Comments on: On-farm experiments in the use of local resources for pigs in Vietnam by Nguyen Thi Loc

From Rena Perez <71055.111@compuserve.com>
Comments on Nguyen Thi Loc's paper
The interesting problem appears to be that at certain times of the year there is an overabundance of a cheap source of energy: cassava.

1. Cassava
Why process the cassava root? Fresh cassava can be used successfully. The low cost of cassava is emphasized throughout the study, however, the performance experiments used cassava root meal?? If cassava cannot be grown year-round, why not organize and/or emphasize the fattening phase when this carbohydrate source is plentiful, and turn cassava into pork, easier to store, etc. I have emphasized this same approach for cane juice, particularly for countries that have a 6-month cane harvest, that is, to fatten pigs during the "carbohydrate" harvest, slaughter at end of harvest, and only keep reproductive herd until next "cheap carbohydrate cycle". In Cuba, it is the daily negative selection of cassava roots, destined for the lunchroom, that go to the pigs. Perhaps, because our operations are larger, 30 to 40 pigs, there is more room for adjustment and/or modification. However, if the operation is for 2 to 4 pigs, why not leave the cassava in the ground, and harvest as in Angola, i.e., the daily removal of outer, larger root pieces.

2. Fishmeal
What about feeding your pigs whole, fresh fish or fish and/or fish offal preserved in A molasses? In Cuba, both techniques are used. For pigs, a small fish morning and night, resolves the problem! Two weeks prior to slaughter remove the fish from the diet. Very simple.

3. Two additional comments

Better results can be had by feeding your protein supplement twice daily. One of our cane coop pig diets is fresh cassava roots and fresh soybean forage, 2 kg, twice daily.

From Jean Zoundi <zoundi@burkina.coraf.bf>

Comments on third paper by Nguyen Thi Loc

Are the on-farm experiments an effective test of local feed resources within systems?

Yes, this is important for optimizing the local feed resources. Nevertheless, it is also important at some stage to carry out research that cannot be done on-farm: this essentially concerns the assessment of the role and of the potential of each feed resources within the diet for a particular production. This often requires sophisticated laboratory works and is necessary before formulating diets and testing them on-farm. The advantage of on-farm research is that they easily permit the integration of socio-economic environment and all the more it permits the researcher to assess the potential of adoption of research results.

Is cassava an appropriate plant resource within integrated farming systems, given the problems of soil erosion associated its cultivation (and competition for human food and starch production in some other countries)?

Yes, there are some regions, for example the humid tropical areas where the availability of cassava permits its use for animal feeding. In this case, this practice is economically and socially justified. My experience on the optimization of local feed resources shows that it is very important for any feed resources to take into account these two factors (economical and social). It is important to think in terms of opportunity.

Is the flat rate feeding of protein supplement (200g/day) the best method for local system ? Should it not increase with time/weight?

According to logical scientific principals, these levels should vary with time/weight. But there are specific constraints for on-farm research especially if we take into account the future use of research results.

Methodological choices have to be made in order to increase the potential of adoption of research results by the producers.

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From Karl Muller-Samman and Carlos Iglesias, Cassava Program, CIAT. Forwarded by Carlos Lascano <c.lascano@cgnet.com>
Comments on paper by Nguyen Thi Loc

Is cassava an appropriate plant resource within integrated farming systems, given the problems of soil erosion associated with its cultivation (and competition for human food and starch production in some other countries)?

Cassava has a reputation as "soil erosion inducing" crop. This image not only exists due to the characteristics of cassava itself, e.g. deficient an slow soil cover in the first two-three months but is to a large extent due to the circumstances of its cultivation. Most of the times cassava is the last crop in a series, after the soil has been impoverished. Though still producing something for the farmer, under those circumstances it certainly will result in severe soil erosion. So it is not the crop itself but the circumstance that lead to its cultivation in degraded soils, since cassava adapts reasonably to those conditions.

Research on soil conservation practices for hillside or upland cassava-based cropping systems has continued both in Colombia and several Asian countries.

