The Sugar Palm Tree As the Basis of Integrated Farming Systems in Cambodia

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Abstract

The sugar palm tree (*Borassus flabellifer*) plays an important role in the small integrated farming systems in Cambodia. The sugar palm is considered to be a multi-purpose tree and provides different products such as juice, sugar, leaves, timber, fruits, underground seedlings and roots. The juice from the sugar palm is rich in highly digestible carbohydrate (sugars) which is an alternative energy source for animal feeding in the rural areas. The impact of the sugar palm on the farming system is increased when the excreta from the animals is recycled through biodigesters to provide gas for household cooking and effluent to fertilize the pond which can produce fish or water plants, the former for the household and the latter for the livestock.

When sugar palm juice is used for pig feeding, rather than the making of sugar, it is better from both the economic and environmental points of view, because sugar production requires large amounts of firewood that makes the cost of production very high. It is even less profitable and extremely harmful to the environment when palm trees are used as fuel in order to produce the sugar.

KEY WORDS: *Borassus flabellifer*, palm juice, palm sugar, fuel, environment, biodigester, sustainable production

Introduction

In Cambodia, 85 per cent of the total population is dependent on agricultural activities. Most of their annual income comes from agriculture. The farming system comprises rice cultivation, sugar palm production, livestock farming, and vegetable growing. Livestock make many contributions to the farming activities, such as draught power, meat, milk, eggs, organic fertilizer, fuel, social status, etc. In order to maintain these important contributions, livestock have to be adequately fed, well managed, and properly cared for. However, there must be a clear division between what is human food and what is animal feed. As Preston and Sansoucy (1987) have suggested, one way to achieve a sustainable animal production system is to match livestock with the available local resources. In this case, there are resources which can be used for animal feed such as multipurpose trees, aquatic plants, agricultural products and by-products.

The sugar palm tree, which is called "Thnot" in Khmer, is a source of income in different seasons of the year. In addition, it provides good materials for house construction such as leaves, leaf branches and trunk, when juice production is not carried out. The palm tree commences to produce inflorescences (maturity) in 15-20 years depending on soil fertility. There is no relevant literature which describes the productive life of the tree, although there are examples of trees today which have been used to produce juice for more than 70 years. Borin Khieu *et al.* (1996a) reported that the juice can be collected for 3 months of the year from the male tree and 5-6 months from the female tree. The average yield was 5 kg of juice per day per tree with an average brix value of 13.5% (sugar content). In 1995, the sugar palm population was estimated at 8 million trees in different provinces in Cambodia. The trees are found mostly on sandy soils with a pH of 5.5. The sugar palm trees are capable of producing 160,000 tonnes of juice or 21,600 tonnes of sugar (sucrose) per year per hectare. This is a great potential feed resource that can be used as an alternative to cereal grains for feeding monogastric animals. The preferred animal species are pigs and ducks which adapt readily to "unconventional" high moisture feed resources. However, it may also be used as a supplement for draught animals.

The system is based on the sugar palm which provides the carbohydrate feed (juice). The other multipurpose trees and water plants supply protein in addition to the important role that the trees play as a sink for carbon dioxide, in nitrogen fixation, in controlling erosion and as a source of biodiversity. Sugar palm trees are integrated into the farming activities.

The Role of Sugar Palm Trees

The sugar palm tree is considered a multipurpose tree since it demonstrates great potential by providing different products for humans, as well as for animal feeding. The role of sugar palm trees in the mixed farming system is as follow:

- To provide sugar, fruits, germinated seeds and juice for human consumption and animal feeding.
- To use as the green fence around the household, as well as on the bunds of rice fields.
- As the sugar palm tree has a deep root system (up to 15 m), it can be used also to control erosion.
- The leaves of the sugar palm tree can be used as a nest for bats which provide manure as a good source of fertilizer. The bats can provide 0.5 to 1 kg of manure per day which could be sold to the city for flower gardens.

The Production of Sugar Palm Tree

The sugar palm tree does not require any management for biomass production. But the leaves should not be harvested when trees are kept for juice collection. Farmers believe harvesting the leaves has a great influence on the yield of juice. The juice from the sugar palm tree is normally collected once a day. However, there are high production trees (20-25 kg of juice per day) which should be collected from twice daily. The yield and the brix value (sugar content) vary from tree to tree, farmer to farmer and time of production. Some skillful farmers can manage to get juice with high brix value that is good for sugar syrup production because it requires less firewood for boiling the juice. Potentially, trees (especially females) can produce juice throughout the whole year.

The composition of the syrup samples (Table 1) showed considerable variation among farmers and between harvest periods. Seasonal variation in composition is shown in Table 2. Sucrose as per cent of total solids in the juice ranged from 66 to 94% in the samples taken in January and from 51 to 88% in April. In contrast, glucose and fructose levels in juice increased. The levels of glucose ranged from 2.1 to 9.6% in samples taken in January and from 3.5 to 18.2% in April. The fructose levels ranged from 2.6 to 11% in samples taken in January and from 4.6 to 24.5% in April.

