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Taro (*Colocasia esculenta*)—An Important Staple Food for the General Population of Fiji Islands

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Abstract

Taro production in Fiji is fluctuating in a yearly basis due to presence of devastating pests and diseases. Lack of knowledge in controlling these pests and diseases and the availability of controlling resources is another problem, which farmers in Fiji are currently facing. Taveuni being the largest supplier of taro in Fiji, is experiencing problems related to mono-cropping which in cooperates problems like soil degradation, unwanted weeds and minor pests and diseases. This research article mainly focuses on pests and diseases associated with taro production in Fiji and possible control measures to help farmers in Fiji to enhance their knowledge in controlling these pests and diseases. A thorough survey of taro farmers and exporting companies in Fiji was done to evaluate the problems that have directly or indirectly affected taro production in Fiji in previous years. As shown in figure 2, Fiji has experienced the shortages of taro in the year 2010, 2012 and 2014 as a result of increasing pest and diseases. This shortage not only has affected the demand from overseas market but also farmers in terms of earning for their livelihood. If these problems are not solved at an earliest, the taro industry in Fiji may collapse resulting in greater number of problems in future.

Keywords: taro, dalo, cassava, staple food, Fiji Islands

1. Introduction

Taro (*Colocasia esculenta*) is one of the most important staple food crops in Fiji not only because of its traditional significance but also because of its economic importance. Taro as an export commodity that begun in 1993, when the taro leaf blight (*Phytophthora colocasiae*) decimated the taro industry in neighboring Samoa. Fiji filled the void and was soon supplying taro universally.

Almost 80% of Fiji's sent out taro originates from the island of Taveuni where the taro beetle species (*Papuana uninodis*) is missing. The Fijian taro industry on the fundamental islands of Viti Levu and Vanua Levu confronts steady harm from the taro beetles.

Fiji is currently the major exporter of taro in the Pacific with exports valued at almost $20 to $23 million dollars annually as shown in Figure 1. With continuous population growth and the availability of new markets for processed taro as human food and livestock feed, taro cultivation is on the increase in Fiji Islands.

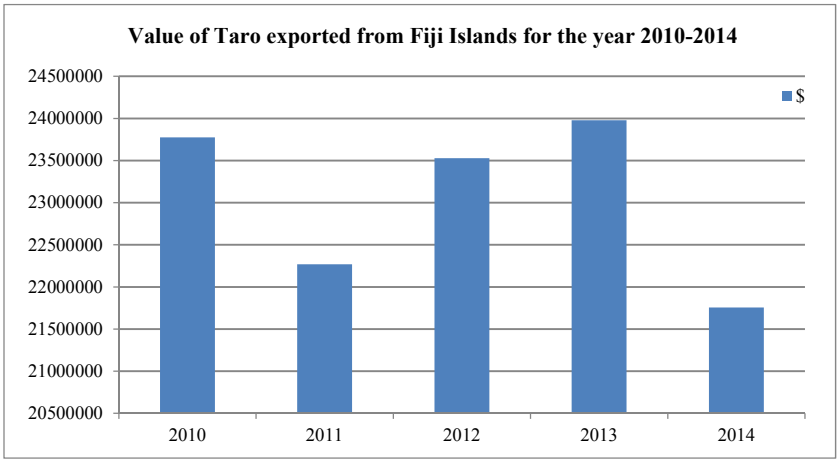

Figure 1. Graph showing the value of taro exported from Fiji to overseas market for the year 2010-2014

2. Geography

Fiji is situated in the South Pacific, 3,000 km (1,875 miles) east of Australia and roughly 1,930 km (1,200 miles) south of the equator. It involves 322 islands, 105 of which are occupied (some are minimal more than rough limestone islets or minor coral cays). The three biggest islands are Viti Levu (Great Fiji), Vanua Levu (Great Land of the People), both of which are wiped out volcanoes rising unexpectedly from the ocean, and Taveuni. There are a huge number of streams and rivers in Fiji, the biggest being the Rewa River on Viti Levu, which is traversable for 128 km (80 miles). Mt Victoria, additionally on Viti Levu, is the nation's most astounding peak, at 1,322 m (4,430 ft).

3. Climatic Condition

Fiji has a warm tropical atmosphere. Most extreme temperatures occasionally move out of the 31 °C (88 °F) to 26 °C (79 °F) territory throughout the entire year. Southeast exchange winds from March to November bring dry climate and the stormy season keeps running from December to April.

Fiji has a wet season, which is described by overwhelming, brief nearby gives and contributes a large portion of the nation's yearly precipitation. The wet season is regularly from November to April and results from the southerly developments of the South Pacific Convergence Zone. Commonly the littler islands in Fiji get less precipitation than the primary Island with different sums as indicated by their area and size. Cyclones do happen in Fiji and are major threat to crops such as taro.

