CASSAVA AGRONOMY RESEARCH IN VIETNAM

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ABSTRACT

During the last decade to the year 2002, cassava agronomy research in Vietnam has been supported by CIAT and the Nippon Foundation. Research has been conducted throughout the country with the objectives of developing new and well adapted technologies, which require only low inputs and result in high net incomes for farmers, while maintaining soil fertility and reducing erosion. The results of this research indicate the following:

-In fertilizer trials, the response of cassava depends on the type of soil and the kind of fertilizer used. In three sites cassava showed strong responses to the annual application of N and K and only slight responses to P. In long-term NPK trials conducted in Thai Nguyen University and in Hung Loc Agricultural Research Center the application of 80-40-80 and 160-80-160 kg/ha of N-P_2O_5-K_2O, respectively, gave higher yields and economic returns than other treatments.

-In long-term intercropping trials conducted on flat land at Hung Loc Research Center, cassava intercropped with grain legumes and with application of fertilizers increased net incomes, but cassava grown between hedgerows of *Leucaena leucocephala* and *Gliricidia sepium* (alley cropping system) gave the highest yields and net incomes, both with and without fertilizer application.

-In sloping areas, intercropping cassava with peanut and/or planting contour hedgerows of vetiver grass or *Leucaena* reduced soil losses by erosion and maintained or improved soil fertility.

INTRODUCTION

In Vietnam cassava is the third most important food crop, after rice and maize; it is used mainly for human consumption and for animal feed. In the last decade of the 20th century, the crop has changed from a subsistence food crop to a cash crop; the planted area is ranked in fifth position, after rice, maize, sweet potato, vegetables and legume crops. According to the national statistics, in 2002 the area under cassava in Vietnam was 246,172 ha, with the estimated total production of 2.0 million tonnes fresh roots and an average yield of 8 t/ha. The Northern Mountainous Region, the Southeastern region, the North Central Coast and the South Central Coast are the four ecological zones of greatest cassava production in Vietnam.

Although cassava is a crop with a capacity to produce high yields, until now the average yield of cassava production and the economic returns for the farmers in Vietnam has been low, as the areas under cassava production were not quite suitable. The main reasons are that cassava was usually grown by small farmers in very marginal areas or on sloping lands and poor soils, using local varieties and without any improved technologies or external inputs.

From 1989 and up to now, cassava breeding and agronomy research in Vietnam

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have been strengthened and supported by CIAT and the Nippon Foundation with the following objectives: to develop new cassava technologies which require low inputs but result in higher yields and incomes while maintaining soil fertility.

RESEARCH RESULTS

Soil Fertility Maintenance through Fertilizer Application

Since 1990 two long-term NPK experiments have been conducted, one on the red latosol clay soil in Hung Loc Agricultural Research Center in South Vietnam, and one on yellow sandy clay loam soil in Thai Nguyen University of Agriculture and Forestry in North Vietnam. Both experiments have 12 treatments, consisting of 4 levels each of N, P and K in an incomplete factorial design. Two cassava varieties were planted in subplots, with fertilizer treatments in main plots.

In the red latosol soil at Hung Loc Agricultural Research Center, the response of cassava to any of the three nutrients was initially not clear, even after four years. But, starting in the fifth year, the response to K application became significant and this response increased year after year. After 12 years of continuous cropping on the same plots the response to N, P and K was very clear, especially the response of cassava to K and N. Among the 12 treatments, the treatment with 80 kg N+40 P_2O_5+80 K_2O/ha gave the highest yield and net income (**Figure 1A**).

In the yellow clay loam soil in Thai Nguyen University of Agriculture and Forestry, the response of cassava to K was clear even in the first and second years. And after 12 years the response of cassava to all three nutrients was very clear, but specially to the application of K. The root yield of cassava was 2.4-2.8 t/ha in the treatment without K applied, and was more than 20 t/ha in the treatment with adequate K applied. Again, application of 80 kg N+40 P_2O_5+80 K_2O/ha gave a high yield and produced the highest net income (**Figure 1B**).

