ROOTS AND TUBERS AS CEREALS SUBSTITUTES

by

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INTRODUCTION

Non-ruminant animals more than ruminants compete with humans since they require feed which can also be consumed by humans. This competition is more rigorous in developing countries. This causes the developing countries to import cereals and other feed sources to meet the needs of both humans and animals. The rapidly increasing dependence on the imported feeds due to rapid expansion of the livestock industry in these regions is of special concern. If this is not reversed, it will be impossible to increase the standard of living in the developing world. Therefore, utilization of locally produced feed resources to substitute the imported ones is needed if the rate of growth of the livestock industry in developing countries is to be maintained. It is the purpose of this paper to explore the technical and economic aspects of the use of root crops as feeds.

Concentrate feed production

As most concentrate feeds originate from foodcrops, their regional availability directly reflects the availability of concentrate feeds. Statistics (Figure 1), indicate that the developing world produced in millions of tons, 822 of cereals, 350 of roots and tubers and 2.6 of soyabean in 1982 (FAO, 1982). These represent 49, 63 and 31 of the world production of the respective crops. On a per capita basis, the availability of cereals in developing countries is 241 kg compared to that of 737 kg/year in the developed world. Similar comparison for roots and tubers is 103 vs 174 kg/year and for soyabean 8.4 vs 54 kg/year. The need for developing feeding systems based on locally available resources is obvious.

Roots and tubers as feed resources

Roots and tuber crops are most efficient converters of solar energy and they give the second highest yield unit (e.g. sugar producing plants). Root crop yield per unit area is approximately twice the biomass of cereal grains without taking into account tops. This superiority is more where annual rainfall and/or soil fertility is low. They are easy to grow and have high resistance to insects, diseases and pests, and can be easily stored underground. They have less lignified stems which can be high in protein and therefore their aerial parts have considerable potential as ruminant feed supplement.

They are well adapted to rough environments in cyclone regions, and are thus more reliable than cereals. These advantages, together with the flexibility in plant age at harvest, make roots and tubers the most promising basis for feeds for many classes of livestock. Sweet potatoes and cassava are the most prevalent species while others such as Winged yam or Ubi (Dioscorea alata), Taro or dasheen (Colocasia esculenta), Pao or Galiang (Cyrtsperma chamissonis) and Chinese yam or tugui (Dioscorea esculenta) are less popularly produced.

Nutritive value of root and tuber feed products

Data on proximate composition of feed products from major root and tuber crops are presented in Table 1. Rootcrops are rich in soluble carbohydrates and low in protein (exception potatoes), fat and, in addition, cassava meal, has low content of vitamins, minerals, essential fatty acids, and s-amino acids. Cassava products also contain cyanogentic glucosides (limamarin and and lotaustralin) levels ranging with varieties and environmental conditions from 15-400 ppm HCN released (Rogers, 1963). Practical methods of root processing such as shredding and sun drying usually liberate HCN from these glucosides.

Because tuber crops are rich in energy but low in protein, extra protein is needed if they are to be used as a basis of a feed. 15% soyabean meal or 11% of fish meal is required to balance cassava for feeding pigs and poultry.

A cassava soyabean meal mixture contains comparable levels of all nutrients but slightly lower methionine and metabolizable energy for poultry than maize. The cassava-fish meal mixture is lower than maize in energy density. Consequently, Khajarern et al (1979) which recommended the fat supplementation at 2.5 to 3.0% of rations contain over 40% of cassava. Earlier, Enriquez and Ross (1967) recommended methionine supplementation at 0.15% of poultry rations containing above 50% of cassava. Apart from correcting the amino acid deficiency, methionine also aids animals in detoxifying the residual HCN in cassava-based rations (Maner and Gomez, 1973).

Technical aspects in substituting cassava for cereals in feeds

It has been widely demonstrated that with supplementation cassava can be successfully substituted for cereals at high level in rations for all classes of livestock and poultry. At Khon Kaen University, suggested maximum levels and general guidelines for incorporating cassava into rations for various categories of animals have been made (Khajarern et al 1979). It appears from the data in Table 2 that cassava can totally replace cereals in rations for broilers, growing-developing pullets, finishing pigs and dairy concentrates without any nutritional problems provided methionine and other micronutrients are supplemented.

