmers' practice of monocropping.

From observations and evaluations at time of harvest each season, almost all farmers selected the planting method that combined hedgerows and intercropping cassava with peanut or black beans.

Trials on cassava intercropping with grain legumes in 1995 and 1996 (**Table 6**) indicate that cassava intercropped with peanut gave better results than intercropping with black bean, not only in terms of production but also in terms of soil conservation. Farmers have adopted this practice and have expanded intercropping with peanut on their own farms. Results of trials conducted in 1997 and 1998 by 17 households (**Table 7**) have confirmed that cassava grown at 1.0 m between rows and 0.6 m between plants in the row, and intercropped with one row of peanut between cassava rows resulted in the highest net income/ha. This technology was also easy to adopt. Therefore, farmers have selected this practice for dissemination in their village.

A survey had indicated that most farmers applied only phosphorus to cassava. So, FPR trials on the application of NPK for cassava were conducted by two farmers in 1995(Nguyen The Dang *et al*., 1998). These trials have shown that without K application cassava yields were reduced significantly, while the treatments without P gave equal cassava yields as those in which 40 kg P_2O_5/ha had been applied. Results of similar trials conducted in 1996 to 1998 (**Tables 8** to **10**) indicate that highest cassava yields were obtained with the application of 80 kg N, 40 P_2O_5, 80-120 K_2O and 10 tonnes of pig manure/ha. Farmers have now adopted NPK fertilization in their cassava fields. They have become aware of the importance of a balanced NPK application for cassava, especially the importance of potassium in maintaining high cassava yields.

Table 2. Results of FPR demonstration plots on 8-10% slope at Thai Nguyen University, Thai Nguyen, Vietnam. Data are average values for 1998 and 1999.

Treatment[2)]	Cassava yield (t/ha)	Peanut yield[1)] (t/ha)	Gross income	Product. costs	Net income	Dry soil loss (t/ha)
			(mil. dong/ha)			
1. C monocult.; no fertilizers; no ridges; no hedgerows	4.61	-	1.12	2.93	-1.81	23.03
2. C monocult.; with fertilizers; contour ridges; no hedgerows	16.75	-	8.38	4.45	3.93	17.89
3. C+P; with fertilizers; no ridges; no hedgerows	16.79	0.61	11.47	4.73	6.74	16.12
4. C monocult.; with fert.; no ridges; vetiver+*Tephrosia* hedgerows	16.63	-	8.32	4.36	3.96	11.45
5. C+P; with fert.; no ridges; *Tephrosia candida* hedgerows	18.72	0.58	12.26	6.71	5.55	10.27
6. C+P; with fert.; no ridges; *Tephrosia*+pineapple hedgerows	18.86	0.51	11.95	7.03	4.92	11.37
7. C+P; with fert.; no ridges; natural grass hedgerows	16.56	0.46	10.58	4.73	5.85	15.44
8. C+P; with fert.; no ridges; vetiver grass hedgerows	17.46	0.48	11.16	6.89	4.27	9.17
9. C+P; with fert.; no ridges; vetiver+*Tephrosia* hedgerows	18.69	0.55	11.83	6.92	4.91	8.26
10. C monocult.; with fert.; no ridges; no hedgerows, closer spacing	24.38	-	12.19	4.38	7.81	12.30

[1)] Dry pods = fresh pods x 0.55.
[2)] C = cassava; P = intercropped peanut

Table 3. Average results of five FPR erosion control trials conducted by farmers in Tien Phong and Dac Son villages of Pho Yen district, Thai Nguyen province, Vietnam in 1996.