Figure 2 shows that the exchangeable K level of the soil after 12 years of continuous cassava cultivation was markedly reduced when no K was applied. The soil K level increased with increasing levels of applied K, but remained below the critical level of 0.15 me K/100 g even with the application of 80 kg K_2O/ha in Hung Loc Center and of 160 kg K_2O/ha in Thai Nguyen (**Figure 3**).

Soil Fertility Maintenance by Intercropping

An experiment on cassava intercropping and alley cropping has been conducted at Hung Loc Center for ten years. The experiment has eight treatments, two with intercropping of grain legumes, three with intercropped green manures and two with leguminous trees planted as hedgerows in alley cropping system, and a check. The objective of the research is to determine the long-term effect of intercropping, green manuring and alley cropping on soil fertility and cassava root yields. **Table 1** shows that the annual yield of cuttings of leaves and stems and the nutrients returned to the soil were highest in case of the two legume tree species, *Leucaena leucocephala* and *Gliricidia sepium*, planted in hedgerows. Also, the soil K levels were highest in these two treatments while soil P was not much affected by any of the treatments except that hedgerows of *Leucaena leucocephala* increased the available P-content of the soil (**Figure 4**).

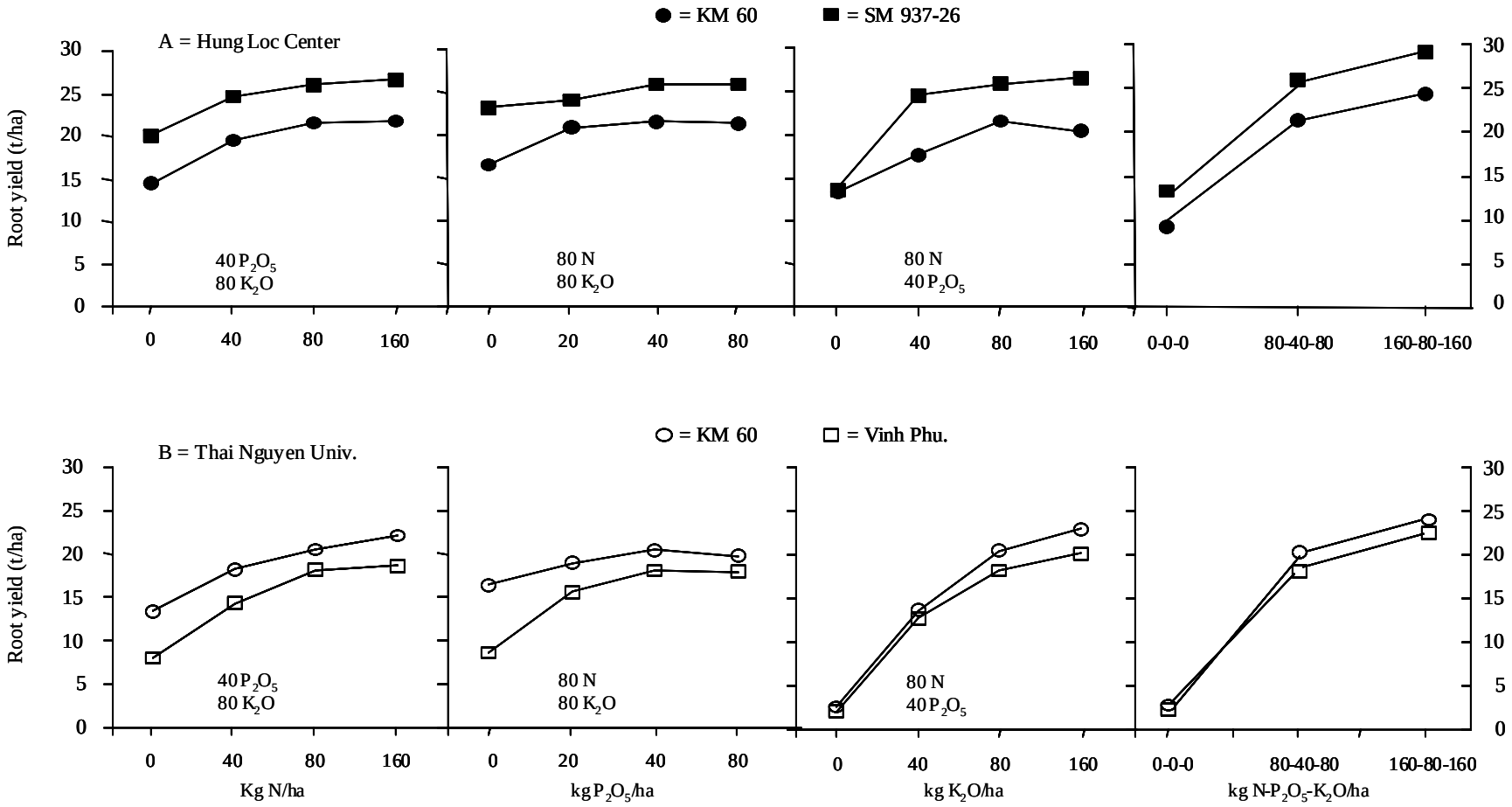

Figure 1. The effect of annual applications of various levels of N, P and K on the root yields of two cassava varieties planted in Hung Loc Agric. Research Center (top) and at Thai Nguyen Univ. of Agric. and Forestry. Data are average values for 1999 to 2001 (10^{th} to 12^{th} cycle).

