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Select markets for taro, sweet potato and yam

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Foreword

This publication is part of RIRDC project UCQ-13A, "Development of taro, yam, yam bean, and sweet potato exports to Japan and the USA" co-led by Central Queensland University and New South Wales Agriculture. The Northern Rivers Agricultural Development Association, Inc. (NORADA) and Queensland Department of Primary Industries (QDPI) have also been closely involved in supporting the project since its inception.

At a workshop organised by Central Queensland University in February 2001, Asian Markets Research presented data related to the markets for three of the crops in Japan and the United States. Those data drew on earlier research undertaken in Japan, the United States, and the Pacific (Fiji, Samoa, and New Zealand) over the period 1998 - 2000. An output from the workshop was that further work should be undertaken to explore the market potential of sweet potato, taro, and yam in the major candidate markets of Japan and the United States. Two missions were determined. One concentrated on establishing what was needed to realise the market potential whilst the other concentrated on the acquisition of genetic material. The missions took place in mid-2001. As preparation for both exercises, Asian Markets Research prepared a series of profiles for sweet potato, taro and yams in the Japanese and United States markets. This publication updates those profiles with information collected on the 2001 market development missions.

Although the project focuses on the international markets of Japan and the United States, this publication also includes sections on the Australian market. This is because the development of international markets is invariably dependent on there being a solid domestic market.

This project was funded from RIRDC Core Funds which are provided by the Federal Government, and includes funds from Horticulture Australia Ltd.

This report, a new addition to RIRDC's diverse range of over 900 research publications, forms part of our Asian Foods Research & Development program, which aims to support industry in its drive to develop new products and markets and to gain competitive advantage through improving productivity in, and achieving price premiums for, Australian production.

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Sweet potato varieties in Japan

(Source: The Vegetable Supply Stabilization Fund, Tokyo, Japan)

1. Beniazuma

2. Kokei No. 14

3. Benihayato

4. Koganesengan

5. Yamakawa murasaki

6. Beniaka

Taro cultivars in Japan

(Source: The Vegetable Supply Stabilization Fund, Tokyo, Japan)

7. Ishikawa-wase

8. Dodare

9. Sereves

10. Yatsugashira

11. Tohno-imo: Ebi-imo

12. Takenoko-imo

Yam cultivars in Japan

(Source: The Vegetable Supply Stabilization Fund, Tokyo, Japan)

13. Naga-imo

14. Icho-imo

15. Yamato-imo: Ise-imo

16. Yamato-imo: Tanba-imo

Executive Summary

This report presents information gained prior to and during visits to Japan and the USA in search of potential export markets for three root crops. Parallel research is also underway on the choice of suitable sites and seasons for production, of suitable varieties, and postharvest practices, with some support being provided to the establishment of an entity responsible for coordination of production, export and marketing of the three commodities. Besides providing information on nomenclature of the species, this report also presents information on the domestic production and marketing scene.

In essence it is concluded that export opportunities are greater into Japan than the USA and that, from the export market price perspective, the yam type called yamato-imo, and more specifically the tanba-imo type, has greater potential than taro, and taro has far greater potential than sweet potato. Based on volume, however, the greatest export opportunity is for taro into Japan, followed by yamato-imo yams, particularly tanba-imo type, into Japan, then taro into USA and then lower potential for sweet potato into both Japan and USA. From a practical production perspective in Australia, however, more producers have experience growing sweet potato, fewer with taro and next to none with yams.

The report is organised by commodity, starting with sweet potato, followed by taro and ending in yam.

In the same order the following are the salient points from the report:

Sweet potato

- China dominates the world figures for production of sweet potato, with animal feed and industrial products the major uses of sweet potato. Availability is year-round (but seasonal according to specific geographical location) and prices in Beijing are quite stable whereas in production zones they rise before, and fall after, harvest season(s).

- In Japan sweet potato as fresh product is concentrated to their summer/autumn season. Between 10-15% of production is consumed as processed product. Wholesale market though put is declining steadily annually, and annual price has remained static, but seasonal price varies with maximum price/kg is achieved during June-August. Frozen imports offset this to some extent; but fresh sweet potato cannot be imported to Japan.

- Australian production of sweet potato is largely confined to Queensland, and varieties in the main have golden flesh (whereas Japanese varieties are normally red-skinned with white flesh). Fresh product supply to the market is constant year round, but price tends to rise in the second half of the year.

Taro

- Various species have been called taro; *Alocasia* spp., *Cryptosperma* spp., *Xanthosoma* spp. and *Colocasia* spp. It is the latter, which is referred to in the report, and then only to the 'small-corm' taro in an export context.

- Japan is the major world importer of the small-corm taro, with annual quantities averaging 20,000 t fresh and 55,000 t frozen. Called sato-imo, various types exist in Japan, and their seasonal price variation is in line with that for sweet potato (and less so far for yam). China supplies most of the imports to Japan, and because they share similar geography cannot supply the off-season with fresh product.

- Most Pacific Islands produce large-corm taro, for home/domestic consumption and for export (to New Zealand, Australia and the USA), the dominance of countries varying according to disease (taro blight) pressure. Fiji is now the major non-USA exporter. The USA follows Japan as the second largest importer of taro (large-corm type) with Costa Rica and the Dominican Republic supplying 90% of the demand.

- The Australian taro industry is quite new, although the crop is not new to Australia. Divided into two types – Taro Pacific (large-corm) and Taro Supreme (small-corm) – production spans NSW, Queensland and the Northern Territory. Production of Taro- Pacific peaks in May-September but prices are reasonably constant and imports reach up to 3000 t per annum. Production of Taro Supreme is in its infancy, with a view to satisfy local and export demand.

Yam

- While data on imports of yam to Japan from China are not available, annual production ranges between 140,000 – 200,000 t since 1986.

- It is highly likely that import opportunities will open if the yam industry follows that of taro and sweet potato, particularly for processed product. Fortunately at present there appears to be no quarantine barrier to entry.

- Efforts should concentrate on the yamato-imo types; ise-imo and the dark-skinned dark-fleshed tanba-imo.

Besides the primary focus of the report on markets and prices, it also provides detail on history of production, geographic locations for growing, their seasonality and varietal names, and contains a number of colour photographic plates depicting samples of various crops.

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1. Introduction

A market development mission was undertaken in 2001 to Japan and the United States in connection with the development of export markets for the Australian sweet potato, taro, yam and yam bean industries.

Using information gained on that mission as well as that resulting from follow-up activities associated with the project, a number of issues have emerged. These issues impact upon the development of the Australian industry for three of the four root crops (yam bean was removed from the priority action list due to its relatively low importance in the Japanese and USA markets), and relate to potential markets for Australian product or potential competitors to Australia. Five such issues are examined in this publication.

Sweet potato – China. Although an assessment of China was not part of the RIRDC project, given the size of Chinese sweet potato production, it is important that aspects of the industry there must be sketched. An understanding of China becomes particularly pertinent given the importance of Chinese exports to the Japanese market.

Sweet potato – processed product. Whilst Project UCQ-13A concentrated on the export development of fresh product, the market development mission to Japan aroused some interest in Japan of Australia as a source of material for processed sweet potato. For this reason the section on sweet potato in Japan contains reference to processed product.

Taro – nomenclature (1). The project was focused on the small golf-ball sized taro for the Japanese market. As part of the project, genetic fingerprinting activities were undertaken in order to ensure that Australia was producing the types required by the Japanese market. This rapidly led to an exposure of the contentious field of taro nomenclature where inconsistencies, contradictions, and confusion abound. The results of the efforts to clarify the nomenclature challenge are outlined in a separate section.

Taro – nomenclature (2). In an effort to consolidate the data on nomenclature, it was determined at an industry workshop[1] that the two basic types of taro would be referred to as follows:

- ***Taro Supreme (or small-corm taro)***: the smaller golf-ball sized taro demanded by the Japanese market and known in Japan as *sato-imo*.
- ***Taro Pacific (or large-corm taro)***: the larger taro typically associated with the Pacific and in the Chinese diasporas.

Taro Pacific. Australia has produced Taro Pacific for at least a century. Taro Pacific has its own market outlets and distribution chains. It is for this reason that Chapter 3 has been expanded to accord Taro Pacific the attention that it deserves. Thus details are provided on the two potential competitors, namely Fiji and Samoa, as well as the potential market of New Zealand. The section on Samoa outlines the devastating impact of the taro leaf blight on Samoan taro production and is a salutary lesson for the Australian industry.

[1] RIRDC Asian root crops project: "Development of taro, yam, yam bean and sweet potato exports to Japan and USA". Brisbane Meeting: Monday 29 July 2002.

Yam – nomenclature. The United States has a yam industry. However, no reference is made to the USA yam industry in this report because of another nomenclature confusion. In the United States the terms "sweet potato" and "yam" refer to *Ipomoea batatas* and *Dioscorea* spp. The terms are also used synonymously. In accessing the available data – principally import statistics and the various market reports – it was impossible to tell if the product referred to was either *I. batatas* or *Dioscorea* spp. It is for this reason that sections about sweet potato and yam in the United States are not included in this report.

2. Sweet potato

2.1 Sweet potato - Asia

Introduction

Sweet potato (*Ipomoea batatas)* is a perennial herbaceous dicotyledonous species of the morning glory family Convolvulaceae that is cropped as an annual in many countries. It is among the world's most important, versatile, and under-exploited food crops.

In stating that world production is estimated at 133 million tons, the following significant caveat is made:
Any review of the available facts on sweet potato production, consumption, and use in developing countries must be cognisant of discrepancies in data. Given the obvious difficulties in estimating production for a crop produced by small farmers on non-contiguous plots, harvested several times a year, and not sold through regulated domestic marketing channels or traded abroad in appreciable quantities, statisticians frequently resort to using available national statistics to estimate production, area, and yield. Unfortunately, there are often discrepancies between national data and those of the Food and Agricultural Organisation, the major supplier of international data from developing countries.

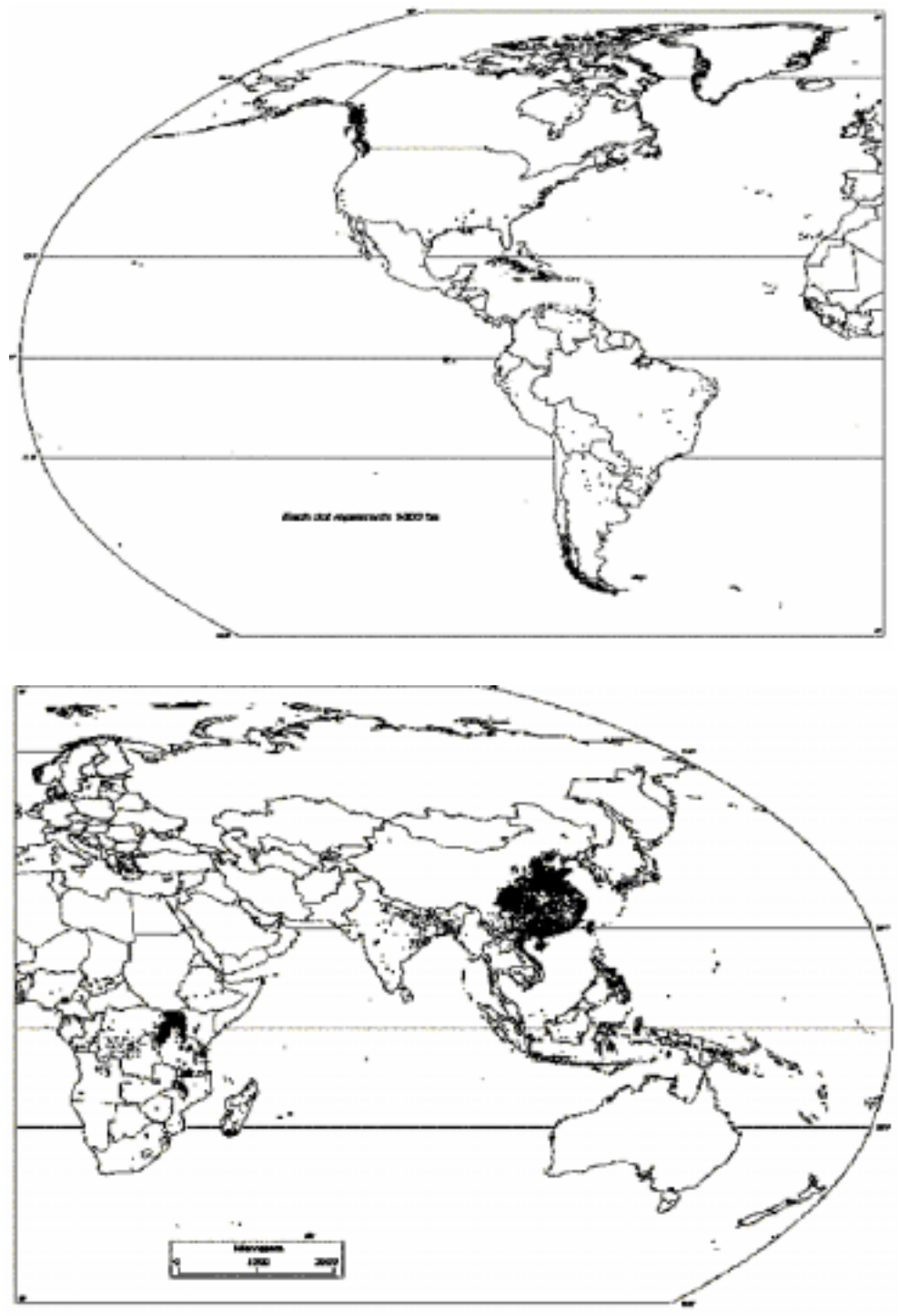
In annual production, sweet potato ranks as the fifth most important food crop on a fresh-weight basis in developing countries after rice, wheat, maize, and cassava. Sweet potato is cultivated in over 100 developing countries and ranks among the five most important food crops in over 50 countries. Several facts probably explain the reason why sweet potato has not received much mainstream research attention:

- Sweet potato is typically a small farmer crop and is often grown on marginal soils with limited outputs.
- Although the crop is grown widely in Asia (n=31), Africa (n=39), and Latin America (n=31), production tends to be concentrated in those countries with lower per capita incomes and, within those countries, in regions such as Sichuan province in China or western Kenya where income levels are relatively low.

Sweet potatoes probably originated in Central or South America but are now grown in many tropical, subtropical, and temperate regions (Fig. 1). Asia is the world's major production area for sweet potato. In Asia, the greatest share of production is in China that accounts for about 85 percent of global production. In the last decade a reversal of previous downward trends in sweet potato production in China has had a positive impact on the global supply. Similar upward trends have emerged in a number of other developing countries. Some of these trends are evident from FAO statistics; others are not.

The previous caveat on statistical data applies to China. Interpreting observations about national trends for root and tuber production, sown area, and yield must be done with considerable caution. These statistics refer to a geographic area of continental proportions and a rural economy that consists of millions of farm units. Major differences exist in cropping systems for these commodities both within and among different regions. This further complicates the monumental task of accurately estimating actual developments. In addition, apparent trends are subject to major revisions based, for example, on new information about under-reporting or over-reporting by zealous officials.

Figure 1. Global sweet potato production locations 1996–1998, each dot represents 1000 ha.



Sweet potato production in Asia is characterized by four trends:

- Continued overwhelming dominance of China.
- Shrinking area planted to sweet potatoes—a trend that has accelerated in much of the region during the last ten years.

- Levelling off of yields as the rate of growth has slowed in many countries, including China. As sweet potato cultivation has been pushed onto more marginal land and average yields have improved to 17 t/ha, it has become more difficult to maintain the rate of growth of improvement in yields.
- The possible shift in future prospects for regional sweet potato production due to recent changes in relative prices for sweet potato versus traditional substitutes such as imported wheat flour, as a consequence of the economic crises in Southeast Asia.

Plant Characteristics

Sweet potato plants produce primary fibrous roots, pencil roots and storage roots. Storage roots are the only part eaten in most developed countries, but in parts of Asia (and Oceania) the leaves are cooked as spinach and eaten as a green vegetable. Storage roots are attached to the stem by a stalk of thinner root that is usually initiated at the stem node just below the soil line. Skin colour of storage roots ranges from white to brown to red-orange. Flesh colour of storage roots can be red-orange, orange, yellow or white. The flesh can be either soft or firm.

Production Practices

In tropical areas, sweet potatoes can grow year-round. Propagation is by shoot-cuttings from plants of the previous crop. In temperate areas roots are stored during the winter months to serve as a source of 'seed' for sprout production. The sprouts are transplanted into the production field. This latter practice in temperate areas is somewhat inefficient, as it requires use of a significant proportion of each crop for production of the next crop, but practical alternatives have not been developed. Sweet potato plants can be cultivated from meristem tissue, but this is done to remove viruses from seed stock rather than to obtain transplants for field production. Planting sweet potato root pieces directly in the field, as is done with white potato tubers, does not result in sufficiently uniform storage roots. True seed is not a viable option because sweet potatoes are genetically complex and plants growing from true seed are extremely variable.

Crop Loss

At all stages of production there is potential for disease transmission. In conventional production, fungicides are used to reduce fungal disease transmission and insecticides are used to prevent insect transmission of viruses. Sweet potatoes can be grown organically. However, production is more difficult and the results less satisfactory than with organic production of other vegetables because of the high potential for disease transmission.

Growth cracks are a common condition and are caused by uneven growing conditions, usually uneven watering, and are sometimes associated with secondary disease problems. Cracks are most common on large roots and on nematode-infested roots. Certain viruses also increase cracking. Souring of roots occurs in waterlogged soils and in airtight storage containers. Roots are very active metabolically and become oxygen-starved at low soil oxygen levels.

Ethanol and CO_2 accumulate as by-products of anaerobic respiration. This accumulation breaks down root tissues of sensitive cultivars in the soil or later in storage.

Sweet potatoes have an unusually high rate of vegetative mutation, as high as 20 percent in the cultivar *Jewel*. Multi-coloured roots, called chimeras, have areas of differently coloured skin or

flesh. An important function of certified seed producers and the foundation seed programs that support them is to rogue out or remove such mutations.

Harvest and Post-Harvest

Depending on the cultivar, roots develop to marketable size in 90 to 150 days after transplanting. Normally, harvest begins when most of the roots are at a size suitable for the market – which may vary with intended end use.

Sweet potatoes are susceptible to damage at harvest. Harvested roots left in the sun at temperatures above 90° F sun scald in 30 minutes. Scalded areas turn purplish-brown and are more susceptible to storage rots. In very dry soil, the root periderm, or outer layer of skin, becomes more fragile and easily abraded or 'skinned' on the hard soil clods during harvest. Sweet potatoes do not have a thick protective outer layer of cells such as that on white potato tubers. Any abrasion can lead to rots in storage. Skinning injury in dry soil can be avoided either by waiting for rain or by irrigating the field before harvest. Rough handling by workers also tears the delicate skin. Skinned areas can become dark and sunken and surrounded by a narrow brown border. These scars offer opportunities for storage rot pathogens such as *Fusarium* spp. to enter the root.

Harvest must take place before severe frost because if vegetation is killed by the frost, roots left in wet soil may sour. Light frosts are not serious unless soil temperatures fall below 50 - 55° F for several hours. If storage roots are exposed to temperatures below 40° F overnight, internal breakdown may also occur in storage.

2.2 Sweet potato - Australia

Background

Sweet potato is not a new crop to Australia and it is thought to have been introduced by the Chinese who came with the gold rushes of the nineteenth century.

Interest in sweet potato as a commercial crop can be traced to work undertaken by the Queensland Department of Agriculture and Stock in the 1920's. Most if not all the varieties documented at this time were produced for feed supplements for cattle and pigs. Since the early 1970's the Queensland Department of Primary Industries has been involved in introduction and testing of many of the American-bred dessert type varieties.

The introduction of the American dessert types has transformed the Australian sweet potato industry. Consumers are now able to purchase smooth easy to peel varieties such as Beauregard. The introduction of Beauregard has improved the convenience and preparation of sweet potato and consumer demand has improved.

The major supermarket chains have reported improvements in sales in the last four years and attribute much of this success to the introduction of Beauregard. Whilst sweet potato only makes up a small percentage of the major retailers total fresh vegetable turnover, the rate of growth in sweet potato sales has been very high. This growth has been more apparent in the higher value end of the market with many stores in affluent suburbs now showing the highest sales. This has lead the major retailers to target sweet potato grading and hence tightening of specifications. The major retailers consistently pay higher than market floor price for product that meets their specifications. This improvement in uniformity and consistency is thought to fuelling improvements in consumption

Further growth in popularity can be expected with the introduction in 2002 of a sweet potato crisp. Sweet potato releases its sugars slowly and evenly. This even release is considered good for diabetics, an attribute that will enhance the tuber's popularity with diabetics.

Production

Current total Australian production is estimated at 16,000 t. Queensland is the major producer, growing around 11,000 t in 2001. The Bundaberg area is that State's largest sweet potato growing region with an estimated 7,500 t grown there. Other major producing centres are in the Rockhampton area with 1,500 t and on the Atherton Tablelands with 1,200 t.

The preferred varieties have gold flesh and include Beauregard, Beerwah Gold, and Hernandez. These constitute around 95 percent of the total with the red-skinned-white-fleshed types being the major component of the remaining 5 percent. In many parts of Australia white skinned purple fleshed types are sought after particularly by ethnic groups such as Vietnamese and Cambodians, however this is only a very small niche market. Shape and size are major considerations as they improve convenience for consumers. The preferred size sweet potato is 180-250 mm with a diameter of 60-75 mm and around 600 g in weight. The most sought after shape is almost submarine-like with minimal grooves and shallow eyes; this facilitates the convenient use of a potato peeler when preparing the product, thus meeting the all-important modern criteria of convenience.

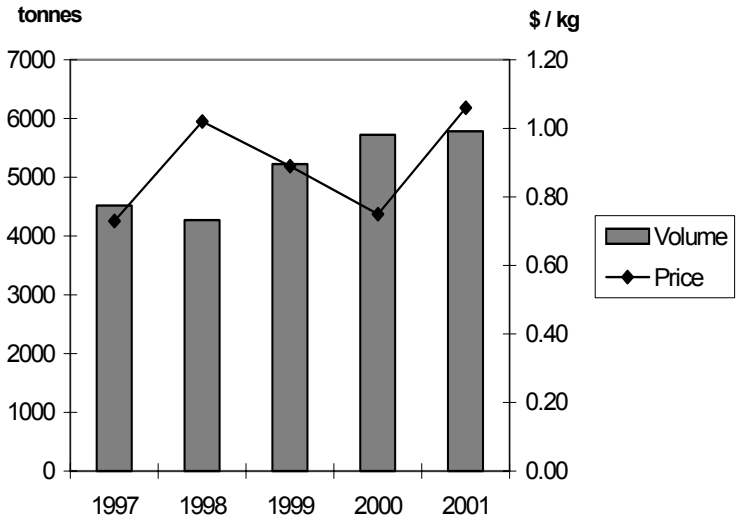
Plant material for a range of varieties is readily available in Australia however the majority of the market is for gold-fleshed types because of their consistency and convenience. Twelve-month supply lines exist for gold flesh varieties with many retailers stating that the only thing that stops them from running white skinned and purple fleshed varieties is the lack of availability of smooth consistent tubers. Research work including selections for these attributes is now being conducted in Australia.

Marketing

Whilst Queensland is the major supplying state, the major outlet is Sydney. For this study wholesale marketing data are drawn from the Brisbane system as an indication of the Australian market[2].

Volume throughput at the markets has steadily increased over the five years to 2001 (Fig. 2). For the four years to 2000, the price–volume interaction is as expected, that is movement in volume in one direction resulted in the movement of prices in the opposite direction. Year 2001 interaction is contrary to expectation: volume increased marginally whilst prices increased by 40 percent[3].

Figure 2. Sweet potato - Australia. Annual wholesale performance, Brisbane: 1997- 2001.

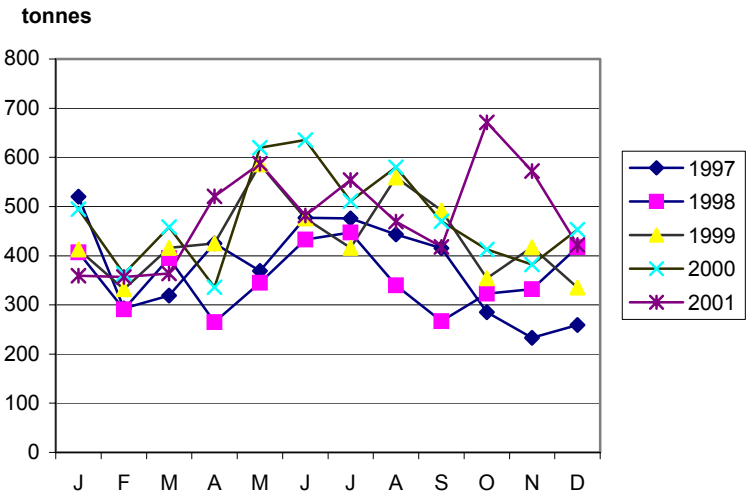


[2] All Australian wholesale market data noted in this report – see Taro and Yams - is derived from data collected by Market Information Services http://www.ausmarket.net.au

[3] Based on total volume of the three types Gold, Red and White, and overall average prices.

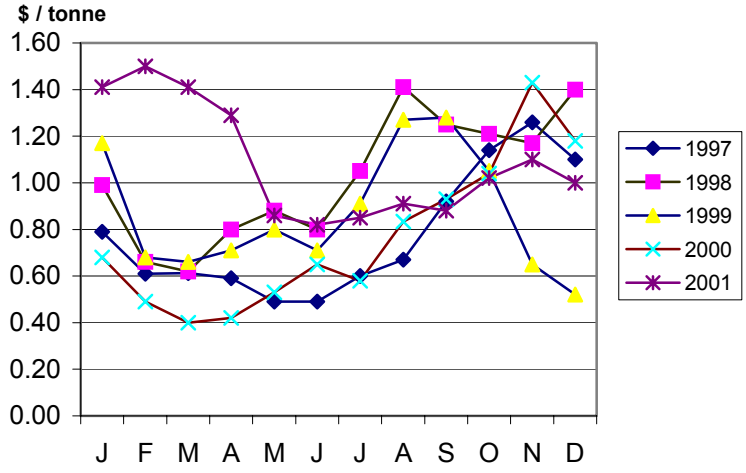
Monthly throughput is erratic making identification of a precise pattern very difficult (Fig 3). About the only distinguishable pattern is that volume declines in February and increases in March.

Figure 3. Sweet potato - Australia. Monthly wholesale throughput, Brisbane: 1997 - 2001.



In contrast, prices (Fig. 4) show a more definable pattern with prices being markedly higher in the second half of the year.