Treatments[1)]	Dry soil loss (t/ha)	Yield (t/ha)		Gross income[3)]	Production costs[4)]	Net income	Farmers' preference (%)
		cassava	peanut[2)]	(mil. dong/ha)			
1. C, Farmer's practice	8.33	11.56	-	6.94	4.39	2.55	0
2. C+P, *Tephrosia* hedgerows, no ridging,	6.62	10.91	0.372	8.41	5.54	2.87	0
3. C+P, vetiver grass hedgerows, contour ridges	6.34	12.80	0.280	9.08	5.54	3.54	39
4. C+P, *Tephrosia* hedgerows, contour ridges	4.85	12.44	0.318	9.06	5.91	3.15	38
5. C, vetiver+*Tephrosia* hedgerows, contour ridges	4.17	12.94	-	7.76	4.86	2.90	3

[1)]Farmer's practice: cassava monoculture, 15 t/ha of FYM+65 kg N+20 P_2O_5+50 K_2O/ha; all other plots received 10 t/ha of FYM+80 kg N+20 P_2O_5+80 K_2O/ha

[2)]Dry pods

[3)]Prices: cassava: dong 600/kg fresh roots
peanut: 5,000/kg dry pods

[4)]Costs: FYM: dong 100/kg
urea (45%N): 2,500/kg
SSP (17% P_2O_5): 1,000/kg
KCl (60%K_2O): 2,500/kg
peanut seed: 6,000/kg; use 50 kg/ha
cassava stakes: 0.63 mil.d/ha
hedgerow seed: 0.20 mil.d/ha
labor: 7,500/manday

Labor: cassava monoculture without fert.: 200 mandays/ha
fertilizer and manure application: 10 mandays/ha
intercropping: 100 mandays/ha
ridging: 50 mandays/ha
hedgerow planting/maintenance: 10 mandays/ha

Table 4. Average results of five FPR erosion control trials conducted by farmers in Tien Phong and Dac Son villages of Pho Yen district, Thai Nguyen province, Vietnam, in 1997.

Treatments[1)]	Dry soil loss[1)] (t/ha)	Yield (t/ha)		Gross income[3)]	Production costs[4)]	Net income	Farmers' preference
		cassava	peanut[2)]	(mil. dong/ha)			(%)
1. Farmer's practice	7.73	11.77	-	5.89	4.05	1.84	0
2. C+P, contour ridges	5.39	17.47	0.36	10.54	5.64	4.90	0
3. C+P, contour ridges, vetiver hedgerows	3.94	19.05	0.37	11.38	5.92	5.46	67
4. C+P, contour ridges, *Tephrosia* hedgerows	3.02	19.00	0.39	11.45	5.92	5.53	83
5. C+P, contour ridges, *Tephrosia*+vetiver hedgerows	2.73	17.92	0.41	11.01	5.92	5.09	3

[1)]Farmer's practice: cassava monoculture, 11.4 t/ha of FYM+68 kg N+20 P_2O_5+50 K_2O/ha;
all other plots received 10 t/ha of FYM+80 kg N + 40 P_2O_5 + 80 K_2O/ha

[2)]dry pods

[3)]Prices: cassava: dong 600/kg fresh roots
peanut: 5,000/kg dry pods

[4)]Costs FYM: dong 100/kg
urea (45%N): 2,500/kg
SSP (17% P_2O_5): 1,000/kg
KCl (60%K_2O): 2,500/kg
peanut seed: 6,000/kg; use 50 kg/ha
labor: 7,500/manday
1 US $ = 11.000 dong

Table 5. Average results of five FPR erosion control trials conducted by farmers in Tien Phong and Dac Son villages of Pho Yen district, Thai Nguyen province, Vietnam, in 1998.

Treatments[1)]	Dry soil loss (t/ha)	Yield (t/ha)		Gross income[3)]	Production costs[4)]	Net income	Farmers' preference (%)
		cassava	peanut[2)]	(mil. dong/ha)			
1. Farmer's practice	6.78	8.30	-	4.15	4.05	0.10	0
2. C+P, no hedgerows	4.74	10.00	0.26	6.30	5.27	1.03	0
3. C+P, vetiver hedgerows	3.90	10.06	0.27	6.38	5.54	0.84	10
4. C+P, *Tephrosia* hedgerows	4.51	10.92	0.31	7.01	5.54	1.47	100
5. C+P, vetiver+ *Tephrosia* hedgerows	4.02	9.65	0.37	6.68	5.54	1.14	9

