The Potential of Taro in Some South Pacific Islands

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ABSTRACT

The South Pacific has more than a thousand scattered islands, large and small. This paper presents potential uses of taro (Colocasia esculenta) in American Samoa, Western Samoa, the Cook Islands, Fiji, Papua New Guinea, The Solomon Islands, and Tonga. The development of taro silage and its use as animal feed, especially swine feed, is emphasized; and pig feeding trial data from recent University of Hawaii and American Samoa Government collaborative studies have been summarized in the paper. The potential of taro alcohol as a fuel for remote islands and the potential of taro starch as a raw material in cosmetics manufacturing are also discussed.

Introduction

No single root crop can claim preeminence in the South Pacific. Cassava (Manihot esculenta), sweet potato (Ipomoea batatas), taro, yam (Dioscorea alata, D. esculenta), tannia (Xanthosoma sagittifolium), Cyrtosperma chamissonis, and Alocasia macrorrhiza (giant taro) are leading crops in one or more of the many islands. However, taro is one of the most common sources of staple carbohydrate and is also used extensively in ceremonial occasions (Yen in Ward and Proctor 1980, Chapter 9). It has attained considerable commercial importance as a fresh crop in many of large islands in the region, such as American and Western Samoa, Fiji, and others. Although taro is said to have originated in India and Asia (Chang, 1958; de la Pena, 1970; Plucknett, de la Pena, and Obrero, 1970), it can now be considered a native plant of the South Pacific islands.

Animal production, especially swine and poultry, makes a substantial contribution to the welfare and total productivity of the people of the South Pacific, although available statistics do not always show the full extent of this contribution. Pig production in particular has been totally integrated in the social and agricultural systems with strong ties to ceremonial uses in everyday life. (Quatermain in Ward and Proctor, 1980, p. 261).

Unfortunately, animal production in the South Pacific islands has been hampered by the high cost of imported feeds. Climatic characteristics that make

South Pacific islands ideal locations for taro production make them unsuitable for the production of feed grains or common forages, such as alfalfa (Steinke et al, 1983). However, taro yields large quantities of plant residues and, except for its acridity, is potentially an excellent source for locally-produced low-cost animal feeds. Actually, taro has been used as pig feed, but cooking was required to render the acridity inoffensive. With the current high cost of energy, this required process is no longer economically practical.

To illustrate importance of meat production in the South Pacific, 1980 American Samoa imports were $1,801,396 beef; $202,109 mutton; and $131,266 pork. Per capita, total fresh meat imports amounted to about $66 per annum (American Samoa Government, 1981). In addition, the government spends the equivalent of about one-third of its Agriculture Department's budget to subsidize swine feed to keep its pig farmers competitive.

The Asian Development Bank (ADB) surveyed South Pacific agriculture in 1979 covering Tonga, Western Samoa, Fiji, Papua New Guinea, the Solomon Islands, the Cook Islands, and Kiribati (Ward and Proctor, 1980). In Chapter 9 of South Pacific Agriculture Choices and Constraints, Yen indicated that per capita importation of rice and flour ranged from 30 to 52 kg per annum in these islands (except American Samoa). American Samoa's per capita importation of rice and flour was over $35 in 1980. Thus a potential exists for locally produced staple food to replace some imported rice and flour.

Availability and cost of energy are important to any developmental scheme and liquid fuels are an important component of the total energy consumed. Alternative liquid fuel sources must be carefully examined and developed, where economically feasible, to reduce the dependence of these islands on imported fuels. On large islands, wood may be a source for alternative energy (Watt in Ward and Proctor, 1980, Chapter 12), but on small islands, the conversion of taro into alcohol using solar distillation may already be economically feasible (Wang and Nagarajan, 1981). The ADB report has shown that fuel importation accounts for about 10% of total imports for these islands and American Samoa imported a total of $27,834,927 in diesel and gasoline fuels in 1980 (excluding aviation fuels). In Kiribati, the annual per capita fuel consumption is $42 and in the Solomon Islands, $143. There are potentials for taro alcohol to substitute for some of these imports.

Utilization of Taro

There are three categories for taro usage: food and processed food for human consumption, animal feeds, and industrial uses.