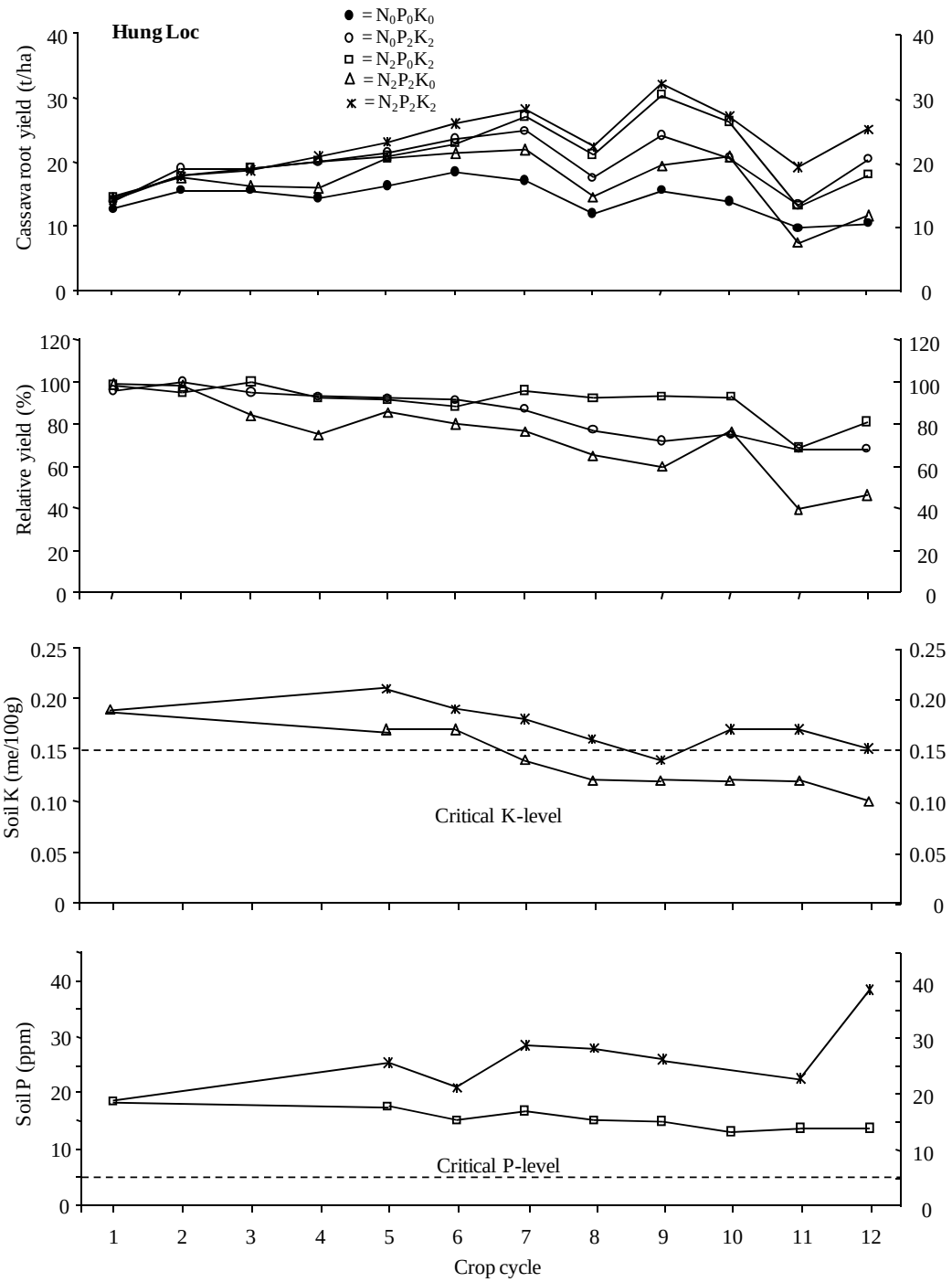

Figure 2. Effect of annual applications of N, P and K on cassava root yield, relative yield (yield without the nutrient over the highest yield with the nutrient) and the exchangeable K and available P (Bray 2) content of the soil during twelve years of continuous cropping in Hung Loc Agric. Research Center, Dong Nai, Vietnam.

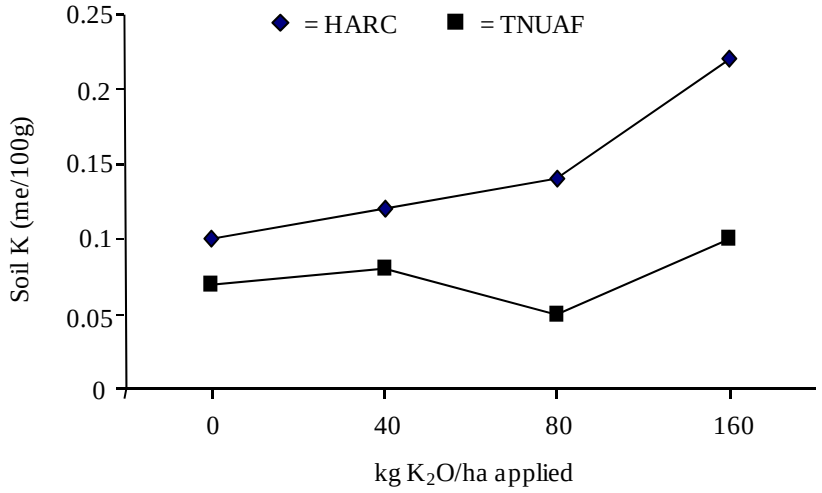

Figure 3. The effect of annual application of four rates of K on the K level of the soil in two long-term NPK trials conducted in Thai Nguyen University of Agriculture and Forestry (TNUAF) and in Hung Loc Agricultural Research Center (HARC), Vietnam in 2002 after 12 years of continuous cassava cultivation.

Table 1. The amount of annual cuttings of legume leaves and stems and the nutrients which returned to the soil in 1999/2000 during the 8th year of continuous cropping in a long-term soil improvement experiment conducted at Hung Loc Agric. Research Center in Dong Nai, Vietnam.