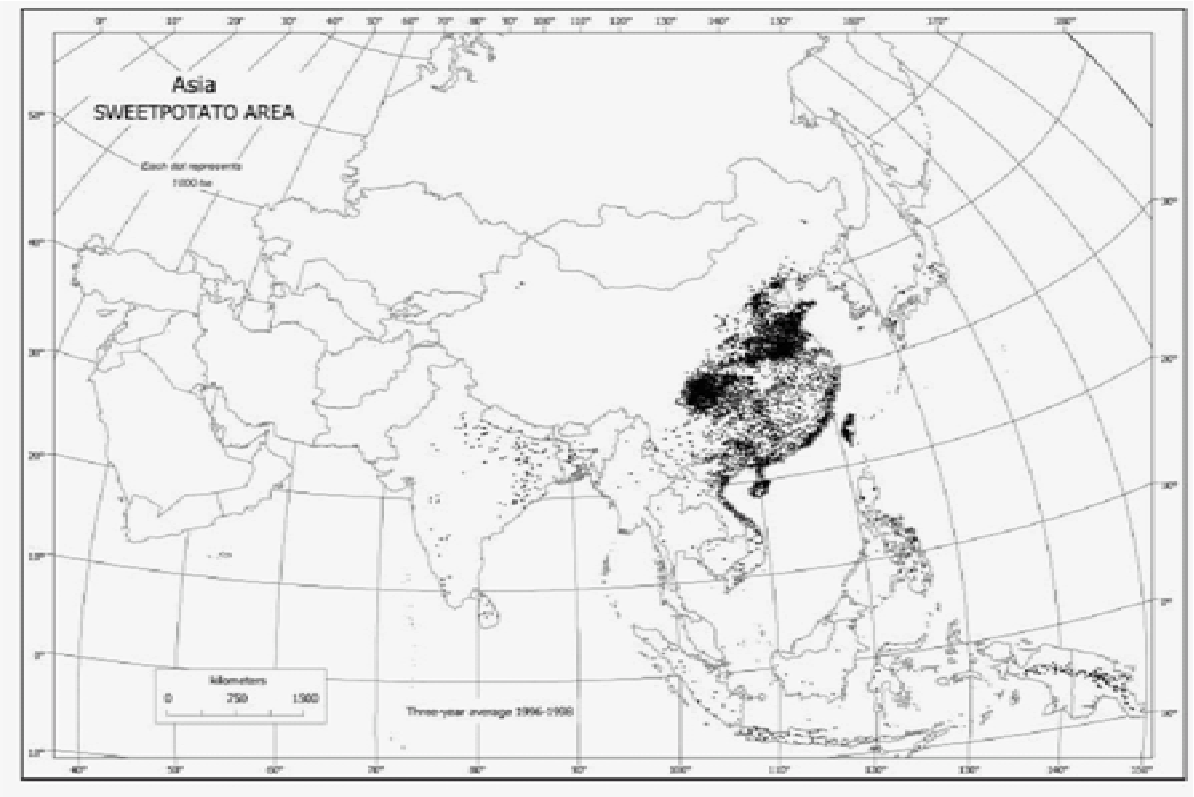
Figure 4. Sweet potato - Australia. Monthly wholesale prices, Brisbane. 1997 - 2001.



2.3 Sweet Potato - China

On aggregate, Chinese farmers produce more sweet potato than anywhere else in the world. Yet outside China little is known about their technology, cropping systems, utilization patterns or research infrastructure.

Figure 5. Asia: Sweet potato production locations, 1996-1998, each dot represents 1000 ha.



Introduction of sweet potato to China

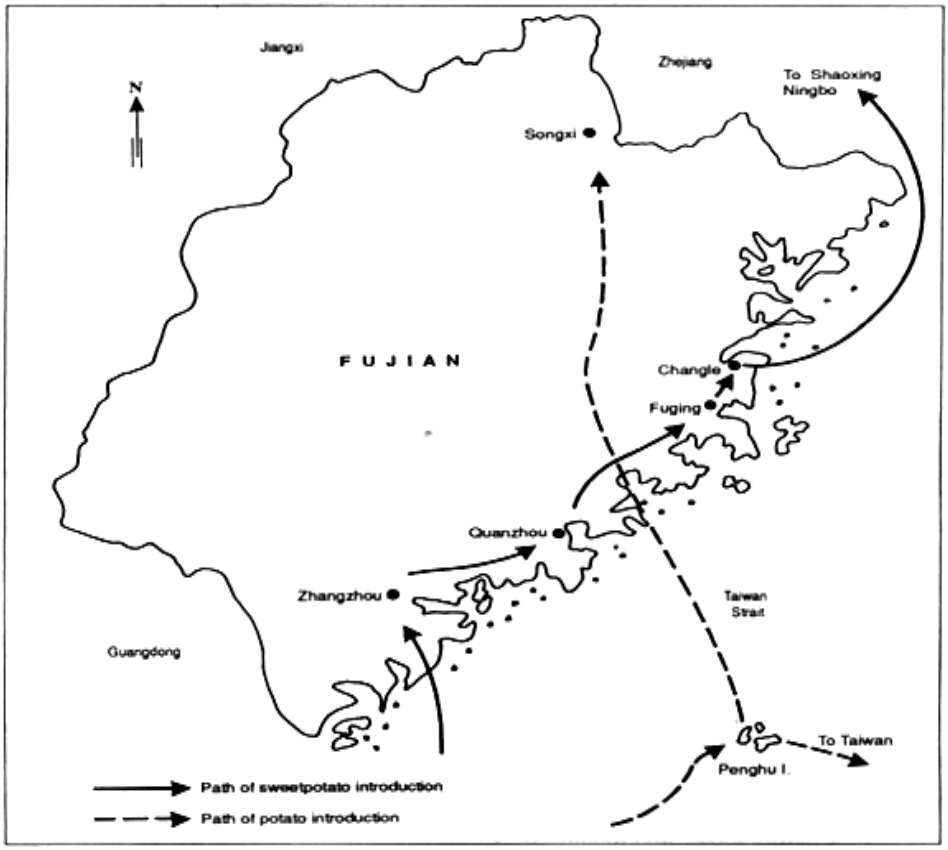
Sweet potato is thought to have been introduced into China by two main routes, each occurring at different times.

- Yunnan Province from India, Burma, or Vietnam sometime before 1563[4].
- Fujian Province[5], probably about 100 years later.

Given the geographic isolation of Yunnan province the spread of sweet potato across China is likely to have been from Fujian to other provinces along the coast and through the Yangzi and Yellow River valleys over the following several hundred years (Fig. 6). Sweet potato may have been introduced to Zhangzhou in Fujian Province and then it spread northward along the coast to Quanzhou and later to Changle and Fuqing.

[4] Sweet potato cultivation in Dali Prefecture in western Yunnan Province is mentioned in the *Dal~fuzhi* (Dali Prefecture Gazetteer) in 1563 and in the *Yunnan Tongzhi* (Yunnan Gazetteer) in 1574.
[5] *Minxiaoji* (Fujian Memoirs) from around 1650 mentions the importation of sweet potato from the Philippines.

Figure 6. China – Fujian Province: spread of sweet potato.



Nomenclature

Nomenclature varies geographically, and is outlined in Table 1. The most common names for sweet potato are *ganshu* "sweet potato" and *hongshu* "red potato". Sometimes nomenclature overlaps for different root and tuber crops in different places. For example, a variety of yam *Dioscorea esculenta* is usually called *shanyao* "mountain medicine", but is also occasionally referred to as *ganshu* "sweet potato". This crop has been cultivated in south China since at least the first century B.C. Sweet potato, a comparatively modern crop, has effectively stolen the name.

Table 1. China – Common names for some root and tuber crops.

Crop	Chinese name	Literal translation	Region of use
Sweet potato	*Ganshu*	sweet potato	General, throughout China
	Hongshu	red potato	General, especially in south and central China
	Hongshao	red creeper	West-central China, e.g., Henan, Sichuan
	Baishu	white potato	Central China, e.g., Henan, Anhui, Beijing
	Shanyu	mountain taro	Central China, e.g., Henan, Anhui
	Hongyu	red taro	West-central China, e.g., Henan
	Digua	ground melon	North and central China, e.g., Henan, Hebei, Shandong
	Fanshu	foreign potato	Henan, Fujian,, Guangdong
Yam	*Shuyu*	potato yam	General
	Shanyao	mountain medicine	General
Taro	*Yu*	taro	General
	Yutou	taro head	General
Yam bean	*Digua*	ground melon	Sichuan
Winter radish	*Dongluobo*	winter radish	General
	Hongluobo	red radish	General (archaic)

Sweet potato in China

Historically, in China all root and tuber crops were grown as a staple and/or for food security. Therefore, on-farm consumption has always been high. Even today in China, on farm consumption of sweet potato is the main use of the crop in the poorest areas. Food security aspects of sweet potato cultivation are probably the reason for its original acceptance.

More recently, as production of fine grains has developed rapidly in most regions, the role of sweet potato has changed, as illustrated in Table 2. A sizeable amount of production is still consumed by humans, although an increasingly greater proportion now is utilized by the processing or livestock feed industries.

Table 2. China - Shandong Province: sweet potato utilization as a percentage of total use in each year.

	Food (%)	Feed (%)	Industrial (%)	Seed (%)
1983	50	30	10	10
1989	10	55	30	5
1997	5	50	40	5

Change is not a universal phenomenon in China; great regional disparities remain in food consumption of sweet potato. Many people still depend on it as a staple or for food security, yet in urban areas such as Beijing or Shanghai, consumers are starting to again consume sweet potato, this time not as a staple but as a high end of the market vegetable.

There are a large number of varieties, either developed, under development or maintained in germplasm collections for breeding. Appendix 5.1 outlines some of the major varieties with their maturity, disease resistance, yield, dry matter content, and distribution characteristics.

Generally only a few varieties will be used within a province, as illustrated in Table 3 for Shandong Province. Provincial differences are evident. A striking characteristic in China is the very rapid adoption by farmers of newly introduced varieties; complete adoption can be within five to seven years.

Table 3. China – Shandong Province: current main sweet potato varieties.

Variety	Main use	Yield (t/ha)	Dry matter (%)	Starch content (%)
Xushu 18	Starch	22.5	27	18
89-1524	Starch	22.5	28	19-22
88-1070	Feed	30	25	12
Nanshu88	Feed	22.5	25-26	14
Chuanshu 27	Table	--	--	12
Chuanshu 1	Table	45	25	12

Production of sweet potato

The total area grown to sweet potato in China is estimated at 6,131,167 ha. The crop is grown in most provinces, the most important being Sichuan, Shandong, Anhui, Henan, and Hubei (Table 4).

Table 4. China - Area planted to sweet potato, 1999.

Province	Area (ha)	Province	Area (ha)
Anhui	623 368	Beijing	7 541
Chongqing	327 274	Fujian	246 902
Guangdong	448 556	Guangxi	335 007
Guizhou	157 878	Hainan	173 941
Hebei	277 068	Heilongjiang	3 258
Henan	632 859	Hubei	161 066
Hunan	271 856	Jiangsu	230 041
Jiangxi	94 420	Jilin	4 782
Liaoning	37 084	Nei-Mongol	429
Shaanxi	113 120	Shandong	1 036 687
Shanxi	43 960	Sichuan	1 036 687
Tianjin	4 966	Xinjiang	3 617
Yunnan	84 242	Zhejiang	134 579

Over time production has been dynamic, with an overall national trend indicating decline in production, planted area, and yield. However, sweet potato trends are not uniform across provinces. Only two provinces follow the national trend. In Beijing, Fujian, Hainan, Inner Mongolia and Jilin production, planted area and yields are all increasing. However, all but Fujian are small production areas. The remaining provinces are categorized into four groups:

- Increasing planted area and decreasing yield – where sown area increase is greater than yield decrease. This group consists of mainly the poor provinces in the south and southeast (Guangxi, Guizhou, Jiangxi, Yunnan, and Liaoning). Production is mainly for fresh consumption.

- Increasing planted area and decreasing yield - where yield decrease is greater than increasing production area. This group includes the large producing provinces of sweet potato, Sichuan, Hubei, Hunan, and smaller producer Shanxi.

- Declining planted area and increasing yield – where yield increase outweighs decrease in planted area. This applies only to the two provinces of Guangdong and Shaanxi.

- Declining planted area and increasing yield – where declining planted area is the predominant. This is the trend in Anhui, Hebei, Henan, Shandong and Tianjin.

Production Technology

High-yielding sweet potato cultivation techniques

Sweet potato yields in China are extremely high. Provincial average yields may be as high as 28 t/ha, with local yields as high as 110 t/ha of fresh roots for small plots: yields of 60-70 t/ha are common. Spring sweet potato is more likely to be higher yielding compared with summer and fall sweet potato. The reasons are that the spring growing season is longer than that for the summer or fall crop, and the time and labour available for spring land preparation is greater.

Whereas the resource endowments for the summer and fall sweet potato crops are poorer than for the spring crop, the crops may be extremely high yielding, especially in the double-cropping region south of the Huai River. Some areas use heavy fertilizer applications, high ridges, and deep furrows to allow greater planting densities, rush ploughing and planting, and intensive field management.

Fertilizer application in high-yielding sweet potato systems

Fertilizer is applied three times to achieve high summer sweet potato yields. The first application is a base application consisting of the stubble from the previous crop as well as three cubic meters of dried manure or 750-1,000 kg of organic manure applied to the previous crop in the rotation. The second application is spread on the borders of the field and afterwards ridges are ploughed. For each hectare, about 30 to 35 cubic meters of barnyard manure or 50 to 60 cubic meters of mixed manure is applied. The third application is combined with ridge ploughing. Each hectare receives 110-150 kg of ammonium bicarbonate and 225 kg of calcium super phosphate. The fertilizer is injected into the ridges rather than applied on the surface, this prevents run-off losses.

Land preparation and planting techniques

High ridges and deep furrows are ploughed to allow planting of double rows of seedlings on ridge crowns. This also allows drainage during the most water logging-sensitive time of the sweet potato-growing season. Summer rains come not long after planting. Ridges are spaced about 42 cm apart, are about 43 cm tall and have 43 cm crown widths. Every 30-40 m, field drainage ditches connected to the furrows and field head canal are built to drain standing water in the fields. Seedling density is around 55,000-60,000 per hectare.

Rush planting

Rush ploughing and planting are ways to maximize the efficiency of labour used during the summer planting season. This is a very busy time with harvest of the spring crop and land preparation and planting of the next crop. As soon as a plot of land is harvested, it is ploughed and planted. Every morning and evening, sweet potato is planted, and in the afternoon the summer rice crop is transplanted. This is all completed before June 20.

Field management

Field management includes weeding, ridge maintenance, fertilizer application, and drainage to promote early development. When ridges are eroded, they are repaired as quickly as possible. Weeds are pulled as soon as they appear, rather than when they grow large. To promote growth in the field, about 150-225 kg/ha of ammonium bicarbonate is applied when seedlings turn green.

China's climatic zones

There are five climatic zones for sweet potato.

Region #1: Northern spring sweet potato region

In this northern most region, sweet potato is grown in a range of terrains, from plains to mountain regions. The region has a humid or semi humid monsoonal, temperate and cold temperate zone climate. The main sweet potato producing areas in Region #1 are:

Province	Principal production areas
Heilongjiang	Dongning and Shangzhi counties
Liaoning	Jinxian, Xinxian, Gaixian, Xingcheng, and Yixian counties
Shaanxi	Weinan Prefecture
Gansu	Wenxian, Wudu, and Kangxian counties of Wudu Prefecture
Beijing	Miyun, Xunyi, Fangshan, and Daxirig counties
Tianjin	Jixian county
Hebei	Parts of Chengde and northern Baoding Prefectures
Xinjiang	Hetian in the south, Shithezi in the north, and Turpan and Harni in the east

Sweet potato is planted in mid-to late May and harvested in late September or early October. The growing season is 130-140 days. The region has short summers and long winters and, although the growing season is short, conditions for sweet potato cultivation are good. Summer rainfall is high, autumn is cool, day and night temperature differential is large, and solar radiation high. Because the high summer temperature period is only three months, selection of early season high-yielding varieties and the use of heated seedling beds is necessary. The cropping system is one crop per year with spring sweet potato as the main crop. In the southern part of the region, summer sweet potato is sometimes cultivated for use as a reserve seed stock.

Region #2: Huang-Huai basin spring and summer sweet potato region

This is the main sweet potato growing region in China encompassing the area north of the Huai River and in the Yellow river basin. The region is bounded on the north by the south face of the Qinling Mountains, and on the south by the Huai River and the North Jiangsu main irrigation canal. The region includes all of Shandong Province, and parts of Henan, Shanxi, Jiangsu, Anhui, Henan, and Gansu Province.

Sweet potato is distributed on the plains and is grown with other dry-land crops. It is the main crop grown, occupying about 40 percent of the total area. In Shandong, sweet potato is grown everywhere with the Province's principal production areas constituting about 60 percent of total area. The principal production areas in the seven provinces in Region #2 are as shown below:

Province	Principal production areas
Anhui	Fuyang and Suxian prefectures
Hebei	Xingtai, Baoding, and Shijiazhuang prefectures
Jiangsu	Xuzhou and Huaiyin prefectures
Shandong	Linyi, Changwei, and Yantai prefectures
Gansu	Wudu Prefecture
Henan	Shangqiu, Luoyang, and Xuchang prefectures
Shaanxi	Shangluo and Hanzhong prefectures

The climate is temperate semi-humid monsoonal. The region is dry in the spring, with rapidly increasing temperatures. Summer is rainy with high temperatures. The difference between day and night temperatures is large. The sweet potato growing season has many dry, sunny days, with sunlight sufficient for high photosynthetic efficiency.

Spring sweet potato is planted in late April to early May (except in the area near the Huai River that grows a winter crop and plants late in May) and harvested in early to late October. The growing season is 150-180 days. During the growing season from May to October, the temperature is 20°C and the daily temperature differential is 9-15°C. Summer sweet potato is planted from mid-June to early July and harvested about the same time as spring sweet potato. The growing season is 110-120 days. Temperatures during July and August average more than 25°C. Starting in September, the temperature gradually falls to an average of 13-16°C in October. Precipitation is higher in the eastern portion of the region and is concentrated in June, July, and August.

The main cropping system is three crops per two years including one spring or summer sweet potato. A single spring crop per year rotation is also fairly common.

The major pathological problems in this region are:

- Sweet potato black rot,
- Sweet potato root rot, *Fusarium solani* or *F. juvanicum*,
- The potato rot nematode, *Ditylenchus destructor*,
- Pests – cutworm & leaf beetle

Region #3: Changiang basin summer sweet potato region

South of the Huai River, sweet potato is grown in hilly areas. Production in Hubei is concentrated in the hilly northern, western, and south-eastern areas where most cultivation takes place above 500 m. Production in Yunnan is distributed at elevations between 1,000–1,500 m. In Sichuan, a leading national producer, sweet potato is concentrated in the Sichuan Basin.

Province	Principal production areas
Hubei	Yun, Yunxi, and Jun counties in the north, Enshi Prefecture in the west, and Yangxin and Tongshan counties in the southeast
Hunan	Changde, Yiyang, and Xiangxi prefectures
Jiangxi	Jiujiang and Yichun prefectures
Zhejiang	Wenzhou, Taizhou, and parts of Zhoushan and Jinhua prefectures
Guizhou	Tongren Prefecture in the northeast, Zunyi Prefecture in the north, and Qiandongnan Autonomous Prefecture in the southeast
Yunnan	Dongchuan, Yuanmou, and Yongshan counties in the northeast
Sichuan	Nantong, Mianyang, and Neijiang Prefectures in the Tuo, Fu, and Jialing River basins

The climate is northern monsoonal subtropical humid. Solar radiation, daily sunlight, and the sunlight coefficient are the lowest among all the regions. The influence of the large number of rivers in the upper and middle reaches of the Yangzi River - high evaporation, and heavy clouds and fog - all tend to affect adversely sweet potato cultivation.

Summer sweet potato is planted from late April to late June and harvested in late October through mid-November. The growing period ranges from 140-170 days, with average temperature above 22°C between June and September. In October, the temperature is still two to three degrees above that found in Region #2. The first frost usually comes in mid-November and occasional cold spells are accompanied by rain during the winter months. The average daily temperature differential during the growing period is 8-11°C, with precipitation concentrated in the spring and summer in the east and in the summer and fall in the west.

The major pathological problems in this region are:

- Black rot *Ceratocyslis fimbriata*
- Bacterial wilt *Pseudomonas solanacearum*
- Root rot
- Sweet potato weevil *Cylas formicarius*

Region #4: Southern autumn and winter sweet potato region

This region is in the south and central parts of the monsoonal semitropical humid climate region. The principal production regions in the six Provinces are shown below.

Province	Principal production areas
Jiangxi	Ganzhou Prefecture
Guangxi	Hechi, Liuzhou, Guilin, Baise, Nanning, and Yulin prefectures
Hunan	Chenzhou, Lingling, and Hengyang prefectures
Fujian	Jinjiang, Putian, and Ningde prefectures
Yunnan	Honghe and Wenshan autonomous states
Guangdong	Shaoguan and Meixian prefectures

Summer sweet potato is sown in May and harvested between August and October. An annual rotation of early rice and fall sweet potato makes up a large proportion of the crop.

The growing season is 120-150 days. The first frost is in early to mid-December. The mean temperature from August to October is 25°C in November; it declines to 13-18°C. The temperature difference between day and night averages 7-10°C.

The main sweet potato diseases in this region are black rot, bacterial wilt, and sweet potato scab. The main insect pests are weevil (*Cylas formicarius*) and leaf beetle (*Colaposoma dauricum*).

Region #5: Humid tropical monsoon region

This region lies in a humid tropical monsoon climate. The principal producing regions in the three main provinces are shown below:

Province	Principal production areas
Guangdong	Zhanjiang, Hainan and Shantou prefectures
Guangxi	Qinzhou Prefecture and some counties of Nanning and Yulin prefectures
Yunnan	Simao Prefecture

It is noted that parts of the three Provinces constitute part of the southern autumn and winter region (Region #4).

Region #5 has a hot season of 8-10 months. It also has the lowest day and night temperature differential in the country. There are two dry seasons when the monsoons change direction between spring and summer, and between fall and winter. In the region, summer temperatures are high with

little difference in day and night temperature. These are poor conditions for sweet potato growth. Fall and winter temperatures are usually warm and the weather is dry, thus exerting opposing influences on sweet potato. Sweet potato may be grown in all four seasons here, but the main crops are fall and winter sweet potato. Fall sweet potato is divided into paddy grown and upland grown. Paddy-grown fall sweet potato is planted from mid-July to mid-August, whereas upland fall varieties are planted from early July to early August. Both are harvested from early November to late December.

The growing season is 120-150 days. Fall sweet potato is also planted for over-wintering and harvested the following spring. Most winter sweet potato is planted in November and harvested the next year in April or May. The growing season is 170-200 days. The average monthly temperature during the growing season for winter sweet potato is above 20°C, except from December to February.

The major pathological problems in this region are:

- Bacterial wilt *Pseudomonas solanacearum.*
- Black rot *Ceratocystis fimbriata.*
- Viral diseases.

Utilization

Fresh root is used for human consumption, industrial processing, and feed. It is eaten fresh after cooking and dried as a staple food in poorer areas. In more affluent urban areas it is consumed as a vegetable, the resurgence in popularity driven by an increasing health awareness trend. Roasted sweet potato is a popular snack throughout China as are a number of chipped products. These can take the form of very basic products in rural areas or sophisticated niche marketed products (i.e. health benefits) in wealthy urban areas (Table 5).

Table 5. China - Principal sweet potato products.

Food products	- Unprocessed fresh, dried, and boiled tubers as food - Canned and candied tubers, cakes, frozen fried tubers, ice cream, sherbet, pancakes, paste - Refined dried tubers including Red Heart brand dried sweet potato and dried strips
Refined starch products	- Starch - Vermicelli, sheet jelly, noodles
Saccharification products	- Dextrose, fructose, glucose, maltose, amylose, amylose paste - Sugar residues

Industrially, fresh root is processed into starch and alcohol products, and both fresh root and vines are used as livestock feed.

Utilization trends vary enormously between provinces and depend on extent of development and relative geographic isolation. Richer provinces such as Jiangsu and Guangdong use less sweet potato for food, and more for processing and feed; these provinces tend to have lower post-harvest losses than poorer provinces such as Sichuan and Guangxi, (Table 6).

Table 6. China - Sweet potato utilization in selected provinces – 1999.

Use	Output (% within province)				
	Shandong	Jiangsu	Sichuan	Guangdong	Guangxi
Food	5	5	70	30	30
Feed	50	20-30	15	70	30
Industrial use	40	50	15		3-5
Exports				10	
Waste, losses, and seed	5	25	up to 60	10	<35

In terms of developing sweet potato for industrial use Shandong is rapidly becoming a major player. This province has an aggressive policy focused on developing sweet potato as an industrial raw material. Farmers in Shandong generally grow two different major types of sweet potato – varieties for table consumption and those for industrial use. The later are normally harvested the earliest.

Processing

Processing of sweet potato occurs at scales ranging from artisan farmer household to industrial scale. Simple processing of sweet potato by farmers includes slicing and field-drying chips after harvest. Dried chips are sold to factories or sent to market by farmers themselves if they have the means to transport the product to the factory gate, or through middlemen if not. Fresh root is also sent to factories, again either by farmers or middlemen. Dried chips are used as a snack food or occasionally as a raw material for starch production.

There are many staple and non-staple food uses for sweet potato. In addition to fresh root, examples include starch, noodles, alcoholic beverages, vinegar, and monosodium glutamate. In Sichuan, sweet potato chip snacks made from starch have been developed for farm-level operations. Boiled, sun-dried flavoured chips and strips are also produced and have become quite popular.

Waste and storage losses

Waste and storage losses vary greatly from area to area, but, in general, they are lower in the north and higher in the south. Less than 10 percent of production is waste, but storage losses are much higher. In Sichuan Province, waste can be as high as 60 percent of the amount stored; Guangdong losses can be up to 30 percent. The primary causes of storage losses are black rot, *Pseudomonas,* and *Rhizopus* spp.

Marketing

Marketing and utilization patterns for sweet potato have undergone drastic changes since the introduction of the economic reforms of 1978.

The structure of demand has changed as incomes have increased, with sweet potato food use declining and industrial and feed use increasing. Utilization is now directed toward higher value uses, such as industrial processing, animal feed, and processed food products in more developed regions of the country, rather than staple consumption.

The marketing structure has changed as a result of government withdrawal from former procurement and marketing functions. Prices also increased during the initial reform period but over the last few years have remained remarkably stable.

