CASSAVA LEAF PRODUCTION RESEARCH IN THAILAND

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INTRODUCTION

The unlignified upper part of the cassava plant is potentially a good source of protein for animal feed rations because of its high yield and nutritive value. Factors affecting yield and protein content of cassava foliage are presently being researched in Thailand to determine the most suitable practices for cassava foliage production in different parts of the country.

MATERIALS AND METHODS

Four types of trials on cassava leaf production, I.e. on varieties, fertilization, plant populations and on cutting height and frequency, were conducted in 2002/03 at Rayong Field Crops Research Center (FCRC) in the eastern part, and at Khon Kaen FCRC in the northeastern part of Thailand. Soils in both sites are light textured (sandy clay loam and sandy loam, respectively), have less than 1% organic matter, are low or very low in Ca, Mg and K, and high in P (due to previous applications of P). The climate is tropical monsoon with year-round high temperatures (mean 26-28ºC) and relatively high but unpredictable rainfall of 1000-1400 mm/year, mostly between June and October.

The experiments were planted with three or four replications; stakes of about 20 cm length of one or more varieties or breeding lines were planted vertically at 30x30 cm (except in the population trial). Plants were fertilized with a total of 450 kg N, 150 P_2O_5 and 150 K_2O/ha, applied fractionated at planting and after every cut. At 2½-3 month intervals the green stems with leaves and petioles were cut off at about 20 cm above the ground; these green plant tops (generally referred to as "leaves") were weighed and then chopped by a mechanical chopper; a sample from each plot was sun and oven dried and weighed again to determine dry leaf yield, and a subsample was analyzed for N to determine protein content and yield. In most cases, leaves were cut at about 2½, 4½, 6½, 10 and 12 months after planting; the last cut coincided with the root harvest.

Chopping

RESULTS AND DISCUSSION

A. Varieties

Table 1 shows the average results of the two variety trials (see photo below) in terms of total dry leaf yield (sum of 5 cuts), total protein yield, fresh root yield, root starch content and net income. Some of the breeding lines as well as the standard "root variety", Kasetsart 50 (KU 50), produced high dry leaf yields of 15-16 t/ha and protein yields of 2.5-2.8 t/ha. However, highest root yields and starch contents were usually obtained with the root varieties Rayong 90, Rayong 72 and KU 50. For optimum total productivity and net income the best varieties/lines were CMR 41-111-129 and KU 50.

Table 1. Average results of two variety-for-leaf production trials conducted in Rayong and Khon Kaen Field Crops Research Centers in Thailand in 2002/03

Variety	Total dry leaf yield[1)] (t/ha)	Average protein content (%)	Total protein yield[1)] (t/ha)	Fresh root yield[2)] (t/ha)	Root starch content (%)	Net income ('000 B/ha)
1. Rayong 1	13.80	17.52	2.20	16.46	13.2	2.78
2. Rayong 5	13.19	18.20	2.32	20.46	20.6	6.18
3. Rayong 90	12.97	18.36	2.32	26.53	21.7	9.20
4. Rayong 72	12.56	19.18	2.38	24.86	20.6	6.20
5. Kasetsart 50	15.48	17.30	2.58	21.77	23.1	14.06
6. Huay Bong 60	12.82	18.07	2.24	20.71	20.2	4.61
7. OMR 41-23-41	13.90	17.70	2.32	16.89	19.0	5.59
8. CMR 41-42-3	14.84	19.46	2.82	18.32	21.6	9.76
9. CMR 41-60-24	13.01	20.62	2.50	17.90	20.7	3.87
10. CMR 41-61-59	14.78	18.22	2.52	18.28	15.0	7.06
11. CMR 41-111-129	15.82	18.15	2.78	23.82	19.2	14.29
12. CMR 41-114-125	12.56	18.52	2.13	16.52	22.2	2.20
13. OMR 41-33-34	15.70	16.64	2.32	12.21	19.0	8.05
14. CMR 42-07-9	15.13	17.51	2.37	12.58	15.1	6.46
15. CMR 42-90-338	14.34	16.22	2.11	10.98	22.2	4.44
Average	**14.06**	**18.11**	**2.39**	**18.55**	**19.6**	**6.98**

B. Fertilization

Table 2 shows the average results of the two fertilizer trials, which had 12 treatments of various combinations of N, P and K applied fractionated after every cutting of tops. Highest leaf and protein yields were obtained with treatments $N_3P_3K_3$ and $N_3P_2K_2$, i.e. 600 kg N combined with 150 or 300 kg P_2O_5 and 150-300 kg K_2O/ha. However, highest root yields and starch contents were obtained at lower rates of N and K, i.e. 300 kg N/ha and 75 kg K_2O/ha, while net income was highest at these rates of N and K combined with 0 or 75 kg P_2O_5/ha. At the highest rate of fertilizer input ($N_3P_3K_3$), total nutrient removal in the harvested leaves was 352 kg N, 37 P, 190 K, 145 Ca and 41 Mg/ha, indicating the high removal rates of N, K and Ca. To replace these nutrients and to obtain high productivity of both roots and leaves, it is recommended to apply about 450 kg N, 300 kg K_2O and 75-150 kg P_2O_5/ha.

Table 2. Effect of the application of different combinations of N, P and K on the average total dry leaf and protein yields, fresh root yield and net income obtained in two experiments conducted at Rayong and Khon Kaen Field Crops Research Centers in Thailand in 2002/03.

