Production and utilization of cassava foliage for livestock in integrated farming systems

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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. Recent experimental findings on the use of cassava foliage as a protein supplement for pigs, goats, cattle and buffaloes are encouraging and lay the basis for future research and development activities that promise to have a major impact in tropical farming systems. .
Introduction

The role of cassava in integrated farming systems is closely linked with two major issues that must be addressed in the course of this century. The first issue is the decline in non-renewable resources the most important of which is fossil fuel (Campbell 1997, 2003). This is already stimulating a move to convert fermentable feedstock into alcohol. It is predicted that by the year 2005 some 60 million tonnes of cereal grain in the USA (the present exportable surplus) will be processed into alcohol, for mixing with gasoline. There are similar trends predicted for use of cassava roots in Thailand, with 8 distilleries presently under construction (Charae Chutharatkul 2002). These tendencies will put pressure on the feed supply base for live stock, especially pigs and poultry, which have only a limited capacity to use cellulosic feeds. The second issue is the need to improve the environment and to reduce pollution, especially that which results from large scale livestock units.

Cassava has been considered mainly as a root crop with occasional use being made of the leaves when the roots are harvested. However, recent research is showing that cassava can also be managed as a high-yielding, protein-rich, perennial forage, with repeated harvesting of the foliage at 6 to 10 week intervals (Figures 2 and 3). In this case the roots are never harvested, acting 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. Such a production system requires close integration between the cassava crop and the livestock in order to facilitate the recycling process.

Cassava as a perennial forage
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 2-3 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 fibre for supplementing a liquid diet of molasses-urea for fattening cattle (Figure 1). Growth rates were over 800 g/day and were not improved when 400 g/day of additional soya bean meal (SBM) was given. 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. Thus an annual yield of 120 tonnes of fresh foliage per hectare contains close to 800 kg of nitrogen.

Figure 1: Cassava foliage was a better source of bypass protein than sweet potato vines in a cattle fattening diet based on ad libitum molasses-urea (Ffoulkes and Preston 1978)

More recent research, first in Vietnam (Preston et al 2000) then in Cambodia (San Thy and Preston 2001, unpublished data), has demonstrated that the cassava plant can be maintained as a semi-perennial forage crop for at least 2 years provided there is heavy fertilization either with goat manure (Figure 2) or with the effluent from biodigesters charged with pig manure (Figure 3).

Figure 2: Fresh foliage yields of cassava managed as a semi-perennial forage crop with repeated harvests at 50 to 70 day intervals and fertilized with fresh goat manure (20 tonnes/ha/harvest) (Preston et al 2000)
Figure 3: 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) (San Thy and Preston 2001, unpublished data)

Even higher annual yields of cassava foliage may be possible with shorter harvest intervals according to recent data from Colombia (Figure 4)

Figure 4: Effect of harvest interval on yield of cassava managed as a perennial forage in Colombia (H Castro 2002, Unpublished data)

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, Government regulations restrict the maximum amount of nitrogen that can be applied as manure to only 170 kg N/ha/year. Tropical counties 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 T R, 2001 unpublished observations).

The processing of livestock manure in biodigesters results in the conversion of much of the organic nitrogen to ammonia (Pedroza et al 2001; 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.

**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 T R, unpublished observations). Cassava as source of fuel (the stems) and protein (the leaves) is a logical complement to energy-rich sugar cane in a co-generation system to provide energy and animal feed (Table 1) from high biomass crops.

| Table 1: Potential for production of electrical energy (by gasification of residual fibre from sugar cane and cassava) and feed energy and protein (high test sugar cane molasses and dehydrated cassava leaves) in a co-generation system (Preston 2004, unpublished data) |
|---------------------------------|---------------------------------|
| **Sugar cane**                  | **Cassava**                     |
| Biomass, tonnes/ha              | 80                              | 80                              |
| Electricity, kwh/ha             | 14,400                          | 12,300                          |
| High test molasses, tonnes/ha  | 11                              |                                 |
| Leaf meal, tonnes/ha            |                                 | 8                               |
Cassava foliage as animal feed

Pigs

The use of ensiled cassava leaves for pigs was reviewed by Ly and Rodriguez (2001) who drew attention to the sources of leaves used in the research. They suggested that the higher levels in the diet achieved in the work in Cambodia may have been related to the different management practices since in Cambodia the leaves were from cassava managed as a semi-perennial forage and harvested at 2-month intervals, while in Vietnam, the leaves were collected when the cassava was being harvested for the roots. Research by Chhay Ty et al (2003) confirmed this hypothesis by showing a major difference in the nutritive value between old (5 months from planting) and young leaves (2 months of regrowth), with higher protein content and higher digestibility for the latter.