[1)]Farmer's practice: cassava monoculture, 11.4 t/ha of FYM+68 kg N+20 P_2O_5+50 K_2O/ha; all other plots received 10 t/ha of FYM+80 kg N + 40 P_2O_5 + 80 K_2O/ha

[2)]Dry pods

[3)]Prices: cassava: dong 600/kg fresh roots
peanut: 5,000/kg dry pods

[4)]Costs: FYM: dong 100/kg
urea (45%N): 2,500/kg
SSP (17% P_2O_5): 1,000/kg
KCl (60%K_2O): 2,500/kg
peanut seed: 6,000/kg; use 50 kg/ha
labor: 7,500/manday
1 US $ = 13,800 dong

Table 6. Average results of 14 FPR intercropping trials conducted by farmers in Tien Phong and Dac Son villages of Pho Yen district, Thai Nguyen province, Vietnam, in 1995 and 1996.

Treatments[1]	Yield (t/ha)		Gross income[2]	Production costs[3]	Net income	Farmers' preference[4]
	cassava	intercrop	(mil. dong/ha)			(%)
1. Cassava monoculture	18.74	-	11.24	4.59	6.65	3
2. Cassava+black bean	17.82	0.31	12.24	5.43	6.81	-
3. Cassava+peanut	18.90	0.65	14.59	5.71	8.88	97

[1]Applied 10 t/ha of pig manure, 80 kg N+40 P_2O_5 +80 K_2O/ha as urea, SSP and KCl, respectively; planted 15 kg of black bean and 61.7 peanut seed/ha.

[2]Prices: cassava: dong 600/kg fresh roots:
peanut: 5,000/kg dry pods:
black bean: 5,000/kg dry grain

[3]Costs: FYM: dong 100/kg
urea (45%N): 2,500/kg
SSP (17% P_2O_5): 1,000/kg
KCl (60%K_2O) 2,500/kg
peanut seed in pods: 6,000/kg
black bean seed: 6,000/kg
labor: 7,500/manday

[4]Farmers' preference in 1996.

Table 7. Average results of 17 FPR trials on planting arrangement in intercropping cassava with peanut conducted by farmers in Tien Phong and Dac Son villages of Pho Yen district, Thai Nguyen province, Vietnam, in 1997 and 1998.

Treatments	Yield (t/ha)		Gross income[1]	Production costs[2]	Net income	Farmers' preference[3]
	cassava	intercrop	(mil. dong/ha)			(%)
1. Farmer's practice[4]	18.46	0.54	11.93	6.06	5.87	10
2. 1 row of peanut[5], cassava 1.0x0.6m	24.55	0.28	13.67	5.43	8.24	55
3. 2 rows of peanut[6], cassava 1.0x0.8m	19.40	0.41	11.75	5.76	5.99	52
4. 3 rows of peanut[7], cassava 1.2x0.8m	16.98	0.48	10.89	6.09	4.80	0

[1]Prices: cassava: dong 600/kg fresh roots
peanut: 5,000/kg dry pods
peanut seed: 6,000/kg dry grain

[2]Peanut seed reguirements: T_1 =120, T_2=40, T_3 =70, T_4 =100 kg/ha

[3]Farmers' preference in 1997

[4]Cassava on ridges spaced at 1.0-1.2 m between ridges, peanut planted cross-wise on ridge in short rows, 0.6-0.8 m between rows (to reduce excess moisture)

[5]1 row of peanut between cassava rows at 0.1 m between plants

[6)]2 rows of peanut at 0.35x0.1 m
[7)]3 rows of peanut at 0.35x0.1 m

Table 8. Average results of four FPR fertilizer trials conducted by farmers in Tien Phong and Dac Son villages of Pho Yen district, Thai Nguyen province, Vietnam, in 1996.

