

## **New diversification crops: MSIRI's recent and innovative contributions**

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### **Abstract**

With the reduction in the guaranteed export price, cane sugar production is no longer viable on part of the land currently under the crop. Therefore, there is a need to seek acceptable agricultural and non-agricultural alternatives for this land; hence, the development during the recent past of a small alternative crop programme at the Mauritius Sugar Industry Research Institute - MSIRI.

New crops are, by definition, innovations in agriculture. However, it does not suffice to propose them or even to introduce planting material. For them to be effectively innovative, some essential research and development work needs to have been completed in order to demonstrate that they are viable options for some target producer groups.

The two examples of new diversification crops that constitute the recent and innovative contributions of the MSIRI are the pejibaye palm (*Bactris gasipaes*) grown for palm heart and the pitaya (*Hylocereus undatus*) grown for the fresh fruit. Both have already been successfully popularized, and the latter is being produced commercially.

In the case of the pejibaye palm, it took five years (1998-2003) of agronomic trials in growers' fields before the crop could be proposed as the best species for palm heart production in the superhumid zone, a region where sugar cane cultivation is being reduced. Since then, large quantities of seeds were imported in 2004, 2005, 2006 and 2007 to satisfy the requests of all producer groups. Another research project is being implemented to establish sustainable production practices on marginal lands.

In the case of pitaya, a cactus that grows in the wild in the dry zone of Mauritius, four years of research (2001-2005) in small plots on station were necessary to show how to produce marketable fruits of high value. A simple production method was

published. Several clones have been propagated, and the distribution of plants to interested growers started at the end of 2006.

**Keywords:** Agricultural diversification, new crops, pejibaye palm, palmito, pitaya cactus, sugar industry

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## 1. INTRODUCTION

For thousands of years domesticated plants and animals have been dispersed as human populations migrated. At the end of the 15<sup>th</sup> century, with the discovery of the New World, the massive transfer of plants between continents expanded dramatically. Such commercially important crops as maize, cassava, groundnut, common bean (*Phaseolus* spp) and rubber were taken from the Americas to Europe and Asia, and other equally important crops such as wheat, barley, coffee, banana and sugar cane were moved in the opposite direction. The process of plant introduction has continued ever since, although it has become more difficult since the Convention on Biological Diversity.

New crop introductions have sometimes been very successful. Well-known examples are : maize, wheat and soya bean in the USA; coffee, banana and sugar cane in Latin America and the Caribbean; wheat, maize and potato in Europe; cassava and sweet potato in Africa, and cassava, sweet potato, oil palm and rubber in Asia. The failures are equally numerous, but they are not as well documented.

All of the current crops in Mauritius were introduced at some time in the past. Successful early introductions by Dutch and French colonists include staple crops such as wheat, maize, rice, cassava and sweet potato, and industrial crops such as cotton, coffee, indigo, sugar cane, tobacco and tea. In many cases, the success lasted for a while only and, today, only the last three are grown to any extent. Today's agriculture in Mauritius is dominated by sugar cane and a very small area is devoted to fruits and vegetables. Newer successful introductions include anthurium, which has been developed into a small industry, and gerbera and ginger flowers, which are produced on a small commercial scale.

When a crop is first taken into a country where it was not known or grown, it becomes a new crop. Several categories of new crops can be recognized. Firstly, crops that are well-known and successful in their country of origin. Most of the crops mentioned above belong to this category. Secondly, crops that are underutilized in their country of origin or grown in restricted geographical areas. Examples from a single area – the Andes of South America – are: grain amaranths and quinoa (*Chenopodium quinoa*), among the grain crops; oca (*Oxalis tuberosa*), ulluco (*Ullucus tuberosus*), mashua (*Tropaeolum tuberosum*), arracacha (*Arracacia xanthorrhiza*), yacon (*Polymnia sonchifolia*) and maca (*Lepidium meyenii*), among the root and tuber crops (Bertram, 1993). Thirdly, crops that used to be very important, at least in certain regions, but whose cultivation has practically ceased. Examples are flax (*Linum usitatissimum*), Indian hemp (*Cannabis sativa*) and kenaf (*Hibiscus cannabinus*), although they are being re-evaluated as fibre crops in several countries in Europe (Van Soest, 1993). Fourthly, plants whose useful product is currently collected from the wild and whose germplasm is being evaluated for commercial production. Examples include the marula (*Sclerocarya birrea*) from Southern Africa and apple cactus (*Cereus peruvianus*) from South America, which are being developed in the Negev desert of Israel (Nerd and Mizrahi, 1993; Weiss *et al*, 1993).