Food and Processed Food

Nutrient values indicate that the taro corm is an excellent source of carbohydrate but low in fat and protein which is of medium quality. Taro leaves do contain a much higher level of protein and are an excellent source of carotene and potassium. The leaves are high in calcium but the bioavailability of its calcium is currently uncertain due to the existence of anti-nutrient oxalic acid (Standal in Wang, 1983, Chapter 5).

Taro has been made into many commercial and experimental food products: flour, cereals, bread and cake, infant food, beverage powder, dried flakes, cooked slices and chips, frozen and canned products, extruded products, and pastes (including poi). Taro can be prepared into dehydrated forms to maintain stability

Table 1. Area, population and food importation pattern of selected South Pacific islands countries.

South Pacific Island Country	Land Area[a] km^2	Population[b]	Staple Importation[c], MT		Importation of Food & Live Animal[c]		Contribution of Agriculture to GDP[d,e]
			Rice	Flour	Imported US$1,000	% of Total Import	
Cook islands	240	18,126	190	800	3,805	21.3 (1977)	16 (1976)
Fiji	18,272	588,068	23,100	3,380	73,424	19.9 (1978)	21 (1977)
Kiribati	684	56,452	2,200	1,700	3,661	27.4 (1977)	11 (1974)
Papua New Guinea	462,243	2,828,600	70,000	22,000	90,928	21.1 (1976)	33 (1977)
Solomon Islands	28,530	197,708	3,200	2,800	5,808	16.3 (1978)	15 (1972)
Tonga	699	90,128	110	3,600	6,950	27.8 (1978)	51 (1975)
Western Samoa	2,935	151,983	1,200	4,300	12,052	28.0 (1977)	--
American Samoa	197	32,000[f]					

[a]P.W. Hodgkinson, Population 1974, Statistical Bulletin of the South Pacific No. 7, Second Edition, South Pacific Commision, Noumea, 1977.

[b]R. Gerard Ward and Epeli Hau'ofa, "The Demographic and Dietary Contexts," Chapter 2 in South Pacific Agriculture Choices and Constraints, edited by R. Gerard Ward and Andrew Proctor, Asian Development Bank in association with the Australian National University Press, Camberra, Australia, 1980.

[c]Douglas E. Yen, "Food Crops," Chapter 9 in South Pacific Agriculture Choices and Constraints, 1980.

[d]Leslei V. Castle, "The Economic Context," Chapter 5 in South Pacific Agriculture Choices and Constraints, 1980.

[e]GDP = Gross Domestic Product.

[f]American Samoa Government, Statistical Bulletin, 1981.

and offer convenience and ease in preparation. It has been demonstrated that stable, intermediate products such as taro flour and dired slices could be prepared and further extruded into convenient, ready-to-use, stable forms such as rice, noodle, and macaroni. The key in wider usage of taro products will be price competitiveness (Moy and Nip in Wang, 1983, Chapter 10). It is unlikely that under current production schemes processed taro food items can become price competitive in the near future but the traditional usage of fresh taro can be expanded.

The Potential of Taro as an Animal Feed

Animal industries have long been hampered in the wet tropics by the inability to produce locally-grown feeds. Imported feeds are simply too expensive and in most cases, unavailable.

In many tropical and subtropical areas, large acreages of agricultural lands are used for the production of products which yield vast quantities of both plant residues and processing by-products which are potential feed-stuffs for livestock. Taro is one of these products; however, it has not been widely used as an animal feed. The acrid principles have rendered fresh leaves, petioles and corms unacceptable for use as an animal feed without costly, high-energy processing. At least one case of cattle poisoning from consumption of the raw material has been documented. There are undocumented cases of use of taro leaves and stems as a pig feed, but these involved cooking the material for long periods of time. This strategy may have been acceptable earlier but with the current energy situation, it clearly is no longer acceptable (Tang in Wang, 1983, Chapter 6).

Based upon assessments of the potential of taro as an animal feed and the need for some degree of processing for storage and to neutralize the acridity, the silage process was determined to be the process most likely to achieve the goals. The high moisture content of the taro tops (up to 92%) and the environmental conditions under which it is grown make it difficult to field-dry taro tops, therefore suggesting that ensiling this product may have some potential for animal feed.