Treatments	Cassava yield (t/ha)	Gross income[2)]	Fertilizer costs[3)]	Net income	Farmers' preference (%)
		(mil. dong/ha)			
1) Farmer's practice[1)]	8.93	5.36	1.79	3.57	0
2) 10 t/ha of FYM; 40 N + 40 K_2O	10.56	6.34	1.39	4.95	0
3) 10 t/ha FYM; 80 N + 80 K_2O	12.40	7.44	1.78	5.66	79
4) 10 t/ha FYM; 80 N + 40 P_2O_5 +80 K_2O	13.22	7.93	2.01	5.92	21

[1)]Average farmer application: 13.3 t FYM +53 kg N + 7 kg P_2O_5+31 kg K_2O/ha
[2)]Prices: cassava: dong 600/kg fresh roots
[3)]Costs: FYM: dong 100/kg
urea (45%N): 2,500/kg
SSP (17%P_2O_5): 1,000/kg
KCl (60%K_2O): 2,500/kg

Table 9. Average results of five FPR fertilizer trials conducted by farmers in Tien Phong and Dac Son villages of Pho Yen district, Thai Nguyen province, Vietnam, in 1997.

Treatments	Cassava yield (t/ha)	Gross income[1)]	Fertilizer costs[2)]	Net income	Farmers' preference (%)
		(mil. dong/ha)			
1) Farmer's practice[3)]	18.50	9.25	1.96	7.29	0
2) 10 t/ha of FYM; 40 N+40 K_2O	19.87	9.44	1.39	8.05	32
3) 10 t/ha FYM; 80 N+40 P_2O_5+80 K_2O	22.37	11.19	2.01	9.18	64
4) 10 t/ha FYM; 120 N+40 P_2O_5+120 K_2O	28.00	14.00	2.40	11.60	61

[1)]Prices: cassava: dong 500/kg fresh roots
[2)]Costs: pig manure: dong 100/kg
urea (45%N): 2,500/kg
SSP (17%P_2O_5): 1,000/kg
KCl (60%K_2O): 2,500/kg
[3)]Average farmer's application: 12.8 t/ha of FYM +60 kg N + 30 P_2O_5+41 K_2O/ha

Table 10. Average results of four FPR fertilizer trials conducted by farmers in Tien Phong and Dac Son villages of Pho Yen district, Thai Nguyen province, Vietnam, in 1998.

Treatments	Cassava yield (t/ha)	Gross income[1)] (mil. dong/ha)	Fertilizer costs[2)] (mil. dong/ha)	Net income (mil. dong/ha)	Farmers' preference (%)
1) Farmer's practice[3)]	15.65	7.83	1.87	5.96	0
2) 10 t/ha of FYM; 40 N+40 K_2O	17.85	8.93	1.39	7.54	54
3) 10 t/ha FYM; 80 N+40 P_2O_5+80 K_2O	18.34	9.17	2.01	7.16	50
4) 10 t/ha FYM; 120 N+40 P_2O_5+120 K_2O	21.45	10.73	2.40	8.33	66

[1)]Prices: cassava: dong 500/kg fresh roots
[2)]Costs: FYM: dong 100/kg
urea (45% N): 2,500/kg
SSP (17% P_2O_5): 1,000/kg
KCl (60% K_2O): 2,500/kg
[3)]Average farmer's application: 10 t/ha of FYM +70 kg N + 40 P_2O_5+60 K_2O/ha

Trials on new cassava varieties (**Table 11**) have shown that KM60, KM94, KM98-7 (SM1717-12) and CM4955-7 gave higher fresh root yields and had a higher dry matter content than the local variety Vinh Phu. Therefore, those new varieties were easily adopted by farmers and were rapidly disseminated in cassava growing areas of Pho Yen district.

Table 11. Average results of 44 FPR variety trials conducted by farmers in Tien Phong and Dac Son villages of Pho Yen district, Thai Nguyen province, Vietnam, in 1995, 1996, 1997 and 1998.