The constraint on sugar palm production is the fuel consumption. The estimate of firewood consumption is 460 kg per tree per year which is equivalent to 3.68 millions tonnes of firewood required for sugar production annually in the country. However, rice husk can be used as an alternative fuel to boil juice but it is still a problem to get sufficient quantity for this purpose. The other way to achieve better utilization of the sugar palm tree is by diverting juice from sugar production to animal feeding.

The Use of Sugar Palm and By-products in Animal Feeding

There is no relevant literature which describes the real amount of sugar palm and its by-products given to domestic animals in the country. But it has certainly been used as a livestock feed supplement in the rural areas.

Ruminant Feeding

The main feed for cattle and buffaloes during the dry season is rice straw. In this period, most of the animals become very thin because of the poor quality feed supply. However, some of the animals which get a supplement from sugar palm products and by-products have good performance or at least maintain weight. The juice from the sugar palm is sprayed over the rice straw and kept for some minutes and then fed mainly to draught animals. This also makes rice straw more palatable.

Table 1. Chemical composition of sugar palm syrup

	DM	Ash	Sucrose	Glucose	Fructose	Total CHOs
		- - - - - -As % of dry matter- - - -				
16 Jan.1995						
Hay Yang	84.8	1.4	65.8	9.6	10.6	86.7
Huy Kiel	86.5	1.3	85.7	5.8	6.6	98.0
Pring Huy	84.3	1.7	74.1	9.4	11.0	94.8
Map Chreb	82.7	1.2	88.2	4.8	5.5	98.6
Sim Hen	87.8	1.0	93.1	2.1	2.6	97.9
Pauv Pauv	84.1	1.4	81.7	5.7	7.5	95.5
Tha Khorn	88.1	1.5	94.3	2.1	3.3	99.7
Thorn Punn	89.9	1.8	74.3	6.8	8.3	91.1
Yem Khnol	84.2	1.8	72.9	9.1	10.6	93.6
Chan Mak	88.4	1.0	93.1	2.5	2.9	98.5
Thorn Chreb	78.6	1.7	85.7	4.8	2.9	96.9
15 Apr. 1995						
Hay Yang	85.8	1.7	69.8	7.3	12.5	89.6
Huy Kiel	88.9	1.5	68.5	11.2	13.4	93.5
Pring Huy	82.9	1.6	51.0	18.2	24.5	91.2
Map Chreb	82.3	1.5	57.4	15.7	18.1	92.7
Sim Hen	85.0	1.3	74.9	8.7	9.9	96.2
Pauv Pauv	79.7	1.6	68.0	10.6	12.2	92.2
Tha Khorn	82.2	1.1	87.6	5.5	5.9	99.0
Thol Onn	86.9	1.2	73.5	8.0	11.0	92.6
Thorn Punn	87.4	1.5	87.1	3.5	4.6	96.1
Yem Khnol	92.0	1.5	62.6	9.4	15.8	90.0
Thorn Chreb	75.6	1.6	76.4	9.8	9.5	95.7

Table 2. T test analysis of changes in sucrose, glucose & fructose (reduced sugar)and ash in sugar palm juice with advance of harvesting season.

	16 Jan 1995	15 Apr 1995	Mean diff	t value	Prob.
Sucrose	81.6	70.4	11.2	2.79	0.021
Glucose	6	10	-4.0	-2.78	0.021
Fructose	7.2	12.3	-5.1	-3.56	0.006
Ash	1.4	1.4	-0.02	-0.19	0.86

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Sugar palm syrup can also be used as an ingredient to make multi-nutritional blocks. Experience from FAO Project TCP/CMB/ 2254 "Emergency Plan for Livestock Security" has shown that multi-nutritional blocks are a good potential supplement for draught animals in the dry season. The formula used for a hundred kg of mixture was: rice bran 40 kg, sugar palm syrup (80% DM) 15 kg, urea 7.5 kg, salt 7.5, lime 5, cement 5, clay 20 kg. The animals have good performance, a bright coat and stop licking urine from others animals.

The fruits from sugar palm are chopped and given to animals after having taken the soft part and kernel for human consumption. The mature fruits are soaked in water and the wiry fibers sucked out. The solution of yellow pulp is given to the draught animals or lactating cows. During the dry season, it has been observed that the leaves from the young palm trees are eaten by cattle.

Monogastric Animal Feeding

The common monogastric animals kept in the rural areas are pigs, chicken and ducks. The population of monogastric animals is growing very fast because of the quick turnover of capital and the available market. A scavenging system is the common practice. The animals are sometimes supplemented with kitchen waste or cereal grains. Another important feed is the solution which is obtained after cleaning the pan from making palm sugar. The solution is mixed with rice bran and fed to

pigs. Pigs show good performance compared to the ones which are fed rice alone.

