FARMER PARTICIPATORY RESEARCH (FPR) TRIALS ON CASSAVA INTERCROPPING SYSTEMS IN VIETNAM

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ABSTRACT

Farmers in Vietnam practiced intercropping before the FPR project. However, they have increased the area of cassava intercropped as a result of the project. A total of 44 FPR intercropping trials were conducted by farmers on their own fields from 1999 to 2001. The results show that intercropping cassava with peanut, black or red bean (actually cowpea) or mungbean increased their net income, improved the soil, and reduced weeds and soil losses by erosion as compared to the monocropping system. As a result of these trials intercropping with peanut has been more widely adopted by farmers in Vietnam.

INTRODUCTION

Intercropping with food crops and grain legumes is a common practice in tropical cropping systems. Since cassava is widely spaced and it takes several months to completely cover the soil, intercropping during the early stage of crop development generally results in the highest land use efficiency, less erosion and higher total income. Estimates indicate that at least one-third of cassava grown worldwide is intercropped (Cock, 1985). Intercropping cassava tends to minimize the risk of crop failure. It generally does not affect the total crop value as the reduced yield of the main crop is compensated by the yield of the intercrops. In sloping areas, intercropping reduces nutrient loss and maintains soil fertility. Biological nitrogen fixation is an important N resource for cassava intercropped with legumes, and the incorporation of the residues of the intercrops may result in an increase in soil organic matter. Therefore, Vietnamese farmers have readily adopted cassava intercropping as a useful production system (**Table 1**).

RESULTS OF FPR TRAILS IN VIETNAM

A. In the North

Intercropping cassava with peanut is more common in north Vietnam, as it is beneficial and easy to adopt. After several years of conducting FPR intercropping trails using various crop species and systems, farmers were most interested in intercropping cassava with peanut in two rows, planted at the same time as cassava. Results confirm that intercropping cassava with peanut was able to maintain cassava yields (Nguyen Hue *et al*., 2001; Nguyen The Dang *et al*., 2001), while cassava and peanut planted at the same time (Vu Thi Luu *et al*., 2001) and in two rows of intercrops (Trinh Phuong Loan *et al*., 2001) were considered the best system.

Tables 2 to **8** show that in Ha Tay, Phu Tho, Tuyen Quang and Yen Bai provinces of north Vietnam intercropping with one or two rows of peanut between cassava rows was optimum, both in terms of the yields of cassava and peanut, and in increasing the net income. This practice has now been widely adopted by farmers.

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Table 1. Number of FPR intercropping trials conducted by farmers in various sites in Vietnam from 1999 to 2001, and the number of households adopting this technology.

Village, district, province	Number of FPR intercropping trials			Adoption (No. of farmers)	
	1999	2000	2001	2000	2001
Tran Phu, Chuong My, Ha Tay	-	3	3	5	60
Thach Hoa, Thach That, Ha Tay	-	-	3	-	-
Dac Son, Pho Yen, Thai Nguyen	-	-	-	-	8
Tien Phong, Pho Yen, Thai Nguyen	-	-	4	37	40
Minh Duc, Pho Yen, Thai Nguyen	-	-	3	-	25
An Thang, Son Duong, Tuyen Quang	-	-	2	-	-
Hong Tien, Son Duong, Tuyen Quang	-	-	1	-	-
Yen Hung, Van Yen, Yen Bai	-	-	1	-	-
Dong Rang, Luong Son, Hoa Binh	-	-	2	-	45
Thong Nhat, Phu Ninh, Phu Tho	-	-	2	-	-
Hong Ha, A Luoi, Thua Thien Hue	-	2	3	-	5
Thuong Long, Nam Dong, Thua Thien Hue	-	-	2	-	-
An Vien, Thong Nhat, Dong Nai	3	3	-	-	5
Dong Tam, Dong Xoai, Binh Phuoc	-	2	-	-	5
Minh Lap, Dong Xoai, Binh Phuoc	-	-	-	-	5
Suoi Rao, Chau Duc, Ba Ria-Vungtau	-	2	2	-	-
Son Binh, Chau Duc, Ba Ria-Vungtau	-	-	1	-	-
Total	**3**	**12**	**29**	**42**	**198**

1. In Ha Tay province:

Table 2. Average results of three FPR intercropping trials conducted by farmers in Tran Phu commune, Chuong My district in Ha Tay province in 2000/01.