The incorporation of cassava into rations creates some feed manufactures problems. These involve, bulkiness, dustiness and the physical form of the product. Root chips are usually irregular in shape and size which causes difficulties in conveying from silo to grinder. A bucket conveyer may help in this regard. With a pneumatic conveyer, one must use cassava root pellets which lend themselves to adulteration and which can be a big disadvantage. Dry cassava as well as other root products have low density and thus require approximately 57-120% more warehouse space than grains. This substantially increases the initial investment of a feed mill. In addition, diets containing a high level of root products are also bulky and thus limit the feed intake of non-ruminants. Therefore, one should pellet pig and poultry rations containing higher levels (over 40%) of cassava.

Due to bulkiness and dispersing nature, dust pollution is a serious problem for feedmills in unloading, grinding and mixing cassava products into rations. Modification of unloader, grinder and usage of a fat or molasses sprayer usually help to solve part of this problem.

Economic apsects in substituting cassava for cereals in feeds

As cassava has become recently an important constituent of feeds in Europe (EEC), curiously, it is not used in the producing countries. This can be explained on the basis of the availability and price fluctuation of feed ingredients. Thailand exports both maize and cassava and imports approximately 75% of its required soyabean meal. In the Thai feed market therefore, both maize and cassava are plentiful and inexpensive. Figure 2 shows the prices of these feed ingredients in Thailand and the EEC in the last ten years. European farmers have much cheaper (42%) soyabean meal than Thai farmers. Soyabean meal in the EEC is 1.4 times that of maize and 1.9 times that of cassava while in Thailand it is 2.6 and 3.8 respectively. It appears that the cassava-soyabean meal mixture has been able to replace maize in economical rations in the EEC throughout the years 1981-85 except in the period from May 1982 to January 1983. (Figure 3). In Thailand on the other hand, the mixture could not economically replace maize from the beginning of 1984 up to the present. The Thailand-EEC agreement on limiting cassava exports to the EEC has created a surplus and continuous price fall of cassava. In those developing countries where feedmills import both cereals and soyabean meal, the chances for using cassava in rations economically are greater than in Thailand.

Perspectives for other roots and tubers as feed

As sweet potatoes and other minor roots and tubers are mainly human foods, these are less available as feeds and only limited data on their feed use are available. Castillo et al. (1964) totally replaced maize in a 17% protein pig ration (25% maize) with either sweet potatoes or cassava root silages without lowering pig performance. Yam , sweet potatoes and cocoyams had similar and high digestibility values for dry matter and nitrogen-free extract but low values for other nutrients in pigs (Oyenuga and Fetuga 1975, Lee et al. 1977). Because of the higher protein content of these main root crops as compared to cassava, it may be more economic to use these products. However, their age at harvesting is less flexible and they have a higher price. Since the root yield per unit area is comparable to cassava, the production programs have been commenced (e.g. in the Philippines).

SUMMARY

As the livestock production systems in several developing countries become more and more industrialized, the countries are more and more dependent on imported feed grains and oil meals. In order to slow down these tendencies, livestock producers in these countries should explore substitute feeds produced locally. Tropical root and tuber crops are potential alternatives. The minor operating problems involved in their use are not difficult to be solved. The only obstruction for such a replacement is economic. These include the irregularity of rootcrops supply, availability and price of the supplements (e.g. protein sources).