This work focussed on the identification and evaluation of appropriate technologies which include relay cropping in unmechanized systems and appropriate soils, forage legume green manure crops, grain legume intercrops, mulch of weeds and crop residues and the planting of live barriers. Results on both continents have shown that soil erosion in cassava- based cropping systems can be greatly minimized by cultivating cassava in contour ridges, with grass barriers, or by in situ production of mulch by inter-planting cassava with green manure species. Agronomic

practices that result in rapid canopy closure, such as selection of healthy, vigorous stakes from fertile plots, the use of appropriate genotypes, application of fertilizer in poor soils and closer spacing, also reduce soil loss. More recently excellent results have been obtained after two years of a grass/legume rotation. The highly productive legume components made soils more productive and less susceptible to erosion for two subsequent cassava cropping cycles. This effect was more pronounced with minimum tillage but also was very clear with tillage.

These research efforts on soil conservation are currently continuing in Colombia with the financial support of BMZ, Germany. On-farm evaluation of soil conservation practices are being conducted on three different locations on hilly lands in the Cauca Department in collaboration with farmer communities, NGO's, national agencies and CIAT's Hillsides Program. In Asia, a five-year soil conservation and management research project in collaboration with several Asian national programs was initiated in 1994 with the financial support of the Sasakawa Foundation of Japan. The projects focuses on the development of a farmer participatory methodology for the selection, testing and adaptation of management practices that are most appropriate under the local physical and socio-economic conditions.

So in brief, we recognize soil erosion is a potential problem for the intensification of cassava production under particular circumstances, but there is enough information to help us minimize that problem.

From Gerard O'Brien c/o <c.lascano@cgnet.com>
Comments on the use of cassava as animal feed

I'd like to comment on two contributions made so far:

1. Issues brought to mind by Nguyen Thi Loc's third paper (On-farm experiments... pigs in Vietnam), and questions raised in response to it.

(a) Dr. Nguyen states (p.3-4) that sun-drying of cassava during the rainy season can be very slow, possibly producing aflatoxin contamination. This is true. She also states that artificial drying is very expensive, and thereby renders cassava meal uncompetitive in relation to cereals. This

is also true. However, there is a third option: combined (or "mixed") drying. In combined drying, the cassava chips are first sun-dried for one day (reaching about 20-25% moisture). On the second day, they are dried artificially the rest of the way (down to around 12% moisture, for example). This method, by firstly employing one day of natural drying to eliminate the majority of moisture, avoids the risk of fungal growth, produces a highly stable final product, and is considerably cheaper than artificial drying.

(b) Among the questions raised by the moderators, mention was made of cheap local sources of protein (question 3). If the livestock in question were cattle, then one obvious potential local source of protein is cassava leaves. These have been shown to be a good protein source for mainly ruminant animals. However, I understand that they are not so good for monogastric animals.

Side Issue: Cassava meal, as a constituent of composite feedstuffs, can produce a highly competitive product in comparison to cereal-containing feeds. Recent investigations by the Colombian scientist Julian Buitrago, together with the American Soya Association, indicate that:
(i) with chicken feed, 40-50% of cereal input can be substituted with cassava meal, as long as the protein component is toasted whole soya bean;
(ii) with pig feed, sorghum may be completely replaced by cassava meal, as long as the protein component is toasted whole soya bean. Doctor Buitrago's company intends to produce these cassava/soya containing feeds commercially.
In both cases, major savings are presented.

2. Dr. Rena Perez' comments
Dr. Perez rightly points out the problem of cassava "gluts". These, of course, can result in grave problems for the cassava growers, as the price of the roots tends to decrease sharply. There is often a lot of waste. Her suggestion of using the roots fresh, harvesting only small amounts daily in order to avoid losses due to rapid post-harvest deterioration, would of course be suitable if:

(a) the cultivar(s) used is/are relatively low in cyanogen content;
(b) one is farming relatively small numbers of animals, close to the cassava growing area (minimal transport required in order to minimise post-harvest deterioration);
(c) there is no pressure and haste to re-plant on the cassava farmer's land as soon as possible (i.e. if the farmer can allow himself the relative luxury of gradually harvesting his crop during a period of perhaps 1-2 months).

Gerard O'Brien Cassava post-harvest specialist, CIAT

From Rena Perez (71055.111@compuserve.com)
Cassava As Animal Feed (comments on O'Brian's comments):
I agree with Gerard O'Brian on all the points he mentioned related to the use of fresh, whole cassava roots as an energy source for pigs. My comments were definitely focussed on the small-size farm operation, only.