The marketing of sweet potato since the reforms of 1978 has changed dramatically. Many enterprises and traders have joined in vying for farm output with the government purchasing organizations that formerly were the only procurement agent for most rural products. These new marketing channels allow multiple entries into the market.

In the case of suburban production for the urban fresh consumption market, farmers may market sweet potato themselves, individually or collectively, if they have access to transportation, for example a bicycle, tricycle, or small tractor-drawn cart. Otherwise they may sell their crop to traders. Fresh root is not transported long distances. But because dried whole or chipped roots may be transported long distances with little damage, they are attractive industrial raw material sources. This attractiveness to users far away has caused some conflicts with local authorities over price instability.

However, the actual extent of trade is unknown, but regional and international trade of sweet potato and sweet potato products has existed for some time and is growing. This is especially the so for sweet potato products for industrial processing such as chips or semi-processed products; factories often procure raw material within a radius of 150-200 km often buying from a number of provinces.

Dried chips are transported far greater distances, for example, from northern Anhui to processors in Beijing, Tianjin, and Shanghai, distances of more than 1,000 km. Also chip products produced in Sichuan can be found in Jilin and Heilongjiang. Long-haul transport of fresh root is not often seen, sweet potato is grown in many areas of China and the fresh root does not tolerate transport well. However, the opening of the Beijing – Shanghai expressway which traverses the major sweet potato growing areas of Shandong may have an impact on supply of fresh root to the urban markets and for export.

Some dry strips and chips are exported for starch processing or feed use. Sweet potato-based snacks and candies, however, are popular in Southeast Asia, Hong Kong, and Japan. High-quality snack foods, including candied sweet potato chunks and strips, and fried starch chips similar to shrimp chips, have been developed to accommodate this export market. These products have sold well abroad. In addition, canned sweet potato is exported.

Prices

Gaining a reasonable estimate of prices in China is difficult. Nevertheless, some trends are evident and an idea of seasonal prices can be gained from interviews carried out by the author over a three year period in Sichuan and Shandong.

Prices increased during the 1980's by as much as 40-60 percent. Though during the late 1990's farm gate prices in processing regions, for sweet potato, across provinces and at the beginning and end of the season were remarkable stable (Table 7).

Table 7. China - Farm gate prices for sweet potato in selected province, 1998–2000.

Province	Root price (RMB / kg)	
	Season start	Season end
Shandong	0.33 – 0.42	0.32 – 0.40
Sichuan	0.32 – 0.34	0.36 – 0.40

Note: Based on surveys by the author, during the period there was no significant difference between years.

The data in Table 7 are based on sweet potato procured in processing areas; these trends will not reflect the situation for the table variety market. Processors only operate for a limited period, which is governed by supply of fresh roots at an economical price.

There is contradictory evidence about seasonal price movements of fresh root for the table market. In Beijing, many retailers claim that price movements are fairly stable. In Chengdu (Sichuan) and Jinan (Shandong), retailers often comment on seasonal price fluctuations. Retail prices are usually highest just before harvest, dropping sometimes by as much as half with the appearance of a new crop on the market. At times of the year when sweet potato is in great demand, especially around certain holidays, the price increases greatly, sometimes by as much as 100 percent. The retail prices farmers charge for fresh root is usually about 20 percent less than that charged by traders, and the wholesale cost to traders is also usually about 20 percent less than the retail price charged by farmers (a price of 0.32RMB /kg wholesale to traders vs. a price of 0.40 RMB /kg retail).

2.4 Sweet potato – Japan

Sweet potato is called both *kansho* and *Satsuma-imo*. An explanation for the former is that one of the two *kanji* characters that form the word *kansho* means "sweet" or "sugary" flavoured. For the latter, it is suggested that sweet potato is not native to Japan but was introduced through Kyushu in the south, the only place allowed to trade with the outside world in the old days. Satsuma is on Kyushu, and sweet potato first become famous there. As *imo* broadly means "potato", *Satsuma-imo* translates as "Satsuma potato".

In general, the name *kansho* is used by farmers and older people whilst the name *Satsuma-imo* is used by younger consumers. Traders used both terms. *Kansho* shall be employed here.

Varieties

Six types of *kansho* are commonly noted:

- *Beniazuma* (Plate 1.)
    - Dark reddish skin with dark yellow flesh.
    - It has a low fibre content and is considered very sweet.
    - *Beniazuma* is widely used in processing.
    - It would appear to be the most common variety.
    - Whilst other countries may have yellow-fleshed types, Japan claims that it has developed the *beniazuma* to achieve the texture popular in Japan.

- *Kokei No. 14* (Plate 2.)
    - Red thick skin.
    - Light yellow firm flesh.
    - Very sweet.
    - Eaten baked.
    - Popular in western Japan.

- *Benihayato* (Plate 3.)
    - Red skin and orange flesh.
    - Has high carotene content of 8.15 mg/100 g.
    - Has a high Vitamin A content of 4530 IU / 100 g.
    - Used for processing into snacks and cakes.

- *Koganesengan* (Plate 4.)
    - Thin yellow skin.
    - Yellow flesh.
    - Mainly used for starch processing and, because of its high starch level - 28 percent or greater - distillation for *shochu.*

- *Yamakawa murasaki* (Plate 5.)
    - Dark purple flesh.
    - Processed into cakes and ice-creams.
    - Used as a food colouring agent

- *Beniaka* (Plate 6.)
    - Thick red skin, clear yellow flesh.
    - Sweet taste.

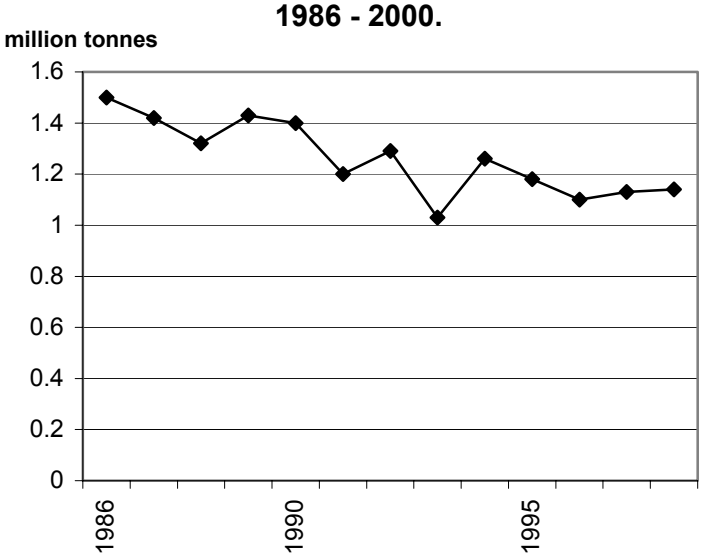
Overall, *Beniazuma* and *Kokei No. 14* are the most popular varieties.

Production

Long term data, that is of more than 30 years, show that until the early 1970s *kansho* production in Japan was more than six million tons[6]. In the 1970s production plunged. This was due to the role of starch. Prior to the 1970s *kansho* was a major source of starch. Indeed, as recently as the early 1990s, new varieties of *kansho* were being released that emphasised starch content. However, with the development of alternative sources of starch, production declined by more than 80 percent.

Since the 1980s, there has been a slow but definite decline in production (Fig 7).

Figure 7. *Kansho* - Japan. Production, 1986 - 2000.



Uses

Kansho is used directly as a food and indirectly in other forms. Between 10-15 percent of production is consumed in the processed form. The raw product is often steamed and then eaten (*mushiimo* – "steamed potato"). *Mushiimo* is also commonly referred to as '*muneyake'* "heartburn". In the warmer south western regions it is often eaten together with fish and shell fish.

Three basic forms are utilised:

[6] All production data for Japan in this report is from the ***Annual Yearbooks of the Ministry of Agriculture, Fisheries and Forests.***

- The tuber is first sliced cross-wise into round slices and then further cut into smaller squares. This is then boiled along with rice. It is popularly referred to as *imo meshi* "potato rice" or *imo gayu* "potato rice gruel" – a more liquid 'soupy' version of *imo meshi*.

- *Namakirihoshi* strips of dried potato and *namakirihoshikona* dried potato powder. The tuber is cut into strips and dried and/or then further crush into a powder. This is stored as a food source. In rural districts and farms it is often stored in straw bags.

  After soaking the dried potato in water it can be used to make *imo meshi* and *imo gayu*. The powder is used to make *dango* "dumplings" and other products such as *mushipan* "steamed bread".

- Using a quality powder potato, the skin is slightly peeled, and together with special *mochi* sticky and glutinous rice, are steamed and then pounded to make rice cakes.

Kansho is consumed widely in a variety of between-meal forms. Two of the most common forms are:

- *Mushi imo* steamed potato. Also popular is cutting the tuber into rings, battering it in wheat flour, then steaming. The latter form when it is made with bean paste has a similar texture and taste to *manju* bean paste buns. Because it is prepared quickly and simply, in the Kumamoto region of southern Japan it is referred to as *ikinari* "suddenly".

- *Yaki imo* roasted sweet potato. The tuber is usually roasted whole but can be sliced into rings. In former times, during the night from autumn to the end of winter it was a common sight throughout Japan to see small trucks selling *ishi yaki imo* sweet potato roasted on hot stones. Sadly, this is a sight, sound (as the salesman sings the particular noise peculiar to the craft announcing their presence), and smell that is disappearing in the larger cities.

Kansho supplied early in the season command the highest prices for these uses.

Kansho is commonly served as a *tempura* quickly deep-fried side dish.

Sweet potato has a large variety of processed foods made from it. Most of these are traditional in form but some are adaptations of western style chips and snacks. The important ones are;

- *Imo an* sweet potato bean paste. The tuber is peeled, steamed and then kneaded with sugar. Some genuine *an* red bean paste made from Azuki beans are added to the original mix.
- *Imo youkan* sweet jelly. This made in a manner similar to *imo an*. To prevent breakdown sugar is added along with gelatin and agar to harden the product.
- *Imo senbei* sweet potato rice crackers. The tuber is cut very thinly and covered in sugar.
- *Imo karintou* sweet potato fried cookies. Rather fat slices of potato are dried, cooked in oil, and then covered in sugar. Recently, imo karintou is being cut more finely or else made from sweet potato powder.
- *Mushikirihoshi* steamed, cut, dried sweet potato. The potato is peeled, steamed, then cut into 7-8 mm slices, and then dried. Also commonly referred to as *mushi imo* and *imo surume* dried potato cuttlefish. Originally, it was a product from the Hamaoaka region in Shizuoka Prefecture but now it is more generally associated with the central eastern section of Ibaraki Prefecture. A similar product is produced in the Tenkusa region of Kumamoto Prefecture. Here, a small round potato is steamed, and becomes just like the popular dried persimmons.

- *Daigakku imo* university potato. The tuber is cut diagonally into irregular chunks then fried in oil. Sugar syrup or honey is added, and finally sprinkled with sesame seeds.
- Sweet Potato Chips. One of the types of *karintou* fried dough cookies. It is made by cutting the potato into extremely thin strips and then adding table salt. It comes in various shapes and forms.
- Sweet Potato Mash : The potato is peeled, steamed, put through a roller to flatten, and dried to finally produce a powder. Used in vegetable salads, croquettes, and also as a raw material for a variety of confectionaries. Products made from the carotene rich potatoes, which have a reddish colour, are said to be rich nutritionally. Also referred to as 'Golden Mash'.
- Frozen Products : Steamed potatoes are sealed into packs and refrigerated.
- Others : Canned and Square Cuts : These two variations have been introduced from other countries, primarily the USA mainland and Hawaii. The raw materials are essentially carotene potatoes. The potatoes are cut into large slices and steamed at high pressure then canned. Square cuts are steamed at high pressure, cut into squares then dried. Often added to soups.

As Japan moves increasingly towards the presentation of foods in a more ready-to-eat form through the convenience stores, it is most likely that greater emphasis will be placed on *kansho* in the processed form.

A major outlet for processed kansho is as *imojochu*, a vodka-like distilled spirit. *Imojochu* is a particular form of *shochu*, a low-valued indigenous spirit. It is considered that *imojochu* has a particular market niche compared with barley-based *shochu* because the *kansho* imparts a distinctive aroma and flavour. About 80 000 tons of *kansho* annually go into *imojochu*.

Another major non-direct food use involves the utilisation of *kansho's* starch and flour properties, and as a food pigment. Some of these uses are noted in Table 8. It is noted that nearly all of these uses are as low-value products. An emerging potential use is in biotechnology with the utilisation route being through the production of lactic acid to make a biodegradable plastic.

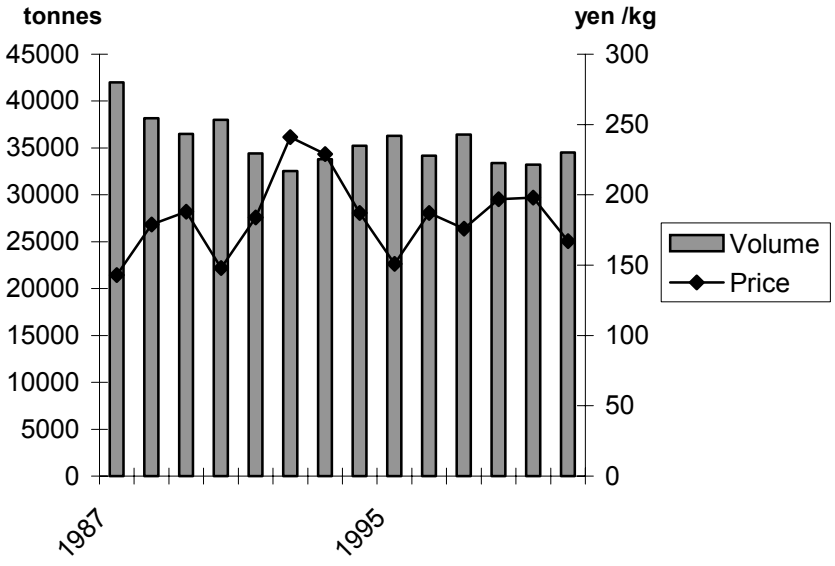
Table 8. Some uses of processed sweet potato and sweet potato extracts in Japan.

Sugar syrup	Sour sugar candy	Caramel, drops, various candies, jam, food boiled down in soy, bean paste, *youkan*-sweet bean jelly.
	Malt candy	Caramel, various traditional confectionaries, food boiled down in soy, medicine, paints.
	Powder sugar syrup	Sake, ice-cream, various confectionaries, sausages, soy sauce, baby foods, foods boiled down in soy.
d-glucose	Refined d-glucose	Bread, canned foods, various confectionaries (eg. chewing gum, biscuits, cakes, roasted confectionary, *youkan*-sweet bean jelly, sugared red beans), drink products (eg. juice, baby drinks), refrigerated products (ice-cream, sherbet, soft cream), jam, marmalade, processed seafood products (i.e., *kamaboko* fish cakes, *chikuwa*-fish paste roll, *satsumaage*-deep fried fish paste with vegetable bits, fish meat sausages), household sweetener, various alcohols.
	Crystallized d-glucose	Confectionaries (chewing gum etc.), drinks, refrigerated canned products, various alcohols and medicines (eg, for use in injections, vitamin C, tablets).
	Solidified or powdered d-glucose	Alcohol, bread, various confectionary, various processed seafoods, tanners.
Processed food articles	Direct food product	*Mochitori* powder
	Processed food articles	Processed seafood products (*kamaboko, chikuwa, satsumaage*, sausage), bean starch vermicelli
	Beer	
Processed starch	Dextrin	Magazine paste, printing, tablets, postage stamp paste, paper manufacture, bookbinding, ink, adhesive tape.
	Soripuru starch Soluble starch	Magazine paste, tablets
Paste based adhesives	Industrial use	Corrugated cardboard, plywood.
Miscellaneous	Make-up	Toothpaste, face powder, washing powder
	Model adhesives	Moulds, dolls, toys, charcoal briquette
	Glues	Toys, matches, umbrellas
	Adhesive protection	Rubber products such as surgical gloves
	Precipitation protection	Shoe polish, agricultural chemical stickers
	Others	Dry cell filler, explosives, float concentrates, glass wool

Annual wholesale performance

Tokyo's wholesale data[7] for *kansho* does not distinguish between the different varieties (Fig. 8).

Figure 8. *Kansho* - Japan. Annual wholesale performance, Tokyo: 1987-2000.



The data indicate that overall throughput is declining but that there can be increases in any given year. Throughput in 2000 was 34,526 t.

Over the 14 years shown in the figure above, annual average wholesale prices can be considered to have risen slightly. In 2000, the price was 167 yen/kg.

Monthly wholesale performance

Kansho has distinct seasonal patterns of monthly throughput (Fig. 9) and wholesale prices (Fig. 10). This allows for confident predictions.

Based on the above, the indications are that prices will rise in May or the beginning of summer, peak in June – July and decline in autumn.

This period coincides with the traditional low usage of *kansho* in summer.

Indications are that retail prices have a one-month lag after wholesale prices.

[7] All wholesale data for Japan in this report is drawn from the reports of the Tokyo Metropolitan Government's various market reports that cover the nine wholesale markets under its jurisdiction.

Figure 9. *Kansho* - Japan. Monthly wholesale volume, Tokyo: 1995-2000.

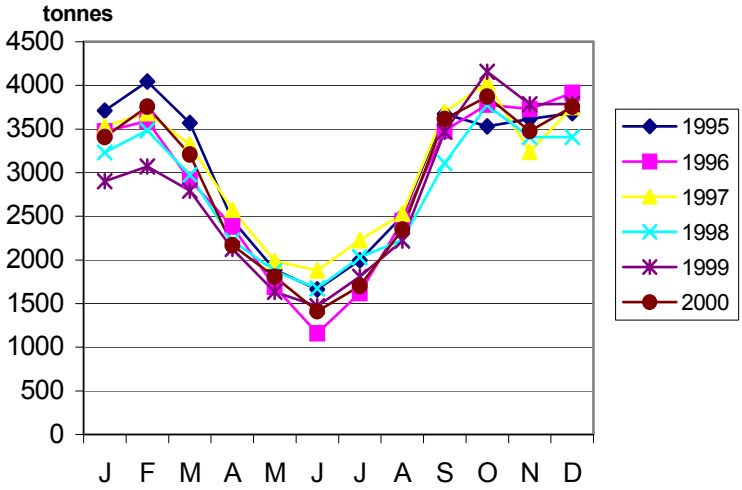
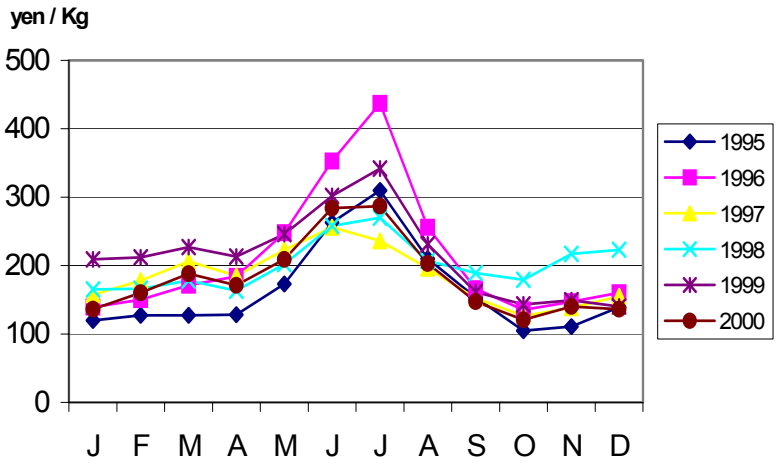


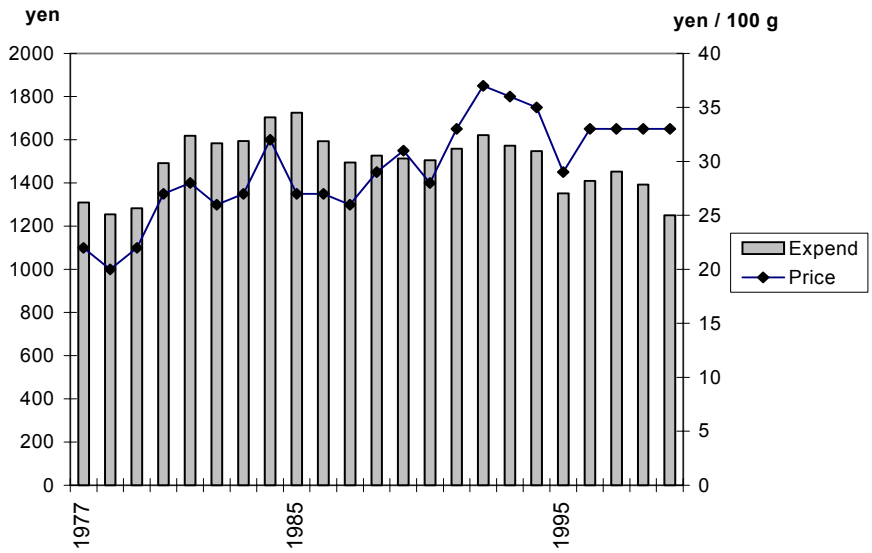
Figure 10. *Kansho* - Japan. Monthly wholesale prices, Tokyo: 1995-2000.



Household expenditure

Annual household expenditure patterns[8] show that the volume being purchased is declining at around the same rate as retail prices are increasing (Fig. 11).

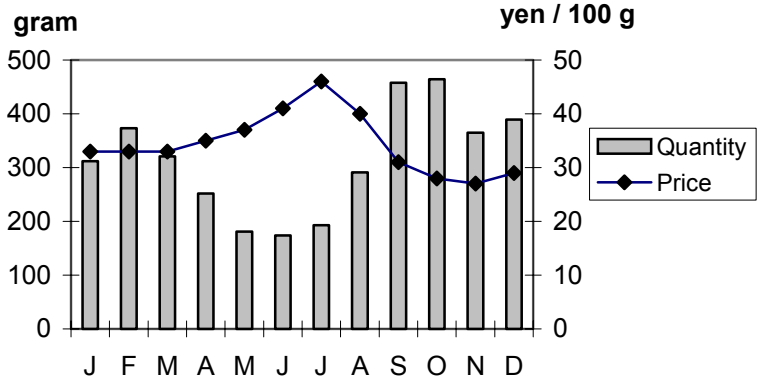
Figure 11. *Kansho* - Japan. Average annual household expenditure, 1977 - 1999.



Given that the rate of decline in household purchases are less than the rate of decline in total production, the implication is that households are consuming more *kansho* in the processed form (Fig. 11).

Figure 12 shows that household expenditure is lowest in late spring to early summer, before prices peak in mid-summer. As to be expected, the quantity purchased by households is lowest when prices are highest and vice versa.

Figure 12. *Kansho* - Japan. Monthly household expenditure: 1999.

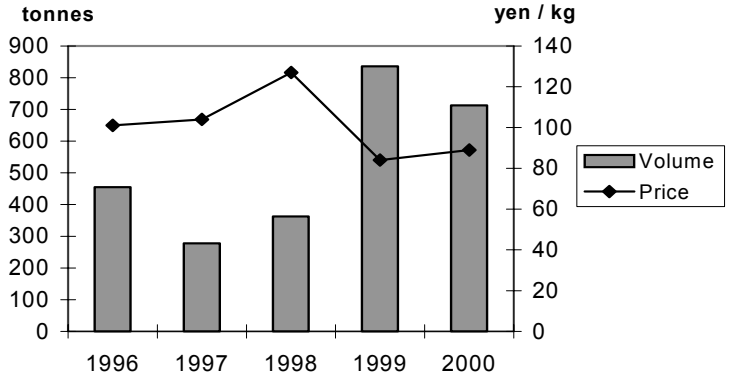


Japan – *kansho* - imports

[8] Data drawn from the ***Annual Reports of the Family Income and Expenditure Survey*** of the Statistics Bureau, Management and Coordination Agency.

Kansho is imported into Japan[9] in the frozen form (Fig. 13) both as a stand-alone product but increasingly in combination with other products such as burdock, carrot, bamboo, and lotus root.

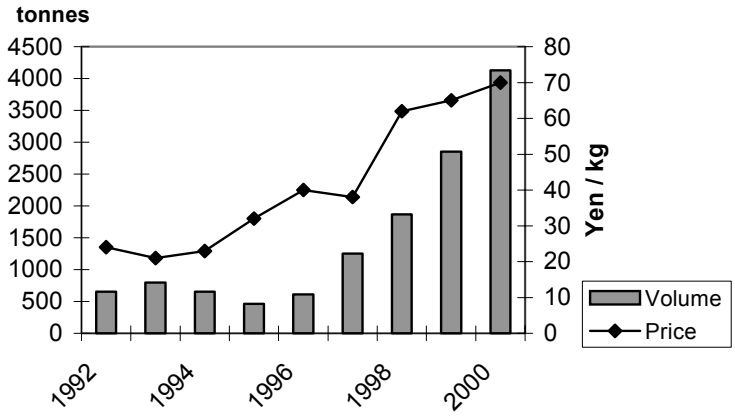
Figure 13. *Kansho* - Japan. Annual imports, frozen: 1996-2000.



In 2000, 713 t were imported at an annual average price of 89 yen/kg.

Data indicate that "fresh" sweet potato is imported into Japan.

Figure 14. *Kansho* - Japan. Annual imports, fresh: 1992 - 2000.



Japan does not allow the importation of sweet potato for quarantine reasons. Importations of fresh produce must follow the post-entry quarantine requirements, that is, it cannot be propagated. It is most likely that the data cited as "fresh" (Fig. 14) refer to dried product. The White Paper on sweet potato in Japan[10] estimates that 15 000 t of sweet potato product in the form of bakery items, flour, doughs, and cereals are imported annually.

[9] All Japanese import data used in this report is drawn from the **Japan Tariff Association** monthly and annual reports.

[10] See White Paper in References.

3. Taro

3.1 Taro - Nomenclature

The word "taro" appears to be derived from the Malaysian word *tales*. It would be tempting to state that this reflects the plant's origins in that region. However, as Ivanic and Lebot (1999) advise, the genetic material that could prove taro's precise origins has long been lost.

There is general agreement that the taxonomy of "taro" is:

Order: Arales
Family: Araceae

After that, uncertainty sets in.

There are about 100 genera of the Araceae family and about 1,500 widely distributed species.

There are four major genera of "taro" utilised today. Please note the use of the term "utilised" as this allows reference to uses other than as a foodstuff such as gift giving in parts of the Pacific and ornamentals in a large number of places. The four are:

- *Alocasia*
- *Colocasia*
- *Cyrtosperma*
- *Xanthosoma*

A fifth genus, *Amorphophallus* ("elephant-foot yam") is not considered as its use appears to be fading.

