Improving the Sustainability of Cassava-based Cropping Systems for Smallholder Farmers in the Uplands of Lao PDR

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Introduction

Cassava (*Manihot esculenta* Crantz) production in Laos is developing rapidly due to the increasing demand for its multiple end-uses in the region. As a result, cassava is changing from a traditional food crop to a cash crop, even for smallholders living in remote upland areas. For farmers growing cassava on sloping lands, one of the main challenges is the high rate of soil erosion, as well as nutrient depletion due to continuous cropping without fertilizers. However, poor farmers are generally not interested in erosion control or sustainability as the effect of these is not readily visible, and most farmers are only interested in maximizing their net income. It is therefore necessary to identify cost-effective fertilization practices as well as farmer-friendly methods of soil erosion control.

Main objective

- To determine the most economic fertilizer practices to obtain and maintain high cassava yields in a particular location, and simple but effective options for soil erosion control in smallholder cassava-based cropping systems

Methodology

The two experiments were conducted at the Extension and Improvement of Livestock Systems Center in Xieng Khouang province, Laos, located at an altitude of 1,100 masl, and at 19° 29' 12" N; 103° 08' 49" E. The area receives an average annual rainfall of 1,200 mm and has an extremely acid (pH 4.9) and infertile soil (2 ppm of available P).

The fertilizer experiment had various combinations of different rates of N, P and K fertilizers (twelve treatments) and two cassava varieties (i.e. Local and CIAT-related cassava variety, KU50).

The soil erosion control experiment had ten treatments with 2 replications. All plots were laid out on the contour and had a plastic-covered channel along the lower side to catch the eroded sediments. The amount of eroded soil in each channel was weighed and a sample of the wet soil was dried to determine the dry soil loss for each treatment.

Results

Balanced fertilizer application

There was a very significant response of both varieties to P and K, while there was almost no response to the application of N, even a small negative response in case of KU 50 (Table 1). This experiment also clearly indicates that KU 50 has a much better tolerance to low-P conditions compared to the local variety (Figure 1).

Figure 1. P deficiency in Xieng Khouang province, Laos.

Figure 2. Contour hedgerows of *Paspalum atratum* hedgerows markedly reduced soil loss by erosion on 10% slope in Laos.

Effective soil erosion control

In the erosion control experiment, the *Tephrosia candida* and *Paspalum atratum* contour hedgerows resulted in significantly less soil loss than with vetiver grass or *Gliricidia sepium* hedgerows (Table 2).The latter two species seem to be not as well adapted to the poor soil and cool climate of this site (Figure 2).

Table 1. Effect of annual applications of various levels of N, P and K fertilizers on the root yields of two cassava varieties in Laos

Treatments[1)]	Root Yield (t/ha) 2005/07		Root Yield (t/ha) 2007/09		Root Yield (t/ha) Average	
	KU 50	Local	KU 50	Local	KU 50	Local
1. $N_0P_0K_0$	12.4	3.0	13.9	4.1	19.3	5.0
2. $N_0P_2K_2$	28.1	15.7	47.9	26.3	52.1	28.8
3. $N_1P_2K_2$	33.2	17.5	52.4	35.6	59.4	35.3
4. $N_2P_2K_2$	24.0	15.0	43.6	24.1	45.8	27.0
5. $N_3P_2K_2$	25.0	18.2	46.8	24.9	48.4	30.6
6. $N_2P_0K_2$	12.0	3.0	20.8	9.3	22.4	7.7
7. $N_2P_1K_2$	23.4	16.3	48.4	38.1	47.6	35.3
8. $N_2P_3K_2$	25.3	19.4	49.2	44.8	49.9	41.8
9. $N_2P_2K_0$	11.6	8.4	13.4	8.7	18.3	12.7
10. $N_2P_2K_1$	24.9	19.9	31.8	23.4	40.8	31.6
11. $N_2P_2K_3$	28.5	20.7	53.4	39.1	55.2	40.3
12. $N_3P_3K_3$	31.7	18.6	56.1	39.5	59.8	38.4
Average	**23.3**	**14.6**	**39.8**	**26.5**	**43.2**	**27.9**

[1)] N_0 = 0N; N = 25 kg N/ha; N_2 = 50 kg N/ha; N_3 = 100 kg N/ha
P_0 = 0P; P = 50 kg P_2O_5/ha; P_2 = 100 kg P_2O_5/ha; P_3 = 200 kg P_2O_5/ha
K_0 = 0K; K = 50 kg K_2O/ha; K_2 = 100 kg K_2O/ha; K_3 = 200 kg K_2O/ha
all plots received 500 kg/ha of dolomitic lime

Table 2. Results of a soil erosion control trial at the Extension and Improvement of Livestock Systems Center in Xieng Khouang province, Laos (2007/8)

No.	Treatments	Dry soil loss (t/ha)
1.	Traditional practice: no fertilizer or lime, no hedgerows, 2 stakes/hill, no ridging, 0.9 m x 0.9 m	16.8
2.	No ridging, with fertilizers and lime; no hedgerows, 1 stake/hill; 0.9 x 0.9 m	11
3.	Intercrop with 2 rows of peanut; with fertilizers and lime; no hedgerows, 1 stake/hill; 0.9 x 0.9 m	8.5
4.	Hedgerow of pineapple; with fertilizers and lime; 1 stake/hill; 0.9 x 0.9 m	10
5.	Hedgerow of *Paspalum atratum*; with fertilizers and lime; 1 stake/hill; 0.9 x 0.9 m	6.6
6.	Hedgerow of *Tephrosia candida*; with fertilizers and lime; 1 stake/hill; 0.9 x 0.9 m	7.4
7.	Hedgerow of vetiver grass (Vietnam); with fertilizers and lime; 1 stake/hill; 0.9 x 0.9 m	8.02
8.	Closer plant spacing (0.7 m x 0.7 m); with fertilizers and lime; 1 stake/hill; no hedgerow	8.44
9.	Contour ridging, with fertilizers and lime; 1 stake/hill; 0.9 x 0.9 m, no hedgerows	8.1
10.	Up-down ridging, with fertilizers and lime; 1 stake/hill; 0.9 x 0.9 m, no hedgerows	30

Conclusions

These and many other experiments indicate that more sustainable crop management practices should emphasize increasing yields by the use of higher-yielding varieties, proper fertilization, good weed control, use of good quality planting material, closer plant spacing; and possibly the use of contour hedgerows of grass or leguminous species, well-adapted to the soil and climatic conditions, not-competing with nearby cassava plants, and preferably useful for feeding animals in a cut-and-carry feeding system.