Starting in 1993 with the introduction of TCP/CMB/2254 and later on with SAREC, research has demonstrated that the sugar palm juice can be used as a source of energy supply for pigs. The trials were adapted and tested in different villages in Cambodia. When the monogastric animals are fed a basal diet derived from tropical feed resources such as sugar cane, cassava, bananas, sweet potatoes or palm oil, the supplementary nutrients needed are protein, lipids, minerals and vitamins (Preston, 1992).

The first idea was to use the scum from making sugar palm syrup to feed pigs. But the reaction from the farmers was to use fresh juice for pig feeding instead of the scum. In 1995, there was a trial involving 72 pigs divided between 12 families in Kandoeung Commune, Takeo Province, Cambodia. The objective of the research was to evaluate the juice of the sugar palm tree as a sole energy feed for pigs. The result was reasonably good compared to sugar palm syrup production. The average live weight gain was 356 g per day per pig with only 156 g CP supplement. In fact, the most important feature is the economic impact of feeding juice to pigs. Elliott and Kloren (1987) reported that the use of fibre-free energy sources such as raw sugar or sugar cane juice permits greater use of cheaper vegetable and aquatic protein sources which are not usually included to a great extent in conventional diets because of their high fibre content. Therefore, the use of sugar palm juice in monogastric feeding, especially for pigs, will provide opportunities to farmers for better utilization of their own locally available feed resources as protein supplements and the cost of production will be reduced.

Economic Aspects of Sugar Palm Tree

Sugar palm production has been one of the main sources of income for rural families. The number of trees ranged from 10 to 30 per family which results in 1 to 3 tonnes of sugar palm syrup (approximately 80% DM) in the 6 month production period. However there are farmers who can collect juice from the female trees for the whole year. The price of the syrup varies from 400 - 600 Riels during the production period (dry

season) to 1,000 - 1,200 Riels afterwards (rainy season). Sugar production still continues to be a source of income for the people who have access to free firewood.

It was shown during the study (Borin Khieu *et al.*, 1996b) that when firewood was purchased for condensing sugar palm juice, some farmers lost an average of 20 Riels per tree per day. There is another alternative source of fuel, rice husks, which can replace firewood. This system requires a new kind of stove that was adapted by a French organization, the GRET. The income from sugar production using rice husk is comparatively better than with firewood. However, there is still insufficient fuel for cooking because the yield of husk from a hectare of rice is approximately 240 kg which provides only 4.5% of the total fuel consumption for condensing the juice of 20 trees. If opportunity cost of labour is taken into consideration, it greatly increases the cost of production because one to two persons are permanently assigned to take care of boiling juice.

Using palm juice for pig feeding has proved to be an effective and sustainable method of production. Several trials showed that, from the economic point of view, the profit from using palm juice for pig feeding was much higher than for sugar production. The net profit was 140 Riels per tree per day, compared to only 10 Riels from sugar production (Borin Khieu *et al.*, 1996b).

The sugar palm tree may produce 8-15 bunches of fruits with a total of about 80 fruits per year from female trees which are not exploited for juice. The price is 3,000 to 3,500 Riels per 40 kernels which are extracted from 15-20 fruits. Therefore, each tree provides approximately 12,000-14,000 Riels annually. In addition, the leaves also contribute other income or at least they can be used to thatch the houses. Finally when palm trees are over 10 m (70-100 years old), it is difficult to use them for juice collection. They are cut and sawn for house construction.

Constraints on Sugar Production

At present, the densest population of sugar palms is found in highly populated areas. This is leading to the disappearance of the trees because of the high demand for land for cultivation to satisfy the needs of the

people. Another important reason could be that there is a need for timber for construction materials and a need for fuel for household cooking and for boiling juice. Many sugar palm tree are used every year as fuel to condense sugar palm juice. As an example, in 1995, it was estimated that 10-15 sugar palm trees were cut to supply part of the firewood requirement by the sugar producers in Tumnop Thom Commune, Punhea Leu District, Kandal province.

It should be noted that by using juice for pigs, 3.68 million tonnes of firewood will be saved each year. Therefore this system will contribute to the reforestation programme which is taking place at present in Cambodia.

Alternative Integrated Farming Systems

It has been calculated that the sugar palm trees in the country may produce enough juice to feed 3-4 million pigs or 14 million ducks. This shows great potential for replacement of cereals for animal feeding which is very important for a country like Cambodia which has not produced enough cereal grain to feed its population since 1979. As the population grows rapidly, there will be a demand, not only for cereal, but also for meat. Pigs and ducks are the first choice as they grow fast and are in high demand by the people.