Variety	1995	1996	1997	1998	Average
Vinh Phu	14.30	20.22	18.83	16.89	17.56
KM60	18.37	22.49	22.54	20.40	20.95
CM4955-7	18.37	23.76	24.66	24.62	22.85
KM95-3=SM1157-3	-	23.81	24.60	18.45	22.29
KM94	-	-	25.75	21.91	23.83
KM98-7=SM1717-12	-	-	25.00	25.44	25.22
SM937-8	-	20.77	-	-	20.77
SM981-3	-	23.35	-	-	23.35
OMR25-33-105	-	21.80	-	-	21.80
OMR33-35-230	-	-	21.35	-	21.35

Besides conducting trials, farmers have adopted the practice of growing cassava intercropped with peanut or black bean; soil erosion control by planting hedgerows of *Tephrosia candida* and vetiver grass, balanced fertilization and new cassava varieties on a

larger scale in Pho Yen district, as these practices produced higher income than the traditional practices.

In summary: four technology components have been studied in FPR trials, conducted by farmers on their own fields. The working together with farmers in Pho Yen district created favorable conditions for farmers to learn by doing and seeing; the methods helped train and increased farmers' capacity, and this enhanced their ability to adapt and adopt new technologies. These technologies were rapidly scaled up to their cassava production fields and resulted in higher income.

2.3.2 Thanh Ba district of Phu Tho province

At the end of 1994 fields days were organized at Thai Nguyen University of Agriculture and Forestry for farmers of Phuong Linh village in Thanh Ba district of Phu Tho province. After this, farmers decided to conduct FPR trials on three components, i.e. cassava soil conservation by planting methods, cassava fertilization and new cassava varieties.

A trial on planting methods for erosion control with seven treatments was conducted on a slope of 32-45%. Average results of this trial, conducted from 1995 to 1998, indicate that the highest amount of soil loss by erosion occurred in the traditional practice of cassava monocropping without hedgerows (**Table 12**). In other treatments soil losses were reduced significantly, especially when cassava was intercropped with peanut and hedgerows were planted along the contour. After observation/evaluation and calculating the economic benefits of each treatment (**Table 12**), almost all farmers selected the practice of cassava intercropping with peanut, balanced NPK fertilizer application and contour hedgerows of *Tephrosia candida* or vetiver grass for their fields.

Trials on cassava fertilization were conducted by five participating households (**Table 13**). Cassava fresh root yields increased from 16.7 t/ha in 1996 to 20.7 t/ha in 1998 with application of 60 kg N, 60 P_2O_5, 80 K_2O and 10 tonnes pig manure/ha. Cassava fresh root yields were slighly lower with application of 120 than with 80 kg K_2O/ha.

Trials on new cassava varieties (**Table 14**) indicate that CM4955-7, KM98-7, and KM94 produced highest fresh root yields among seven clones tested at Phuong Linh commune; these varieties are now being multiplied by farmers.

2.3.3 Luong Son district of Hoa Binh province

Three types of FPR trials have also been conducted at Dong Rang village in Luong Son district of Hoa Binh province.

Trials on cassava planting methods for soil erosion control showed that the practice of cassava intercropping with peanut and planting hedgerows of vetiver grass or *Tephrosia candida* was most effective in reducing soil erosion (**Table 15**). Highest cassava fresh root yields and net income were obtained with the combination of peanut intercropping, applying a balanced NPK fertilization and planting hedgerows of *Tephrosia candida*.

Trials on cassava fertilization conducted by three participating households (**Table 16**) indicate that the highest cassava fresh root yield was obtained with intermediate levels of NPK, followed by the treatment of 40 kg N and 80 K_2O/ha.

Table 12. Average results of an FPR erosion control trial conducted by six farmers in Kieu Tung village, Thanh Ba district, Phu Tho province, Vietnam, in 1995, 1996, 1997 and 1998.