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Table 1: Proximate composition of major root and tuber crops

Crops	Composition, % of dry matter						ME, Mcal/kg DM
	DM	CP	EE	CF	Ash	NFE	
Cassava (*M. esculenta* Crantz)[1/]	36.	2.5	0.6	2.9	3.8	90	3.2
Potatoes (*S. tuberosum* L.)[2/]	21.	12.1	0.9	3.9	5.0	78	3.6
Sweet potatoes (I. *batatas*)[2/]	28.	5.4	0.5	0.3	3.2	9	3.2
Taro or Dasheen (C. *esculenta*)[2/]	24.	3.4	0.7	3.3	3.2	89	3.3
Winged yam or water yam (D. alata)[2/]	34.	5.2	0.8	2.6	5.2	83	3.2
White yam (D. *rotunda*)[3/]	31.	6.4	0.4	2.7	4.3	86	3.7
Chinese yam (D. *esculenta*)[3/]	20.	8.9	0.6	3.5	4.3	83	3.3
New cocoyam (*Xanthosoma* sp)[3/]	41	5.9	0.8	2.6	1.7	89	3.6

Sources: 1/ Khajarern *et al*.(1979)
2/ Harris *et al*.(1982)
3/ Oyenuga and Fetuga (1977)

Table 2: Suggested maximum levels of cassava root products in livestock and poultry diets

Species / Growth period	Maximum cassava level, % of ration				
	Starter	Grower	Finisher	Developer	Breeder
Broiler	58	-	58	-	-
Replacement pullet	40	60	-	60	-
Layer	-	-	-	-	50
Pig	50	60	70	-	not established
Cattle	-	-	over 60	-	68

Source: Khajarern *et al.* (1979)

Figure 1. World Foodcrop Production in 1982 (FAO, 1982)