Treatments	Cassava yield (t/ha)	Intercrop yield (t/ha)	Gross income[2)]	Product. costs[3)]	Net income	Farmers' preference (%)
			----------('000 dong/ha)----------			
Cassava monoculture	29.03	-	8,709	3,900	4,809	-
C+peanut (1 row)	32.50	0.887	14,185	5,143	9,042	-
C+peanut (2 rows)	30.43	1.760	17,929	5,386	12,543	94.0
C+black bean (1 row)	27.27	0[1)]	8,181	5,020	3,161	-
C+black bean (2 rows)	25.83	0[1)]	7,749	5,140	2,609	-

[1)] No yield of black bean due to drought

[2)] Prices: cassava dong 300/kg fresh roots
peanut 5,000/kg dry pods

[3)] Costs: peanut seed 6,000/kg dry grain (need 40.5 kg/ha for 1 row, 81 kg/ha for 2 rows)
black bean seed 6,000/kg dry grain (need 20 kg/ha for 1 row, 40 kg/ha for 2 rows)
Cost cassava production 2.8 mil. dong/ha
Labor costs intercropping 1.0 mil. dong/ha
Cost manure and application 1.1 mil. dong/ha

Table 3. Average results of three FPR intercropping trials conducted by farmers in Tran Phu commune, Chuong My district in Ha Tay province in 2001/02.

Cropping system[1)]	Cassava root yield (t/ha)	Intercrop yield (t/ha)	Gross income[2)]	Production costs[3)]	Net income	Farmers' preference
			('000 dong/ha)			(%)
1. Cassava monoculture	29.46	-	8,838	3,660	5,178	0
2. C+ peanut (1 row)	22.37	0.975	11,586	4,546	7,040	0
3. C+ peanut (2 rows)	31.96	2.125	20,213	5,432	14,781	100
4. C+ mungbean (1 row)	33.45	0.133	11,099	4,560	6,539	12
5. C+ watermelon (2 rows)	32.09	0	9,627	3,860	5,764	0

[1)] Peanut planted 10 days before cassava
[2)] Prices: cassava dong 300/kg fresh roots
peanut 5,000/kg dry pods
mungbean 8,000/kg dry grain
[3)] Cost of fertilizers 859,500/ha

Table 4. Average results of four FPR intercropping trials conducted by farmers in Thach Hoa commune, Thach That district in Ha Tay province in 2001.

Cropping system[1)]	Cassava yield (t/ha)	Peanut yield (t/ha)	Gross income[2)]	Production costs[2)]	Net income	Farmers' preference
			('000 dong/ha)			(%)
1. Cassava monoculture	24.9	-	7,470	3,660	3,810	0
2. C+1 row of peanut	23.1	1.293	13,395	4,546	8,879	0
3. C+2 rows of peanut	27.8	1.870	17,690	5,432	12,258	100
4. C+3 rows of peanut	29.9	2.220	20,070	6,118	12,932	0

[1)]Cassava planted 2 weeks after peanut
[2)]Prices: cassava dong 300/kg fresh roots
peanut 5,000/kg dry pods
peanut seed 6,000/kg dry pods
Source: *Trinh Phuong Loan et al., 2001.*

2. In Tuyen Quang province:

Table 5. Results of an FPR intercropping trial conducted by a farmer in Hong Tien commune of Son Duong district in Tuyen Quang province in 2001.

Treatments[1)]	Yield (t/ha)		Gross income[2)]	Production costs[2)]				Net income	Farmers' preference
	cassava	intercrop		labor	seed	fert.	Total		(%)[3)]
			('000 dong//ha)						
1. Cassava monoculture	23.60	-	11,800	2,900	-	1,430	4,330	7,470	11
2. C +maize	26.30	1.08	14,770	3,900	200	1,430	5,530	9,240	2
3. C +mungbean	33.30	-	16,650	3,900	250	1,430	5,580	11,070	5
4. C +peanut	29.10	0.76	18,350	3,900	300	1,430	5,630	12,720	50

[1)] All plots were fertilized with 1,100 kg/ha of 7:4:7 = 1.43 mil. dong/ha
[2)] Prices: cassava dong 500/kg fresh roots
maize 1,500/kg dry grain
peanut 5,000/kg dry pods
7:4:7 fertilizers 1,300/kg
maize seed 4,000/kg (use 50 kg/ha)
mungbean seed 12,500/kg (use 20 kg/ha)
peanut seed 6,000/kg (use 50 kg/ha)
labor cost of cassava monoculture: 2.8 mil. dong/ha
cost of fertilizer application: 0.1 mil. dong/ha
cost of intercropping: 0.3 mil. dong/ha
[3)] Out of 46 farmers

Table 6. Results of an FPR intercropping trial conducted by a farmer in Am Thang commune of Son Duong district in Tuyen Quang province in 2001.