In the early research, ensiling (or sun-drying) of the leaves was considered to be an essential first step in order to reduce the risk of toxicity from the HCN derived from the cyanogenic glucosides (Tewe 1991). In a recent experiment in Vietnam, cassava leaves were fed fresh, or after 24 wilting, as the only supplements to broken rice for local pigs (Tram 2003). A similar experiment in Laos used only the fresh leaves as the supplement to broken rice for local pigs (Bouor 2004). There were no apparent ill effects from feeding the fresh leaves and no advantage from wilting. Intakes of leaves were rather low in both experiments which may have been the result of the bitter taste of the cyanogenic glucosides, or a feedback mechanism related to the process of detoxification of the HCN in the liver.

Ruminants
In Thailand, the cassava research programme is mainly based on first converting the cassava foliage into hay with the aim of reducing the risks of HCN toxicity (Wanapat 2001). The results of several experiments showed that cassava hay supplementation could be a partial replacement for the concentrates fed to dairy cows (Wanapat et al 2000), and that it appeared to reduce the level of nematode worm infestations in grazing buffaloes (Neptana et al 2001). In Cambodia, based on the original findings of Ffoulkes and Preston (1978), the cassava foliage has been fed successfully in the fresh state to both goats and cattle. Results from feeding fresh cassava foliage as a supplement to Brewer's grains for goats are summarized in Figures 5 and 6.

**Figure 5:** Effect of tree foliages compared with grass on nematode infestation in goats (Seng Sokerya and Rodríguez 2001)

There were positive effects of the cassava foliage in reducing nematode worm burdens (Figure 5) and in supporting growth rates (Figure 6). These advantages of feeding cassava foliage to goats were confirmed by Ho Quang Do et (2002) who reported a curvilinear increase in feed intake (Figure 7) and N retention (Figure 8) in goats when fresh cassava leaves replaced grass as the supplement to untreated rice straw. Confirmation of the positive effects on growth rate and nematode worm burdens were subsequently reported by Nguyen Kim Lin et al (2003) and Seng Sokerya et al (2003). The mode of action of the cassava foliage in reducing nematode worm burdens may be a combination of reduced exposure to the infective larvae (they are unlikely to climb the stems of the cassava) and a direct anthelmintic effect due to the presence of condensed tannins.

**Figure 6.** Effect of tree foliages compared with cut grass on growth rate of goats (Seng Sokerya and Rodriguez 2001)
Figure 7. Effect of proportion of cassava leaves in the diet on intake of ammoniated rice straw and the total diet in goats (Ho Quang Do et al 2002).

Figure 8. Effect of proportion of cassava leaves in the diet on N retention in goats fed untreated rice straw as basal diet (Ho Quang Do et al 2002).

For cattle the emphasis in recent experiments in Cambodia was on the use of the fresh cassava foliage to supplement untreated rice straw as a fattening system for local Yellow cattle. Encouraging results were obtained, especially when the cassava foliage was combined with a single drench of vegetable oil at the beginning of the fattening period (Figure 9).

Figure 9: Supplementing rice straw (RS) with cassava foliage and a single oil drench for local cattle in Cambodia (all had urea-minerals) (Seng Mom et al 2001)

Conclusions

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

Cassava can produce very high yields, especially of protein (up to 4 tonnes/ha/year), which make it an ideal element for taking advantage of the potential fertilizer of livestock wastes. Recent experimental findings on the use of cassava foliage as a protein supplement for pigs, goats, cattle asnd buffaloes are encouraging and lay the basis for future research and development activities that promise to have a major impact in tropical farming systems.

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