Treatments[1)]	Total dry leaf yield[2)] (t/ha)	Total protein yield[2)] (t/ha)	Fresh root yield[3)] (t/ha)	Starch content (%)	Net income ('000B/ha)	Total nutrients in leaf harvests (kg/ha) N	P	K	Ca	Mg
1. $N_0P_0K_0$	4.72	0.82	13.52	22.4	-2.18	132	20	56	61	21
2. $N_0P_2K_2$	5.19	0.87	15.17	21.2	-8.18	139	22	77	68	23
3. $N_0P_3K_3$	6.88	1.17	16.73	19.6	-5.26	187	25	88	86	30
4. $N_2P_2K_2$	10.03	1.67	24.00	17.9	5.42	267	33	125	121	40
5. $N_2P_3K_3$	12.03	2.18	22.55	17.2	5.44	349	36	145	142	46
6. $N_3P_1K_2$	9.65	1.65	21.24	17.6	7.62	265	31	123	117	38
7. $N_3P_1K_2$	9.81	1.58	22.76	18.4	7.06	253	30	121	118	39
8. $N_3P_3K_2$	10.53	1.79	22.42	18.0	1.08	287	34	132	128	42
9. $N_3P_3K_0$	8.48	1.50	18.65	18.0	-0.18	239	31	79	103	37
10. $N_3P_2K_1$	9.70	1.61	22.88	19.4	5.22	258	32	109	116	40
11. $N_3P_2K_3$	9.47	1.55	20.16	16.9	-0.62	248	30	141	116	37
12. $N_3P_3K_3$	12.29	2.20	21.78	14.2	-2.57	352	37	190	145	41
Average	**9.06**	**1.55**	**20.15**	**18.4**	**1.07**					

[1)] N_0 = 0 N; N_2 = 150 kg N/ha; N_3 = 600 kg N/ha; P_0 = 0 P; P_1 = 75 kg P_2O_5/ha; P_2 = 150 kg P_2O_5/ha; P_3 = 300 kg P_2O_5/ha; K_0 = 0 K; K_1 = 75 kg K_2O/ha; K_2 = 150 kg K_2O/ha; K_3 = 300 kg K_2O/ha

[2)] sum of five cuts

[3)] at 12 MAP

C. Plant population

Table 3 shows the average effect of plant spacing of three varieties (see photo below) at two locations on dry leaf and protein yield, root yield and net income. It is clear that close spacing at 30x30 cm will optimize leaf and protein yields, but to optimize root yield as well as net income the wider spacing of 60x60 cm is required.

Table 3. Average effect of plant spacing of three cassava varieties on total dry leaf and protein yields, fresh root yield and net income obtained in two experiments conducted in Rayong and Khon Kaen Field Crops Research Centers in Thailand in 2002/03.

Plant spacing (cm)	Total dry leaf yield (t/ha)	Average protein content (%)	Total protein yield (t/ha)	Fresh root yield (t/ha)	Starch content (%)	Net income ('000B/ha)
60x60	11.20	20.14	2.15	23.11	16.92	14.31
50x50	9.64	19.96	1.81	20.16	16.49	6.45
40x40	10.93	19.46	2.00	20.19	17.06	6.65
30x30	12.77	20.04	2.38	16.77	15.71	1.76
Average	**11.14**	**19.90**	**2.08**	**20.06**	**16.54**	**7.29**

D. Cutting height and frequency

Table 4 shows that cutting tops at 15-25 cm above the ground and at intervals of 2½-3 months (see photo below) produced highest leaf and protein yields, root yields as well as net income. Thus, too frequent cutting may be counterproductive, unless high protein and low fiber contents are required.

Table 4. Average effect of cutting frequency of Rayong 72 on the total dry leaf and protein yields, fresh root yield and net income obtained in two experiments conducted in Rayong and Khon Kaen Field Crops Research Centers in Thailand in 2002/03. Data are averaged over three cutting heights of 15, 20 and 25 cm above the ground.

Cutting frequency (months)	Total dry leaf yield (t/ha)	Average protein content (%)	Total protein yield (t/ha)	Fresh root yield (t/ha)	Starch content (%)	Net income ('000B/ha)
1½ months	11.21	20.24	2.14	19.22	13.31	-5.15
2 months	11.64	19.37	1.97	26.60	15.96	1.94
2½ months	13.65	19.20	2.45	26.88	13.86	6.18
3 months	13.07	17.97	2.14	32.94	16.59	12.13
Average	**12.39**	19.20	**2.18**	**26.41**	**14.93**	**3.78**

[1)] the first cut was at 2½ MAP for all treatments.

CONCLUSIONS

It may be concluded that:

1. Varieties producing both high leaf and root yields include KU-50, Rayong 90, Rayong 72 as well as lines CMR 41-111-129, CMR 41-42-3 and CMR 41-33-34; these also produced the highest net income
2. To optimize root and leaf yields and maintain soil fertility it is recommended to apply a total of about 450 kg N, 75-150 kg P_2O_5 and 150-300 kg K_2O/ha
3. The optimum spacing is 60x60 cm while plants should be cut at 15-20 cm from the ground at 2½-3 months intervals.

With this type of management cassava can produce in one year 15-20 t/ha of roots in addition to 13-15 t/ha of dry leaves containing 2.5-2.8 t/ha of crude protein; **the latter is 3-4 times higher than a good crop of soybean. !!!**