Cropping system[1)]	Yield (t/ha)		Gross income[2)]	Production costs[2)]				Net income	Farmers' preference
				labor	seed	fert.	Total		
	cassava	intercrop	('000 dong//ha)						(%)[3)]
1.Cassava monoculture	15.00	-	7,500	2,900	-	1,430	4,330	3,170	11
2. C +maize	32.50	1.030	17,795	3,900	200	1,430	5,530	12,265	2
3. C +mungbean	31.20	0.400	18,000	3,900	250	1,430	5,580	12,420	5
4. C +peanut	23.70	0.500	14,350	3,900	300	1,430	5,630	8,720	50

[1)] 1.100 kg/ha of 7:4:7 applied to all treatments = 1.43 mil. dong/ha

[2)] Prices:

cassava	dong 500/kg fresh roots
maize	1,500/kg dry grain
peanut	5,000/kg dry pods
mungbean	6,000/kg dry grain
maize seed	4,000/kg dry grain (use 50 kg/ha)
peanut seed	6,000/kg dry pods (use 50 kg/ha)
mungbean seed	12,500/kg dry grain (use 20 kg/ha)

[3)] Out of 46 farmers

Source: *Nguyen Thi Dang et al., 2001.*

3. In Phu Tho province:

Table 7. Results of two FPR intercropping trials conducted by farmers in Thong Nhat commune of Phu Ninh district in Phu Tho province in 2001/02.

Treatments[1)]	Cassava yield (t/ha)			Intercrop yield (t/ha)			Gross income[2)]	Product. costs[2)]	Net income
	Hue	Luc	Av.	Hue	Luc	Av.	('000 dong/ha)		
C monoculture	15.5	16.2	15.8	-	-	-	6,320	4,539	1,781
C+peanut	14.2	15.8	15.0	0.80	1.00	0.90	11,400	6,374	5,026
C+black bean	14.2	16.2	15.2	0.42	0.33	0.37	7,375	6,374	1,001

[1)]Fertilizers: 10 t FYM +80 N+40 P_2O_5+80 K_2O/ha = 1.924 mil. dong/ha

[2)]Prices:

cassava	dong	400/kg fresh roots
peanut		6,000/kg dry pods
black bean		3,500/kg dry grain
urea (45%N)		2,000/kg
SSP (17% P_2O_5)		1,000/kg
KCl (60% K_2O)		2,500/kg
FYM		100/kg
labor		7,500/manday
labor for monoculture cassava (272 md/ha)		2.040 mil. dong/ha
labor for intercropped cassava (450 md/ha)		3.375 mil. dong/ha
labor for fertilizer application (10 md/ha)		0.075 mil. dong/ha
bean seed	dong 5,000/kg	0.5 mil. dong/ha
peanut seed	10,000/kg	0.5 mil. dong/ha
cassava stakes		0.5 mil. dong/ha

Source: *Nguyen Hue et al., 2001.*

4. In Yen bai province:

Table 8. Results of an FPR intercropping trial conducted by farmers in Yen Hung commune of Van Yen district in Yen Bai province in 2001.