Treatments[1)]	Slope (%)	Dry soil loss (t/ha)	Yield (t/ha)		Gross income[3)]	Production costs						Net income
			cassava	peanut[2)]		Labor	Fert/ manure	Peanut seed	Cassava stakes	Hedgerow seed	Total	
						(mil. dong/ha)						
1. C monocult., with fertilizers, no hedgerows	40.5	55.1	21.93	-	10.96	1.57	2.07	-	0.63	-	4.27	6.69
2. C+P, no fertilizers, no hedgerows	45.0	52.4	16.22	0.75	12.23	2.25	1.00	0.32	0.63	-	4.20	8.03
3. C+P, with fertilizers, no hedgerows	42.7	40.5	17.92	0.93	14.07	2.32	2.07	0.32	0.63	-	5.34	8.73
4. C+P, with fertilizers, *Tephrosia* hedgerows	39.7	32.2	16.55	0.79	12.62	2.40	2.07	0.32	0.63	0.20	5.62	7.00
5. C+P, with fertilizers, pineapple hedgerows	32.2	28.1	20.49	0.87	15.03	2.40	2.07	0.32	0.63	0.20	5.62	9.41
6. C+P, with fertilizers, vetiver hedgerows	37.7	28.7	22.58	0.89	16.19	2.40	2.07	0.32	0.63	0.20	5.62	10.57
7. C monocult., with fert., *Tephrosia* hedgerows	40.0	30.7	23.04	-	11.52	1.65	2.07	-	0.63	0.20	4.55	6.97

[1)]All plots received 10 t/ha of pig manure; fertilizers = 60 kg N+40 P_2O_5+120 K_2O/ha; C = cassava, P = peanut intercrop

[2)]Dry pods

[3)]Prices: cassava: dong 500/kg fresh roots
peanut: 5,500/kg dry pods

[4)]Costs: FYM: dong 100/kg
urea (45%N): 2,500/kg
SSP (17%P_2O_5): 1,000/kg
KCl(60%K_2O): 2,500kg
peanut seed: 6,500/kg dry pods; use 50 kg/ha
labor: 7,500/manday

Table 13. Combined results of five FPR fertilizer trials with cassava conducted in Phuong Linh commune, Thanh Ba district, Phu Tho province from 1996 to 1998.

Treatments	1996		1997		1998		Average yield (t/ha)
	Cassava yield (t/ha)	Farmers' preference[1)] (%)	Cassava yield (t/ha)	Farmers' preference[1)] (%)	Cassava yield (t/ha)	Farmers' preference[1)] (%)	
1. 10 t/ha FYM	15.93	82.0	15.85	86.7	15.96	88.6	15.91
2. 10 t/ha FYM + 60 kg N+ 60 P_2O_5 + 120 K_2O/ha	17.64	80.6	20.18	80.0	18.22	82.9	18.68
3. 10 t/ha FYM + 60 kg N+ 60 P_2O_5 + 80 K_2O/ha	16.67	61.0	19.31	60.0	20.75	68.6	18.91
4. 10 t/ha FYM + 60 kg N+ 40 P_2O_5 + 120 K_2O/ha	17.89	70.0	17.64	56.7	17.72	65.7	17.75

[1)]Farmers' preference from field day

Table 14. Combined results of FPR cassava variety trials conducted in Phuong Linh commune, Thanh Ba district, Phu Tho province from 1996 to1998.

Varieties	1996		1997		1998		Average yield (t/ha)
	Cassava yield (t/ha)	Farmers' preference[1)] (%)	Cassava yield (t/ha)	Farmers' preference[1)] (%)	Cassava yield (t/ha)	Farmers' preference[1)] (%)	
1. Vinh phu	16.67	85	22.22	87	13.59	89	17.49
2. KM60	19.79	100	18.86	100	-	-	19.33
3. CM44	12.50	0	-	-	-	-	12.50
4. CM4955-7	-	-	38.57	83	15.23	86	26.90
5. OMR35-16-4	-	-	17.50	77	-	-	17.50
6. KM98-7 (SM1717-12)	26.04	100	35.20	100	17.90	100	26.38
7. KM94	-	-	28.90	80	14.53	83	21.72
8. KM95-3	-	-	-	-	18.10	100	18.10

[1)]Farmers' preference from field day

Table 15. Average results of an FPR erosion control trial conducted by Mr. Ngyyen Van Tho in Dong Rang village, Luong Son district of Hoa Binh province, Vietnam, in 1995, 1996, 1997 and 1998.

