PRODUCTION AND UTILIZATION OF CASSAVA IN INTEGRATED FARMING SYSTEMS FOR SMALLHOLDER FARMERS IN VIETNAM AND CAMBODIA

T.R. Preston

ABSTRACT
A considerable amount of new research information about the use of cassava foliage as animal feed is becoming available from ongoing research in Vietnam, Thailand and Cambodia. Previously, cassava has been characterized as an “exploitive” crop, destructive of soil fertility. However, when cassava is grown as a component of a whole farming system, in which livestock and crops are closely integrated, its capacity to “exploit” the nutrients in livestock manure becomes a valuable asset.

Managed as a perennial forage, annual foliage yields equivalent to four tonnes of protein per hectare have been obtained, using heavy dressings of biodigester effluent as fertilizer and with repeated harvesting of the foliage at eight week intervals. For cattle, fresh cassava foliage has been successfully fed as the only protein supplement in diets based on rice straw or molasses. Goats fed cassava foliage as a supplement have been shown to have negligible nematode worm infestations. For pig feeding the ensiled cassava leaves have a higher digestibility when the crop is managed as a semi-perennial forage and harvested at eight week intervals compared with ensiled leaves from cassava plants destined for root production and harvested at 8-12 months.

Key words: Cassava, foliage, livestock, nutritional value, integrated farming system.

INTRODUCTION

The role of cassava in integrated farming systems is closely linked with three major issues that must be addressed in the course of this century. The first issue is the need to develop new feed resources in order to respond to the predicted doubling of the demand for animal products in developing countries by 2020 (Delgado et al., 1999). The second issue is the need to develop renewable sources of energy to compensate for the inevitable decline in fossil fuel supplies (ASPO, 2002). The third issue is to improve the environment and to reduce pollution. The question then is: how can the cultivation and utilization of cassava become a part of the above strategy?

The first point to be appreciated is that there is more than enough energy coming from the sun to cover our present and future needs for food and fuel (Table 1). At the same time, this only holds true if optimum use is made of our natural resources, the most important of which is solar energy.

Cassava as a Dual Purpose Crop
Cassava has one important characteristic, namely that it can be managed to produce carbohydrate (by harvesting the roots), or protein (by harvesting the leaves). For root production the growth cycle is from 6 to 12 months, at the end of which the entire plant is harvested. When maximum protein production is the aim, the foliage is harvested at 2 to 3

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month intervals by cutting the stems at 50 to 70 cm above the ground, thereby encouraging
the plant to re-grow. In this case the roots act as a nutrient reserve to facilitate the re-
growth of the aerial part. This process can continue for 2 to 3 years if the nutrients exported
in the leaves are recycled as fertilizer (Preston et al., 2000). Dual-purpose production
systems are also possible whereby one or two harvests of the leaves are taken before the
plant is allowed to continue the normal development of the roots.

Table 1. Relative use of solar energy for production of biomass and food/feed.

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<tr>
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<th>Joules</th>
<th>Relative to sun=100</th>
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<tbody>
<tr>
<td>Sun</td>
<td>52x10^{23}</td>
<td>100</td>
</tr>
<tr>
<td>Biomass</td>
<td>4x10^{21}</td>
<td>0.077</td>
</tr>
<tr>
<td>Fuel energy</td>
<td>3.9x10^{20}</td>
<td>0.0077</td>
</tr>
<tr>
<td>Food/feed</td>
<td>16x10^{18}</td>
<td>0.003</td>
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</table>

Figure 1. Biomass yield from different ecosystems.

Cassava as a Perennial Forage

In tropical ecosystems, the cultivation of perennial crops is the most efficient way to capture solar energy in the form of biomass (Figure 1). Thus the management of cassava as a perennial forage is one way of responding to the need to use solar energy more efficiently. Growing and using cassava as a perennial forage was first proposed by Moore (1976) based on observations at CIAT in Colombia. High yields of foliage were obtained when cassava was managed as a semi-perennial crop with repeated harvesting of the foliage at 2 to 3 month intervals. This idea was taken up in the Dominican Republic by Ffoulkes and Preston (1978) who showed that the fresh foliage could be used as the sole source of protein and fiber for supplementing a liquid diet of molasses-urea for fattening cattle. Growth rates were over 800 g/day and were not improved when 400 g/day of additional soybean meal was given (Figure 2). However, although successful at the level of the animal, the system could not be sustained agronomically. Yields of foliage fell rapidly with successive harvests and were negligible by the fourth harvest, due to a lack of appreciation of the need to return to the soil the considerable amounts of nitrogen and other nutrients removed by repeated harvesting (T.R. Preston, personal observations).

Figure 2. Cassava foliage can provide all the protein and fiber in a cattle fattening diet based on ad libitum molasses-urea, and is superior in this respect to sweet potato vines


More recent research, first in Vietnam (Preston et al., 2000), then in Cambodia (Preston, 2001), has demonstrated that the cassava plant can be maintained as a semi-perennial forage crop for at least two years provided there is heavy fertilization either with goat manure (Figure 3) or with the effluent from biodigesters charged with pig manure (Figure 4).
Figure 3. Fresh foliage yields of cassava managed as a semi-perennial forage crop in Vietnam, with repeated harvests at 50 to 70 day intervals and fertilized with fresh goat manure (20 t/ha/harvest).