Colocasia is considered as "true taro" and is the most common form. The specific name, esculenta, refers to the fact that plants of the species *Colocasia esculenta* are eaten, a recognition that not all taros or even all aroids (members of Family Araceae) can be eaten. In general, it is preferable to use the term "edible aroids" for edible species of Araceae. This does not exclude recognising other uses such as ornamental uses and gift presentation. Both edible and non-edible aroids have ornamental uses. The main and common ornamental aroids are not edible aroids.

The Polynesian term "taro" is much abused in English. "Taro" properly refers just to *C. esculenta.* There are perfectly good Polynesian or other vernacular names that distinguish other species and genera. Since "taro" is already used for *C. esculenta*, Matthews (pers. com. June 2002) suggests that using other common Polynesian names for the other aroids might make sense, especially those that are cognate with other Austronesian language names for the same plants (i.e. that are already in broad use, in one form or another). The use of the more common vernacular names such as *ape* for *Alocasia macrorrhiza*, *pulaka* for *Cyrtosperma*, and *yautia* (a South American native name) for *Xanthosoma* is a possibility.

The entire plant may be consumed.

- **Leaf**: It is necessary to distinguish between the leaf stalk and the leaf blade. The leaf in aroids consists of a petiole (stalk) and a blade or leaf. Taro leaves have the same nutritional value as spinach: they are an excellent source of vitamins A and C, and

riboflavin and thiamine. Ideally the leaves should be green or pink but not brown or purple. Leaves are usually eaten boiled or baked with coconut cream. Leaves from *Colocasia*. are preferred.

- **Stalk**: Not all taro stalks are suitable for eating. The preferred stalks are from *Colocasia*.

- **Root**: There are two parts to the root (which in the strict botanical sense is a corm): (i) the central stem or corm and (ii) the smaller structure, commonly referred to as cormels, that are attached wart-like to the central corm. Not all roots are commonly consumed. Corms are good sources of carbohydrates and potassium (Table 9).

Table 9. Nutritional information for taro.

Component	Per 100 g edible portion		
	Corm	Leaf	Petiole
Edible portion (percent)	81	55	84
Energy (cal)	85	69	19
Protein (g)	2.5	4.4	0.2
Fat (g)	0.2	1.8	0.2
Carbohydrate (g)	19	12.2	4.6
Calcium (mg)	32	268	57
Potassium (mg)	514	1237	367
Iron (mg)	0.8	4.3	1.4
Thiamine (mg)	0.18	0.10	0.01
Riboflavin (mg)	0.04	0.33	0.02
Niacin (mg)	0.9	2.0	0.2
Vitamin A (IU)	Trace	20385	335

Whilst the corm is a poor source of carotene, the carotene level is at least twice that of potato. Corms contain greater amounts of vitamin B-complex compared with milk. Corms are highly variable with respect to hydration, size, colour, and chemistry.

Taro corms can contain up to 35 percent starch. Taro starch digestibility is as high as 98 percent. As the taro starch grain is significantly smaller compared with that of potato[11], taro is excellent for people with digestive problems, for those allergic to cereal starch, and those sensitive to animal milk. Protein content can range from 1.0 – 4.5 percent. Nearly all taros are cooked before eating because of the existence of the irritant calcium oxalate. Taro can be cooked with the skin on or off.

It is accepted that, according to FAO data, taro production in Africa and Asia dwarfs that of the Pacific. However, in the following, emphasis is placed on Pacific nomenclature because it can be argued that taro is comparatively more important there than elsewhere[12]. Historically, taro was a major staple in the smaller and more isolated Pacific Islands because it served as both a leaf vegetable and a starch source, and the leaf blade has good protein content. Few other leafy greens

[11] Taro starch granules vary from 1 – 6.5 micrometers. As such they have a potential role as an additive to render plastics bio-degradable.

[12] Taro is considered a staple in the Polynesian and Melanesian countries of Cook Islands, most of Fiji, Futuna, Niue, Samoa, Tahiti, and Tonga, and the Micronesian states of Guam, Palua, Kosrae, Pohnpei, Saipan, and Yap.

were available. There was much differentiation of cultivars, but from a narrow genetic base. As Matthews (pers. com. June 2002) points out, in the region from New Guinea to mainland Southeast Asia and East Asia, there is great genetic diversity and many specialised kinds of taro.

Nomenclature in the Pacific is highly variable and extremely localised, a result of the peoples of the Pacific being isolated and spread over vast areas. For example, Kiribati with a population of just 78,000 and a land mass of 726 m^2 is spread over an east-west distance of around 3 500 km.

Issues that can determine a specific name include:

- Leaf shape and size.
- Petiole colour, spininess, length, and thickness.
- Ability to produce suckers.
- Duration of crop.
- Corm shape, colour, and taste.
- Wet-land or dry-land production.
- Degree of coarseness of the corm.

The information that follows is not to be treated as definitive in terms of the country/language identified, all the names for the various taros within that language, nor the precise spelling of each local name.

Alocasia

Alocasia corms can be extremely large, up to a metre long and weighing more than 20 kg. They are not commonly eaten because they contain calcium oxalate crystals that cause considerable irritation when eaten. *Alocasia* are eaten only after prolonged cooking in order to breakdown the crystals. *A. macrorrhiza* is the only species of the genus cultivated in the Pacific.

In the Pacific *Alocasia* spp. is usually sold by the piece because of its size.

Alocasia is more popular with Tongans and Samoans than it is with other Pacific Islanders. It is important to Tongans for ceremonial use in feasts and to accompany the giving of pigs. Its size makes it ideal for cooking *umu*-style for Sunday family feats. Nevertheless, it cannot be considered a staple as it is less important than other root crops such as sweet potato, yams, cassava, and other types of taros. There are numerous common names for *Alocasia* (Table 10).

Table 10. Common names for *Alocasia*.

Country or Language	Name
Cook Islands	*kape*
English	*giant taro, Tongan taro, elephant ear*
Guam	*piga*
Hawaii	*'ape*
New Caledonia	*aware, ica, ka'ait, kape, kaxete, koe, kowe, pai, wave*
Palau	*bisech*
Philippines	*biga*
Papua New Guinea	*paragum*
Pohnpei	*cha, sepwikin*
Samoa	*ape, kape, ta'amu, pulaka*
Solomon Islands	*fila kwasi, vila, fila fanua, paragum, te kape, tahela*
Tonga	*kape*
Tuvalu	*ta'amu*
Vanuatu	*lese-en, pia*

Colocasia

Colocasia appears to be derived from the Egyptian word *culcas/qolkas/koulkas*. In turn this came from the Sanskrit word *kuchoo*. *Colocasia* is considered one of man's first domesticated foods with some evidence suggesting that this occurred some 8,000 years ago.

Matthews (pers. com. June 2002, Matthews *et al*., 1992) and others agree[13] that botanically speaking, it is better to ignore the host of varietal names associated with *Colocasia esculenta*. Of particular note are the conclusions drawn from the Taro Network for Southeast Asia and Oceania (TANSAO) project[14]. The TANSAO project had as its objective the enhancement of the competitive position of taro in rain-fed cropping systems in South East Asia and Oceania. Eight research organisations in Europe, Indonesia, Malaysia, the Philippines, Papua New Guinea, Thailand, Vanuatu, and Vietnam worked on five components (a) germplasm characterisation (b) disease resistance and improvements (c) agronomic evaluation of cultivars and hybrids (d) genetic diversity of *Phytophthora colocasiae*, and (e) physico-chemical characteristics of the corms from selected cultivars. Morphological characterisation of more than 2000 accessions was conducted. The results of the studies indicate that the existing taxonomic differentiation of essentially *C. esculenta* var. *esculenta* and *C. esculenta* var. *antiquorum* (Purseglove, 1975) is unreliable and should be avoided[15]. Instead, the preference is to treat *C. esculenta* as a single polymorphic species with numerous named cultivars and cultivar groups, named variously across different countries (Table 11).

[13] Explored at length in Ivanic and Lebot (2000).

[14] See the Section 3.8 **Taro leaf blight in the Pacific** below.

[15] Our thanks to Dr Danny Hunter, Australian Team Leader AusAid/SPC Taro Genetic Resources Project (TaroGen), Suva, Fiji who provided us with the abstract of the TANSAO Final Report.

Matthews (pers. comm.) states that existing varietal descriptions are not all based on naturally occurring wild varieties but mostly on whatever cultivars that various taxonomists have had at hand in collections, either as herbarium specimens or living plants. *C. esculenta* var. *aquatilis* has been recognised as a wild-type, but even this is better referred to as simply "wild-type *C. esculenta"*. Yoshino (2002) continues this theme with an in-depth discussion of the morphological and genetic variation in cultivated and wild taros, particularly focusing on Asian accessions, and the implications for taxonomy and nomenclature. The taro breeding work of Yoshino and others (as described in Yoshino, 2002) demonstrates how easily various cultivated and wild forms of *C. esculenta* can be crossed with each other to produce progeny with different levels of ploidy (Isshiki, *et al*., 1999) and significantly different phenotypes (physical characteristics), particularly corm morphologies, to the parents. Thus demonstrating the danger in defining botanical varieties of taro based on morphology alone. The various cultivated forms of *C. esculenta* originated through sexual reproduction and have been perpetuated as cultivars through vegetative propagation. Based on current evidence, none of the many cultivars or cultivar groups of *C. esculenta* can be considered as true botanical varieties.

Attention is drawn to *poi*. This is the unique and distinctive food of Hawai'i[16]. When pounded, the spongy textured corm of *poi* taro produces a viscous substance. It is the viscous "goo" left after the pounding process that becomes *poi.* In contrast nearly all other taros can be easily cut into crisp pieces. Production of *poi* taro in Hawai'i is centred on the one valley on Oahu. Aficionados, who appear limited to Hawaii and Hawaiians, claim to be able to tell if the *poi* is made from taro grown on the other islands. Even if *poi* taro is grown elsewhere, lacking the micro-climate that produces the Oahu distinctive flavour profile, it is doubtful if they could penetrate the limited market for *poi*. More-over, *poi* has a very short shelf life. Commercial production of fresh *poi* in Hawaii occurs daily and is timed so as to be available as people go to work.

The Samoan or Niuean "pink" taro, is so called for its relatively smooth skin that scrapes to a pink colour.

Colocasia esculenta is the most widely cultivated species out of the four taro genera because, essentially, it does not require a large area and planting material is relatively easy to obtain and maintain.

Colocasia corms are consumed boiled and baked. In the Pacific, the use of the earthen oven *umu* to bake taro is an integral part of family and communal life: in Apia, the capital of Samoa, the air is heavy with smoke first thing on a Sunday morning as *umus* are fired up to be opened after church for the Sunday feast. The tradition of the Sunday feast has been carried to New Zealand and Australia by Samoans and Tongans and has a great deal to do with the price sensitivities in the two countries, at least amongst Islander.

Colocasia has the oxalic acid but not in as great concentrations as *Alocasia* and *Xanthosoma*. The presence of the acid leaves a slight stinging sensation in the mouth and throat. Cooking removes the acid. Experiencing such a sensation reflects poorly on the cook.

Colocasia leaves/blades are eaten after being baked in coconut cream. This is called r*u kau* in Cook Islands, *rourou* in Fiji, *lululu* in Tonga, *palusami* in Samoa, and *lu* in Niue.

[16] *Poi* is also produced in Tahiti and in the Cook Island (where it is called *poi* and *poke,* respectively).

Table 11. Common names for *Colocasia*.

Country or Language	Name
China	*woo tau (*black head*), yu tou (*central corm*), bun long wootau (*betel nut taro*), hung nga woo tau (*red budded taro*), yu nai (*baby corm*)*
English	*dasheen*[17]*, eddoe, edo, taro, Chinese potato*
Fiji	*Dalo*
Hawai'i	*Kalo*
Japan	*sato-imo, yatsugashira (*eight heads*), ebi imo (*lobster taro*) oya imo (*parent taro*), serebesu (*Celebres*)*
Korea	*t'oran*
Malaysia	*ta'o, keladi, tales*
New Caledonia	*dap, di, ekengad, io, inagad, kening, moa*
Palau	*Kukau*
Papua New Guinea	*anega, ba, biloun, guarava, hemar, ifem, kukun, mabo, sagani*
Philippines	*gabi, abalong, amalong, dogmay, gablos*
Samoa	*talo, ta'o, tue, taro niue*
Solomon Islands	*taro, alo, kake, taro tru, pupu, tama*
Tonga	*talo tonga*
Truk	*Oni*
Vanuatu	*pes, peta, vembierr*

Cyrtosperma

This is the largest of all the taros. The plant itself can grow up to 4 m high and corms up to a metre long and weighing up to 100 kg are found, albeit corms of 30 - 50 kg are more common (Ubaito 1996). Size alone assures the plant of having a high element of prestige, especially as an exchange item.

Cyrtosperma chamissonis is the main taro of Micronesia. Given the lack of land availability and the nature of the land on the islands that make up Micronesia and a number of the coral atolls elsewhere in the Pacific, it is not surprising that special techniques have been developed for its production. In Kiribati *babai* production occurs in pits dug deep into the coral down to the fresh water lens and lined with organic matter. It can take four years to mature but plants can stay in the pits for up to 15 years. The entire production cycle is associated with much ritual[18]. To some extent, the time to maturity has resulted in *babai* tending to be consumed only on special occasions as well as enhancing the ritual associated with the production cycle. It is possible that quicker maturing varieties could increase consumption.

[17] Appears to have derived from a corruption of the French "de Chine".

[18] Even with ceremonial uses and big feasts there are preferred cultivars.

The common English name "swamp taro" identifies where it usually grows. It can withstand high levels of water. Other names are presented in Table 12.

Cyrtosperma must be cooked immediately after harvest to prevent the formation of bitter spots.

Table 12. Common names for *Cyrtosperma*.

Country or Language	Name
Carolines	*onokokung, simetun, sinaitah, ponon, musiang an ngatik*
English	*swamp taro, giant swamp taro*
Fiji	*via, viakana*
Kiribati	*babai*
Marshalls	*iaratz, kailiklik*
Palau	*brak*
Pohnpei	*mwahng*
Polynesia	*ape veo, brokka maota, opeves, pula'a pulaka, tao, kape taa taa*
Samoa	*pula'a*
Solomon Islands	*kakake, kakama, kano kano, te puraka, vakehu, pulaka*
Tokelau	*pulaka*
Tuvalu	*babai*

Xanthosoma

This is larger and stronger tasting compared with *Colocasia esculenta*. The principal corm is relatively large. It is rarely eaten because the flesh is very acidic. For this reason only the lateral cormels are harvested. Up to three cormels make a kilogram.

The plant takes 9 – 12 months to reach maturity.

There are three main species:

- *Xanthosoma sagittifolium*: the most widely grown *Xanthosoma* in the Pacific
- *Xanthosoma violaceum*: "purple taro" with a pronounced blackish-green appearance
- *Xanthosoma brasiliense*: grown for its leaves

In the Pacific *Xanthosoma* spp are usually sold by the coconut-leaf basket of about 4-18 kg.

Table 13. Common names for *Xanthosoma.*

Country or Language	Name
Cook Islands	*trua*
English	*tannia, cocoyam, American taro, Chinese taro*
Fiji	*dalo ni tana*
New Caledonia	*New Hebridean taro*
Niue	*pulaka*
Palau	*saibal*
Papua New Guinea	*taro kong kong*
Samoa	*talo papalagi/taro palagi,*
Solomon Islands	*taro kong kong,*
Tonga	*talo futuna*
Truk	*yautia*
United States	*malanga, yautia, tannia*
Vanuatu	*taro fiji*

3.2 Taro - International trade

Trade in taro tends to be focused on supplying expatriate populations from their home countries. Taro is traditionally consumed by Pacific Islanders, Hispanics and Chinese. International trade in taro reflects that orientation (Table 14).

Taro trade in the Pacific is based around supplying Islanders who live in New Zealand, Australia, and the West Coast of the United States.

Until the mid-1990s, this trade was dominated by Samoa supplying Samoans and other Pacific Islanders in New Zealand, Australia, and the United States. It is useful to remember that there are more Samoans living in the capital of New Zealand than there are Samoans living in the capital of Samoa. The growth in non-Samoan based trade was caused by outbreak in 1993 of Taro Leaf Blight (caused by *Phytophthora colocasiae*) in Samoa. Production in Samoa was devastated with production in the next year dropping to about ten percent of the pre-blight level. Fiji started to grow the pink "Samoan" cultivar to fill the gap. Its trade to New Zealand, Australia, and the West Coast of the United States increased dramatically.

Trade into North America is based around supplying Pacific Islanders and Hispanic people from the Caribbean with taro from the Pacific and the Caribbean-Latin America region. Supply is from these regions. In addition, North America has a large Chinese population. For this reason China is a growing supplier to the United States.

There is a growing expatriate-based trade into Europe, especially England and France. This is in response to demand by expatriate Africans and Caribbeans. Most suppliers are drawn from the Caribbean.

An example of the expatriate hypothesis is that Jamaica exports to the United States, Canada, and the United Kingdom. Taro is not that popular in Jamaica but expatriate Jamaicans look upon the eating of taro as a means of confirming their roots with Jamaica. Exporters in Jamaica are conscious of this. By taking particular care at the farm gate to export part of the distribution chain, they have made their product the quality and price leader in the United States even though they are very much a minor supplier.

The exception to the expatriate-supply explanation of the international taro is Japan. Whilst Japan does not have an expatriate population of any size, it does have a long history of consuming taro. With the decline in local production imports have risen. Thus the trade into Japan is for nearly exclusively its own population and not from suppliers with expatriate links to Japan.

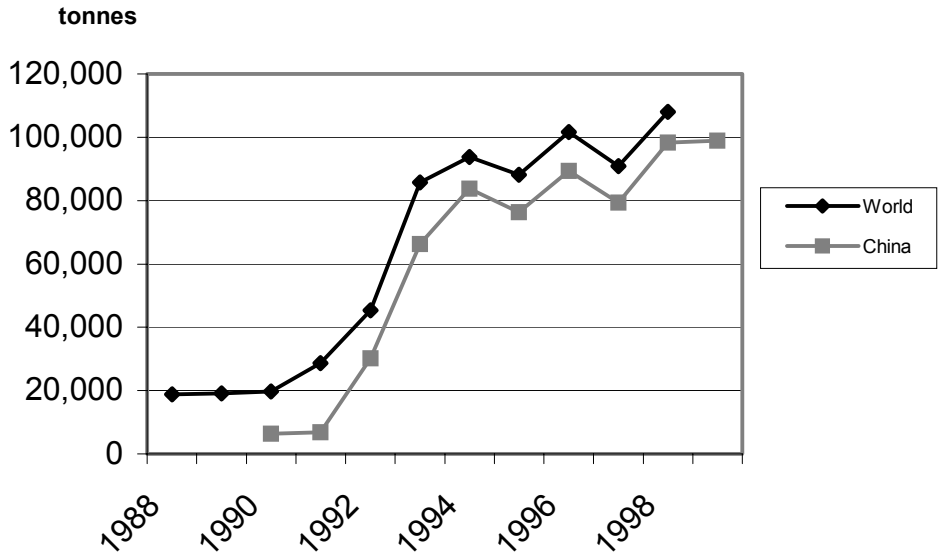
World trade in taro is estimated at around 145,000 tonnes annually. This estimate does not include the trade into Singapore and Hong Kong from, variously, Malaysia, Indonesia, China, and Vietnam. It also excludes cross-border trade in Africa and Latin America, and inter-island trade in the Caribbean.

Table 14. Taro imports, 1999.

Importing country	Volume
Japan	20,000 t fresh and 56,000 t frozen[19]
United States	37,000 t
New Zealand	approx. 8,000 t
Australia	approx. 3,000 t
Europe	approx. 10,000 t

The estimate of 145,000 t is much higher than that of the FAO (Figure 15). Bearing in mind that Chinese exports constitute the bulk of the FAO estimates, and bearing in mind the caveat regarding what is not included in the estimate of 145,000 t, it is clear that world trade in taro is much higher than usually estimated.

Figure 15. Taro - World and China exports according to FAO, 1988 - 1999.



[19] Converted to approximately 70 000 t fresh equivalent. This estimate does not include the importation of taro in other forms such as in "three vegetable mixes", both frozen and in brine.

3.3 Taro - Australia

Taro is not new to Australia.

Anecdotal references were made to taro being brought into Australia by Chinese joining the Gold Rushes of the Nineteenth Century. This is particularly true for north Queensland where taro is known variously as "Chinese taro", "bun long" and "purple taro"[20]. It is also believed that taro was also brought in by Kanakas when they were blackbirded to Australia to work in the cane fields. However, no firm data were presented to support this. Nevertheless, a family that has been farming continuously in the upper Currumbin Valley in the Gold Coast hinterland of southern Queensland confirmed that Taro Pacific (large-corm taro) has been grown on the farm since 1920[21]. Obviously others also brought taro into Australia because in a number of the creeks and gullies of the hilly country in the hinterland of northern New South Wales, and southern and north Queensland taro grows virtually as a feral plant. Finally, taro has been present in some parts of Australia for such a length of time that on the Atherton Tablelands in north Queensland it is also called "Australian taro".

During the 1980's the Department of Primary Industries' research station at Kamuranga on the Atherton Tablelands brought in planting material that was distributed locally. A major innovation in the introduction of planting material occurred in the mid-1990s. The precursor was the ACIAR[22] Project initiated by Professor Colin Asher, at the University of Queensland, into nutrition and diseases of root crops vital to the Pacific. Material was imported under full quarantine protocols from the Pacific in order to generate material locally for the research. The released varieties of Alafua Sunrise and Samoan Pink[23] were imported along with a number of other accessions. In the late 1990s, surplus material was given to the Department of Primary Industries in north Queensland. This formed the nucleus of the current industry in that region.

Since then, Australian quarantine regulations prohibit further importation of taro germplasm for propagation. Nevertheless, it would appear that the importation of planting material in a non-documented manner has occurred up until very recent times.

Australia produces three types of taro. Two of these – Taro Pacific and Taro Supreme – have been identified in the section Taro – Nomenclature. The third is Taro Vietnam that appears a mid-type of taro, with its shape and size being midway between those of Taro Pacific and Taro Supreme. In Queensland at least it appears largely in Vietnamese grocery stores. Examples of the three types of taro available in Australia are presented in Figure 16.

Taro Pacific

The bulk of taro grown in Australia is Taro Pacific. Production has been for the Islander and Asian trade with production being by Islanders and Asians. It is only in the last five to ten years that Taro Pacific production has become a mainstream production item.

[20] This is a reference to the streaks of purple within the flesh rather than the flesh colour itself.

[21] My thanks to the Freeman Family, Tomewin Road, Currumbin Valley. The taro had been brought to Australia from Fiji by the first Freeman to work on the farm following his having worked in Fiji.

[22] Australian Centre for International Agricultural Research, an initiative funded by the Federal Government that is based on collaborative research between scientists in Australian and underdeveloped countries.

[23] See Section of Taro – Samoa.

Figure 16. Examples of three types of taro available in Australia.

Taro Pacific

Suva Municipal Markets.

Usually marketed from 1.0 –2.0 kg.

Taro is commonly sold in the Pacific with the tops attached as there is the likelihood that re-plantings may occur.

Taro Vietnam

Bac Can Province.

10-12 cm long.

Clear-skinned with no hairs.

Taro Supreme

Ishikawa wase cultivar

Tsukiji Wholesale Markets, Tokyo.

Size varies from 20 g – 60 g.

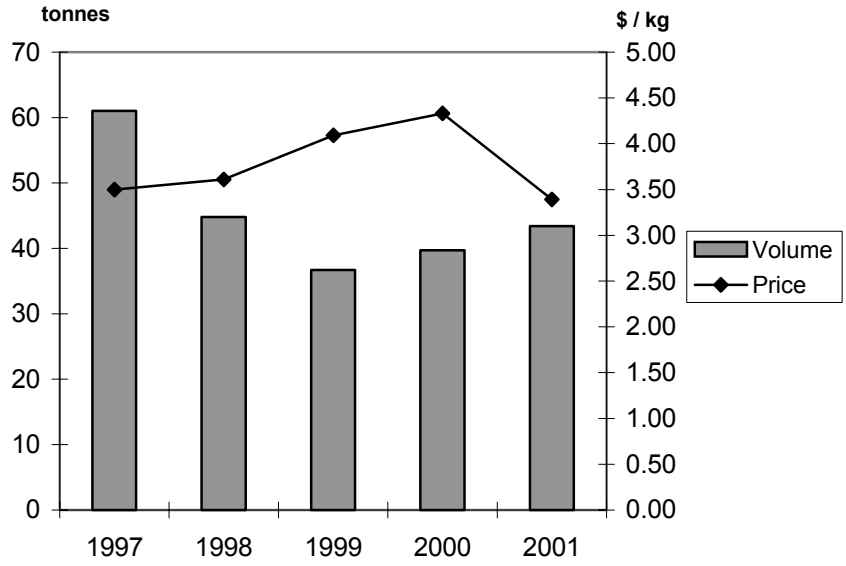
Production occurs in northern New South Wales – from around Grafton northwards – and virtually along the entire Queensland coast up to Cairns. It is difficult to be precise but it would appear that well over half the total number of producers are Islanders – Samoan, Tongan, and Fijian – with the most of the balance being Asian – Chinese, Vietnamese and Cambodians. This mix is changing with more and more Australians entering the industry.

In 2002 the Taro Growers Australia was formed: most of the 40-plus members are Australian. In volume terms, Australians provide vastly more than their proportionate share: an Australian grower on the Atherton Tablelands in north Queensland has around 20 ha on his farm. On the other hand, a large number of Islanders living in Brisbane grow taro within their gardens varying from a few plants to a serious garden[24].

The bulk of the home-garden taro does not enter the formal market system of wholesale markets. Instead it goes directly to end-consumers on family-to-family basis or goes to small stores that specialise in servicing the Islander and Asian communities in mainly Brisbane and Sydney but also as far away as Melbourne and Perth.

The bulk of the taro grown in Queensland that is formally traded does not go through the Brisbane Wholesale Market system. In 2001 this was a very small 43 t: understandably, much of Brisbane's demand is meet by the informal system. The figure for formal trading in Sydney is much higher because of its larger Islander population and the smallness of its backyard industry. As Figure 17 shows, prices in Brisbane have retained a degree of consistency over the past five years, notwithstanding the sharp decline in 2001. However it is stressed that this is estimated to be only a very small percentage of the total volume traded.