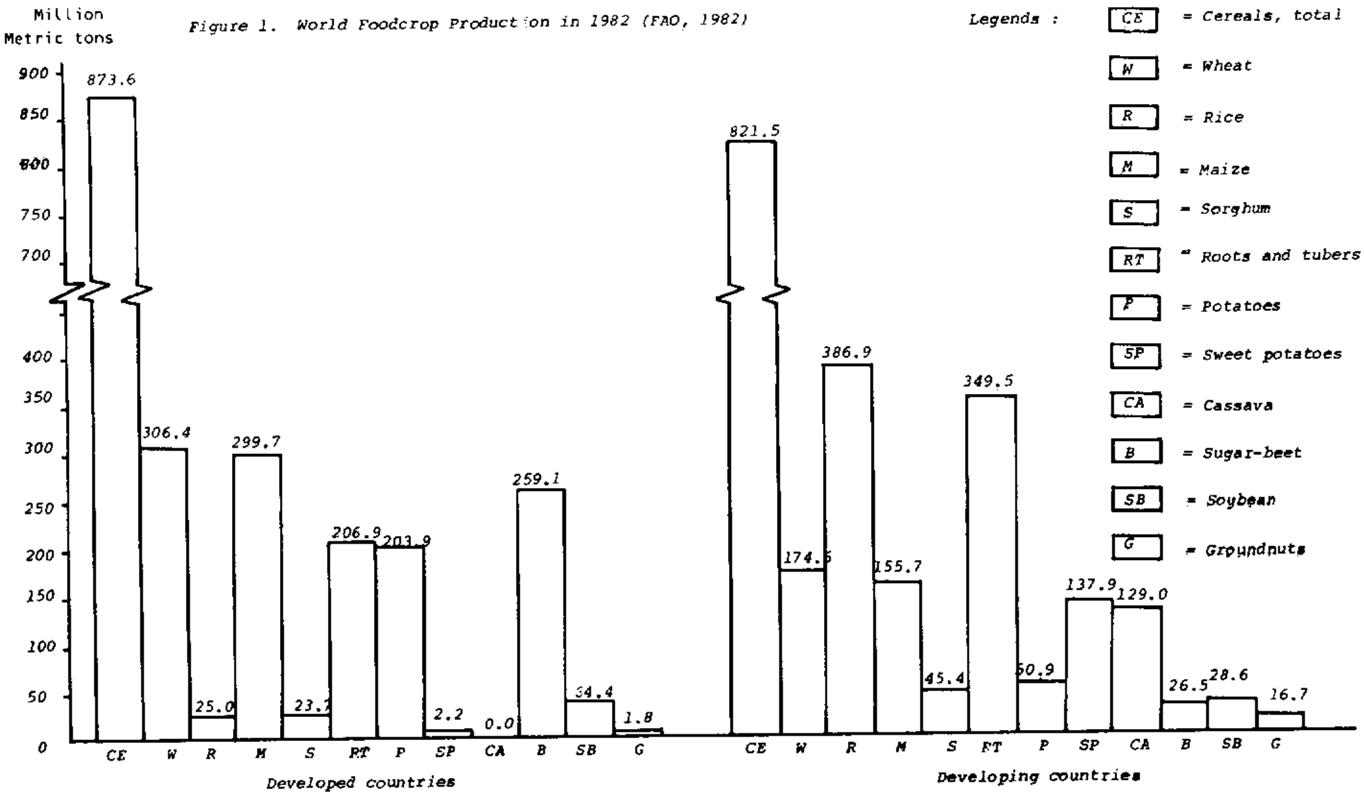


Figure 2. World Averages of Foodcrop Yield/Unit Area in 1982 (FAO, 1982).