Treatments	Cassava yield (t/ha)	Intercrop yield (t/ha)	Gross income	Product. costs	Net income	Farmers' (%)
			--------(mil. dong/ha)-------			
1. Cassava monoculture	41.5	-	12.45	4.20	8.25	0
2. C+ peanut (1 row)	39.2	0.970	16.61	6.60	10.01	
3. C+ peanut (2 rows) (15 days before planting cassava)	38.5	1.660	19.85	7.60	12.25	30
4. C+ peanut (1 row)	39.6	0.890	16.33	6.60	9.73	
5. C+ peanut (2 rows) (at the same time as cassava)	39.0	1.530	19.35	7.60	11.75	70
6. C+ peanut (1 row)	40.8	0.690	15.69	6.60	9.09	0
7. C+ peanut (2 row) (15 days after planting cassava)	40.0	0.960	16.80	7.60	9.20	

Prices: cassava: dong 300/kg fresh roots; SSP: dong 1,100/kg
peanut: 5000/dry pods; labor: 15,000/manday
urea: 2,200/kg

Source: *Vu Thi Luu et al., 2001.*

B. In the Central Region

1. In Thua Thien-Hue province:

In Thua Thien-Hue province intercropping with grain legumes, like peanut, red bean and black bean, did not significantly reduce the yield of cassava. In poor soils or without fertilizer application, cassava intercropping with red bean or black bean gave the best result (**Table 9**). In fertile soils or with fertilizer applications, cassava intercropping with peanut or red bean produced high yields of both the intercrops and cassava (**Table 10**). Based on the results of these FPR trials, almost all farmers selected this planting method.

Table 9. Average results of two FPR intercropping trials conducted by farmers in Hong Ha Commune of A Luoi district in Thua Thien-Hue province in 2000.

Intercropping treatments	Cassava yield (t/ha)	Starch content (%)	Intercrop yield (t/ha)	Gross income[1)]	Product. costs[2)]	Net income	Farmers' (%)
				--------('000 dong/ha)--------			
1. Cassava monoculture	7.14	27.0	-	3,570	1,800	1,770	0
2. C+red bean	8.80	27.3	0.600	6,500	2,940	3,560	100
3. C+peanut	8.77	27.7	0.400	5,985	4,060	1,925	0
4. C+black bean	8.84	27.8	0.600	6,520	2,940	3,580	100
5. C+mungbean	8.73	27.6	0.300	6,165	3,180	2,985	54

[1)] Prices: cassava dong 500/kg fresh roots; peanut seed 8,500/kg (need 160 kg/ha)
red bean 3,500/kg dry grain; red/black bean seed 6,000/kg (need 40 kg/ha)
peanut 4,000/kg dry pods; mungbean seed 12,000/kg (need 40 kg/ha)
black bean 3,500/kg dry grain; labor 15,000/manday
mungbean 6,000/kg dry grain

[2)] Cost of cassava monoculture: 1.8 mil. dong/ha (120 mandays)
Cost of intercropping: 0.9 mil. dong/ha (60 mandays)

Table 10. Results of an FPR intercropping and fertilizer application trial conducted by farmers in Thuong Long commune of Nam Dong district in Thua Thien-Hue province in 2001/02.

Cropping system[1)]	Cassava yield (t/ha)		Starch content (%)		Intercrop yield (t/ha)	
	no fert.	with fert.	no fert.	with fert.	no fert.	with fert.
1. Cassava monoculture	9.9	26.0	26.7	27.8	-	-
2. C + red bean	9.7	25.7	26.4	28.1	0.500	0.750
3. C + peanut	9.6	25.1	26.8	27.9	0.430	0.600
4. C + black bean	9.7	24.9	26.7	27.7	0.500	0.750
5. C + mungbean	9.6	25.0	26.5	28.0	0.300	0.450

Cropping system[1)]	Gross income[2)] ('000 dong/ha)		Product. costs[2)] ('000 dong/ha)		Net income ('000 dong/ha)		Farmers' Preference (%)	
	no fert.	with fert.	no fert.	with fert.	no fert.	with fert.	no fert.	with fert.
1. Cassava monoculture	4,950	13,000	1,800	3,700	3,150	9,300	0	0
2. C + red bean	6,600	15,475	2,940	4,840	3,660	10,630	0	100
3. C + peanut	6,950	15,550	4,028	5,928	2,922	9,622	0	100
4. C + black bean	6,350	14,700	2,940	4,840	3,410	9,860	0	10
5. C + mungbean	6,600	15,200	3,180	5,080	3,420	10,120	0	74

[1)] Fertilizers applied: 60 kg N+60 P_2O_5+120 K_2O/ha

[2)] Prices: cassava dong 500/kg fresh roots
peanut 5,000/kg dry pods
red bean 3,500/kg dry grain
black bean 3,000/kg dry grain
mungbean 6,000/kg dry grain