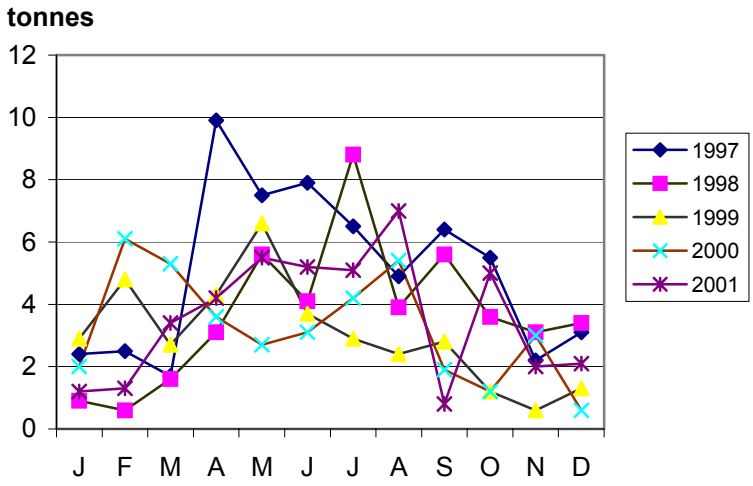
Figure 17. Taro - Annual wholesale performance, Brisbane: 1997 - 2001.



[24] An estimate of that number is that there are 10 Pacific Islander community churches in Brisbane with each church averaging 250 families.

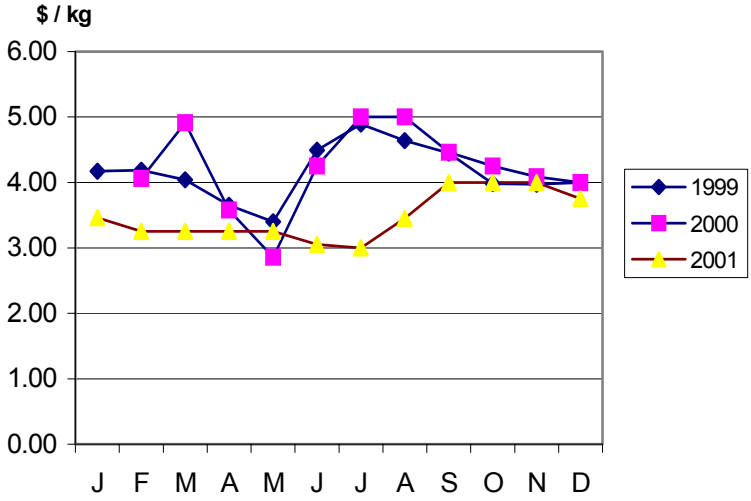
The small volume of monthly throughput (Fig. 18) endangers detailed analysis. However, it is clear that volumes tend to rise in the winter period.

Figure 18. Taro. Monthly wholesale volumes, Brisbane: 1997 - 2001.



In contrast, monthly prices are far more constant throughout the year (Fig. 19), making the identification of any pattern very difficult.

Figure 19. Taro - Monthly prices, Brisbane Wholesale Market: 1999 - 2001.



Imports

Taro Pacific is imported into Australia from Fiji and Tonga, and, prior to the outbreak of Taro Leaf Blight in 1993, Samoa[25]. Import data are not available in Australia but an examination of Fiji export data[26] and reports on Tongan exports[27] indicates annual imports of around 3,000 t.

Australia imports both pink and white varieties from Fiji.

Fiji *dalo* exports to Australia go mostly to Fiji Indian distributors and corner stores.

Australia's quarantine service AQIS takes a stern view of Fiji *dalo* imports. Product is required to be topped and de-eyed. Topping refers to the amount of stalk left on the corm with different countries having different requirements. As explained in Section 3.4, (Taro - Fiji), it is common in Fiji for the corm to be sold with the entire stalk. This allows the city-dweller to use the stalk for planting material as so desired as well as making convenient the transporting of the *dalo*. New Zealand requires around 8 cm of stalk or trim and the United States less than five. In contrast, Australia's AQIS requires a zero trim. Fiji exporters complain that AQIS fumigates its exports regardless of whether it finds a pest. Fumigation of a zero-trimmed corms that have been de-eyed results in a very rapid deterioration of the product and thus a significantly reduced shelf life. This tends to make importers and stockists wary of dealing with Fiji products.

In 1998 and 1999, FijiAgTrade, the trade facilitation unit of the Ministry of Forests, Fisheries and Agriculture, undertook a promotional campaign in major supermarkets of Australia to expand consumer awareness and market demand for taro. The philosophy behind the promotion was to grow the market beyond the islander stores and particularly to establish the mainstream Australian market through supermarkets. The majority of the pink variety goes to islander stores but mainstream Australian markets take both white and pink taro. At that time, supermarket prices ranged from A$5.99 to A$6.99 per kilo in 1999 with islander stores retailing taro at $3.50/kg fresh. One outcome of the campaign was the appreciation that Islander consumers were accepting cooked taro retailed at $4.99 / kilo as part of the general move towards convenient and ready to eat products. Vacuum-packed taro was also considered to have potential[28].

Taro Supreme

Over the past five years there has been strong interest shown in Taro Supreme. A great deal of this interest has centred in the northern rivers region of New South Wales but there are also emerging centres in north Queensland and the Northern Territory

Australian quarantine regulations prohibit further importation of taro germplasm for propagation, so genotyping or DNA fingerprinting methods are being used at Central Queensland University to identify domestic cultivars that are similar to the preferred Japanese cultivars.

The Australian domestic cultivar of Taro Supreme appears to be similar to the Japanese cultivar *Ishikawa wase*, and is now being grown in a number of districts in New South Wales and Queensland. Currently this product goes to the domestic market but it is planned to commence exporting to the Japanese fresh market in 2003. Trial plots of this cultivar have been grown in Gosford and northern NSW, northern and southern Queensland, and near Darwin in the Northern Territory. Leaf samples from these sites have been tested at Queensland University of Technology for five viruses common to taro in Australia and the Pacific, and only one sample from northern Qld tested positive for taro bacilliform badnavirus (TaBV). This result is not surprising, as TaBV has already been detected in Australia and taro is grown in north Queensland on a significant scale

[25] See the section Taro – Samoa.
[26] See the section Taro – Fiji.
[27] Pers. com. exporters in Fiji.

[28] Pers. com. Waisiki Gonemaituba (see section on Authors).

commercially and non-commercially. By itself, TaBV does not seem to cause any problems for commercial production. NSW Agriculture assessed corms from the trial plots and commercial crops for quality and taste.

Further multi-location trials are underway for 2002-2003, in NSW, Queensland, Northern Territory and Western Australia. The first commercial shipments are planned for 2003.

The Japanese interest in good quality Australian-produced sato-imo has encouraged further interest from Australian producers. In July of 2002, a Brisbane meeting of taro producers, researchers and industry development representatives from NSW and Queensland explored options to further develop the Japanese taro export industry. Producer representatives included members of Northern Rivers Agricultural Development Association (NORADA) and Taro Growers Australia (TGA)[29].

It is noted that processed Taro Supreme is imported into Australia from China. Three forms are noted:

- Frozen, peeled and stand-alone
- Peeled and in brine
- Frozen, peeled and with other products, principally *gobo* (*Arctium lappa)*, *Renkon* (*Nelumbo nucifera)*, and *takenoko (Dendrocalamus latiflorus)*[30].

[29] Based on an article on the project by Daniel White (see section on Authors), David Midmore (Central Queensland University), Vong Nguyen and David Hicks (NSW Agriculture, Horticultural Research & Advisory Station, Gosford) Peter McLaughlin (Northern Rivers Agricultural Development Association), Grant Vinning (see section on Authors), and Eric Coleman (see section on Authors).

[30] Also called burdock, lotus, and bamboo, respectively.

3.4 Taro - Fiji

Dalo – background

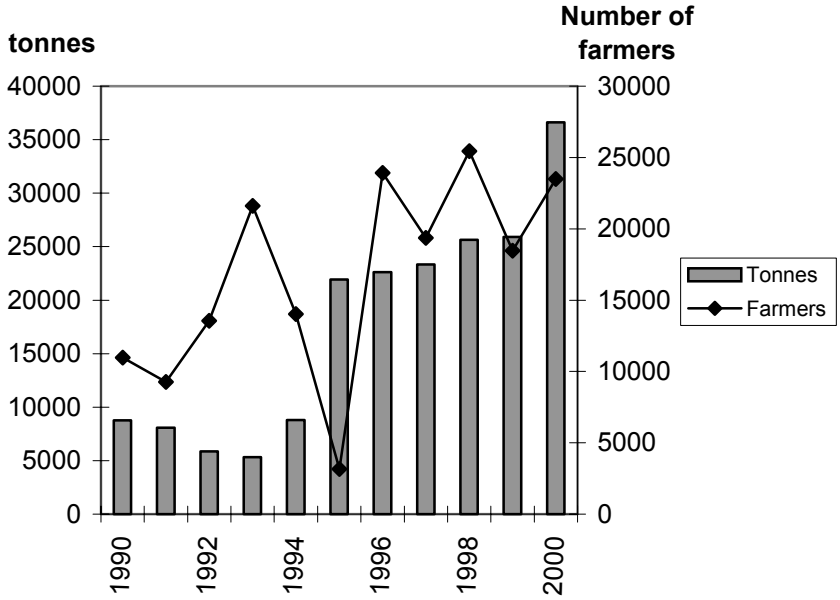
Taro - *dalo* - has a two-fold presence in Fiji.

- At the subsistence level, *dalo* is produced using traditional methods with surplus being sold for commercial trading in urban markets. Subsistence production is estimated at around 50,000 tonnes.

- Commercial *dalo* production that began in the late 1950s. Supplies now go to the large towns, especially Suva the capital on the main island, and are the exports made to New Zealand, Australia, and the United States.

Bearing in the mind the difficulties in distinguishing between surpluses emanating from food security-based subsistence production and commercial production, apparent commercial production has more than trebled over the decade to 2000[31] (Fig. 20).

Figure 20. Fiji - *dalo* . Production and farmer number: 1990 - 2000.



The major export variety is *Tausala ni Samoa.* It is estimated that *Tausala ni Samoa* production will continue to expand on the main island and some of the outlying island. What is termed "mixed varieties" will continue to dominate production.

The origins of *Tausala ni Samoa* are worth noting. The name is an obvious reference to the Samoan Pink type, a taro type highly considered amongst taro eaters of Samoa, Tonga, Fiji, and some of the smaller countries in the South Pacific. In turn, the pink type from Samoa is derived from the Niuean Pink. Niue, an isolated tiny (260 km^2) coral island north of the Kingdom of Tonga, has 34 different taros. Pink types are just one of three major coloured taros grown on the island. The other two are "white", and "red". In terms of production and eating qualities, "white" types are considered hard

[31] All data derived from the Ministry of Agriculture, Fisheries and Forests.

taros and have not only longer production cycles – of around twelve months – but also the ability to be kept in the ground for a longer period. "Pink" types have shorter production cycles of around nine months and are considered soft types of taro. "Red" types appear to be halfway between the pinks and the whites. Whilst it is the origin of Fiji's *Tausala ni Samoa* and Samoa's *Taro Niue*, it is unlikely that Niue is likely to be a niche supplier rather than a major exporter, for reasons related to the fragility of its soil, the sensitivity of its environment, and significant logistics challenges.

When Samoan exports were devastated by the Taro Leaf Blight outbreak in 1993 and producers on the island of Taveuni in Fiji sought to fill the supply-gap, they called their taro *Tausala ni Samoa* "Samoan taro" in order to capitalise on the positive image of Samoan *Taro Niue* that in turn was based on the Niuean Pink.

Production methods

Fiji's experience is that the highest yield of marketable corms is obtained at 60 cm x 60 cm spacing. This is a planting density of 26,900 plants/ha. Mechanisation requires a minimum row spacing of 90-100 cm to allow for inter-row cultivation. This results in a planting density of 17,930 plants/ha.

Manpower required to plant a hectare in the traditional method results in plantings each of around a few square chain patches. Plantings done using oxen and tractor cultivation result in much larger areas.

Yields are high when the crop is planted at the beginning of the rainy season from August to October. In wet areas, planting is possible throughout the year. Off-season planting from March to June often achieves higher prices due to shortage. In drier areas, off-season *dalo* can be grown under wetland or irrigated methods. *Dalo* is usually grown in rotation with ginger and *yaqona* (kava: *Piper mysterium*) to control nematodes and rot but also to optimise the return from total farm enterprise. *Dalo* can also be used as a nurse crop to provide shade for young *yagona*. Weed control is crucial for the first 4-5 months, or until the canopy forms a full ground cover.

Dalo types

It is only in relatively recent times, since the rapid expansion in commercial production especially for export, that Fiji has dedicated resources to *dalo.* Because *dalo* growing is traditional and widespread, Fiji had an attitude that it did not need dedicated *dalo* expertise "as everyone knew". Ironically, introduced crops such as cocoa or coffee received far greater research effort compared with *dalo*. However, this approach has changed and many aspects of *dalo* production are now subjected to the same degree of scientific endeavour as many other aspects of Fiji agriculture.

One such area has been the development of a number of improved varieties. In 1984 the first improved cultivar, a Samoan Hybrid, was released. The most recent releases have been *Wararasa* and Yellow Taro. The former has shown significant advantageous commercial features compared with *Tausala ni Samoa* (Table 15).

Table 15. Comparative features of taro cultivated in Fiji.

Attribute	*Wararasa*	*Tausala ni Samoa*
Yield	30 - 32 t/ha[32]	12 – 13 t/ha
Time to maturity	7 - 9 months	9 – 12 months
Corm weight	1 – 2 kg	0.7 – 2 kg
Corm dry matter	30 –35 percent	31 percent
Sucker	5 – 6 per plant	3 – 4 per plant

Another specifically bred type is commonly known as Yellow Taro. Slightly smaller than the traditional taros, it sells for a distinct premium because its taste is considered superior, an attribute associated with its harder texture. All the introduced varieties have prices considerably higher - up to double - compared with the local cultivars.

Marketing arrangements

Fiji has three major islands. Commercial production started on Viti Levu, the main island, by supplying the large cities like Suva, Nadi, Lautoka, and Sigatoka. It has since expanded to the other major island of Vanua Levu, the third biggest island of Taveuni, and some of outlying islands. Expansion has been due to development in terms of:

- construction of infrastructure such as main roads, local roads and farm roads
- construction of wharves and storage facilities
- improved communications, especially telephone
- improvements in shipping capacity and schedules.

Taveuni now supplies about 70 percent of the exportable variety *Tausala ni Samoa.*

Recently, commercial production has shifted from traditional hill planting to flatland-mechanized cultivation. The river flats near Suva are the major site of the latter form of production. Domestic commercial demand is estimated at around 16,000 t.

Dalo is marketed through a number of methods.

- Farmer selling at farm gate. This is the major method used in exports. A buyer will go directly to the farmer and ask for availability of a pre-determined quantity and offer a price. The buyer will return after a few days to collect and pay. The exporter usually specifies the method by which he wants the *dalo* to be handled. Prices are determined by weights of the corms with two inches of stem. Usually the price offered is paid in cash. Some exporters have contracted farmers and assist the farmers with credit for a whole range of reasons many of which are not directly related to the production of *dalo*. Again, some exporters have their own farms.

[32] Based on yields at the Koronivea Research Station, not commercial yields.

- Farmers sell to middlemen/vendors at market places. *Dalo* farmers living close to the urban centres either sell their produce to the premises of the middlemen or sell direct at the municipal markets. Prices are set in terms of a bundle or weight.

- Farmers sell export quality *dalo* to an exporter(s) and market the balance directly. Prices and quantity very much depend on the exporter's needs at that specific time. For the producers it is very much a take-it-or-leave-it situation.

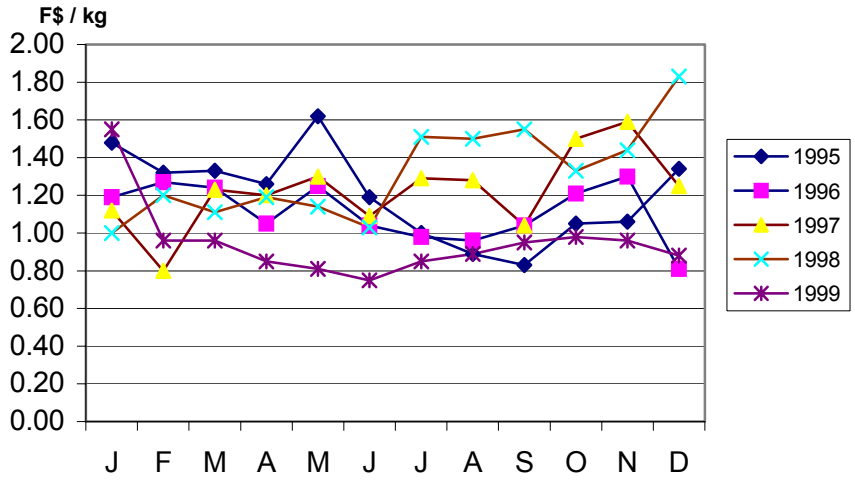
- Farmers sell directly at the market. Producers will have a general idea of the price they should get for their produce at the local market at the various times of the year. For example, prices are traditionally low just before the commencement of the school year as farmers seek to raise cash to pay for school fees and books. At most municipal markets, farmers are only allowed to sell their produce on Fridays and Saturdays. From Monday to Thursdays, permanent market vendors will buy the taro from the farmers and are the only retailers on the market.

- Roadside selling is found in and around the major cities and towns. Individual volumes are small. This form is increasingly common.

Domestic marketing

It is difficult to determine any wholesale patterns for *dalo* in Fiji. Figure 21 below shows monthly prices in Suva for the period 1995 – 1999.

Figure 21. Fiji - *dalo*.
Monthly wholesale prices, Suva: 1995-1999.



Data in Figure 21 does not support the claim that prices tend to be low just before the start of the school term (January, May, and September) as farmers dump *dalo* in order to raise money to pay for their children's school fees and material.

A retailer at the Suva market could buy a large 36 kg bundle of taro for FJ$40 directly off a farmer's truck. After cleaning, he rearranges the taro into smaller bundles of 7 - 8 kg each. Bundle are sold for FJ$10 each. As the retailers' customers usually do not want to carry the stems home,

these are cut off by the retailer and on-sold as planting material for FJ$0.10 each. Assuming daily sales of four large bundles, the vendor would have generated FJ$20 - $30 per day.

One of Fiji's challenges is that producers' share of the retail dollar is quite high – around 70-80 percent.

For exports, the marketing chain is much longer and the exporter's costs and risks much higher. Familiarity with domestic marketing is biasing producers against the need for higher exporter margins and thus lower producer returns.

Export markets

Fiji's taro exports have been targeted at the Pacific Island expatriate population in New Zealand, Australia, and the west coast of the United States.

Fiji's first *dalo* exports to New Zealand were in 1950: Samoa started in 1957. Fiji was the main supplier until 1963 when severe flooding in Fiji allowed Samoa to fill the gap. Samoa continued to dominate the market until the collapse of the industry in 1993 due to the devastation caused by the Taro Leaf Blight. Following the Samoan industry's collapse, Fiji has recaptured the New Zealand market. It now has more than 80 percent of the market.

Whilst Fiji has exported *dalo* since the 1950s, exports in earnest really only stated with the outbreak of the leaf blight in Samoa in 1993 (Fig. 22). Prior to then performance was very erratic and whilst there has been variation since, the trend is clearly upwards. In 1999, Fiji exported 4,967 t.

Fiji exports to over ten countries but three markets - New Zealand, Australia, United States, respectively - take more than 95 percent of all exports (Tables 16 and 17). The United States, whilst the smallest market, yields the higher FOB price.

Some of the smaller and one-off markets are unusual: Denmark, India, Lao PDR, Sri Lanka, and United Arab Emirates.

Figure 22. Fiji - *dalo*. Annual exports by volume and FOB unit value: 1990 - 2000.

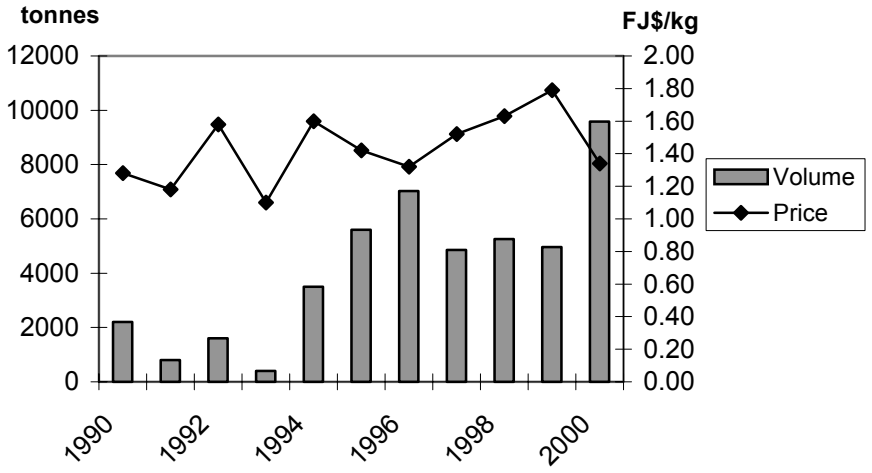


Table 16. Fiji - *Dalo* annual exports by volume: 1995 – 2000 (tonnes).

	1995	1996	1997	1998	1999	2000
Australia	654	950	801	739	573	2,031
New Zealand	4,446	5,594	3,705	3,900	4,009	6,417
United States	403	426	333	592	279	1,806

Table 17. Fiji – *Dalo* annual exports by value: 1996 – 2000 (FJ$/kg, FOB basis).

	1995	1996	1997	1998	1999	2000
Australia	1.33	1.18	1.44	1.71	1.68	0.67
New Zealand	1.38	1.33	1.50	1.50	1.77	1.36
United States	1.91	1.73	1.98	2.38	2.61	1.96

Industry issues

In order to advance the industry, especially for exports, Fiji established a Root Crop Industry Council in 1997. The Council developed a strategic plan that seeks to address issues of quality, market development and market competition. Areas identified as requiring attention include:

- Lack of planting material of the varieties required by farmers.
- Diversification of concentration of *Tausala ni Samoa* away from the major production region of the island of Taveuni.
- Inefficient production system that leads to high cost of production.
- The need to develop mechanised methods for flat land cropping in order to reduce costs and thus enhance international competitiveness.
- Lack of appropriate research staff, especially plant pathology and post-harvest preservation.
- Lack of credit facilities to the agricultural sector.
- Limited shelf life of the product.
- The threat from the taro beetle *Pauana* spp. First reported in 1984, the pest is particularly serious in Central Division, the planned area of expansion into flat land and mechanised production. The beetle burrows into the corm and apart from making the corm look particularly unattractive, the resulting holes and wounds act as a vehicle for the incursion of pathogens.
- Lack of industry standards.

- Poor market intelligence.

Due to a lack of funds, the Council went into recess in 2001.

Three additional issues are noted:

- **Taro leaf blight** *Phytophthora colocasiae*. When this struck Samoa in 1993[33], Fiji's initial reaction was not one of great concern. Indeed, the blight was seen as an opportunity for Fiji to fill the resulting void of Samoan exports. However, there has been the realisation that Fiji grows virtually the same variety as Samoa and thus is as susceptible to the potential disaster as what Samoa was. Thus recently there has been effort invested in breeding and general husbandry of the crop.

- **Inter-island shipping**. Product from Taveuni, the main source of exports, must be shipped to the main island for eventual exporting. Such a system results in multiple handling. With each handling exercise, the product can be damaged. Unfortunately, those inflicting the damage do not see the results of their action as the damage, essentially bruising, is endemic and only becomes epidemic after several weeks.

- **Taro mite**. In 2002 taro mite *Rhizoglyphus minutus* was discovered by New Zealand Quarantine on a shipment to New Zealand. The mite is a microscopic organism that attaches to the bottom of the lower half of the corm. Being so small and of the same colour as the corm itself the mite is difficult to detect with the naked eye. From Fiji's perspective, the mite is not a pest as such because it does not damage the corm. More-over, there are ten species of the mite; they are found in almost all the islands exporting taro to New Zealand, and they have been reported as present in New Zealand. Nevertheless, the mite is a Regulated Quarantine Pest in New Zealand. As such, all taro imported from Fiji into New Zealand has to be fumigated.

[33] This matter is treated in more detail in the section on Samoa.

3.5 Taro - Japan

Japan refers to *Colocasia esculenta* as *sato-imo.*

Sato-imo types

Six types of taro are commonly identified in Japan:

- *Ishikawa-wase* (Plate 7.)
  - Only the daughter corm is used.
  - New plants appear from August to September.
  - Considered to have a plain taste.

- *Dodare* (Plate 8.)
  - Only the daughter corm is used.
  - Have a sticky texture.
  - Grown mainly on the Kanto Plain around Tokyo.
  - Year-round production.

- *Sereves* (Plate 9.)
  - Word derives from the Celebes in Indonesia.
  - Mother and daughter corms are used.
  - Corm has a reddish bud.
  - Taste is considered not to be soggy.
  - Suitable as a boiled dish with light seasoning.

- *Yatsugashira* (Plate 10.)
  - Both mother and daughter corms are used.
  - Daughter corms do not separate from mother corm.
  - Used in boiled dishes.
  - Especially popular at New Year.

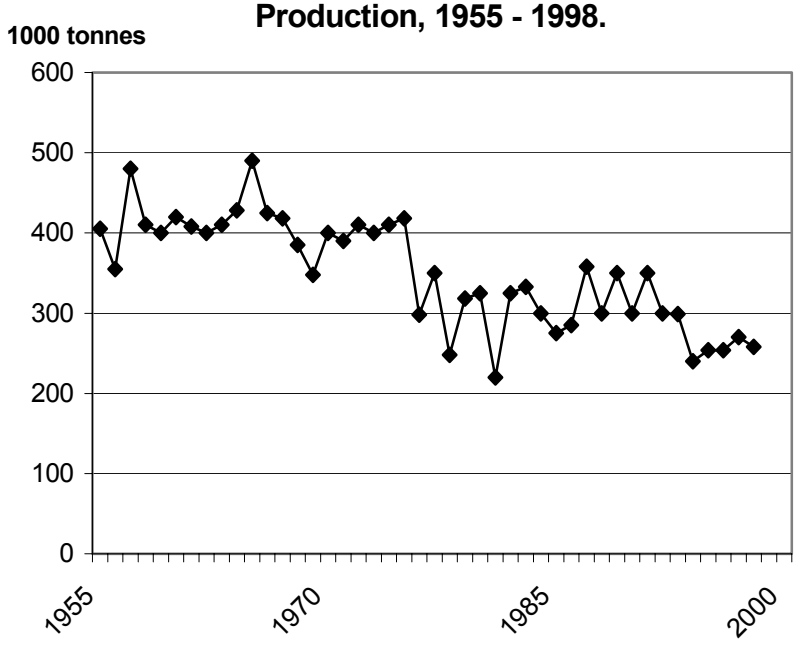
- *Tohno-imo* (Plate 11.)
  - Both mother and daughter corms used.
  - *Ebi-imo* or "lobster *imo*" is produced by manipulating the soil to make a corm bent to look like a lobster.