Most large countries with well-developed agriculture now have national policies to accelerate the introduction, evaluation and commercialization of new crops. Four main reasons explain this interest in new crops (Janick, 1993):

- (i) For ecological reasons, it is necessary to plant diverse crops on farms devoted to alternative agriculture;
- (ii) In many industrialized countries, there is interest in plants, not just for food or fibre, but also increasingly, for chemicals and pharmaceuticals;
- (iii) Many consumers in affluent countries increasingly demand new culinary products and ethnic foods;
- (iv) In some countries, such as many in the European Union, the decrease in prices of traditional agricultural commodities has prompted efforts to diversify into other crops so as to maintain farm revenues and rural employment.

It is for this last reason – agricultural diversification – that the MSIRI initiated work on new crops starting in 1998.

## **2. MSIRI'S FRAMEWORK FOR CROP DIVERSIFICATION**

MSIRI's involvement with crop diversification started in 1970 with the creation of a Food Crop Agronomy Department to support the crop diversification efforts of the sugar industry. This first phase was devoted to such field crops as maize, groundnut and potato, already cultivated on a limited scale. The earlier accomplishments of MSIRI in crop diversification have been amply documented (e.g. Antoine, 1973; Govinden, 1990).

But the sugar industry is now facing new challenges and, consequently, MSIRI has had to reconsider its approach to crop diversification. The export price of sugar is decreasing to the point that, soon, sugar production will no longer be financially viable on part of the area under the crop (Tonta and Ramasamy, 2006). Since this area may be quite large, it is of strategic importance to seek alternatives to sugar cane. One alternative which has been mentioned but which has not yet been tested is to grow sugar cane for uses other than sugar, such as rum or ethanol. Moreover, part of this area has been classified as environmentally sensitive, essentially because of the risks of soil erosion. It has been proposed to restrict land uses in such areas (Ministry of Housing and Lands, 2003).

Alternative land uses include agricultural and non-agricultural ones. The more financially attractive, but less environmentally friendly non-agricultural uses include urban and industrial development, while the less financially attractive, but more environmentally friendly ones, include forestry, deer ranching, ecotourism and recreational uses. Some agricultural alternatives have been proposed, but none has yet been validated. Annual vegetables are not appropriate for the sloping land susceptible to soil erosion. Perennial fruit crops are preferable. Possibilities include banana in the superhumid zone, mango and litchi in the humid zone and coconut in the subhumid zone. However, on the marginal lands where sugar cane production is more likely to be abandoned, their yield potentials have not yet been established.

In MSIRI's new framework to guide the choice of diversification crops, the land under sugar cane has been divided into two categories: suitable lands and marginal ones. Sugar cane is expected to remain on the suitable lands. Efforts are being made to reduce the cost of production by mechanizing cultural operations and rationalizing the use of inputs, and to increase productivity by irrigating and cultivating better varieties. Crop diversification on such lands can be undertaken along previous lines, that is, in sugar cane interrows and in rotation. In sugar cane interrows, such crops as potato and tomato may be grown on a large scale, while such crops as green bean, sweet corn, fresh groundnut and a range of vegetables may be grown on a limited scale. In rotation, crops that can be mechanized include potato and carrot, but it may be necessary to lengthen the rotation to fit in other crops, such as onion.

The marginal lands are very diverse in their characteristics. Some are marginal because of excessive rainfall, while others are too dry. Some are on steep slopes, while others are on flat but excessively rocky land. Consequently, it is necessary to choose crops carefully on the basis of financial viability as well as agronomic and environmental sustainability.