Costs: urea 3,500/kg
SSP (17% P_2O_5) 1,500/kg
KCl (60% K_2O) 3,000/kg
labor 15,000/manday
peanut seed 8,300/kg dry pods (use 160 kg/ha)
red/black bean seed 6,000/kg (use 40 kg/ha)
mungbean seed 12,000/kg (use 40 kg/ha)

Labor for cassava monoculture 120 mandays/ha = 1.8 mil. dong/ha
Labor for fertilizer application 20 mandays/ha = 0.3 mil. dong/ha
Fertilizer costs: 1.6 mil.dong/ha
Labor for intercropping 60 mandays/ha = 0.9 mil. dong

Source: *Nguyen Thi Cach et al.,2001*.

C. In the South

Short-duration crops such as mungbean, peanut and maize were intercropped with cassava. The results indicate that intercropping cassava with peanut or mungbean was most effective in increasing farmers' income as compared to monocropped cassava. The highest net income was obtained for the crop combination of cassava+peanut in Dong Nai, Binh Phuoc and Baria-Vungtau provinces (**Tables 11, 12, 13** and **14**). The next best combination was cassava+mungbean in Baria-Vungtau province (**Table 15**) . However, the yield of cassava intercropped with maize was significantly lower than that of the monocrop. In this case, the cassava yield was affected by the competition for nutrients and water, or by

shading out by tall maize plants. **Tables 15** and **16** show that intercropping with peanut or mungbean produced better yields and income than intercropping with maize.

1. In Dong Nai province:

Table 11. Average results of three FPR intercropping trials conducted by farmers in An Vien village of Thong Nhat district in Dong Nai province in 1999/2000.

Treatments	Cassava root yield (t/ha)	Intercrop yield (t/ha)	Gross income[1)]	Production costs[1)]	Net income	Farmers' preference[2)]
			----------('000 dong/ha)----------			(%)
1. Cassava monoculture	25.96	-	6,480	2,950	3,530	20
2. C+peanut (1row)	26.59	0.66	9,287	4,050	5,237	60
3. C+peanut (2 rows)	25.27	0.28	8,195	3,785	4,320	20

[1)] Prices: cassava dong 290/kg fresh roots
peanut 4000/kg dry pods
urea 2000/kg
SSP 1000/kg
KCl 2200/kg
labor 20,000/manday

[2)] Number of participating farmers: 20

Table 12. Average results of three FPR intercropping trials conducted by farmers in An Vien village of Thong Nhat district in Dong Nai province in 2000/01.

Treatments	Cassava root yield (t/ha)	Intercrop yield (t/ha)	Gross income[1)]	Production costs[1)]	Net income	Farmers' preference[2)]
			----------('000 dong/ha)----------			(%)
1. Cassava monoculture	30.60	-	8,874	4,298	4,576	50
2. C+peanut	30.28	0.20	9,781	5,248	4,533	50
3. C+cowpea	23.89	0	6,928	4,798	2,130	0
4. C+mungbean	29.74	0	8,625	4,698	3,927	0

[1)] Prices: cassava dong 290/kg fresh roots
peanut 5000/kg dry pods
urea 2300/kg
SSP 1000/kg
KCl 2300/kg
labor 25,000/manday

[2)] Number of participating farmers: 22

Table 13. Average results of three FPR intercropping trials conducted by farmers in An Vien village of Thong Nhat district in Dong Nai province in 2001/02.

Treatments[1)]	Cassava root yield (t/ha)	Peanut yield (t/ha)	Gross income[2)]	Production costs[2)]	Net income	Farmers' preference (%)
			----------('000 dong/ha)-----			
1. Cassava monoculture	29.15	-	12,243	4,651	7,592	30
2. C+ peanut (1 row)	33.32	-	13,994	5,051	8,943	50
3. C+ peanut (2 rows)	30.73	-	12,907	5,451	7,456	20

[1)] Fertilizers: 80 N+40 P_2O_5+80 K_2O/ha = 950,850 d/ha

[2)] Prices:

cassava	dong	420/kg fresh roots
urea (45%N)		2,300/kg
SSP (17% P_2O_5)		1,000/kg
KCl (60% K_2O)		2,300/kg
labor for planting		300,000 d/ha
land preparation		600,000 d/ha
peanut seed (8,000 d/kg)		400,000 d/ha for one row
fertilizer application		100,000 d/ha
weeding (3x)		1,600,000 d/ha
harvest (55 md/ha)		1,100,000 d/ha
labor		20,000 d/md

Source: *Nguyen Huu Hy et al., 2002.*

2. In Binh Phuoc province:

Table 14. Average results of two FPR intercropping trials conducted by farmers in Dong Tam village of Dong Xoai district in Binh Phuoc province in 2000/01.