Treatments[1]	Yield (t/ha)		Gross income[2]	Prod. costs[3]	Net income	Dry soil loss
	cassava	intercrop	(mil. dong/ha)			(t/ha)
1. Farmer's practice	11	2.19	6.71	3.08	3.63	98.3
2. C+taro, with NPK, vetiver hedgerows	13	1.77	7.19	4.21	2.98	27.6
3. C+taro, with NPK, *Tephrosia* hedgerows	15	1.77	7.77	4.21	3.56	25.8
4. C+peanut, with NPK, vetiver hedgerows	14	0.76	9.06	4.31	4.75	11.0
5. C+peanut, with NPK, *Tephrosia* hedgerows	16	0.83	10.37	4.31	6.06	13.2

[1]Farmer's practice: C + taro, no NPK, no hedgerows; NPK = 40 kg N, 40 P_2O_5 and 80 K_2O/ha

[2]Prices: cassava: dong 400/kg fresh roots
taro 1,000/kg fresh corms
peanut 4,500/kg dry pods

[3]Costs: urea (45%N): dong 2,500/kg
fused Mg-phos. (15%P_2O_5): 1,000/kg
KCl (60%K_2O): 2,200/kg
labor: 7,500/manday
cassava stakes: 0.63 mil. d/ha
hedgerow seed: 0.20 mil. d/ha
peanut seed: 0.30 mil. d/ha
taro cormels: 0.20 mil. d/ha

Table 16. Combined result of three FPR fertilizer trials with cassava conducted in Dong Rang, Luong Son district, Hoa Binh province, from 1996 to 1998.

Treatments	Yield (t/ha)			
	1996	1997	1998	Average
1. Farmer's practice (no fertilizers)	8.94	11.63	10.95	10.51
2. 40 N + 40 P_2O_5 + 80 K_2O	15.42	15.88	16.50	15.93
3. 40 N + 40 P_2O_5	13.10	12.25	12.40	12.58
4. 40 N + 80 K_2O	14.96	15.13	15.35	15.15
5. 40 P_2O_5 + 80 K_2O	14.52	14.19	13.40	14.04

Trials on cassava varieties indicate that KM98-7, KM95-3 and KM94 produced the highest fresh root yields among 14 tested clones at Dong Rang village (**Table 17**).

When farmers were asked to evaluate the treatments most farmers selected the cropping system that combined cassava intercropping with peanut, and planting contour hedgerows of *Tephrosia candida* or vetiver grass (**Table 18**).

Table 17. Combined result of three FPR fertilizer trials with cassava conducted in Dong Rang, Luong Son district, Hoa Binh province, from 1995 to 1998.

	Yield (t/ha)				
Varieties[1)]	1995	1996	1997	1998	Average
1. Vinh Phu	7.50	19.03	15.49	12.21	11.87
2. KM60	17.29	19.71	-	-	18.50
3. KM94	-	23.01	19.63	19.71	20.78
4. KM95-3	-	-	23.13	20.14	21.64
5. KM95-1	-	12.92	-	-	12.92
6. CM4955-7	-	-	13.75	-	13.75
7. OMR29-56-101	11.55	-	-	-	11.55
8. OMR35-16-4	-	-	15.88	-	15.88
9. OMR35-17-15	-	-	19.13	19.71	19.42
10. OMR35-38-79	-	-	-	19.71	19.71
11. KM98-7 (SM1717-12)	-	-	25.00	24.00	24.50
12. SM981-3	-	21.21	-	-	21.21

[1)]Fertilizer: 5 t/ha of FYM + 20 kg N + 40 P_2O_5 + 80 K_2O/ha

Table 18. Farmers' preference for contour hedgerows in Dong Rang, Luong Son district, Hoa Binh province.