Two suitable crops have already been identified. They constitute MSIRI's recent and innovative contributions. They are the pejibaye palm (*Bactris gasipaes*) for the humid and superhumid zones, and the pitaya (*Hylocereus undatus*) for the subhumid and humid zones. The basis on which they have been chosen, the evidence to show that they are indeed promising and the work being undertaken to develop their potential are described briefly in the next sections.

### **3. THE PEJIBAYE OR PEACH PALM**

The pejibaye is grown for palm heart, a gourmet vegetable. It is an important source of palm heart for domestic consumption and for export in several countries in Latin America, such as Brazil, Ecuador and Costa Rica. Although its potential was mentioned as early as 1975 (National Academy of Sciences, 1975), it was only introduced into Mauritius in 1998 when MSIRI initiated a project to evaluate different species for the production of palm heart.

A small palm heart production industry has existed here since the 1950s, and current producers deem that the potential to develop it further is good, given that the demand exceeds the supply. However, the species being used, the hurricane palm (*Dictyosperma album* var *album*), is not appropriate because of its long cropping cycle and its susceptibility to a major insect pest, *Brontispa limbata*.

At the request and with the partial funding of a group of producers (Groupement Palmiste), MSIRI collected or imported seeds of eight species, planted nine trials on growers' fields, three each in 1999, 2000 and 2001, and measured growth up to 2004. The pejibaye was the most suitable species for the humid and superhumid zones because of its faster growth, 2 to 2 ½ years from transplantation to harvest, compared to 4 to 6 years for the hurricane palm, and because it was not attacked by

*Bronstipa limbata*, in contrast to hurricane palm, which was seriously affected at several sites (Govinden, 2004a). Moreover, the pejibaye produces suckers and regrows when the main stem is harvested. Consequently, it does not have to be replanted after harvest. This unique characteristic makes it more suitable than non-suckering palms for sloping lands susceptible to erosion. Additionally, the pejibaye palm heart does not oxidize, in contrast to that of other common species, such as the coconut and the hurricane palm (Govinden, 2004b). The hearts can therefore be extracted and presented in barquettes wrapped in cling film for the convenience of shoppers.

However, the pejibaye is not suitable for dry regions, where it suffers much more from water stress than, for instance, the coconut. And it is very susceptible to attacks by hares, which is a serious constraint to production in many areas.

The experimental results were presented to the agricultural community in 2004 (Govinden, 2004a), but even before the project was completed, members of the Groupement Palmiste imported seeds in 2003 and 2004 for commercial plantations. At the request of interested growers, MSIRI imported 65 000 seeds in 2004, 115 000 seeds in 2005, 60 000 seeds in 2006 and 65 000 seeds in 2007. Two work sessions were held with Sugar Estate Agronomists and extension officers of the MSIRI, the Farmers' Service Centre (FSC) and the Agricultural Research and Extension Unit (AREU), and a booklet on palm heart production (Govinden, 2004c) and a Recommendation Sheet (MSIRI, 2004) were published.

In 2005, MSIRI started a follow-up project on the sustainable management of pejibaye on marginal lands. Five field trials were planted in growers' fields in order to establish the optimum sucker population density. When an excessive number of suckers emerge after the harvest of the mother plant, they have to be removed to ensure that the few that remain attain an acceptable size quickly. Rather than discard those small suckers, it was proposed to pickle the small hearts in brine and acid. The method was worked out (MSIRI, 2008). Even if the product were to be too expensive for it to compete on the export market, it could still be produced for the domestic market, where the price is currently very attractive.

In Brazil, Costa Rica and Ecuador plots are harvested monthly or bi-monthly, with selection of plants for the appropriate size of heart. This makes production from any plot a year round activity and yields more uniform product for processing. This method yields small hearts not suitable for our local market. It was therefore recommended to harvest a pejibaye plot in one go (Govinden, 2004c). This leads to a proportion of undersized hearts. Wrapping them in cling film is a possibility. Another possibility is to process them into spicy pickles (*achard*) for which domestic and export markets exist. The recipe was developed, validated and published (MSIRI, 2006a).