Upland taro can be harvested as forage and the best harvest interval seems to be 12 weeks with relatively heavy application of nitrogen fertilizers. Ensiling taro is a relatively simple process and a number of feed materials can be ensiled with taro tops. The fermentation process generally reaches stability and the silage should be ready to be used by the tenth day. Lactic acid levels would indicate the capability for prolonged storage.

A joint collaborative feeding trial with swine was conducted in American Samoa under an agreement between the University of Hawaii and the American Samoa Government Department of Agriculture. Financial support for the project came from the Western Regional Office of the U.S. Department of Agriculture.

Satisfactory performance can be obtained when gilts are fed varying amounts of taro silage. This seems to indicate that taro silage potentially can be utilized in pig production in the humid tropics without adverse effects.

An initial report (University of Hawaii, 1982) on dryland Bun-Long taro indicates that with soil moisture stress maintained at the 20 millibars level and a cutting interval of 12 weeks, an annual yield of about 5 MT/ha of dry matter can be harvested from taro tops. With bagasse mulching, 8 to 10 MT/ha of dry matter may be potentially available annually. An additional 5 to 10 MT/ha of dry matter may be derived from corms. These data are preliminary and more conclusive information will become available in 1983. The reason that they are discussed here is to give some preliminary indications of what potentials dryland taro crops may have as a feed crop.

Potential Industrial Used

Cosmetics

Rice starch has been commonly used in cosmetic dusting preparations such as face powders and other colored powders some of which are dispensed through various aerosol systems. Rice starch is regarded as the finest commonly available starch with a size of about 5 micrometers mean diameter. Considering that taro starch varies from 3.5 to 5 micrometers with higher gelation temperatures than rice starch (Bun-Long at 71°C vs rice at 64°C), one may speculate that taro starch can compete with rice starch in the cosmetic field where unit price is not much of a problem but small particle sizes and the efficiency with which color can be added to the particles may be important (Griffin and Wang in Wang, 1983, Chapter 12).

Fuel Alcohol

Many developing countries could reduce their dependence on imported oil considerably by replacing part of their petroleum requirement with alcohol produced from sugar or starch-containing crops. Taro would serve perfectly well as a raw material for alcohol production provided that local economies favor such production.

Roughly, the starch-to-alcohol conversion ratio has been identified as 1.76 kg of starch to 1 liter of alcohol.

The cost of alcohol production from cassava has been estimated at $0.15/liter or $0.57/gallon in 1978 dollars (Milfont, 1978; Phillips, 1978). As a first approximation, alcohol production cost from taro should be similar. As a comparison, the estimated costs of ethanol production from corn is $0.43/gallon and from sugarcane it is $0.57/gallon (Brown, 1980). The processing costs, of course, will vary with plant efficiency, fuel cost, and others. The starch-to-alcohol conversion process requires a substantial amount of energy, particularly in the distillation process, and where the energy comes from is clearly an important consideration. Sugarcane, because of the bagasse, brings with itself a large percentage of the required processing energy in the form of fuel for steam production. Taro, because of the high feed value of its leaves, may have an equally good overall energy balance if multiple uses of the entire plant are considered and a majority of the heat requirements for distillation could come from both solar and methane gas generated from animal waste.

Wang and Nagarajan (1981) have given the design parameters for a 43-hectare integrated fresh taro/swine/alcohol production system and estimated operational parameters of such an integrated system. The values used by Wang and Nagarajan were only best estimates that are subject to revisions to meet local conditions, and were used to illustrate how such a system could be designed and evaluated, and to show that such systems could be potentially economically feasible.

Summary

Taro (Colocasia esculenta) is an important plant in many South Pacific islands. There are sufficient existing data to indicate that taro silage, whether made of tops only or made of the entire taro plant, can be an effective substitute for a substantial portion of the commercial swine feed currently in wide use in these islands. Since pork production is important in these islands, and since taro prices tend to fluctuate widely following the annual production pattern of taro, an integrated taro/swine production system for small farmers in these islands has the potential of bringing significant economic benefits to the small farmers and consumers in these developing areas by stabilizing taro and pork prices and by directly increasing farm income through utilization of currently wasted plant materials.

The development of integrated taro/swine/alcohol production in some remote islands where fuel cost is high is a possibility that needs to be further explored. Production of alcohol is a well established technology; nevertheless, the technology is not currently available in many of the islands where the economic potential may exist.

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