I thought the comments on one-day sun drying to be followed by artificial drying an interesting approach. What about storing the one-day-dried cassava chips in molasses for future use? Would it work? In Cuba, for pigs, we store small fish or fish offal in about a 50:50 (by volume) arrangement for months with no problems. A similar idea with cassava chips, perhaps a 70:30 or 80:20 mixture, only to coat the chips, might serve to reduce fungal growth and even increase palatability. And interestingly, molasses and cassava often coexist in the same farm/area in sub tropical/tropical countries.

Rena Perez Ministry of Sugar, Havana, Cuba

From Carlos Sandoval Castro <bcasso@tunku.uady.mx>
1. Comments on O'Brian's comments (drying cassava):
Cassava dry-off is a serious problem when thinking of making use of it on an industrial scale. The proposal for sun-drying, and molasses preservation looks fine. I would like to suggest a further system which if not new is sometimes forgotten.

For "solar ovens" the principle is simple. Big boxes covered inside with aluminium foil, the bottom of the box painted black, and covered with a transparent glass of plastic lid.

This oven can reach temperatures around 100°C and can therefore cook the cassava and get rid of cyanogenic compounds. But probably somebody can think of some modifications to convert them into "solar dryers."

The technology is widely used nowadays in some African countries and in some areas of Mexico for cooking in small villages. Why not cook cassava for animals: it will be cheap, non-pollutant and will probably increase performance.

Carlos Sandoval Castro. E-Mail: bcasso@tunku.uady.mx Faculty of Veterinary Medicine and Animal ScienceUniversity of Yucatan, Mexico

From Denis Bastianelli <bastienelli@cirad.fr>
Comments on use of cassava leaves
G. O'Brien comments on the possible use of cassava leaves raise an important aspect : 10-30t /ha/year of leaves can be obtained with a protein content as high as 17-40% DM. This is an important resource which is very often wasted.

It seems obvious that the potential is important for ruminants, but the high protein content could also be valuable for monogastric animals despite a high fibre content (around 20% DM).

We are at present interested by this topic and I would be grateful if someone could provide information on practical experiments of use of cassava leaves in pig feeding.

Denis Bastianelli CIRAD-EMVT, France

From Rider Perez <Rider@mailbox.uq.oz.au>
Comments on comments from Denis Bastianelli, on use of cassava leaves

I have been working with polyphenolic compounds such as condensed tannins in tropical fodder trees and forages and with grain legumes. I have experience in feeding ruminants and more recently I am working with poultry.

I think cassava leaves have a great potential for animal feed particularly in tropical environments. The main problem with cassava leaves is its high tannin contents in leaves which interfere with protein availability for animals. Useful paper to read is:

Reed, J.D., McDowell, R.E., Van Soest, P.J. and Horvath, P.J. (1982)Condensed tannins: A factor limiting the use of cassava forage. Journal of the science of the food and agriculture 33: 213-20

Rider Perez, University of Queensland, Australia

From Robert H. Faust
Comments on comments from Denis Bastianelli on use of cassava leaves

Concerning the use of Cassava leaves for livestock feed: my work here in Hawaii with St. Croix Hair Sheep have clearly shown that Cassava leaves is an ideal dry season feed for tropical sheep and the high fiber is a plus for sheep. The other forage that has potential is Avocado (Persea americana) which we use quite successfully in the dry season. Keep in mind that Hair sheep are very effective in the tropics and less of a problem than pigs, which here are pests that destroy the forests and crops.

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Comments from Paschal Osuji on Denis Bastianelli's request:
Part of the questions he asked might be answered in the following Workshop Proceedings:-

Barry Nestel and Michael Graham (eds) (1977) Cassava as Animal feed: Proceedings of a workshop held at the University of Guelph, 18-20 April 1977. Ottawa, IDRC, 1977. 147p.

Additional references are available from the reviews contained in the book.

Paschal Osuji, ILRI Debre Zeit

From Nguyen Van Lai, Rodriguez Lylian and Preston T R
Comments from Vietnam group on Denis Bastianelli's comments
"G. O'Brien comments on the possible use of cassava leaves raise an important aspect : 10-30t /ha/year of leaves can be obtained with a protein content as high as 17-40% DM. This is an important resource which is very often wasted."
It seems obvious that the potential is important for ruminants, but the high protein content could also be valuable for monogastric animals despite a high fibre content (around 20% DM).