#### 4. THE PITAYA OR DRAGON FRUIT

The pitaya is a climbing cactus that grows wild in the dry zone of Mauritius, where it can be seen commonly on walls, rock heaps in sugar cane fields and as an

epiphyte on trees. The flowers that appear in the summer are large, white and trumpet-like. The pitaya is not native to Mauritius; it may have been imported by the French in the late 1700s to feed giant land tortoises. The pitaya normally does not produce fruits in Mauritius, which may explain why it had not attracted attention until quite recently.

At MSIRI the interest in pitaya started at the end of 2000 when a shortlist of alternative crops was proposed for inclusion in the non-sugar strategic plan. The interest is justified by the fact that, on one hand, the plant grows wild in Mauritius and, on the other, it is an export crop in two regions whose climate is essentially similar to ours - Vietnam and Thailand in the Far East, and Guatemala and Ecuador in Central and South America. The challenge was to produce fruits in Mauritius.

Cuttings were planted at Réduit at the beginning of 2002. They bloomed two years later in the period December 2003 to April 2004. The flowers were pollinated manually to test a first hypothesis that the plant does not set fruits because of a problem with natural pollination. However, artificial pollination did not result in fruit set and the first hypothesis was abandoned.

By January 2005, when the plants flowered for the second time, two morphologically different clones had been found among ornamentals in people's backyards. The country of origin of these ornamentals is unknown, but one was imported by a cactus enthusiast to enrich his collection. When crossed with these two new clones, the local clone produced large and attractive fruits.

These results were confirmed early in 2006 when more crosses were made. They were presented in a public talk in March 2006 (Govinden, 2006), which generated much interest in the agricultural community and in the media. A series of work sessions was held with sugar estate field personnel and officers of the extension services of the MSIRI, AREU and FSC. Visits were organized to the small experimental plot at Réduit. Plants were given to AREU to establish demonstration plots and to Barkly Experiment Station for propagation. A Recommendation Sheet was published on pitaya cultivation (MSIRI, 2006b). By the end of 2006, MSIRI started to give out plants to those who expressed an interest in pitaya. The requests of all three groups of sugar cane producers - sugar estates, large-scale and small-scale growers - were met by the end of 2007. Thus, extension of the crop started in 2006 and the first fruits were produced in a small commercial plantation at the beginning of 2007. Market acceptance tests were made in several supermarkets in 2007 and 2008. From the feedback received from those who have visited the experimental plots, purchased and tasted the fruit, the success of pitaya as a new diversification crop seems probable. By early 2009, several producers were selling the fruit in supermarkets.

Since 2006, more clones have been introduced or collected locally from cactus enthusiasts and have been evaluated at Réduit in the humid zone, Pamplemousses in the subhumid zone and Belle Rive in the superhumid zone. New clones, including two self-compatible ones, were released in 2008 (MSIRI, 2009), and plants sold to growers as from 2009.

## 5. CONCLUSION

With very limited resources, MSIRI has demonstrated with pejibaye and pitaya that it is worthwhile to develop new diversification crops here. After an initial phase of introduction and evaluation, extension and development are underway. In the case of pitaya, the commercialisation phase has started.

A new crop introduction and evaluation programme was proposed in MSIRI's Research and Development Programme, 2005-2009 (MSIRI, 2005), and is being revised for the 2010-2014 one. Preliminary work has been initiated. Contacts have been established and germplasm of selected new crops has been imported. Emphasis is on perennial tree fruit crops for planting on marginal sugar cane lands. To-date, the following have been introduced: seashore mangosteen (*Garcinia hombrioniana*), rambutan (*Nephelium lappaceum*) and white sapote (*Casimiroa edulis*). All of them are well known and appreciated in their countries of origin and practically unknown in Mauritius. They may or may not succeed here. Any one that does succeed will become a useful addition to the range of fruits grown here.

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