- *Takenoko-imo* (Plate 12.)
  - So called because it looks like *takenoko* (bamboo).
  - Also called *Kyo-imo*.
  - Only mother corm is used.
  - Grows to 60 cm.

Production

Production data do not differentiate amongst the different types of *sato-imo*. *Sato-imo* production in Japan is steadily declining (Fig. 23). In 1998 production was 258,000 t.

Figure 23. Japan - *Sato-imo*. Production, 1955 - 1998.



Sato-imo production is widely spread throughout Japan. ***The Statistical Yearbook of the Ministry of Agriculture, Forestry and Fisheries*** records production in every prefecture except Hokkaido in the far north.

There are two major centres of production:

- Kanto Plains based around Tokyo that supplies about a quarter of the national total. The two main producing prefectures are Chiba and Saitama.
- On Kyushu Island where production is centred on Miyazaki and Kagoshima in the southern part of the island.

This is a major change from five years earlier. Then, production was more evenly balanced with both regions producing near equal volumes. In 1998 Kanto production was considerably greater than that of Kyushu. Nearly 99 percent of production is based on the autumn-winter harvest period. Again, this is a major change from even five years ago when just over 90 percent of the harvest occurred in the autumn-winter period.

Interestingly, the major variety in Japan, *Ishikawa wase* "Early Ishikawa", is produced in Ishikawa, on the west coast virtually opposite Tokyo. Despite it being the high priced and most sought after type, production from the prefecture is extremely small, around 500 t only in 1998.

Wholesale performance

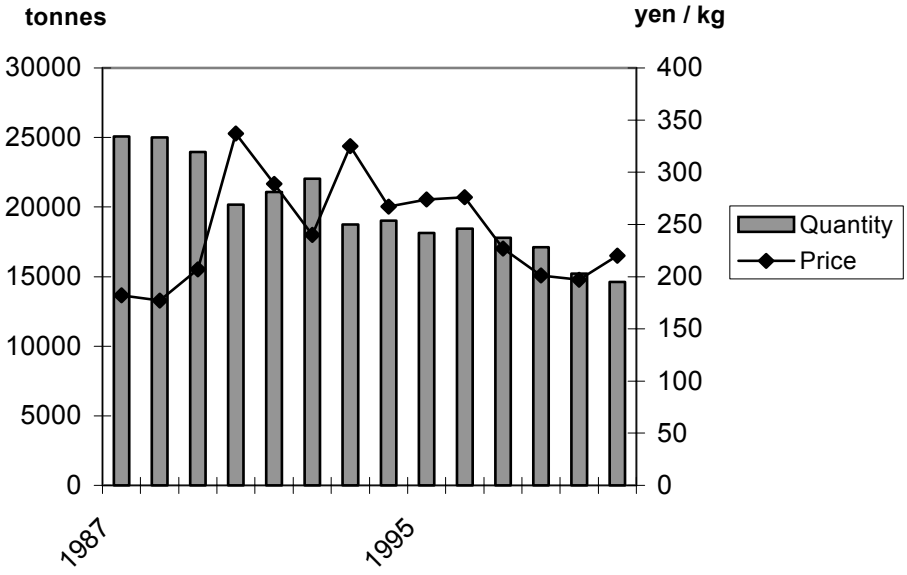
Japan has excellent data relating to its wholesale markets. These are available both nationally and for a large number of the major markets[34]. The quality of the data allows for detailed analysis.

Just under 60 percent of total taro production is marketed through the country's wholesale marketing system. The balance is consumed on-farm, traded with consumers in a system known as *sanchoku* direct marketing under strict production criteria, or processed. The labour costs associated with processing taro into either par-boiled, preserved in brine, or frozen are so high as to make this a declining outlet.

Annual wholesale performance

Annual wholesale performance at the Tokyo wholesale markets shows declining throughput over the last decade and declining prices (Fig. 24).

Figure 24. Japan - *Sato-imo* - fresh. Annual wholesale peformance, Tokyo: 1987 - 2000.



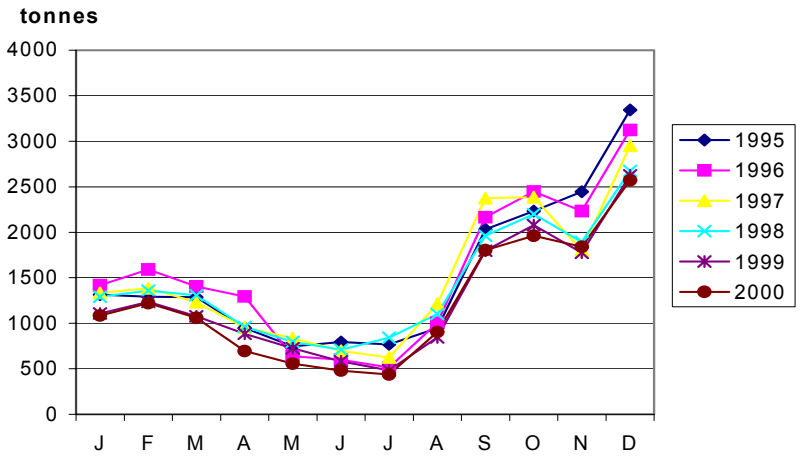
In 2000, the nine markets that constitute the Tokyo wholesale system handled 14,619 t at an average annual price of 220 yen/kg.

[34] All Japanese wholesale data used in this publication, unless otherwise stated, relate to just Tokyo and comes from the Tokyo Municipal Authority.

Monthly wholesale performance

Monthly wholesale throughput data show that production is lowest in the hot months of May to August (Fig. 25). After August throughput volume rises sharply.

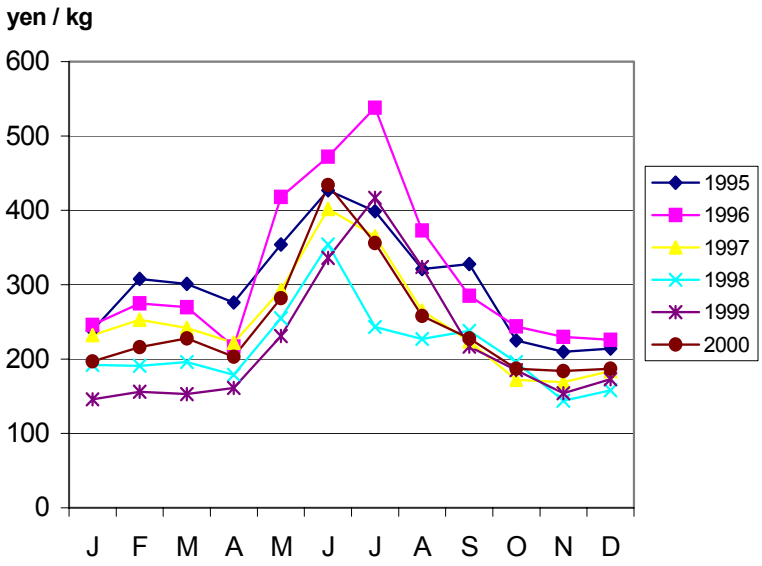
Figure 25. Japan - *Sato-imo* - fresh. Monthly wholesale volumes, Tokyo: 1995 - 2000.



Monthly wholesale prices peak in late spring - early summer (Fig. 26). Even allowing for annual variations, the clear-cut and repetitive nature of the seasonal patterns of, first, supply, and, then, prices allows for two confidence comments:

- Prices are highest in the period May – August.
- Price peaks of around 400 yen/kg can be expected.

Figure 26. Japan - *Sato-imo* - fresh. Monthly wholesale prices, Tokyo: 1995-2000.



The daily reports on the wholesale markets state three prices – high, medium, and cheapest. They also give the originating Prefecture. These more detailed data show a great deal of daily fluctuation. To illustrate, the data in Table 18 for just one week recorded by ***Asian Markets Research*** on another mission to Japan in April 2001.

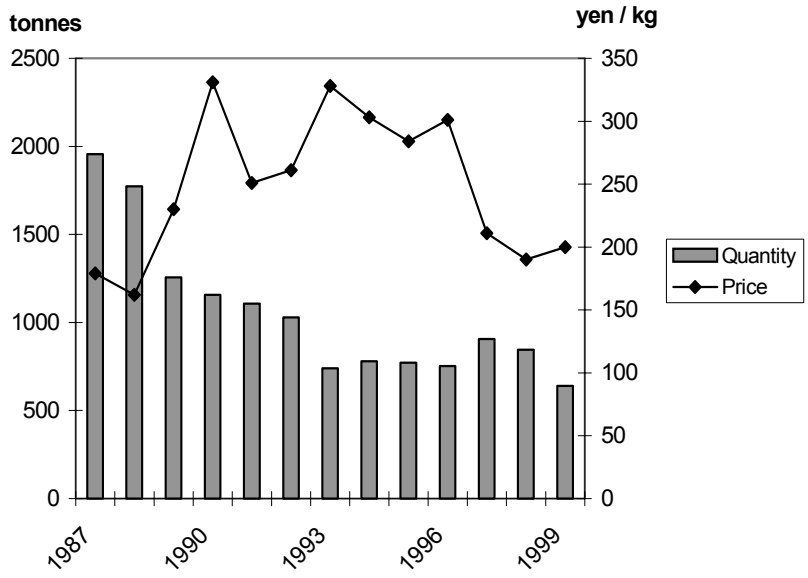
Table 18. Price variation for fresh sato-imo during one week in April, 2001.

Originating Prefecture	High LL size (Yen / kg)	Medium – LL size (Yen/kg)	Low – LL size (Yen / kg)
Saitama[35]	472	420 - 451	420 - 367
Chiba	168	148	136 - 148

Sereves type sato-imo – annual wholesale performance

Data are available for the *sereves* type (Fig. 27). These show that annual wholesale volumes are less than a tenth of those of *sato-imo*.

Figure 27. Japan - *Sereves* type *sato-imo* - fresh. Annual wholesale performance, Tokyo:1887-1999.



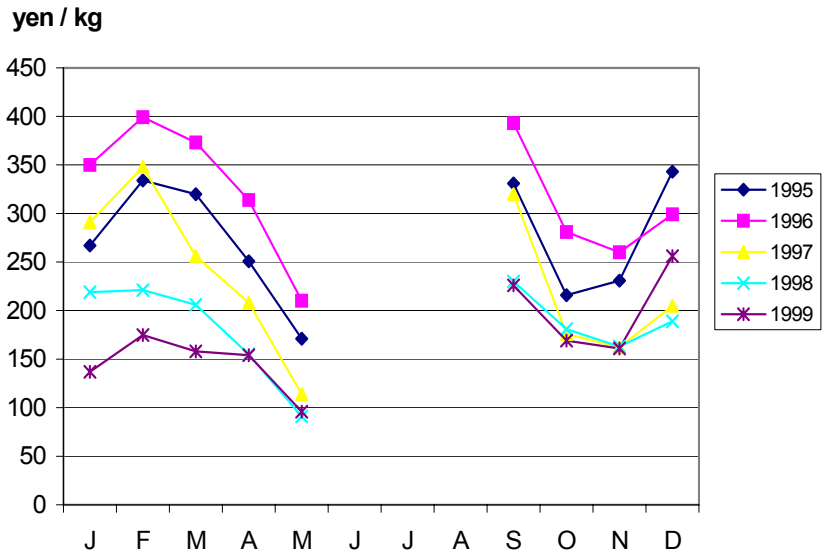
Sereves type sato-imo – monthly wholesale performance

Monthly wholesale prices peak in January - February before bottoming out in May (Fig. 28).

Throughput in June to August is virtually negligible. Prices start high in September with the resumption of throughput volumes but the high prices must be seen as being of novelty value as they drop rapidly in October.

[35] Saitama product packed in 10 kg boxes whilst Chiba product packed in 500 g boxes.

Figure 28. Japan - *Sereves* type *sato-imo* - fresh. Monthly wholesale prices, Tokyo: 1995-1999.



Grades

The above price data are for the average of all grades. Individual grade data are not commonly available.

Sato-imo is one of a number of crops subjected to domestic shipping standards. Suites of grades are provided for the *Ishikawa wase* and the *Dodare* types in Table 19.

Table 19. Domestic shipping grade standards for *Ishikawa wase* and *Dodare* types of sato-imo.

Type	2L	L	M
Ishikawa –wase	60 g	40 – 60 g	20 – 40 g
Dodare	90 g	60 – 90 g	30 – 60 g

In addition, there are two over-arching grades:

- A for fresh consumption
- B for processing, usually by peeling and freezing.

Imports are not required to comply with the domestic grading schedule. However, given the fact that the market is used to sizes determined by the domestic standards, importers are well advised to be very conscious of them.

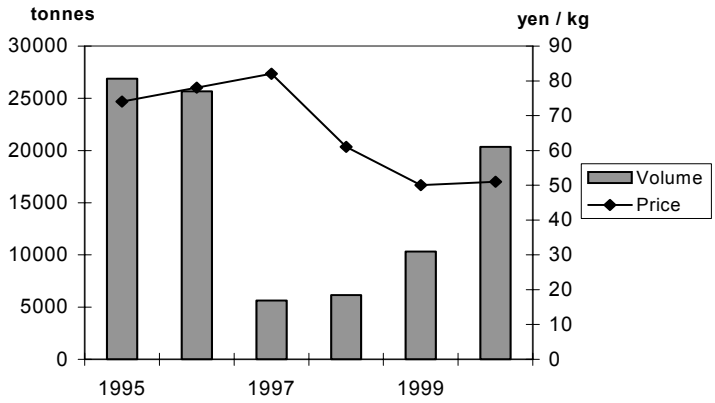
Imports

There are two obvious trends that tend to lead to a third. One trend is the decline in annual *sato-imo* production. The other is that wholesale prices, especially the monthly ones, show that there still is considerable demand. From the two comes the inevitability of imports.

Japan is a significant importer of *sato-imo* in both the fresh (Fig. 29) and frozen (Fig. 32) form.

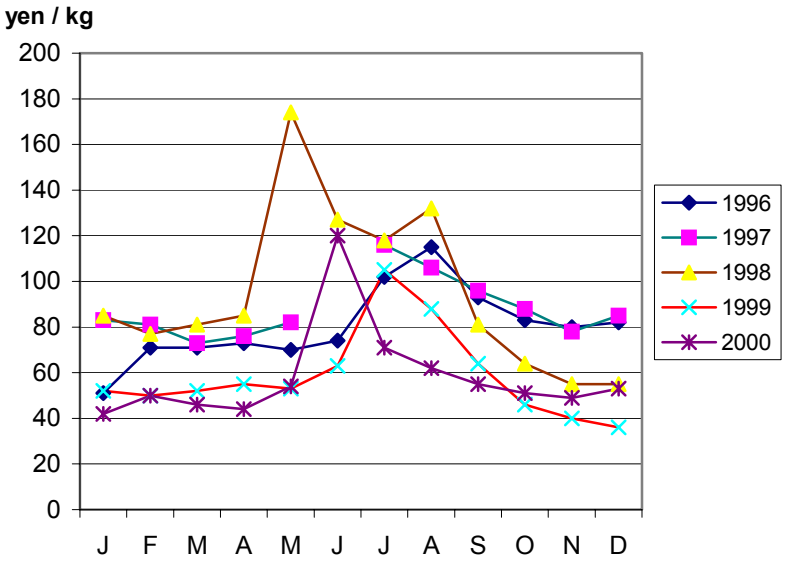
Sato-imo - fresh - annual imports

Figure 29. Japan - *Sato-imo*. Annual imports - fresh: 1995-2000.



In 2000, Japan imported 20,344 t at an average annual CIF price of 51 yen/kg. Monthly import data (Fig. 30 and Fig. 31) reflect the seasonal conditions in China, the origin of nearly all of Japan's fresh imports of *sato-imo*. That is, Japan's low season of throughput is its summer months and as China shares to a large extent the same geographic region, then China's production is lowest in the northern summer.

Figure 31. Japan - *Sato-imo*. Monthly CIF prices of fresh produce: 1996-2000.



It is clear that volumes are lowest, indeed virtually non-existent in the period May to August. Monthly CIF prices tend to rise in the summer months. The period of high prices can stretch into August (Fig. 31).

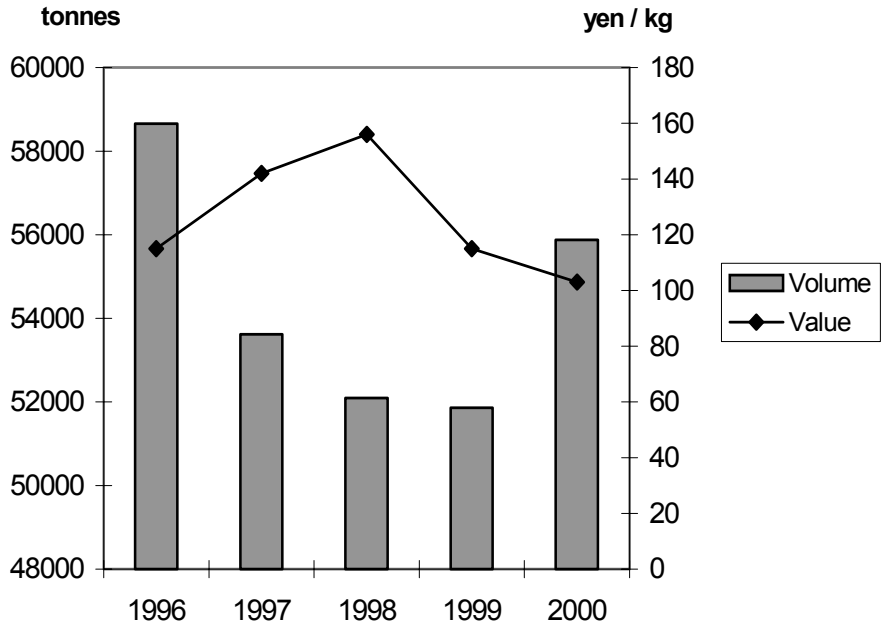
Fresh imports tend to go to the wholesale markets rather than the food processing sector.

Sato-imo - frozen - annual imports

Imports of frozen sato-imo are significant (Fig. 32). For the five-year period 1996–2000, imports never fell below 50,000 tons.

In 2000, Japan imported 55,875 t at an annual average price of 103 yen/kg.

Figure 32. Japan - *Sato-imo*. Annual imports, frozen: 1995 - 2000.



The common variety imported from China in the frozen form is the *dodare*.

The process is that the product is washed in hot water to remove the dirt, peeled, and then graded according to size. Peeling can be by hand or machine. With the former, the distinctive characteristic is the actual slice marks on the product, which has an appearance like a diamond. Machine peeled *sato-imo* tends to be smoother and more regular in shape. It appears that the former attracts a premium but this could not be quantified.

It would appear that there are problems with the supply of frozen product from China. There are two forms of supplying exports from China to Japan. One is from Chinese owned factories with sale to Japan being either on contract or on speculation.

The second is from plants that are either fully owned by Japanese firms or under some form of joint venture with Japanese firms. The latter route suggests that the trade is more company-to-company rather than country-to-country.

It appears that some Chinese growers supplying Japanese factories considered that they are not getting a fair return for their effort.

Japanese standards are extremely high with the result that, on average, the grower must produce around three kilograms in order to get one accepted. However, payments do not reflect this and is causing some resentment. An end result of this is that Chinese growers could turn to other crops.

Imported frozen product has several outlets:

- Retail where it can be packed under contract for specific labels.
- Food service sector, probably the biggest outlet.

At the same time, frozen *sato-imo* imports need not necessarily be as stand alone items. Imports are increasingly in the mixed pack, that is, taro with other products. The Chinese in particular have been energetic in developing this sector. Typically mixes involved what could be called "western vegetables" such as broccoli, cauliflower, carrots, and asparagus. More commonly have been mixes with traditional Japanese vegetables:

- *renkon* lotus root *Nelumbo nucifera*
- *gobo* edible burdock *Arctium lappa*
- *takenoko* bamboo *Phyllostachys* spp.

Data are not available for frozen sato-imo imported in the mixed product form. This suggests that total imports are higher than the 55,000 noted above.

Sato-imo – frozen – monthly imports

Volume and value data for monthly imported frozen product (Fig. 33 and Fig. 34) show a surprising lack of evenness that one would automatically assume for frozen product. More over, the volume pattern has no mirror image in price data. The lack of symmetry in the two makes it extremely difficult to forecast with confidence precise price windows.

Figure 33. Japan - *Sato-imo* . Monthly volume of imports - frozen: 1996 - 2000.

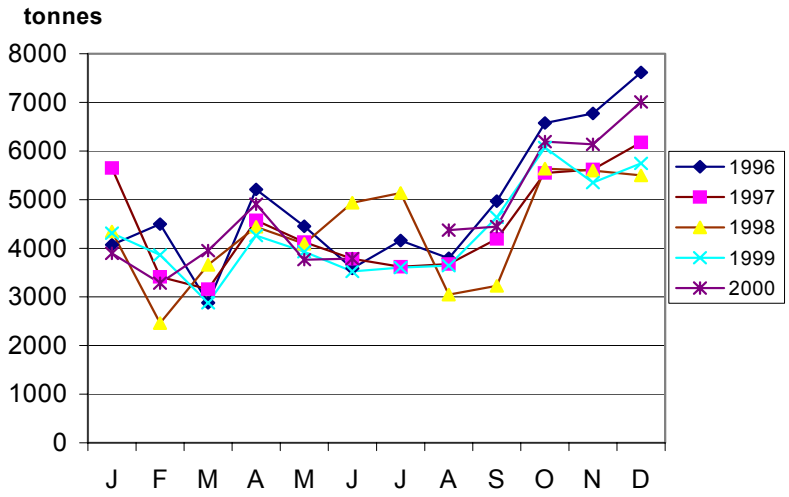
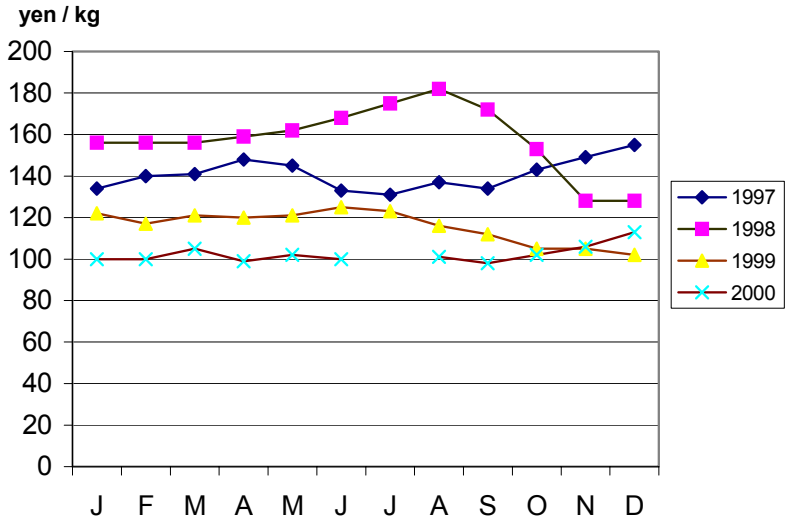


Figure 34. Japan - *Sato-imo* - frozen. Monthly CIF prices: 1997 - 2000.



3.6 Taro - New Zealand

Imports

New Zealand is the major export destination for Pacific taro. Two basic reasons are advanced for this:

- Size of the Pacific Islander population – about 190 000.
- Preference by Pacific Islanders for "their" taro.

Fiji began exporting taro to New Zealand in 1950 and Samoa started in 1957. Since then supplies to the New Zealand market have oscillated between the two as one country has a disaster - Fiji in 1963, Samoa in 1993 - the resulting gap is filled by the other. Currently, Fiji has more than 80 percent of the market.

The previous domination by Samoan exports was based primarily on the size of the Samoan expatriate population in New Zealand. They number about 190 000 of which about 90 percent live in Auckland the biggest city. There is a second vastly smaller population in Wellington the capital. No other place is really worth considering. The Islander population of New Zealand is expected to double in the next 30 years.

Analysis of New Zealand imports is handicapped by its method of statistical collection. Data are reported in detail up to 1997 where-after taro is not recorded.

The size of the New Zealand taro market is estimated at around 8,000 t annually.

Standard

To gain entry, the following general standards apply:

- taro must be scraped clean and washed clean of soil
- must be de-eyed and tailed
- trimmed to 2 inches of top
- packed in 30 kg bags
- have a corm size of 800 g - 1 kg.

Between 1992 and 1997, ten countries have exported taro to New Zealand, Table 20. Most suppliers are to be expected – Fiji, Samoa, Niue, Tonga, Cook Islands, - but there are some unexpected suppliers such as Vietnam, Thailand, the Philippines, and Korea.

It is possible to argue that with the latter four suppliers they are merely following the example of the Islanders suppliers in sending taro to their kin in New Zealand. On the other hand opportunism should not be ruled out: the Philippines, taro was loaded on to a banana boat and given a vastly subsidised freight rate to New Zealand. With virtually a zero freight cost, the Filipino retail price was very attractive. However, the product was considered to be extremely poor, breaking down when it was boiled and loosing a great deal of its colour.

Table 20. New Zealand taro imports by country, C.I.F. NZ$.

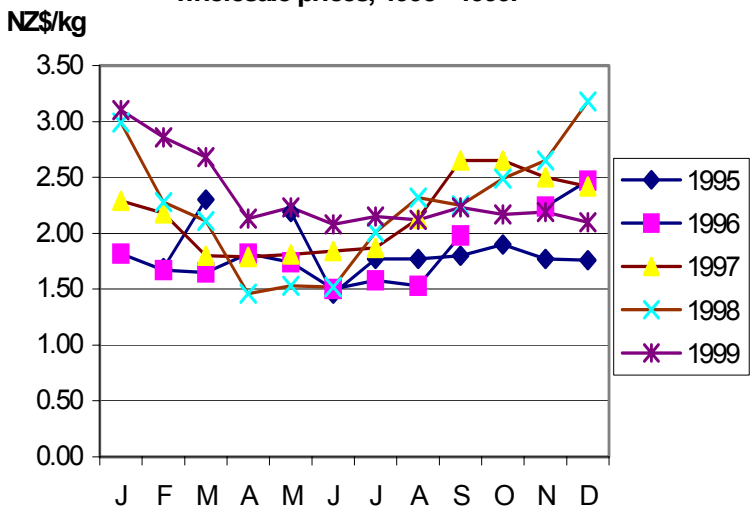
	1992	1996	1997
Cook Islands	3,700	216,927	54,967
Fiji	1,685,000	8,915,103	8,043,941
Niue	81,000	312,051	164,054
Tonga	4, 000	557,621	321,664
Samoa	2,169,000	64,992	11,712
Australia	N/a	13,442	N/a
Korea	N/a	716	178
Philippines	N/a	10,334	174,226
Thailand	N/a	N/a	1,844
Vietnam	N/a	1,879	N/a
Total	**3,987,700**	**10,093,065**	**8,772,583**

Consumption

It is a common hypothesis that second generation emigrants move away from their traditional foods and thus traditional foods are declining. This is disputed at least for taro in New Zealand where it is clearly still an important part of Pacific Islander culture and cuisine. Having such an obvious hero as Johu Lomu (the world's highest paid rugby player) advocating the advantages of Pacific Island taro helps keep the tradition very much alive.