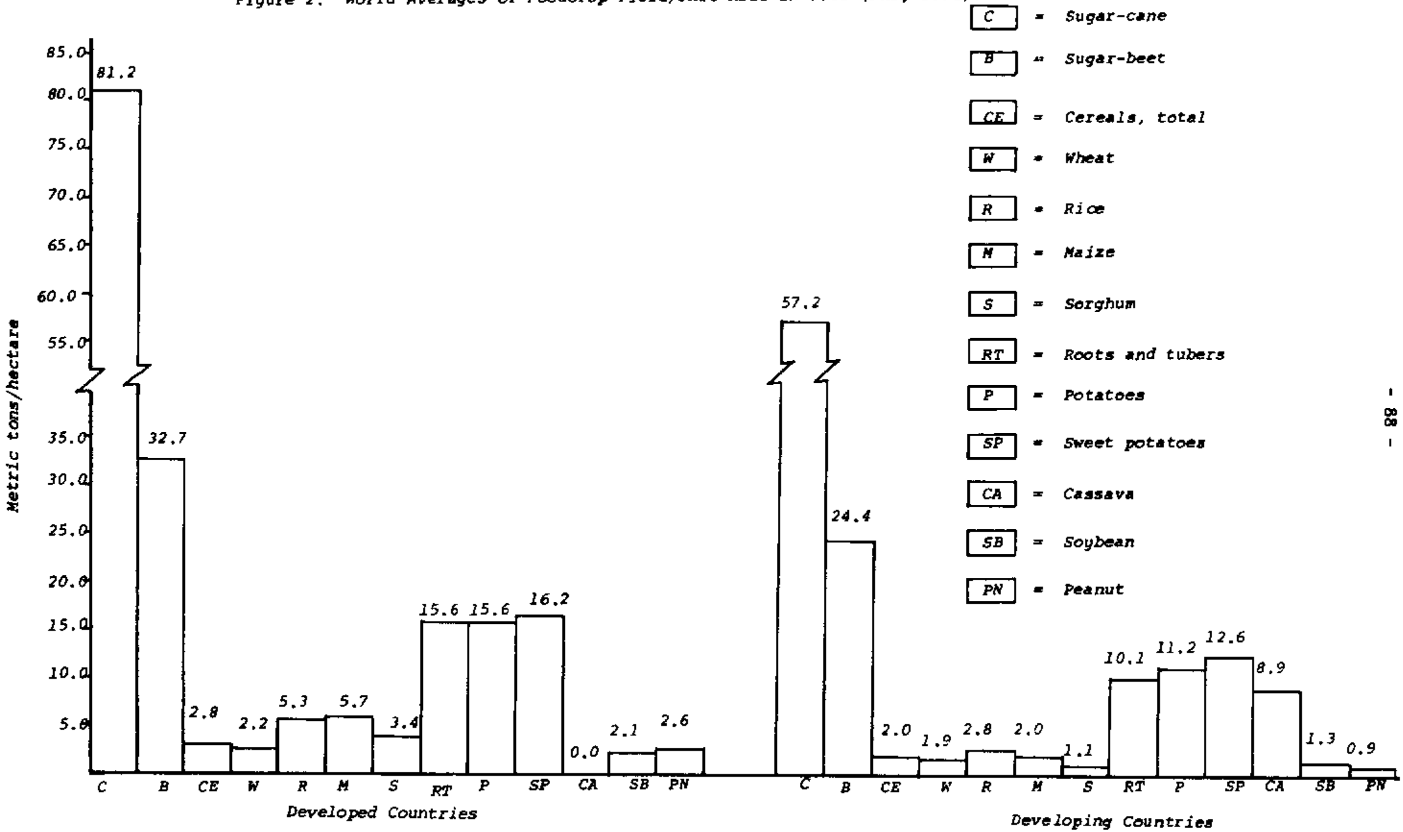
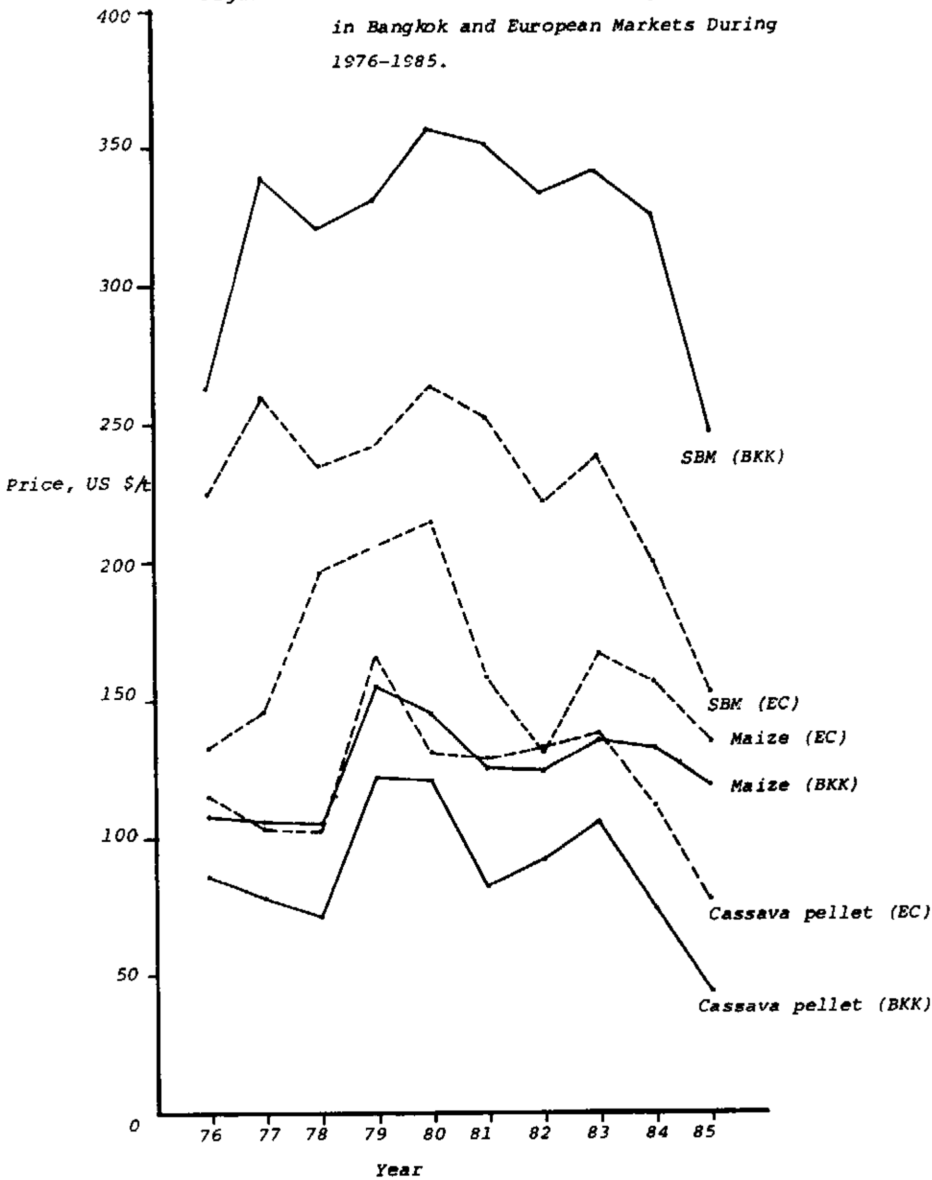


Figure 3. Fluctuation of Prices of Major Feedstuffs in Bangkok and European Markets During 1976-1985.