When low protein basal diets such as sugar cane and sugar palm products and by-products are fed to monogastric animals, the total protein needed is reduced considerably. This is because the ratio of essential amino acids is close to the optimum when the animal is supplemented with tree foliage and water plants such as Nacedero (*Trichantera gigantea*), duckweed (*Lemna* ssp.), water spinach (*Ipomea aquatica*) and azolla (*Azolla anabaena*) (Preston, 1995 and Leng *et al.*, 1995). All these sources of protein are available in the ponds or around the households which are fertilized with the effluent from the plastic biodigester.

This integrated farming system provides an environmentally friendly solution, where the biodigester is playing an intermediate role in the system. Biodigestion enables the farmers to recycle waste and excreta from animals as well as humans. The number of biodigesters is growing

very fast in Cambodia; up to now, there have been 450 digesters installed in different provinces of Cambodia. The popularity of the biodigester is connected to that of the human latrine and the need to solve the firewood problem. In addition, when pigs are raised in confinement, they produce waste and manure as a substrate for the digester which has not been the case in the past when they were mostly kept in a scavenging system. The biodigester does not produce only gas (methane) for household cooking but also provides fertilizer for rice fields and vegetable gardens which is better than the fresh manure. Farmers participating in the FAO GCP/RAS/143/JPN and Lutheran World Service (LWS) projects demonstrated that the biodigester provided great value by cutting down the expenditure on chemical fertilizer. The slurry from the digester is safe and it can be used as feed in the fish pond. It is also very important that the housekeepers (wives) are happy to participate in the system because it provides a clean environment in the kitchen, as well as the whole house, and it gives her more time to perform other work or participate in social activities.

Strategy for Animal Production Based on Sugar Palm

The development of livestock production in Cambodia will be based on small-scale farmers and the utilization of local resources. The free range system is the common practice for all kinds of animals. But now there is a need to utilize available land for crop production in order to satisfy the demands of the growing population. The sustainable way to keep the system working and to solve these problems is to raise animals (especially cattle, buffaloes and poultry) in a semi-scavenging system. For instance, sugar palm products and by-products can be used as the energy basal diet with the protein supplement from the leaves of multipurpose trees like *Gliricidia, Acacia, Leucaena, Trichanthera* etc. and water plants such as duckweed, *Azolla,* water spinach and so on. This should be the alternative way for livestock production in Cambodia. In the same strategy, pigs are proposed to be confined because of their propensity to destroy crops like sweet potato and vegetable gardens. By keeping pigs in a pen, they will also provide additional income as mentioned above.

Perspectives

In order to further develop this integrated system, more involvement from farmers is vitally important. A credit programme is needed for the poorer farmers who do not have money to start. It is crucial that both women and men participate in the discussion, in planning as well as implementing. The role of women in these activities is very important because the woman is the one who feeds the animals and spends most of her time looking after the farming system. However, the man does the rest of the activities such as climbing the sugar palm tree, ploughing the land, digging the pond, etc.

The majority of farmers are interested in raising fattening pigs but very few keep sows which makes the system unbalanced. Therefore the price of the piglets (15-20 kg) is 100,000 Riels, relatively high compared to the finishing pigs (90-100 kg) which cost about 330,000 Riels. The strategy for long term and sustainable development is to establish the reproduction system which can provide piglets in the villages so that they are more adapted to the native environment and local conditions. In this case, the indigenous pigs such as Chrouk Domrey, Chrouk Hainam, Chrouk Kandor, etc., are likely to be the best for prolificacy and efficient use of poor quality feed.

In the tropics there are many plant species that can be utilized better for animal feeding from the economic and environmental points of view than imported concentrate feeds. They are excellent components of the integrated farming system and part of the local ecological context. The plants which produce energy-rich feed are sugar cane, sugar palm trees and all palms yielding juice (*Coco nucifera, Arenga pinnata, Borassus species, Caryota urens, Nypa fruticans*, etc), palm oil, cassava, etc. However, in all livestock feeding, the most expensive ingredient is protein. In fact, on the small farm in remote areas, the availability of protein is restricted to what can be grown on the farm and the by-products available in the areas. In these cases, it is crucial to introduce multipurpose plant species that could be used as animal feed and which have a better amino acid balance.

Conclusions

In Cambodia, it is important to diversify the use of sugar palm trees for animal production in order to maintain these trees as part of the farming system because sugar production will not survive any longer in the provinces due to the firewood problem.

The multipurpose sugar palm trees have played an important role in an integrated system. They are very efficient utilizers of solar energy and may not require any fertilizer inputs. They provide high energy feeds, low in fibre but with very low protein contents. This allows the optimum use of on-farm products and by-products as protein sources for monogastric nutrition. These include leaves of Nacedero (*Trichantera gigantea*), sweet potato leaves, water spinach, silage of cassava leaves, duckweed, azolla, etc.

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