Figure 4. Fresh foliage yields of cassava managed as a semi-perennial forage crop in Cambodia with repeated harvests at 50 to 70 day intervals and fertilized with biodigester effluent (100 kg N/harvest).

Cassava and Manure Recycling

In countries with industrialized agriculture the disposal of manure from large-scale livestock units situated close to urban areas has become a major problem (Narrod, 2001). This situation is exacerbated by the restricted growing season in temperate latitudes where industrialized livestock production is concentrated. For example, in Germany the maximum amount of nitrogen that can be applied as manure is only 170 kg N/ha/year. Tropical countries with year-round growth potential do not have this problem. Livestock manure is a major asset and crops such as cassava are capable of taking up as much as 1000 kg N/ha/year in the form of fresh livestock manure or effluent from biodigesters (Preston, 2001).

The processing of livestock manure in biodigesters results in the conversion of much of the organic nitrogen to ammonia (Pedrosa et al., 2002; San Thy et al., 2003). This makes the biodigester effluent a potentially better source of plant nutrients than the manure from which it is derived. Data in support of this hypothesis were reported by Le Ha Chau (1998) who showed that the effluent supported higher yields of cassava foliage with a higher protein content than the raw manure (either from cattle or pigs) used to charge the biodigesters (Figure 5).

![Figure 5. Protein content in cassava leaves is higher when fertilization is with biodigester effluent rather than the original manure used to charge the biodigester. Source: San Thy et al., 2003.](image)

Cassava as a Source of Biomass Energy

Irrespective of whether cassava is grown for root or forage production, a considerable part of the biomass is present in the stem. Some stem material is needed as cuttings for re-establishing the crop; however, when it is grown as a perennial forage this requirement is much reduced as the plant will continue to produce from the same root stock for at least 2 to 3 years, provided there is an adequate supply of nutrients.
The cassava stem is a potential source of energy and has been used successfully as a fuel source in a downdraft gasifier (Dinh Van Binh and Preston, unpublished observations). Cassava as a source of fuel (the stems) and protein (the leaves) is a logical complement to energy-rich sugarcane in a co-generation system to provide energy and animal feed (Table 2) from high biomass crops.

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<tr>
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<th>Sugarcane (ha/yr)</th>
<th>Cassava (ha/yr)</th>
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<tbody>
<tr>
<td>Biomass, tonnes</td>
<td>190</td>
<td>120</td>
</tr>
<tr>
<td>Electricity, kwh</td>
<td>61,920</td>
<td>37,840</td>
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<tr>
<td>High test molasses, tonnes</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Leaf meal, tonnes</td>
<td></td>
<td>8</td>
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<td>Protein, tonnes</td>
<td></td>
<td>2.24</td>
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Cassava Foliage as Animal Feed

Recent work in Cambodia has aimed to evaluate cassava as a protein supplement for cattle and goats (the fresh foliage) and pigs (the ensiled leaves). Ensiling the leaves after chopping and wilting for 24 hours reduced HCN concentrations to levels that presented no deterrent to feed intake or N retention in growing pigs (Ly and Rodriguez, 2001). In several trials, the cassava silage has been fed successfully to pigs at up to 50% of the diet dry matter (Chhay Ty et al., 2003a). In this connection, an important recent finding is that the digestibility of the organic matter and of the protein by pigs was significantly higher when the leaves were derived from fresh re-growths (from repeated harvesting at 2-month intervals) than from mature leaves harvested at 5 months from cassava grown for root production (Chhay Ty et al., 2003b).

For ruminant animals, the approach in Cambodia and Vietnam has been on the use of the fresh foliage from cassava grown as a semi-perennial crop on a year-round basis. This is in contrast with the cassava research program in Thailand, which is mainly based on production and utilization of cassava dry hay for dry season feeding (Wanapat et al., 1997; Wanapat, 2001).

Results from feeding fresh cassava foliage as a supplement to Brewer’s grains for goats are summarized in Figures 5 and 6. There were positive effects of the cassava foliage in reducing nematode worm burdens (Figure 5) and in supporting growth rates (Figure 6). Similar findings have been recorded in Vietnam with goats fed rice bran supplemented with fresh cassava foliage or grass (Nguyen Kim Lin et al., 2003). In a trial reported by Ho Quang Do et al. (2001), N retention in goats increased linearly when cassava foliage replaced elephant grass in the diet.
Figure 5: Effect of feeding goats with three types of tree foliages or grass on counts of faecal nematode eggs.

Figure 6: Effect of tree foliages on the growth rate of goats.

For cattle the emphasis has been on the use of the cassava foliage to supplement untreated rice straw as a fattening system for local yellow cattle. The results are encouraging, especially when the cassava foliage was combined with a single drench of vegetable oil at the beginning of the fattening period (Figure 7).
CONCLUSIONS

Cassava can produce very high yields, especially of protein (up to 4 tonnes/ha/year), which makes it an ideal element for taking advantage of recycled livestock wastes. This high yield potential is complemented by the high nutritive value of the leaves for cattle, goats and pigs. The presence of cyanogenic glucosides does not appear to be a problem in ruminants and can be neutralized by ensiling or drying the leaves before feeding them to pigs. Recent findings that the leaves have anthelmintic properties in goats and cattle confer further advantages on this crop as a component of integrated farming systems.

Figure 7. Effect of supplementing rice straw with cassava foliage and a single oil drench for local cattle in Cambodia (all had urea and minerals).
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