Source : Board of Trade Bulletins, 1976-1985, Thailand Board of Trade, Bangkok, Thailand.

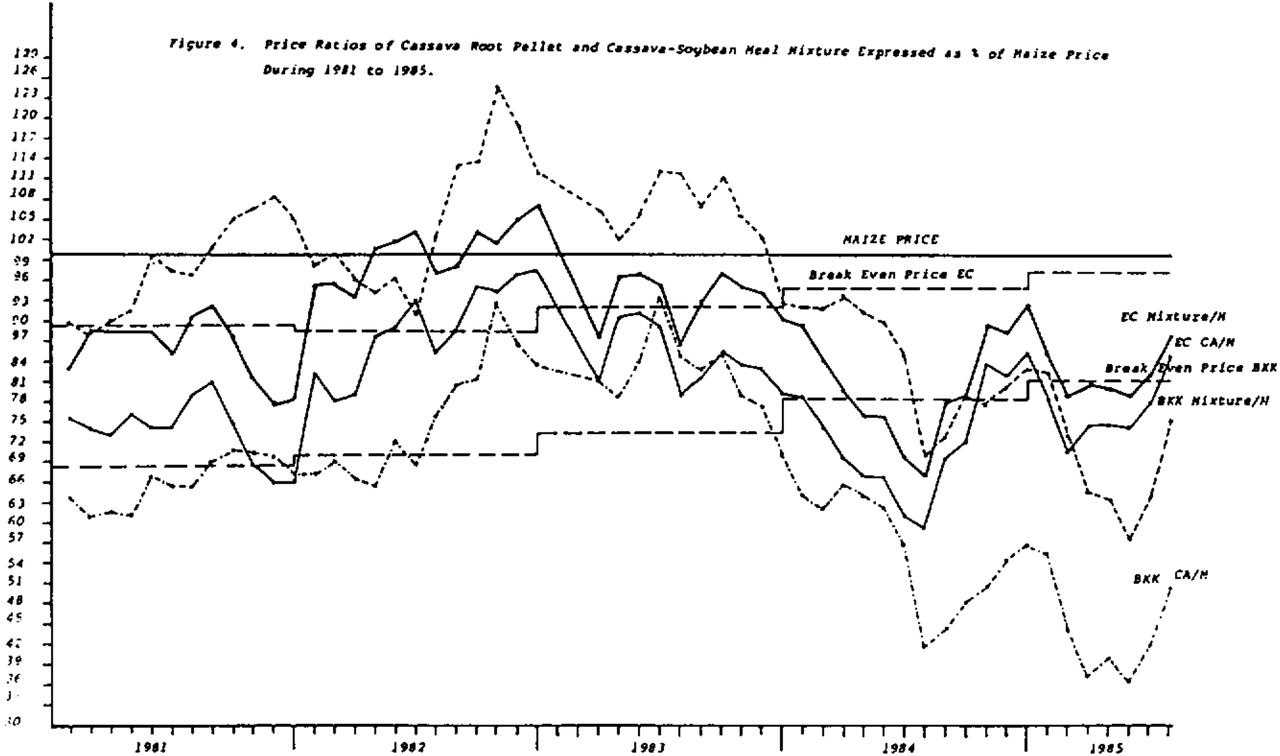


Figure 4. Price Ratios of Cassava Root Pellet and Cassava-Soybean Meal Mixture Expressed as % of Maize Price During 1981 to 1985.

Source : Board of Trade Bulletins, 1981-1985, Thailand Board of Trade, Bangkok, Thailand.