Treatment	Crop residues or leaf/stem cuttings (t DM/ha)	Nutrient content (%)			Nutrients returned (kg/ha)		
		N	P	K	N	P	K
1. Cassava monoculture	-	-	-	-	-	-	-
2. C+pigeonpea green manure	4.92	3.47	0.92	3.88	17.1	4.53	19.1
3. C+*Mucuna* green manure	2.86	2.52	0.41	1.38	7.2	1.18	3.9
4. C+peanut intercrop	4.75	2.87	0.44	1.35	13.6	2.08	6.4
5. C+cowpea intercrop	3.56	2.42	0.32	2.10	8.6	1.15	7.5
6. C+*Canavalia* green manure	4.23	2.59	0.65	2.79	10.9	2.75	11.8
7. C+*Leucaena* alley crop	8.67	3.36	0.65	1.59	29.1	5.60	13.8
8. C+*Gliricidia* alley crop	7.71	3.50	0.78	2.77	26.9	6.03	21.4

Table 2 shows that the cassava root yields in the *Canavalia* green manure and the two alley cropping treatments were significantly higher as compared to cassava grown in monoculture. And among the eight treatments, cassava planted as an alley crop with *Leucaena leucocephala* and *Gliricidia sepium* hedgerows, gave the highest yields and economic benefits, while cassava intercropped with peanut and *Mucuna* produced the lowest yields and net income.