However, whilst there will always be a demand for taro, it is an extremely price sensitive market with there being adequate alternatives in the form of plantains, sweet potato, *kumala*, and even potatoes. When retail prices are between NZ$2.00 - $3.00/kg (Fig. 35), demand for taro is strong. At these prices, Pacific Islanders will eat *dalo* several times a week. Above NZ$3.00/kg retail, demand starts to decline. At NZ$4.00/kg taro demand virtually dries up because taro ceases to be an everyday meal item. Consumption becomes limited to special occasions, such as the Sunday feast and other community-cultural events. Thus, whilst there is a market, it is one whose loyalty must be continually courted and not taken for granted.

Figure 35. Taro - New Zealand. Monthly wholesale prices, 1995 - 1999.



Trade issues

Two issues are noteworthy.

- Non-traded imports. A particular challenge for exporters of taro to New Zealand is the role of non-trade imports. A significant volume of taro enters through church groups with church groups in the Pacific supply kindred church groups in New Zealand. A great deal of this volume is not actually marketed but rather distributed directly to the church members. The handlers of these imports do not impose commercial mark-up with most of the "trade" occurring on a cost-only basis. Much of the direct traded produce moves through the large Pacific Islander-based informal market at Otaro in Auckland where it is virtually impossible to measure volume and prices.

- Quarantine. New Zealand has a most rigorous quarantine system, albeit a most transparent one. Potential costs faced by taro exporters/importers are numerous and petty but combined they add up. For example, in New Zealand MAF's Quarantine Service charges included:
- Document fee
    - Inspection fee
    - Treatment fee (avoidable)
    - Re-inspection fee (avoidable)
    - Zone fee (if they have to travel to the inspection site)
    - Facility fee (if the inspection occurs at the MAF site)
    - Specimen I.D. fee (if any insects are found)
    - Post/pack/courier fee (to transport the insect/s to the MAF entomologist).

3.7 Taro - Samoa

Production

Up until 1993, taro was the major crop of Samoa. It was one of three staples (with bananas and breadfruit) that fed the island and was the major export earner: in 1993 taro exports were 58 percent of total export earnings. Ironically, the preferred cultivar was called locally *Taro Niue*.

Taro Leaf Blight *Phytophthora colocasiae* was first noticed in July 1993[36]. By December the blight had spread to every district on the main island of Upolu and covered most of Savai'i, the other island. Given that plantings were dominated by the cultivar *Taro Niue*, lack of resistance was common, abetting the rapid spread of the fungus. To some extent the lack of varieties and cultivars is a natural outcome of farmer bias as they tended to concentrate on those popular varieties in the domestic market.

The continuing popularity of *Taro Niue* was despite the release in 1988 of Alafua Sunrise. This was the first improved taro cultivar developed by the Aroid Breeding Program of the Institute for Research, Extension and Training for Agriculture at the Alafua Campus of the University of the South Pacific. The hybrid resulted from a breeding program that addressed the major constraints to taro production in Samoa and the South Pacific in general: low yield, seasonal production, shortage of planting material, weed competition, low soil fertility, the presence of a number of pests and diseases, perishability, acridity, and eating qualities. Wilson *et al*. (1994) show that on a number of objective measurements, Alafua Sunrise was superior to *Taro Niue* (Table 21).

Table 21. Performance of *Colocasia esculenta* cultivars in on-station advanced trials, Alafua: 25 November 1989 – 11 July 1990.

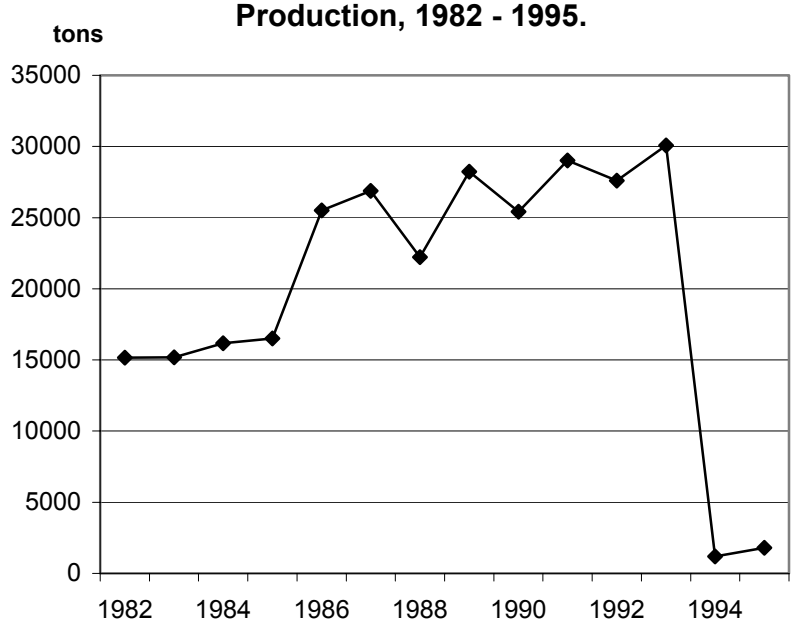
	Yield (marketable tonnes/ha)	Suckers per plant	Dasheen Mosaic Virus susceptibility	Dry weight (percent)	Eating qualities
Taro Niue	5.8	7.2	1.4	33.5	3.1
Alafua Sunrise	10.3	6.2	0.4	33.2	2.9

In retrospect, taro eating quality is of critical importance. *Taro Niue* is a round corm, with a distinctive pink bud, and a hard-textured flesh that is off-white in colour. In contrast, Alafua Sunrise is yellow-fleshed and tender with a tendency to produce long corms if planted too deep. Thus, despite the initial interest in Alafua Sunrise, by the early 1990s, *Taro Niue* was still the most popular choice by farmers. As the Taro Leaf Blight was to show, the near dependence on a single cultivar was a primary issue in the rapid and near total destruction of the crop.

Whilst it was rather casually reported that the blight would wipe out 40 percent of the 1993 taro crop and "at least for one year, virtually the entire crop of 1994"[37], it must be doubted if the real impact of the fungus was truly known (Fig. 36).

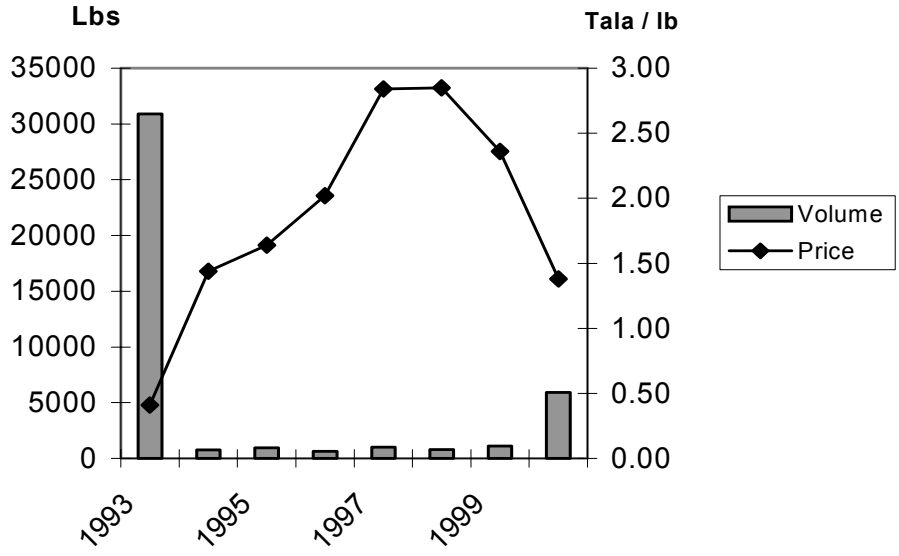
[36] Given the importance of the Blight to the Pacific taro industry, Section 3.8 contains more extensive notes.
[37] ***Pacific Islands Monthly***, December 1993.

Figure 36. Taro - Samoa. Production, 1982 - 1995.



Prices at the Fugalei Markets in Apia more than trebled[38], indeed the annual average price for 2000 has only now returned to 1994 post-Blight prices, see figure below (Figure 37).

Figure 37. Taro - Samoa. Annual market throughput and prices: Fugalei Markets, Apia: 1993 - 2000 (source: Central Bank of Samoa).



[38] All statistical data drawn from the reports of the Central Bank of Samoa.

It is only now that taro production has commenced recovery: full recovery is a long way to go[39]. Whilst use has been made of fungicides, most of the recovery seems to be related to enhanced field sanitation, use of disease free planting material, greater use of crop diversification, and the breeding of taro leaf blight resistant varieties of comparable taste and texture to the pre-blight varieties. Nine new leaf blight-resistant cultivars have so far been released.

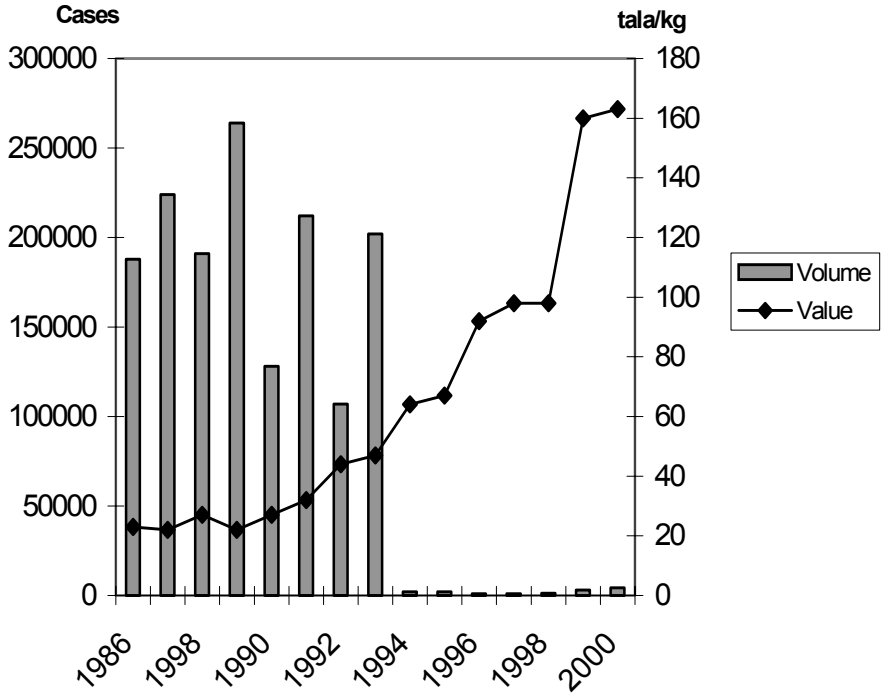
Exports

Samoa commenced exporting taro well after Fiji started. The spur to serious exporting to New Zealand began with the Fiji floods of 1963. Samoa took hold of the market and continued its domination until the outbreak of its Taro Leaf Blight in 1993. Whilst Fiji attempted to fill the resulting void, its taro was not considered as favourably as the Samoan "Pink".

At the heights of its exporting prior to 1993, Samoa supplied around 1,000 t of "Pink" to the West Coast of the United States. Data show that even during the Taro Leaf Blight, Samoa was able to maintain some small volume of exports, albeit very small (Fig. 38).

Samoa suffered in two ways. First, the volume of exports was negligible. Second, the unit price per kg of whatever taro was available became so high as to discourage sales.

Figure 38. Taro - Samoa. Annual exports 1986 - 2000 (source: Central Bank of Samoa).



[39] American Samoa experienced a comparable situation. In 1993, American Samoa production was 357,000 kg: this declined to 21,900 kg in 1994 and 5,000 kg in 1995.
Before the leaf blight disease, taro sold for US$1.10/kg ($0.50/lb); when it returned to the market in 1998, taro sold for $4.95/kg ($2.25/lb). In July 2001 taro sold for less than $2/kg ($1/lb). Leaf blight resistant taro cultivars from Micronesia were introduced in early 1997.

Even though in the United States there has been a seamless move to white types of taro from Fiji and other origins, the demand for the Samoan pink is such that should re-exporting commence, and assuming that the Leaf Blight varieties have comparable eating qualities to the non-resistant cultivars, Samoa could quickly rebuild the market.

Taro production occurs on both islands of Samoa, albeit the greater proportion occurs on Upolu. Produce from in Savai'i is loaded by truck and the entire unit ferried to Upolu. Compared with Fiji, this has the distinct advantage of reducing damage caused by excessive and rough handling.

Samoa's ability to re-capture its pre-blight export market share is also due to its lower selling price. This is reported at FJ$0.50 /kg compared with Fiji's FJ$1.80 /kg[40]. However, it must be borne in mind that Samoa's tala is worth around half that of the Fijian dollar.

[40] ***Fiji's Business Magazine***, January 2002.

3.8 Taro leaf blight in the Pacific

Taro leaf blight *Phytophthora colocasiae* is a relatively common disease. In Asia where taro originated, the plant and the disease have co-existed through their co-evolution. As a result the natural resistance by the plant to the disease prevented the blight from becoming a problem. When the emigration from Asia to the Pacific occurred, it was natural that the population would take one of the their major food items with them. But whilst they took the taro with them they separated the plant from its native environment and thus the plant was most likely unable to keep pace with the development of resistance to the diseases.

The blight has been present in Papua New Guinea[41], Federated States of Micronesia, Northern Mariana Islands, Palua, and the Solomon Islands for over 50 years. An outbreak in the Solomon Islands after World War II resulted in a permanent shift in some parts of the country away from taro to sweet potato and cassava production. Because of the heavy dependence on the same varieties as were common in Samoa, a number the Pacific countries are considered particularly susceptible to an outbreak – Fiji, Tonga, Cook Islands and Vanuatu. In addition they share the common blight-enhancing conditions of rainfall greater than 2,500 mm annually that is spread relatively evenly throughout the year.

One of the issues that became clear after the outbreak of the blight in American Samoa and Samoa was that when they needed to access varieties for selection for leaf blight resistance, they had to look elsewhere since their national germplasm collections did not have resistance. Further, within the region the other collections did not have a great deal of diversity owing to major losses through diseases, lack of staff, costs of maintenance, and drought. The collections in Papua New Guinea and the Solomon Islands, the two countries where blight has been present, has some blight resistance cultivars but not enough to develop new commercial varieties.

Subsequent to the outbreak in Samoa, three international programs have been established to conserve and enhance taro germplasm.

- Australian Centre for International Agricultural Research's Virus Indexing and DNA fingerprinting.

- Taro Network for Southeast Asia and Oceania – TANSAO - aims to advance the competitive position of taro in cropping systems and markets. TANSAO seeks to utilise existing fragmented germplasm collections and appropriate biotechnology to facilitate crop improvement for which there had been little progress in the member countries. The members are Thailand, Vietnam, Malaysia, Philippines, Indonesia and Papua New Guinea, and TANSAO is coordinated by CIRAD (France). The Wageningen Agricultural University (The Netherlands) is a scientific collaborator. Funds come from the European Union. TANSAO's current activities include describing 1700 taro accessions and analysing their genetic diversity, exchanging 170 clones in vitro among all participants, identifying sources of disease resistance, developing achievable breeding strategies and sharing information.

- Taro genetic resources, conservation and utilisation - TaroGen is a network of Pacific island countries extending the work of TANSAO eastward from Papua New Guinea, where there is overlap. The network was started in 1998 with AusAID funds and several scientific collaborators in Australia and New Zealand and through TANSAO. The immediate objective is to develop improved varieties to overcome the severe problem of taro leaf blight (caused by *Phytophthora colocasiae*).

[41] In 2002 the Blight wiped out sufficient production in the Morobe Province that food aid was requested.

As a result of this work there are active breeding programs in Papua New Guinea and Samoa. As noted, Samoa has released nine new varieties whilst Papua New Guinea's National Agricultural Research Institute has released three new taro hybrids. In addition effort has gone into publicising the benefits of improved taro varieties, and, especially, taro diversity. A Regional Germplasm Centre has been established with the objective of developing a collection representing about ninety percent of the taro diversity in the region[42].

Mention is made of the unique role of Palau taro. This appears to be the exception to the phenomenon that when emigrants took with them taro they removed them from the environment that enabled the taro to develop resistances to blight. Palau taro has uniquely developed a strong degree of blight resistance. As a result, genetic material from Palau has been very important in the various blight-resistance breeding programs.

At the same time it is noted that the Palau-derived blight resistance taros are considered to have poor eating qualities[43]. It must be borne in mind that whilst Alafua Sunrise was considered superior to Taro Niue in all respects but eating quality it was the latter quality that was responsible for Taro Niue's popularity with farmers[44].

[42] Given that this publication deals also with yams it is worth noting that the South Pacific yam network (SPYN) was initiated in 1998 to enhance the competitive position of yam in traditional cropping systems in Fiji, New Caledonia, Papua New Guinea, Solomon Islands and Vanuatu. The decline in yam production in the region may be overcome by tackling the problems of irregular tuber shape, starch quality, anthracnose disease (caused by *Colletrichum gloeosporoides*), and the need for staking the plants. As most of the germplasm collected in the 1980s no longer exists, the network will be particularly valuable in collecting, conserving and sharing remnant germplasm. The University of Reading in England is using DNA technology for 'fingerprinting' to identify clones.

[43] Pers. Comms. Dr Danny Hunter, Dr Mary Taylor, and Mr Sam Foi.

[44] It is noted that the notion of a peculiar "Polynesian taste" was reported in the potential release of new varieties developed at the University of Hawaii: ***Honolulu Star – Bulletin***: 27 May 2001.

3.9 Taro – United States

Background

Given the size of the United States and the diversity of its population, the fact that it should be both a producer of taro and a sizeable market should not be a surprise. What is surprising is the segmentation of the production base and the market.

Production can be categorised into two distinct forms in two distinct areas:

- *Poi* in Hawaii
- Taro in Florida.

Demand similarly can be categorised into ethnic groups and taro types:

- Pacific Islanders[45] : pink and white
- Chinese and Hispanic : white and "Japanese" type
- Hawaiians : white, pink and, exclusively, *poi*

Production

Hawaii

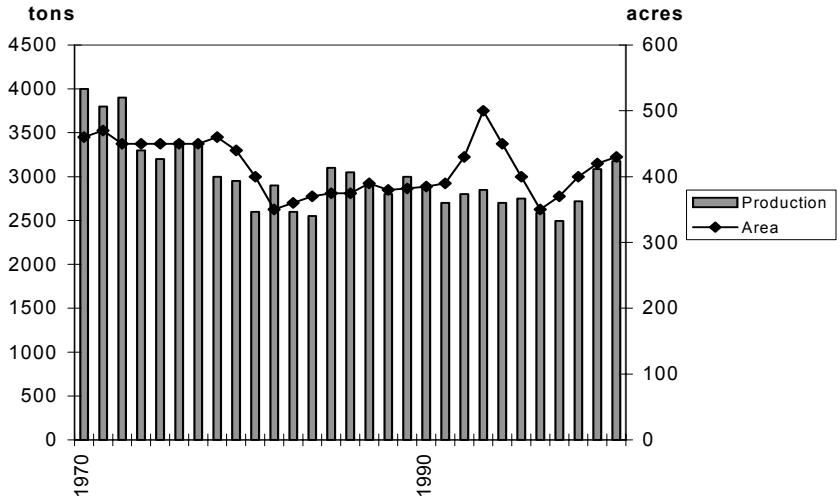
Hawaii has long been the centre of taro production in the United States. Despite the role of taro in Hawaiian culture and in *waianae,* the movement associated with the revival of Hawaiian culturalism, especially the role of taro in the traditional diet, taro is not indigenous to Hawaii. Instead, taro's ability to germinate after lengthy periods of storage made it the crop of choice for the Pacific islanders that colonised Hawaii over 1,000 years ago. Climate, soil types, and topography resulted in two forms of production – wetland and dry-land types.

Over the past 50 years production has gone from a high of 6,000 tons in the early 1950s to the current level of 2,000 – 2,500 tons in a near continuous, albeit small, year-on-year decline (Figure 39)[46]. There has been some recent revival in production but it needs to be seen if this is a short-term phenomenon or part of a major trend.

[45] Polynesians such as Hawaiians, Samoans, and Tongans; Micronesians from the current and former United States dependencies such as Guam, Saipan, Yap, and Palau; and Melanesians such as Fijians.

[46] Data drawn from the Hawaiian Agricultural Statistics Service.

Figure 39. Taro - Hawaii. Production volume and area: 1970 - 2000.
(source: Hawaiian Agricultural Statistics Service)



Two types of taro are grown

- *Poi.*
- "Chinese" or "white".

Poi production is about ten times the volume of "Chinese". In the late 1980s, "Chinese" type commanded a premium of around 50 percent over *poi*. By the early 1990s *poi* type received a higher price, a fact that continued throughout the 1990s.

Moreover, since 1988 farmer prices for *poi* have increased from around US$0.60 /kg to a little over US$1.00/kg. Farmer prices for Chinese type has been more static, moving from a little over US$0.80 /kg to around US$0.90 /kg. Despite the increases, total production continues to fall. High production costs in terms of the price in land in relation to competing uses, high water costs (again in terms of potential alternative uses), and high labour costs make both types of taro production increasingly uneconomic.

It is possible that the downward trend in production could be at least stabilised if not reversed. Basically, the Hawaiian economy is in a degree of trouble. Tourism, the key plank in its economic platform, is under-performing. The Asian Currency Crisis had a major impact with visitor numbers from Korea and Japan declining by as much as 80 percent. The impact of the terrorist events of September 2001 could exacerbate this problem as mainlanders stay at home. There are efforts to revive the Hawaiian agricultural economy. The University of Hawaii has sought to develop new crops. Taro has been mooted as a candidate crop for the vacant land on the old pineapple and sugar plantations. Three new varieties have been developed and are awaiting final patent approval[47]. These are crosses between Hawaiian and Polynesian taros, including varieties from Palua that seek to incorporate the local varieties' taro leaf blight resistance. The varieties are supposed to outyield by about 30 percent local *lehau* varieties under Hawai'i's unique wetland production regime, and more than that with the dry-land production regimes in the Pacific.

[47] *Palehua*, a purple coloured type best suited for the *poi* market, *pauakea* that is pale yellow and *pa'akala* that is pink. The latter two are seen as suited for the processed taro market, namely flour producion, crisps, and the french fries.

Three issues remain:

- Labour is a problem[48]. Unless taro production can be considerably mechanised, efforts to increase Hawaiian taro production will be handicapped.

- Availability. Given that the three new varieties have been bred under plant variety protection, the varieties will have to be purchased. It remains to be seen if growers are willing to pay to adopt the new varieties.

- Taste. It is considered that the new varieties do not have the "Polynesian taste". It is claimed that as the new varieties "have fewer disease problems to contend with, they have a better taste"[49]. However, as the experience with Alafua Sunrise has shown, taste to Polynesians is critical and appear to outweigh traditional production- based criteria.

Florida
Taro is grown in Florida, especially the southern parts. In American terms, the taro is "Chinese" type: in terms of this paper it is *Xanthosoma*.

Production is not sufficient to achieve the status of being recorded but it is sufficient for there to be a number of officers in the State's extension service that have responsibilities in taro. Trade comments suggest that production is around 2,500 t.

Demand

The United States taro market has three sub-sets.

Pacific Islanders
This group consists of Polynesians including Hawaiians, Micronesians, and Melanesians. Accurate ethnically-based statistics are difficult to obtain but Pacific Islanders appear to be concentrated on the West Coast. There appears to be two distinct centres:

- Samoans and Hawaiians are concentrated in Southern California around the Los Angeles area.
- Fijians and Tongans are concentrated to the north, around San Francisco.

A more ephemeral group constitutes the "Mormon Trail". This refers to Pacific Islanders who come to the United States as part of their faith. They tend to arrive in Los Angeles. As they make their way north east to Utah, a few tend in stay back in one place, another few in another place, and even a few more in yet another place. Whilst there is a Pacific Island community in Utah it is comparatively small.

Samoans number about 70,000, the same number as Fijian and Tongans. Indications are that the total Islander market is growing.

Pacific Islanders consume both pink and white type taro. Indications are that the preference for pink type by Pacific Islanders in New Zealand is not as marked on the West Coast. Supplies of

[48] "Taro production is hard work". ***Pacific Business News***, 31 December 2001.

[49] ***Honolulu Star Bulletin***, 27 May 2001.

pink type ceased after the 1993 Taro Leaf Blight outbreak in Samoa. Neither Fiji nor Tonga stepped in to fill this gap. The absence of the preferred taro type has not made the Pacific Islander heart grow fonder: instead it becomes more pragmatic and Islanders now consume whatever type of taro they can get, albeit pink is their first preference.

Hispanic

The term "Hispanic" refers in this context to those of Cuban extraction and from Latin America. They tend to be concentrated on the East Coast but in two groupings. One grouping is in the north around New York and the other in the south in Florida. There are Hispanics on the West Coast but they tend to be from Mexico.

Hispanics consume white types of taro. Their preference is for a product about 10 cm long with a marked tail.

Asians

The bulk of the United States' Asian population is Chinese but there are sizeable numbers of nearly all of the Asian ethnic groups. Similarly, whilst there are Chinese in virtually every part of the United States, the bulk of the population is on the West Coast.

The Chinese prefer the white type. Preference is for a product between 500 g – 1 kg in size.

There was a demand for the Japanese type by a number of Asians in the Los Angeles region, especially expatriate Japanese and Thai, but the non-availability of consistent supplies has resulted in the demand dropping away.

Overall

Despite this apparent diversity of the market, taro is considered as a minority food item within a specific ethnically-based market. There appears no crossover from this niche into the mainstream American market.