"We are at present interested by this topic and we would be grateful if someone could provide information on practical experiments of use of cassava leaves in pig feeding."
From Vietnam, we have published recently a paper on cassava leaf meal and cassava leaf silage at up to 45% replacement for soya bean meal in pig diets based on cassava root meal (Bui Huy Nhu Phuc, T R Preston, R B Ogle and J E Lindberg 1996. The nutritive value of sun-dried and ensiled cassava leaves for growing pigs. Livestock Research for Rural Development. Volume 8, Number 3:26-32; on Internet at: http://ifs.plants.ox.ac.uk/lrrd/lrrd.htm). No change in N retention at up to 30% substitution of soya protein but reduction at 45%. Protein was in range 24-32% in DM and fibre 9-14% in DM. There were indications of higher digestibility of N for ensiled compared with dried leaves.

More recently we are feeding cassava leaf silage as only protein supplement to native (Chinese type) pigs fed a basal diet of sugar cane juice. Intakes (fed ad lib) were high enough to provide 10% protein in the diet dry matter which is close to optimum when protein with optimum balance of AA is fed (Cassava leaf protein is better than soya bean protein in AA balance). Detailed results will be in LRRD 1997, 9(1).

Nguyen Van Lai, Rodriguez Lylian and Preston T R in Vietnam

From: Velmurugu Ravindran <velmurug@camden.usyd.edu.au>
Comments on cassava leaf products

I have enjoyed these proceedings (and, in particular, the comments and practical experiences of so many from various parts of the world) very much. It had been a good learning process for someone like me who work mainly at the research station level. As someone who has worked on cassava leaves for the Ph.D dissertation, I would like to contribute the following to the on-going discussion on use of cassava leaf products in swine feeding. Hopefully people currently working with cassava leaves may find some of this useful.

1. I agree (with Denis Bastianelli, CIRAD-EMVT, France) that cassava leaves represent a wasted feed resource in tropical animal production systems. For a non-leguminous plant, the leaves contain high levels of protein - an average of 21% CP (with values ranging from 15 to 40% CP). The stage of maturity at harvest is the major factor contributing to this wide variability.

2. The protein quality is reasonably good, but marginally deficient in methionine, for monogastric animals. An important feature to note is that it is a rich source of lysine - the most limiting amino acid in swine diets. But it must be noted that the stage of maturity at harvest will significantly influence the amino acid profile (see Ravindran & Ravindran. 1988. Food Chem. 27: 299-309).

In general, the amino acid profile is better or compares well with most common protein sources available in the tropical regions. Unfortunately, it is inferior to soyabean meal in protein quality. Our assays with adult

cockerels in Virginia Tech University, USA, have shown that the protein and amino acid digestibilities (%) of cassava leaf meal is much lower than those of soyabean meal. Just to give some values for cassava leaf meal & soyabean meal, respectively: nitrogen, 67 & 89; methionine 58 & 92; lysine, 67 & 89; Isoleucine, 82 & 92; leucine, 71 & 90; Threonine, 66 & 90. These differences are probably due to the (a) high fibre and (b) condensed tannins (see Reed & co-workers. 1982. J. Sci. Food Agric. 33: 213-220) in cassava leaves. I would expect that these digestibility data are applicable to swine feeding as well.

3. This means that the level of cassava leaf meal that you can include in swine diets will depend on the type of protein supplement that is to be replaced. For example, as a replacement for a low-to-moderate quality protein source (such as coconut meal), our studies in Sri Lanka shows that cassava leaf meal can be included up to 40% level in balanced grower-finisher swine diets. However, as a replacement for soyabean meal, you cannot include more than 10% level unless the diets are supplemented with additional amino acid sources (especially containing methionine) and energy.

Just to add few words on digestible energy in cassava leaf meal, our work in Sri Lanka (Ravindran, V. 1992. J. National Science Council of Sri Lanka, 20: 91-98) indicates it has only 2130 Kcal DE/kg (as against 3160 Kcal/kg for soyabean meal). This is again largely due its high fibre content.

There is general agreement nowadays that hydrocyanic acid is not a problem in properly processed cassava leaves. The major limitations are: (1) high fibre, (2) the resultant bulkiness, (3) low available energy (and energy dilution in the diets), and (4) low available amino acids, especially methionine. If these limitations can be considered and manipulated using judicious processing/feeding practices (ex: wet feeding, leaf silage) and local feed resources (ex: energy-rich feeds like molasses and cassava roots, cheap protein feeds like fish waste or fish silage), then perhaps cassava leaf meal can be economically and effectively utilized in tropical swine production systems. I am sure that some groups especially from South/Central America are looking at these possibilities.