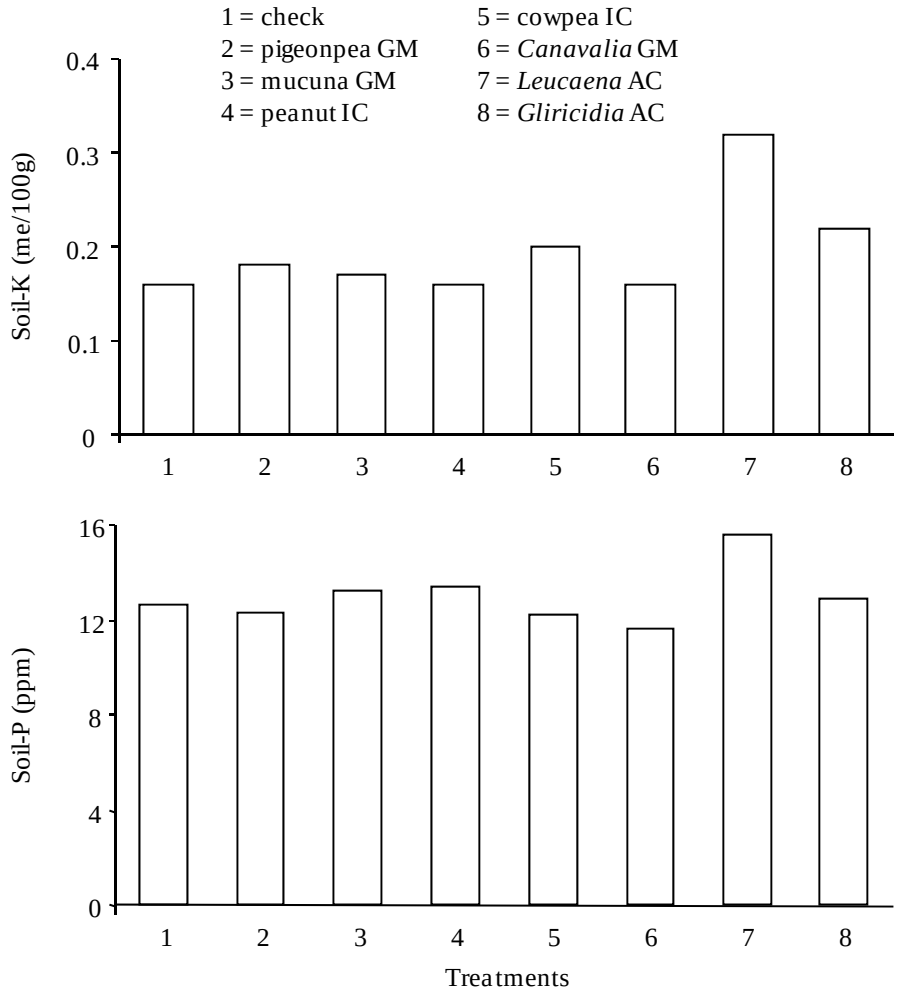

Figure 4. The effect of green manures (GM), intercropping (IC) and alley cropping (AC) on the exchangeable K and available (Bray II) P-content of the soil after ten consecutive years of cassava cultivation without fertilizers at Hung Loc Agric. Research Center in south Vietnam in 2002.

Erosion Control

In Vietnam, mountainous areas occupy about 75% of the total area. According to estimates of Nguyen Tu Siem and Thai Phien, deforestation, and the practice of slash-and-burn for growing upland rice and cassava without control of erosion, resulted in one million ha of soil being eroded and degraded with little or no production capacity.

Table 3 indicates that on sloping land in Hung Loc Agricultural Research Center cassava intercropping with mungbean or peanut, or the planting of contour hedgerows of vetiver grass, *Leucaena* or *Gliricidia* reduced the soil loss and gave higher yields than cassava grown in monoculture. Also, intercropping cassava with peanut or planting hedgerows of *Leucaena* produced the highest economic benefits.