Treatment	Farmers' preference[1)] (%)
1. Without hedgerows	0
2. *Tephrosia candida* hedgerows	66.0
3. Vetiver grass hedgerows	53.0
4. *Tephrosia* hedgerows + peanut intercrop	76.6
5. Stone walls + *Tephrosia candida* hedgerows	19.2

[1)]Total number of farmers: 47

2.4 Farmer's field days

Farmers' field days were organized every harvesting season to evaluate the trials and to discuss the work plan for adoption of new technologies and the trials that farmers wanted to conduct the following year (**Table 19**). The number of farmers participating have increased during the four years of the project, with 77 farmers participating in various trials in 1998.

Table 19. Number of farmers who participated in the first phase of the project (1994 – 1998).

	Number of participating farmers[1)]			
Research site	1995	1996	1997	1998
1. Pho Yen	21	37	38	40
2. Thanh Ba	11	14	19	29
3. Luong Son	6	8	8	8
Total	**38**	**59**	**65**	**77**

[1)]Including extension workers.

3. Plans for Phase II (1999-2003)

3.1 Objectives of the project

- To continue to develop with farmers improved crop management practices that will increase productivity and maintain the soil resources.
- To disseminate new technologies at the local, provincial and national levels.
- To conduct research that overcomes constraints identified at the farm level.
- To develop new and innovative participatory methodologies for dissemination or scaling up of new technologies.
- To strengthen farmer participating approaches among institutions and farming communities.
- To develop and implement procedures for monitoring the impact of new technologies.

3.2 Principal activities

- Conduct FPR trials to develop integrated technologies that incorporate improved varieties, increased fertilizer use efficiency, intercropping and erosion control practices at 21 sites
- Develop and implement methodologies for scaling up and disseminating improved technologies.
- Train staff and key farmers in cassava agronomy and extension using participatory approaches.
- Conduct applied research for supporting extension activities.
- Monitor progress and assess impact of new technologies on farmers' welfare and resource sustainability.

3.3 Work plan

Table 20 shows the work breakdown schedule for various activities, while **Table 21** shows the responsibilities of each collaborating institution during the year 2000.

Table 20. General work plan during the 2nd phase of the project.

Contents	Year				
	1999	2000	2001	2002	2003
1. RRA for new sites	7	6	5	0	0
2. Demonstration plot	TUAF HARC	TUAF HARC Hong Ha	TUAF HARC	0	0
3. FPR research sites	6	8	10	11	5
4. Dissemination	+	+	+	+	+
5. FPE	0	+	+	+	+
6. Training for researchers	0	+	+	0	0
extensionists	+	+			
farmers	+	+	+	+	+
7. Workshop			HCM city		

Notes: Total number of pilot sites: 21 in 2003.

Table 21. Work plan for each collaborating institution during the year 2000.

Contents	Work of FPR teams					
	TUAF	NISF	VASI	HUAF	IAS	UAF4
1.FPR trials						
- PhoYen	+					
- Phuong Linh, Dong Rang		+				
- Thong Nhat, Chau Thanh					+	
- Phuoc Long					+	
2. Dissemination						
- Pho Yen	+					
- Phuong Linh, Dong Rang		+				
3. Demonstration plot	+				+	
4. New research sites (RRA and FPR trials)	+	+	+	+	+	+
5. Training						
- Researchers and extension workers					+	
- Farmers	+	+	+	+	+	+

CONCLUSIONS

Phase I

FPR is a new research and extension approach. It involves combining the knowledge of researcher/extension workers and the experience of farmers in solving problems identified at the farm level.

The project helped to strengthen the capacity of farmers to diagnose their problems, to find and select potential solutions and ways to test these in FPR trials on their own fields, to evaluate these trials, to select the most suitable practices for adoption, and to adopt these in their cassava production fields.

The project also strengthened the relationship between researchers, extensionists and farmers. Results of adopted technologies have been rapidly transferred into production fields, increasing the income of many small cassava farmers.

Phase II

The objective is to further strengthen the capacity of farmers to analyze their current situation, to conduct FPR trials in order to develop the most appropriate technologies that can be adopted and to disseminate the most suitable practices to other farmers.

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