4. Soil Type

A total of ten soil orders exists in Fiji, and of these three are suitable for taro culture.

Flurentic Eutropet (Inceptisol)—Reva Series-reasonably drained soils found on river planes—fertility is only moderate and nutrient soil amendments may be required;

Typic Eutropet (Inceptisol)—Waidina Series—colluvial pockets, easy rolling to moderate slopes of S.E. Viti Levu and Vanua Levu-moderately fertile soil, but needs occasional application of NPK fertilizers;

Typic Hydrandept (Antisols)—comparatively young volcanic soils (Taveuni, Koro and Rotuma)—soils are generally fertile, but require additional application of potassium fertilizer.

5. Taro Production in Fiji

Most taro crops in Fiji are produced and supplied from the island of Taveuni, which is considered as taro pest free island. Taro production in Fiji fluctuates each year, as shown in Figure 2, due to unfavorable weather conditions and invasion of exotic pests and diseases. Last 3 years have incurred shortage during cool season (May to September) and after cyclone Winston, the supply is very short as of now (Garden City Export & Import Limited).

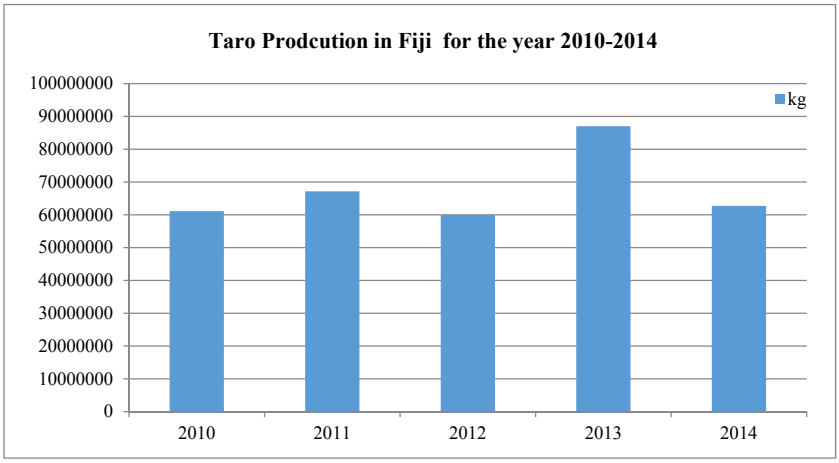

Figure 2. Graph showing taro production in Fiji Islands for the year 2010-2014

The best time for planting taro in Fiji is from July to January with offseason planting from March to June. The Ministry of Agriculture in Fiji recommends farmers to plant taro varieties such as Samoa hybrid, Samoa, Tausala ni Samoa, Vula Ona, Maleka Dina, Dalo ni Toga, Kuro Kece, Wararasa, Toakula and Vavai due to its ability to resists certain pest and diseases and its ability to mature faster compared to traditional varieties. The recommended seed rate and spacing for planting taro in Fiji are as follows:

- Traditional farming system: 10000 suckers/ha with spacing of 1 m between rows and 1 m within rows.
- Mechanize system: 16660 suckers/ha with spacing of 1 m between rows and 60 cm within rows.

6. Varieties of Taro Available in Fiji

Fiji currently has 401 varieties of taro available out of which 84 are upland varieties (planted under non-flooded conditions), 13 are e-line varieties and the rest 7 varieties are breeding lines. Hybrid taro such as Maleka Dina, Wararasa, Vula Ono, Samoa Hybrid and Samoa variety are established in Fiji to improve production rate and to meet the growing demands for taro in the local market. Tausala Ni Samoa, White Taro, yellow taro, Uro ni Vonu and Vaivai is one of the major exporting taro varieties in Fiji due to its taste and consumer acceptance. It likewise has a superior execution rate in the agro-climatic states of Fiji, which in turns expand production of taro to take care of the developing demand in the abroad market.

7. Common Pests and Diseases of Taro Found in Fiji and Its Control Methods

One of the ways to boost taro production in Fiji is to minimize pest and diseases that affects not only taro leaves but also its corm. The most common pests and diseases of taro found in Fiji are as listed below:

7.1 Pests of Taro

7.1.1 Taro Beetle (*Pupuana* spp.)

Taro beetles are a major pest of taro in Fiji that appears to be shiny black and are 15 to 25 mm in length. Taro beetle was first found in Fiji, in 1984 and since then it is being localized in the Central Division of Viti Levu extending from Tailevu to Sigatoka and up to Vunidawa in the interior. Lovoni in Ovalau, the Ra Province from Nalidi to Navitilevu along the Kings Highway are also taro beetle infested areas. Adult taro beetle damage the underground corms by chewing and burrowing into them creating tunnels. These beetles create large cavities allowing secondary rots to develop causing low quality corms for consumption. Taro damaged by beetles cannot be exported.