Table 2. The effect of green manures, intercropping and alley cropping on the yield of cassava and intercrops, as well as on gross and net income when casssava was grown without fertilizer for the tenth consecutive year at Hung Loc Agricultural Research Center in Dong Nai, Vietnam in 2001/02.

Treatments[1)]	Cassava yield (t/ha)	Starch content (%)	Intercrop yield (t/ha)	Gross income[2)]	Product. cost[2)]	Net income
				('000 dong/ha)		
1. Cassava monoculture	12.10c	26.6c	-	5,324	3,100	2,224
2. C+pigeonpea green manure	13.27bc	27.0bc	8.30b	5,839	3,700	2,139
3. C+*Mucuna* green manure	8.71d	25.8d	1.90d	3,832	3,700	132
4. C+peanut intercrop	12.21c	26.7bc	4.59c	5,372	3,700	1,672
5. C+cowpea intercrop	13.77bc	27.2b	2.41d	6,059	3,700	2,359
6. C+*Canavalia* green manure	15.87b	26.0d	2.46d	6,983	3,700	3,283
7. C+*Leucaena* alley crop	21.14a	28.1a	12.67a	9,367	3,400	5,967
8. C+*Gliricidia* alley crop	21.45a	26.8bc	8.35b	9,438	3,400	6,038
CV (%)	12.00	3.85	12.82			
LSD (0.05)	2.62	0.51	0.95			

[1)] Cassava and intercrops were fertilized annually with a total of 100 kg N, 40 kg P_2O_5 and 100 kg K_2O/ha only for the first seven years.

[2)] Prices:

cassava	dong 440/kg fresh roots
cassava cultivation without fertilizers or intercrops	3.1 mil. dong/ha
intercrop planting	200,000 dong/ha
intercrop seed	200,000 dong/ha
intercrop harvest/cutting	300,000 dong/ha
weeding with intercrop	100,000 dong/ha less than without intercrop

Table 3. The effect of intercropping and contour hedgerows on soil losses by erosion, the yield of cassava and intercrops, the root starch content, and the gross and net incomes when cassava, SM937-26, was grown on 8% slope at Hung Loc Agricultural Research Center in Dong Nai, Vietnam in 2001/02.

Treatment	Dry soil loss (t/ha)	Cassava yield (t/ha)	Starch content (%)	Intercrop yield: Residue (t/ha)	Intercrop yield: Grain (t/ha)	Gross income	Product. cost[2)]	Net income
						('000 dong/ha)		
1. Cassava monoculture	39.1a	32.13	28.8a	-	-	14,137	4,986	9,151
2. C+mungbean intercrop	30.9b	34.54	27.3b	-	-	15,197	5,686	9,512
3. C+peanut intercrop	25.0bc	33.13	28.9a	3.15	0.129	15,222	5,686	9,536
4. C+vetiver hedgerows	11.3d	33.68	28.8a	13.32	-	14,819	5,686	9,232
5. C+*Leucaena* hedgerows	17.8c	37.00	29.6a	7.24	-	16,280	5,686	10,694
6. C+*Gliricidia* hedgerows	20.5c	34.11	26.7b	6.14	-	15,008	5,686	9,422
CV (%)	19.2	NS	2.9					
LSD (0.05)	6.9		1.2					

[1)] Prices:

cassava	dong	440/kg fresh roots
peanut		5,000/kg dry pods

[2)] Cost:

cassava planting material	0.5 mil.	dong/ha
intercrop seed or material	0.2 mil.	dong/ha
labor for cassava cultivation	3.3 mil.	dong/ha
fertilizers	1,186 mil.	dong/ha
labor for intercropping	0.5 mil.	dong/ha
labor for hedgerow cutting	0.6 mil.	dong/ha

FUTURE DIRECTION

Based on the results obtained from this research, future cassava agronomy research in Vietnam will focus on the following research topics:

-Maintenance of soil fertility by intercropping and fertilizer application

-Erosion control in cassava areas with sloping land in various parts of the country

-Using FPR and PRD methods to develop practical agronomic practices and enhance the adoption of these practices by farmers.

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