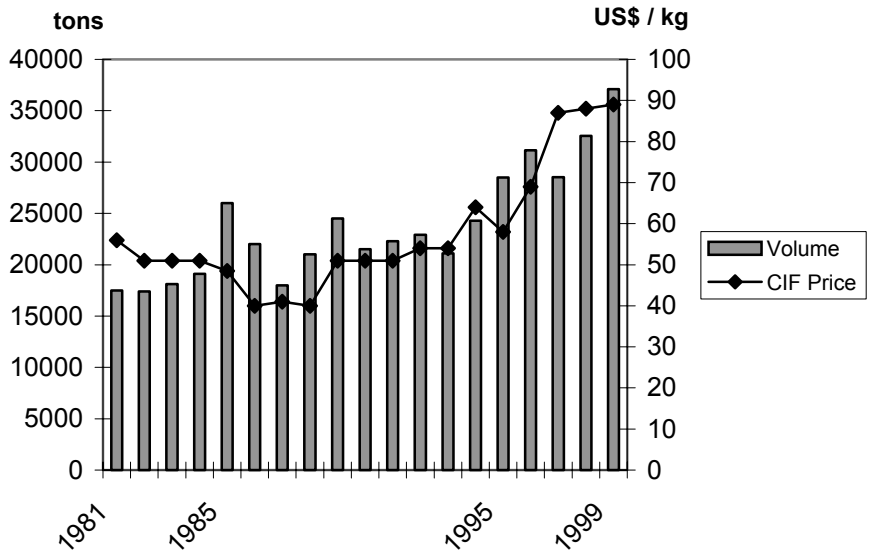
This is particularly true with *poi*. Consuming *poi* is an expression of one's "Hawaiian-ness". Consumption appears limited to indigenous Hawaiians and those "white" Americans who wish to demonstrate some relationship with Hawaii, either as a casual visitor or as a long term resident. It certainly is not the taro of choice for most Pacific Islanders.

Taro is sold through independent stores rather than the chains. This is partly because the chains are focused on the mainstream American market and taro is definitely a niche market. There is also the fact that the distribution chain for chain stores for imported fresh product is quite lengthy as their systems are geared essentially for domestic supplies. The smaller independent stores have shorter chains and thus able to better handle fresh imported product. However as long as taro is marketed through smaller independent stores, the transition to a crossover vegetable will be slowed down.

Imports

The United States has a long history of importing taro. There is a marked upward trend in both volume and CIF price. In the 20 years to 1999, imports have more than doubled to around 37,000 t (Fig. 40).

Figure 40. Taro - United States.
Annual imports, 1981 - 1999.



In 1999, the United States imported 37,161 t at an average CIF price of US$0.89/kg.

Over the years about 30 countries have supplied the United States with taro. Costa Rica and the Dominican Republic currently provide nearly ninety percent of all imports.

In terms of quality and price, Jamaican product (called *dasheen*) is the market leader. Aspects that seem to contribute to Jamaica's success include:

- **Conditioning**. The Jamaicans leave the crop on the ground after harvest for at least a day. It is gently turned during the day so that all surfaces are dried. This process hardens the skin. As a result the crop can be handled with less danger of damaging as it is the cracks in the damaged skin that facilitate the invasion of harmful pathogens. The hardened skin resists bruising better during handling and transport to the export facility and allows for more vigour in the removal of soil.

- **Dipping**. After conditioning the product is transported to a central handling exporter complex in Kingston. There it is dipped in a fungicidal dip including Methyl Bromide and Ridomil. Care was taken to ensure that the dip does not become ineffective due to excessive dirt dissolving in the mix and the mixture becoming diluted with the topping-up of just water. The correct concentration of fungicide is critical because of inspection for Minimum Residue Level (MRL) standards that the *dasheen* is subjected to upon arrival in the United States.

- **Packaging**. After treatment, the *dasheen* is packed in 50 lb cartons. The tops of the boxes are then covered with coconut "dust", made up of pounded coir. The intent is to preserve moisture and keep the product cool. No plastic liners are used and the boxes by their nature of them being topped with coconut dust must be sealed with no ventilation holes.

With the balance of imports, there has been quite a change in the composition of imports. For most of the 1990s, Chinese product was the price leader. This is a separate notion from it being the bulk supplier. Chinese pricing was highly erratic. Based on a 50 lb bag, over a week the price could be US$18, US$19, US$24, US$28 then US$19. Price variation was not necessarily related to volume fluctuations. This made price prediction all the more difficult. Other suppliers with far more stable pricing could not afford to maintain their prices in the face of such huge differences, thus forcing them to follow. Quality was acceptable in that there was a demand when price were low but when prices were a little higher and other product was available, buyers would switch to the better quality product.

The 2000 coup in Fiji was a cathartic experience. Prior to that, Fiji was a relatively small supplier. Nevertheless, its CIF prices were nearly three times that of the total average. The higher prices can be largely attributed to the fact that Fiji product was airfreighted to the West Coast. However, the fact that it was able to achieve a significant price is a tribute to Fijian quality. With the coup and the various bans imposed, flights to the West Coast were significantly curtailed. Fiji was forced to turn to sea freight. Product is now exported both in the fresh form as well as in the frozen form. In the process, Fiji's exports have increased strongly to over 1,200 t and with a vastly reduced CIF price. As a result, Fiji has become the market leader.

Most Latin American and Caribbean product enters the United Sates through Miami. This is because of:

- The large residual Hispanic population.
- Proximity to the Caribbean and Latin America for shipping.
- Adequate infrastructure in terms of shipping facilities and road transport for onward despatching to the rest of the United States.

The logistics indicate that Caribbean and Latin American supplies need about 12 days transport life. That is, a week for shipping to Miami and a maximum of five days for movement from Miami to the rest of the United States.

Imports of pink type taro from Samoa peaked at about 1,000 t annually. With the 1993 Leaf Blight disaster, supplies of this type dried up. It is considered that this market could rapidly re-establish itself at the 1,000 t mark because Samoan pink is the quality leader amongst Pacific Islander consumers. However it is doubtful that the previous premium enjoyed by "pink" over "white" would re-emerge.

Import issues

Taro exports to the United States have been an unwitting victim of the outbreak of the Foot and Mouth Disease in the United Kingdom. Imports, especially from Fiji, have been subjected to considerable USDA inspection. It costs US$600 – US$800 to unload and then re-load a container. On top of this is the *circa* US$300 required to transport the container to and from the inspection site. Refrigeration of the container as it waits inspection is an additional charge.

Boiling and then freezing taro seems to address all quarantine-based issues. However, the end product is not as preferred by the consumers.

Border inspection for pesticide residues is rigorous.

Containerisation of fresh produce suffers from a lack of precision in the required temperature. However, even if there was definitiveness in the required shipping temperature, there still is the

necessary prior condition that the produce be loaded at the appropriate temperature and appropriate moisture level.

As was noted by Waisiki Gonemaituba in his section on New Zealand, commercial importers of Pacific taro on the West Coast have a great deal of competition from the informal trade. It would appear that after the 2000 coup, a number of Fijian Indians fled to the West Coast. One means of expatriating money from Fiji is for taro to be sent to relatives and/or friends on the West Coast with the importer selling the taro on a cash basis for whatever money that can be gained. Recoupment of costs is not an issue. It was a comparable practice that followed Fiji's 1987 coup that caused the breakdown of orderly exporting to the West Coast of Canada. Formal importing chains have disappeared with the trade now being devolved to an individual basis[50].

[50] Vinning, G. 1998. ***Taro market of North America: unfilled potential***. Asian Development Bank – Ministry of Agriculture, Fisheries and Forests, Fiji.

4. Yam

4.1 Yam - Japan

Japan uses the term *yamano-imo* to refer to yams *Dioscorea alata* and *D. opposita*.

Yam types

Four basic yam types are recognised in Japan:

- *Naga-imo* (Plate 13.)
  - Considered succulent and crisp.
  - Low stickiness.
  - Used as a food thickener.

- *Icho-imo* (Plate 14.)
  - Also called *Yamani-imo*
  - Quite sticky.
  - Stick types are gaining popularity as easy to peel and grate.

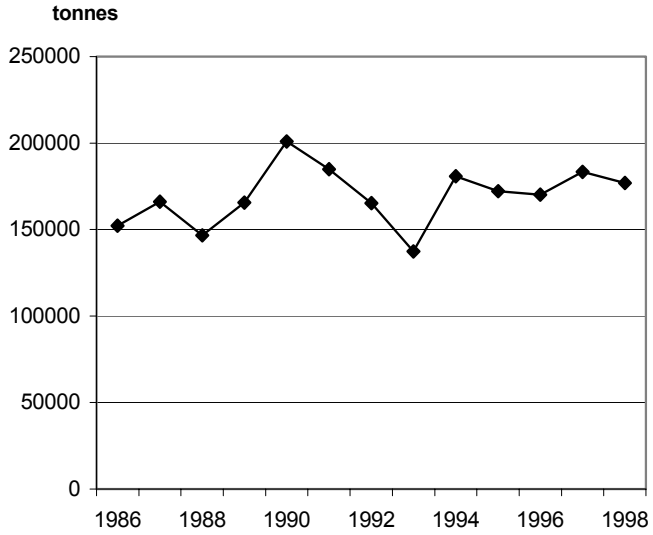
- *Yamato-imo*
  Two types are recognised as *yamato-imo*.
  - *Ise-imo* type has a white to pale brown skin (Plate 15.). This is popular in the Nara region.
  - *Tanba-imo* has a dark brown skin and a dark flesh (Plate 16.). It is a speciality of the Hyogo region around Kobe.

Another type of yam is *jinenjo,* a much more slender root that is less straight and longer compared with the *nago-imo* type.

Production

Production data does not differentiate between the different types. Yam production in Japan is

Figure 41. Japan - Yam. Annual production: 1986 - 1998.



holding steady (Fig. 41). Yam production in 1998 was 176,900 t, a little higher than ten years earlier but down from the peak of 200,900 t in 1990.

Production is extremely narrowly based. In 1998 just over 60 percent of the national crop was produced in the two northern prefectures of Hokkaido and Aomori. The other three prefectures listed as being producers are Ibaraki, Gumma and Nagano, just to the east and north of Tokyo.

This is a vastly different situation compared with just five years ago. In 1992 when production was marginally higher at 185,300 t, production was recorded in every prefecture but one, albeit some of the recordings were for volumes of less than 500 t. In the same year, the two northern prefectures were responsible for under half the national total.

It would appear that the decline outside the five major prefectures has been due to market forces. Trade comments make it clear the terms "*naga-imo*" and "Aomori" have become synonymous: virtually, if it is not from the north it is not *naga-imo*.

There are two basic production methods:

- Stake: stakes are planted to form an "X" and the vines trained onto the stakes. The notion is to maximise the degree of sunshine that the leaves receive and thereby increase the amount of photosynthesis.

- Pipe. Pipes are buried under ground but slanted in the direction of the root. This is mainly used for *jinenjo* production.

Naga-imo – wholesale performance

A relatively high 78 percent of total Japanese yam production goes to the wholesale market system. This figure is virtually unchanged compared with ten years earlier.

This figure is a little surprising because of the increasing popularity of *tororo* yam foam with soba buckwheat noodles as a convenience food. The yam is ground into a paste and placed into a sachet that is then placed into *obento* or lunch box. As far as could be observed, all of Japan's major convenience store chains stocked this product in one form or another. Some indication of the size of the mini-market and convenience store market is given below:

Annual wholesale performance

Wholesale market data covers

- *Naga-imo*
- *Yamato-imo*

The challenge is that the term *yamato-imo* covers:

- *Icho-imo*
- *Ise-imo*
- *Tanba-imo*

It is difficult to comment on the annual throughput and price trends for *naga-imo* at the Tokyo wholesale market system (Fig. 42).

Figure 42. Japan - *Naga -mo*. Annual wholesale performance - Tokyo: 1987 - 2000.

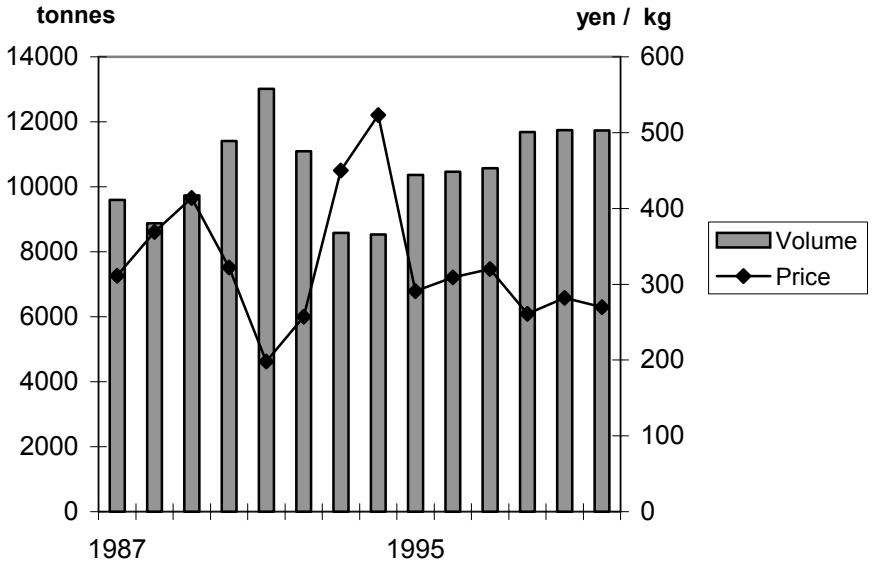


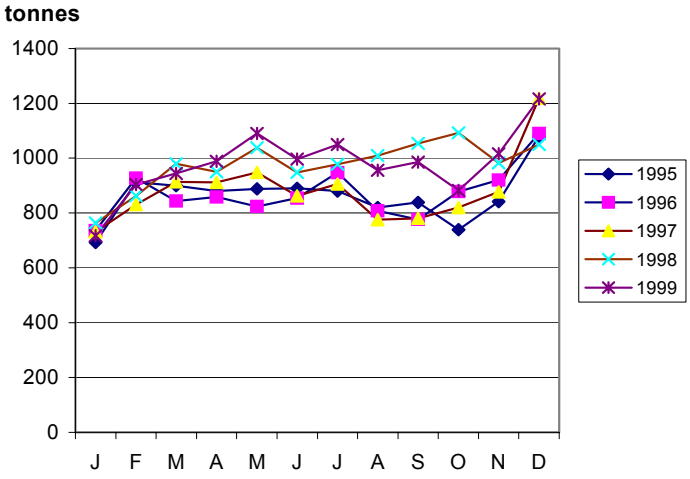
Figure 42 illustrates that annual prices and throughput are inversely related. Thus, when throughput rises or falls then prices move in the opposite direction. However, there is no high - low seasonal pattern (Fig. 43 and Fig. 44), for example throughput for the three years 1998 – 2000 was relatively static as were the previous three-year period 1995 – 1997.

In 2000, the Tokyo wholesale market system handled 11,732 t at an average annual wholesale price of 270 yen/kg.

Monthly wholesale performance

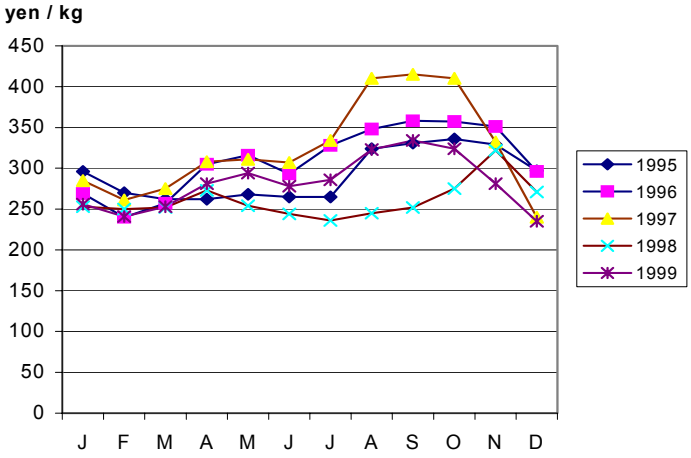
It is difficult to identify a market window for *naga-imo* as monthly throughput is too erratic (Fig. 43).

Figure 43. Japan. *Naga-imo* monthly wholesale volume, Tokyo: 1995-1999.



Monthly wholesale price patterns (Fig. 44) have a higher degree of recognisable pattern compared with throughput. The extreme high-low price patterns for 1997 and 1998 inhibit stating that the high price period is usually July – October at around 325 yen/kg.

Figure 44. Japan. *Naga-imo* monthly wholesale prices, Tokyo: 1995-1999.

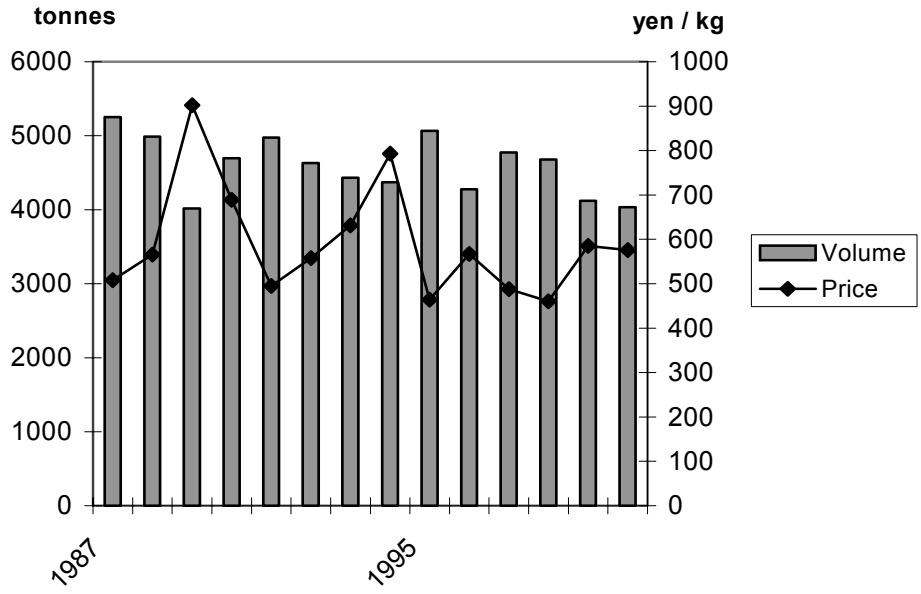


Yamato-imo – annual wholesale performance

Unlike the data for *naga-imo*, the annual data for *yamato-imo* shows a far more identifiable trend (Fig. 45).

Annual throughput is slowly trending downwards while prices appear to be steady.

Figure 45. Japan - *Yamato-imo*. Annual wholesale performance - Tokyo: 1987 - 2000.

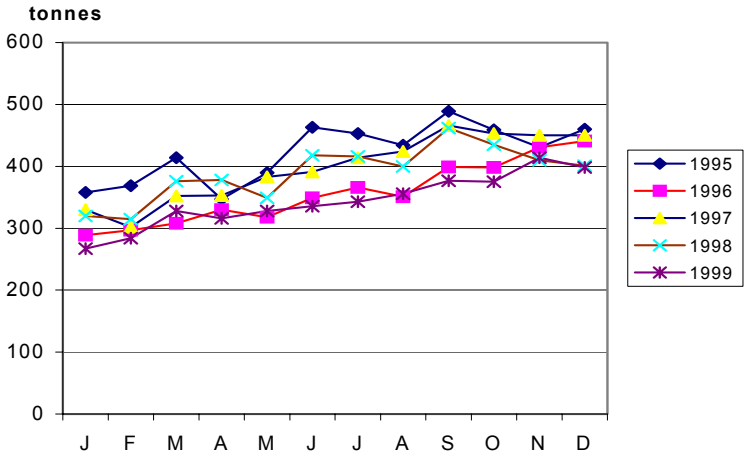


In 2000, the Tokyo wholesale market system handled 4,036 t of *yamato-imo,* less than half of that of *naga-imo*. In contrast, annual average wholesale prices were an encouraging 576/kg.

Yamato-imo – monthly wholesale performance

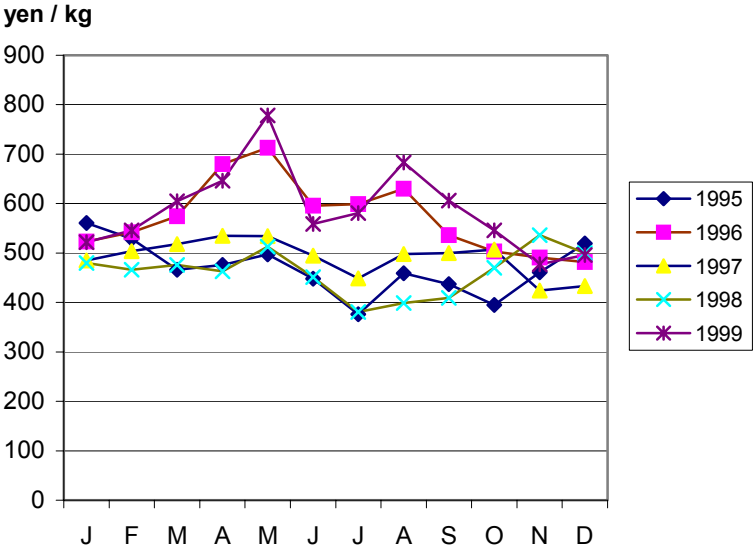
As with *naga-imo*, the monthly wholesale throughput pattern for *yamato-imo* is difficult to decipher (Fig. 46).

Figure 46. Japan. *Yamato-imo*. Monthly wholesale throughput, Tokyo: 1995-1999.



Two years, 1996 and 1999, show continuous upward movement whereas for the other four years there were three discrete high-low seasons within a general upward movement throughout the calendar year.

Figure 47. Japan. *Yamato-imo* monthly wholesale prices, Tokyo: 1995-1999.



As with monthly *naga-imo* wholesale prices, the existence of the two years 1996 and 1999 make it difficult to identify a window of opportunity (Fig. 47). At best, monthly wholesale prices of around the 500 yen/kg level appear to be consistent.

Yamano-imo imports

It would appear that some *yamano-imo* are imported from China but official data are unavailable.

Given the industry standard of the *naga-imo* from Aomori, fresh imports have a high level to aspire to.

There appears to be no quarantine barriers to entry other than the usual phytosanitary requirements.

Some processed product is imported. This is in the powdered or, more accurately, pounded form to go with *soba* noodles to form *tororo*.

5. Appendix

Appendix 5.1 Some important sweet potato varieties in China.

Xushu 18

Maturity and season: Spring, summer, autumn

Origin: Jiangsu Academy of Agricultural Sciences, back cross of Xindazi x 52—45, 1972.

Disease resistance: Root rot—strong; vine split—moderate; black rot, *D. destructor*—poor

Yield (t/ha): 30

Dry matter content (%): 26—30

Distribution: Shandong, Henan, Jiangsu, Anhui, and Hubei

Yubeibai

Maturity and season: Early-mid, autumn

Origin: Guangdong, Guangxi local variety.

Disease and pest resistance: Susceptible to bacterial wilt

Yield (t/ha): 22-30, may be as high as 75

Dry matter content (%): 24-26

Distribution: South China, Guangdong, Hunan, Fujian, Zhejiang

Zhan 64-285

Maturity and season: Early, autumn and winter

Origin: Bred at Zhanjiang, Guangdong, selected from hybrid progeny of Yubeibai x Huabei 48, 1964.

Disease resistance: Susceptible to bacterial wilt

Yield (t/ha): 30-38, as high as 60

Dry matter content (%): 23

Distribution: Guangdong and Guangxi

Huabei 48

Maturity and season: Late

Origin: Gaozhou, Guangdong, selected from hybrid progeny imported from Henan.

Disease resistance: Highly bacterial wilt resistant, with weakening in the past few years

Yield (t/ha): 22—30, as high as 45

Dry matter content (%): 28—33

Distribution: Hunan and Zhejiang

Yiwohong

Season: Spring, summer

Origin: Hybrid cross of Nancy Hall and Okinawa 100, 1959.

Disease and pest resistance: Susceptible to black rot and *D. destructor*

Yield (t/ha): 22, as high as 52

Dry matter content (%): 30—35

Distribution: Hebei, Beijing, Shandong, and Jiangsu

Ningshu 2

Maturity and season: Early, summer and autumn

Origin: Jiangsu Academy of Agricultural Sciences, selected hybrid progeny of Ningyuan 30 Day Early x Lizixiang, 1973.

Disease resistance: Black rot and *D. destructor*—poor*;* bacterial wilt—moderate

Yield (t/ha): 20-40% greater than Okinawa 100

Dry matter content (%): 32—33

Distribution: Jia~gsu, Anhui, Henan, and Zhejiang

Fengshu 1

Season: Spring, summer
Origin: Selected from hybrid cross of Yubeibai x Lizixiang, 1967. Extended in 1971.
Disease resistance: Root rot—moderate; black rot and *D. destructor*—poor.
Yield (t/ha): 21-47% greater than Okinawa 100
Dry matter content (%): 27—30
Distribution: Henan and Shandong

Nanjing 92

Maturity and season: Spring, summer
Origin: Jiangsu Academy of Agricultural Sciences, selected from hybrid progeny of Jiagoudazi x 52—45, 1964.
Disease resistance: Black rot—strong; root rot, *D. destructor,* bacterial wilt—moderate
Yield (t/ha): 20% greater than Okinawa 100
Dry matter content (%): 34—37
Distribution: Shandong and Henan

Fengshoubai

Maturity and season: Spring, summer
Origin: Xuzhou Agricultural Research Institute, maternal Pengwei x paternal Lizixiang, bred in 1971.
Disease resistance: Root rot—none; all others—moderate
Yield (t/ha): More than 30% greater than Okinawa 100
Dry matter content (%): 25
Distribution: Jiangsu, Anhui, Henan, and Shandong mountain and hill areas

Yanshu 1

Maturity and season: Spring, summer
Origin: Yantai, Shandong Agricultural Research Institute, selected from progeny of Okinawa 100 x Nancy Hall, 1963.
Disease and pest resistance: Moderate
Yield (t/ha): 30—38
Dry matter content (%): Somewhat lower than Okinawa 100
Distribution: Suited to dry, low-fertility spring and summer production areas

Qingnong 2

Season: Spring, summer
Origin: Natural hybrid of Ziye 100, from Shandong, 1964.
Disease resistance: Root rot—moderate; *D. destructor*—resistant
Yield (t/ha): 22—30, as high as 52
Dry matter content (%): 2—3% less than Okinawa 100
Distribution: In areas with *D. destructor* problems, and in areas with light root rot problems

Hongpizao

Season: Spring, summer
Origin: Sichuan Academy of Agricultural Sciences, hybrid cross of Huabei 117 and Wushan Hunanshao, 1956.
Disease resistance: Sensitive to black rot
Yield (t/ha): 30% higher than original varieties
Dry matter content (%): 28—31
Distribution: Sichuan, Yunnan, Beijing

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