Treatments	Cassava root yield (t/ha)	Intercrop yield (t/ha)	Gross income[1)]	Production costs[1)]	Net income	Farmers' preference[2)] (%)
			----------('000 dong/ha)----------			
Cassava monoculture	30.23	-	8,767	3,879	4,888	60
C+cowpea	29.33	-	8,506	4,359	4,147	0
C+peanut	30.22	0.225	9,889	5,139	4,750	40
C+mungbean	29.70	-	8,613	4,299	4,314	0

[1)]Prices:

cassava	dong	290/kg fresh roots
peanut		5,000/kg dry pods
peanut seed		6,000/kg (need 100 kg/ha)
cowpea seed		6,000/kg (need 30 kg/ha)
mungbean seed		8,000/kg (need 15 kg/ha)

[2)]Number of participating farmers: 24

Source: *Nguyen Huu Hy et al., 2001.*

3. In Baria-Vungtau province:

Table 15. Average results of two FPR intercropping trials conducted by farmers in Suoi Rao village of Chau Duc district in Baria-Vungtau province in 2000/01.

Treatments	Cassava root yield (t/ha)	Starch content (%)	Intercrop yield (t/ha)	Gross income[1)]	Product. costs[1)]	Net income	Farmers' preference
				------('000 dong/ha)-----			(%)
Cassava monoculture	36.13	30.4	-	10,839	6,843	3,996	-
C + peanut	40.20	29.6	0.524	14,890	8,360	6,530	67
C + mungbean	42.24	30.0	0.287	14,394	7,600	6,794	100
C + maize	29.07	27.7	4.653	13,467	8,200	5,267	-

[1)] Prices: cassava dong 300/ kg fresh roots
peanut 5,400/ kg dry pods
mungbean 6,000/ kg dry grain
maize 1,020/ kg dry grain

Table 16. Average results of three FPR intercropping trials conducted by farmers in Suoi Rao and Son Binh villages of Chau Duc district in Baria-Vungtau province in 2001/02.

Treatments	Cassava root yield (t/ha)	Intercrop yield (t/ha)	Starch content (%)	Gross income[1)]	Product. costs	Net income	Farmers' preference
				---------('000 dong/ha)-------			(%)
Cassava monoculture	31.88a	-	27.9	17,534	7,116	10,418	29.0
C + peanut	30.74a	1.483	27.7	25,805	10,071	15,734	48.3
C + mungbean	29.81a	0.570	26.7	20,383	8,640	11,743	41.9
C + soybean	34.54a	0	27.5	18,997	8,620	10,377	6.4
C + maize	21.00b	3.643	24.3	15,557	8,588	6,969	35.0
C.V. (%)	12.16						
LSD (0.05)	6.872						

[1)] Prices: cassava dong 550/kg fresh roots
peanut 6,000/kg dry pods
mung bean 7,000/kg dry grain
maize 900/kg dry grain
labor for cassava 4,140,000/ha (207 mandays/ha)
labor for intercrops 800,000/ha (40 mandays/ha)
labor for fertilizer application 100,000/ha (5 mandays/application)
cassava stakes 500,000/ha
fertilizers for cassava 1,095,600/ha
fertilizers for maize 550,000/ha

Source:*Tran Thi Dung et al., 2002.*

CONCLUSIONS

Cassava intercropping systems practiced by farmers generally had a greater total productivity than monocropping. The results of these FPR trials indicate that intercropping cassava with grain legumes produced generally a higher gross income than cassava grown in monoculture. The best intercropping systems were the combination of cassava and peanut, or cassava and mungbean. After evaluating the intercropping of several intercrops with cassava, peanut was found to be the most successful and profitable intercrop. The

adoption of this technology would considerably improve the sustainability of the cropping system, optimize the use of land and increase farmers' income.

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