4. Finally, in these studies, evaluation of the economics of cassava leaf production should be an integral component. The question facing the producer will be whether to (a) produce leaves as a by-product at root harvest (in which case the leaf product quality will be lower), or (b) produce leaves and roots (in which case the optimum time and number of leaf harvests will have to be carefully worked out without detrimental effects of root yields; this will vary very much depending on the cultivar, environment and agronomic conditions), or produce only cassava leaves (in which case, studies are needed to evaluate suitable agronomic practices to obtain high yields of forage with better nutritive value).
5. I will be glad to forward copies of the following reviews on cassava leaves to anyone interested (velmurug@camden.usyd.edu.au).

Ravindran, V. 1990. Cassava leaf meal. In: Nontraditional Feed Resources for Use in Swine Production (P.A.Thacker & R.N.Kirkwood, eds), Butterworths, Stoneham, USA. pp. 91-101.

Ravindran, V. 1993. Cassava leaves as animal feed: potential and limitations. J.Sci.Food Agric. 61: 141-150

V.Ravindran, Dept of Animal Science, The University of Sydney, Camden, NSW 2570, Australia.

From P. Osuji <ilri-debre-zeit@cgnet.com>
Comments on Denis Bastianelli's request on cassava leaves (more detailed information)

As the following Workshop Proceedings [Barry Nestel and Michael Graham (eds) (1977) Cassava as Animal feed: Proceedings of a workshop held at the University of Guelph, 18-20 April 1977. Ottawa, IDRC, 1977. 147p.] previously mentioned might be difficult to get (hopefully copies might still be obtained from IDRC), you will find below a summary which I got quickly and also a selected list of more accessible references selected from the same Proceedings. Most of this material has been drawn from one of the papers in Cassava as Animal Feed - Improving the Quality of Cassava Root and Leaf Product Technology by Z. Muller.

Paschal Osuji, ILRI

The use of Cassava leaves in feeding Pigs and Poultry:
Cassava leaves are a good source of protein; the protein level being much higher than that of tropical legumes. The yield of leaves is similar to that of roots (about 10 t/ha) but by close planting and nitrogen fertilization it is possible to obtain a much higher level of vegetative growth (40 t/ha or more). The aerial part should not be harvested later than 4-5 months after planting otherwise the development of the root is seriously affected. Limited quantities of leaves can be harvested at any time during the vegetative stage but always at the expense of lower root yields.

Apart from their high protein content and relatively low level of crude fibre, the leaves are very rich in ether extract, which can be attributed to high levels of chlorophyll and xanthophylls (Table 1). The content of calcium and phosphorus is also relatively high.

Because of the architecture of the plant, sun drying of leaves is quite easy and they can be dried within a few hours on sunny days. Dry leaves are preserved either in the form of leaf meal or pellets. Pelleting in the absence of steam inevitably results in some Maillard products and mild damage to the protein, which exhibits lower solubility. This is beneficial to ruminants but not to monogastric animals; therefore, leaf meal is more suitable for pig and poultry diets; pellets are more suitable for ruminants.

Table 1: Chemical analyses (% dry matter) of leaves collected in Thailand during the wet and dry seasons and in different development stages (in weeks) (Holm 1971 cited by Gohl 1975).

SEASON	WET			DRY		
WEEKS	4	6	8	4	6	8
(cm)	70	100	135	50	60	65
Dry matter	15.3	14.5	16.1	17.8	16.2	18.5
Crude protein	24.8	22.8	24.1	25.8	29.0	25.4
Ether extract	5.2	6.2	5.0	5.6	6.2	7.0
Crude fibre	18.3	22.8	26.0	15.2	16.7	18.4
NFE	43.2	40.6	39.9	45.0	39.5	40.6
Ash	8.5	7.6	8.0	8.4	8.6	8.6
Ca	0.98	1.03	0.99	1.18	1.17	1.41
P	0.52	0.55	0.56	0.73	0.62	0.59

Until very recently the agronomic aspects of producing cassava foliage for animal feed were virtually ignored. Recent work has indicated that there are distinct possibilities in treating cassava as two distinct crops with the roots rich in energy and the foliage rich in protein, pigments, minerals and vitamins. It also appears that the same plant can be used to produce several cuttings of leaves prior to harvesting, which would naturally result in a reduced yield of roots.