Control methods:

- Cultural control: Crop rotation, cleaning planting material (*i.e.* free from soil) and destruction of breeding sites near farms.
- Chemical control: Imidacloprid, Bifenthrin or Confidor.
- Biological control: Metarhizium anisopliae.

7.1.2 Taro Hornworm (*Hippotion celerio*)

Hornworm (hawk moth) caterpillars consume large amount of leaf, causing conspicuous damage. It is widespread throughout the pacific region. The symptoms of hornworm are very noticeable- infested plants have large area of leaf missing and the leaf appears ragged.

Control methods:

- Physical method: The hornworm larvae is very large which can be seen by our naked eyes. It can be easily picked and destroyed.
- Chemical method: Indoxacarb (*e.g.* Steward), Spinosad (*e.g.* Success), Bt (*e.g.* Delfin, Thuricide, Dipel) and Imidacloprid (*e.g.* Confidor, Mustang).

7.1.3 Taro Armyworm (*Spodoptera litura*)

Spodoptera litura is a pest of Asian and pacific. The early larval stages remain together at first, later radiating out from the egg mass, stripping in interveinal leaf surface and skeletonizing the leaves as they advance. Later (solitary) stages eat all parts of the leaf, including the petioles.

Control methods:

- Physical control: Removal and destruction of leaves infested with egg masses or young larvae.
- Chemical control: Spinosad and Bt. Neem extracts.

7.1.4 Aphids (*Aphis gossypii*)

Aphids are small, pear-shaped insects with soft, fragile bodies. Often present in large numbers, they pierce leaves to obtain sap. It is widely distributed throughout the pacific region. If aphids are present in high numbers and rainfall is low, leaves senesce faster than normal. In severe cases, the plants wilt and may become stunted.

Control methods:

- Cultural control: If taro plants are heavily infested with aphids, avoid planting new crops down-winds since aphids are not strong fliers and are readily blown in the wind so the new planting is likely to become contaminated.
- Chemical control: It is not recommended to use pesticides since most of the aphid population in taro is controlled by the predators such as ladybird beetles, syrphids and lacewings.

7.1.5 Mealybugs (*Pseudococcidae*)

Mealybugs have a long feeding tube that is used to pierce the plant and suck the sap- in doing so, they cause variety of symptoms. Direct feeding results in distorted foliage, yellowing, stunting and wilting; indirectly, mealybugs cause a build-up of sooty mould fungi, which grows on honeydew excreted as they feed. They also transmit viruses. In these ways, mealybugs are similar to aphids.

Control methods:

- Mealybugs rarely cause direct damage to taro from their feeding or indirect damage by promoting the growth of sooty mould; numbers are rarely sufficient. If control is required, the best course of action is to check if the ants are present and take actions against them, so that the activities of natural enemies are not curtailed. If this is not sufficient, then a spray of horticultural oil or soap should be considered.

7.1.6 Taro Plant-Hoppers (*Tarophagus* spp.)

Taro plant-hoppers feed mostly on taro, although they have been observed on *Alocasia* spp. and *Cyrtosperma* spp. Heavily infestation by taro plant-hoppers cause plants to wilt and, in exceptional cause, to die. Sap sucking and laying of eggs cause sap exudation, which forms small red encrustations on petioles, particularly at the base.

Control methods:

- Biological control: The egg predator *Cyrtohinus fulvus* has successfully controlled taro plant hoppers in many parts of the pacific, but *C. fulvus* is unlikely to reduce populations sufficiently to prevent the spread of alomae and bobone virues disease.
- Chemical control: Pesticide such as imidacloprid (Confidor or Mustang) should be used only when there are no natural enemies present in the field. Other recommended pesticides are malathion, carbaryl and acephate.

7.1.7 Spider Mites (*Tetranychus* spp.)

Spider mites are common plant pests- sucking of leaf tissues results in characteristics white to pale yellow speckling, usually between the main veins. When infestations are severe, the speckling is seen all over the leaf. Webs occur on the undersurface. As the infestation advances, the leaves turn yellow and die prematurely.

Control methods:

- Managing spider mites requires preservation of natural enemies. Other than that, horticultural oil and soap are possibly effective.

7.2 Diseases of Taro

7.2.1 Corm Rot (*Athelia rolfsii*)

Athelia rolfsiic is a soil-borne fungus that infects taro at the soil level, causing corm and roots to rot and leaves to wilt.

Control methods:

- Cultural and sanitary control measures- removing and destroying infected plants by burning, applying good cultural practices (deep ploughing and encouraging the growth of micro-organism that inhibit fungal growth), using soil solarisation, liming the soil, applying fungicides and using practicing crop rotation can minimize corm rot disease.