With respect to the feeding of cassava meal to pigs, there has been a rather limited amount of work done. Mahendranathan (1971) fed fresh cassava leaves, containing 250-300 ppm HCN (dry basis), to pigs from 8 to 34 weeks of age. He reported that his pigs consumed 1.4-2.3 kg of fresh cassava leaves daily and that there were no clinical symptoms of HCN poisoning. Also, pigs receiving 75 % normal levels of basal feed with ad libitum intake of cassava leaves gained as well as those receiving 100% levels, and both groups were significantly superior to a third group that received a 50% leaf basal diet. The efficiency of feed conversion was, however, decreased with decreasing basal feed allowance. The pigs on a 50% basal diet gained most economically. In a short-term study, Lee and Hutagalung (1972) fed piglets, averaging 13.6 kg body weight, diets containing 0, 10, or 20% cassava leaf meal for 4 weeks. They demonstrated that as the leaf meal content of the diets increased, feed intake, daily gain, and feed efficiency were significantly decreased. Methionine at a level of 0.20% significantly improved performance with the 20% treatment; whereas, 0.15% thio-sulfate supplementation did not. In their subsequent 6-week experiment with a heavier pig (30.9 kg), they demonstrated that addition of palm oil, molasses, and methionine to a 20% cassava leaf meal diet significantly improved performance compared with those supplemented with molasses or palm oil alone or palm oil with methionine. However, pigs on the basal diet performed significantly better than the rest. There were no clinical symptoms of HCN toxicity in these trials.

Ravindran's comments should complement the above.

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From Rena Perez <71055.111@compuserve.com>

Comments related to the potential of cassava leaves for feeding animals

Our experience in the Cuban cane coops is that upon harvesting cassava (for the tubers) only a few leaves remain attached to the stalk, therefore, the strategy most often employed is to chop the stalk and attached leaves as a feedstuff for ruminants, and not separate the leaves for swine.

Perhaps, Dr. Ravindran could comment with respect to the relative production of leaves and stalk, at root harvest. Practical experience suggests that there is more stalk than leaf, which might throw the balance in favor of using this feed resource for ruminants. But then, there are cassava producers that only have pigs!

Rena Perez

From: Velmurugu Ravindran <velmurug@camden.usyd.edu.au>

Comments in response to Rena Perez' comments on cassava leaf production

Rena Perez was correct to point out that cassava leaves are of little value as a swine feed when they are obtained at root harvest - not only the yield will be low, but also there will be less protein and more fibre. We often see only few leaves remaining at the harvest time, but this varies with the cultivar used. In some cultivars, you see reasonable quantity of leaves still remaining. In a study where we examined the relative proportion of various components of 12 cultivars at root harvest (on a fresh weight

basis), the following range of values was observed: 5-14 % of the plant is leaves (leaf + petiole), 5-8 % tender stem, 30-40 % stem and the balance roots.

However, it is possible to harvest cassava leaves during growing season without greatly reducing root yields. In a Sri Lankan study (see Table 1), we were able to harvest about 6.8 t DM/ha by defoliating once during a 7-month growing season and we still obtain within 85% of normal yields of roots. In another related study conducted by Dahniya et al. (1981. Experimental Agriculture, 17: 91-96) in West Africa, it was recommended that a harvest frequency of 2-3 months, starting from 4 months into the growing season, will give best all-round yields of roots and leaves in 12-month cultivars. However, it is very important that differences among cultivars (in their tolerance to defoliation) and agronomic practices etc. must be taken into account before making any recommendation under a given situation.

TABLE. Effect of leaf harvesting (by pruning) during the growing season on various root and leaf production attributes of cassava

	No. of leaf harvests*		
	A	B	C
Fresh root yield, t/ha	13.9a	12.0b	6.1c
No of roots/plant	5.49a	5.52a	3.90b
No of marketable roots/plant	3.68a	3.39a	0.90b
Leaf DM yield, t/ha	4.64c	6.75b	7.63a
Leaf CP content, %	20.4c	23.3b	27.0a

* No. of leaf harvests:
A: only at root maturity at 7 months;
B: leaf harvests at 3 months and root maturity;
C: leaf harvests at 3 and 5 months, and root maturity.

(Data from Ravindran, V. & Rajaguru, ASB. 1988. Effect of stem pruning on cassava root yield and leaf growth. Sri Lankan Journal of Agricultural Science, 25: 32-37).