7.2.2 Shot Hole (*Phoma* spp.)

Fungi that produce relatively large lesions on the leaf cause shot hole. As the spots ages, their centers fall out, giving the 'shot hole' effect.

Control method:

- Chemical control: As these diseases cause little economic loss, fungicides are not recommended.

7.2.3 Dasheen Mosaic Virus (*Dasheen mosaic potyvirus*)

Dasheen mosaic virus causes patterns of various colours, shapes and sizes to appear on the leaf. The disease may reduce corm yield.

Control methods:

- There are no effective control measures for dasheen mosaic virus. Removal and subsequent burning or burial of infected plants is recommended, as these plants may serve as sources of infection.

8. Fertilizer

Poultry Manure: 10 tonnes/ha. Broadcast and mix well with soil before planting.

NPK: 13:13:21 200 kg/ha Basal application at planting and after 15 weeks from planting

Superphosphate: 25 kg/ha & Muriate of Potash 100 kg/ha at planting (can be used if NPK is unavailable)

Urea: 100 kg/ha. Apply in 2 split application 15 g/plant at 5, 10 weeks after planting.

9. Taro Export from Fiji

Over the past few years, taro has become a regular export item from Fiji. The major part of this trade is directed to United States of America, Hawaii, New Zealand, Canada, Kiribati and Australia. Fiji currently has ten major taro exporting companies which exports a value of $20 to $23 million of taro each year as shown in Figure 3. These major taro exporting companies in Fiji incorporate; Balthan Western Ltd, Sai Yee Foods Industries Ltd, Ben's trading Fiji, Joes Farm Produce Ltd, Garden City Export & Import Ltd, Taveuni kava & dalo dealers, Produce International Fiji Ltd, Island express company, Agro Marketing Fiji Limited and Kaiming Agro Processing Ltd. Taro is received, processed and packed for export in a more hygienic way as per the HACCP standards to combat possible health issues (Garden City Export & Import Ltd.). The following quality standards are suggested to assist farmers when selecting taro to meet export market requirements:

- Weight: Corms must be above 1 kg and not more than 3 kg. A tolerance 10% (wt. basis) is allowed for taro less than 1 kg but above 750 g.
- Shape: Uniform oval shape and plumb without segments unduly elongated crooked or having peanut shape.
- Right stage of maturity.
- Free from internal or external soft rot and any other decay, beetle or worm holes, cuts or breaks.

- Must be fresh without any shriveling or discoloring of tops and flesh.
- Tops must be trimmed down to 2 inches long with older removed.
- Taro must be practically free from rootlets and soil.
- Eating quality must be good; "Wet" or rouka taro is rejected.

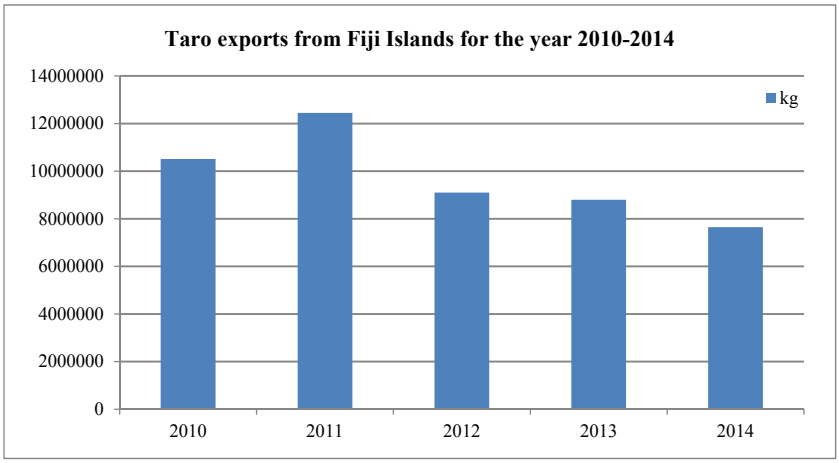

Figure 3. Graph showing taro exports from Fiji Islands to overseas markets for the year 2010-2014

Packaging taro for export additionally requires couple of measures to experience as set by the Biosecurity Authority of Fiji. These measures include:

- The corm should be topped and free from all foliage including petiole bases, and
- It should also be free from sprouting suckers and attaché daughter corms, and
- Free from soil, and
- Washed clean and packed in new clean packaging with holes (nylon bags).

10. Conclusion

After compiling this research, it can be said that taro has become a major source of income for the locals of Fiji Islands. Apart from Taro, Taro Leaves, Cassava, Coconuts-Fresh & Frozen agro products and vegetables are also sold to overseas markets (Garden City Export Ltd.). Taro chips are also a famous snack in Fiji due to its taste and consumer acceptance.

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