

A Short History of Sugarcane in Hawaii

Susan Schenck

Hawaii Agriculture Research Center, Kunia, HI, USA.

Ancient Hawaiian canes

When the Polynesians first landed in the islands of Hawaii they brought with them their staple food crops of taro, sweet potato and sugarcane. These canes were the *Saccharum officinarum* 'noble canes'. They were not milled for sugar, but chewed and squeezed for juice. Many colorful canes were propagated that became part of ancient Hawaiian traditions. Then, in the early 1900s Dr. W.W.G. Moir of Hawaiian Sugar Planters' Association gathered a collection of these canes and attempted to identify the related cultivars based on morphology (Moir, 1932). He kept detailed records of the collection and the sources of all the canes, including ones imported from other Pacific locations. This collection remains with HARC and has been further studied as to actual genetic relationships (Schenck et al. 2004). It is now clearer how these *S. officinarum* canes are related genetically to each other and to the commercial hybrids.

Development of the industry

Cultivation of the noble canes on a field scale was started as early as 1800. The first successful commercial mill was started in 1835 in Koloa on Kauai (Vandercook, 1939). However, the noble canes were not really suited for milling and sugar production for several reasons. They are very soft and not easily millable. They were susceptible to various diseases and pests that soon arrived in the islands along with increasing arrivals of foreign plants and people. So sugarcane breeding became one of the first priorities of the plantations. Unfortunately, the Hawaiian *S. officinarums* produce very little viable pollen, so the breeding program was started from several imported canes. 'Lahaina' and 'Yellow Caledonia', both imported, were two of the first cultivars to be grown commercially. 'Lahaina' was crossed with another unknown cultivar to produce H109 that became the first widely grown plantation hybrid cultivar.

Between 1841 and 1855 sales of Hawaiian raw sugar abroad averaged only 240 tons per year. By 1861 it increased to 1000 tons because the American civil war cut off supplies to the north from the southern states. Sugar was shipped to California in barrels on sailing ships that took 20 days to make the crossing.

Then, in 1875 the Reciprocity Treaty was signed between the United States and Hawaii (still an independent kingdom). This ensured that Hawaii would not lease any "port , harbor, or territory" to any other foreign power. It also gave duty-free entry of raw sugar into the United States. With the new market assured, Hawaiian sugar production doubled within four years. By 1890, the island's sugar yield was 129,000 tons.

Native Hawaiians did not prove to be satisfactory field laborers and the native population was tragically diminished from diseases and other causes. It became necessary to import labor.

Thus began a history of immigration into the islands from China, Japan, Portugal and the Philippines that make up much of the population of today. Infrastructure, mills, ports, irrigation ditches, and trains were constructed and the sugar industry grew, mainly through the efforts and capital of several American businessmen.

Without blatant seizure, more and more land and industry was taken out of the Hawaiian's control. Most of the foreigners were Americans and most of the capital invested in Hawaii was American dollars. The closest advisors of the Hawaiian government were American and Hawaii had become, in effect, an American colony. Eventually, in 1893, the last Hawaiian monarch, Queen Liliuokalani, was overthrown, placed under house arrest, and Hawaii became a territory of the United States. Eventually, in 1959 it was voted in to become the 50th state of the union.

HSPA and research

In 1882, The Minister for the Kingdom of Hawaii allowed the establishment of The Planters' Labor and Supply Company which became the Hawaiian Sugar Planters' Association in 1895. The Experiment Station of the Hawaiian Sugar Planters' Association was also founded in 1895 (Grammer, 1947). Cooperation between the various sugarcane companies has always been a characteristic of the sugar industry in Hawaii and they all contributed to the maintenance of the research that benefitted them. HSPA Experiment Station undertook to bring in breeders, chemists, pathologists, entomologists, agronomists and soil scientists to solve the many problems that the industry faced.

The offices, research plots and laboratories were originally located in Kaimuki, now part of urban Honolulu. As the city grew up around it, a new laboratory was constructed west of Honolulu near the Aiea sugar mill. HSPA moved to the new site in 1976. Field research was carried on at other substations owned by HSPA on Oahu (Kunia and Waianae), Kauai (Lihue), Maui (Puunene) and Hawaii Island (Hilo), as well as the breeding station at Maunawili, Oahu. About 150 personnel, including field workers, technicians, office workers and research scientists were employed by HSPA at that time.

Plantations 1970 to 2014

In 1973 there were 19 mills operating in Hawaii on the four main islands. The total combined production that year was 1,128,529 tons raw sugar. Most was shipped to the California and Hawaii (C&H) refinery in California. However, the cost of production in Hawaii is high. Labor wages and benefits cost more than in many foreign countries. All machinery, fertilizers and herbicides must be imported. But the price for raw sugar worldwide did not increase as fast as cost of production, mainly because of the increased competition worldwide. The last 1 million ton harvest was in 1990 and production has diminished since then.

The number of plantations in operation in 1990 was 13. By 1995, with the closure of Hamakua Sugar on Hawaii island, the number had decreased to 9 and the total sugar production in Hawaii was 492,346 tons. Subsequently, one by one the plantations closed and today only Hawaiian Commercial & Sugar Co. (HC&S) on Maui remains in production. It continues to farm

about 35,000 acres (14,165 ha) and to produce around 200,000 tons sugar per year. Only about half the acreage is harvested each year because sugarcane in Hawaii is a two-year crop. Planting and harvesting continue 12 months a year.

HSPA becomes HARC and moves to Kunia

As the sugar industry decreased in size, it could no longer support an institute the size of HSPA. Funding was procured from other sources, such as the State of Hawaii, Hawaii Farm Bureau Federation, USA federal grants and private contracts. The name was officially changed to Hawaii Agriculture Research Center in 1994 to better reflect the wider range of crops and research projects undertaken. The two remaining sugarcane plantation on Oahu, Oahu Sugar Company and Waialua Sugar, had both ceased operations by 1996 and the Aiea sugar mill was closed in 1998. The Aiea research building was eventually sold and HARC moved to its present Kunia location. The 100 acres that had been leased for the Kunia substation were bought and a new laboratory building was constructed. This laboratory was designed to specifications for molecular biology and micropropagation research. Field operations, chemistry, pathology and sugar technology labs are located in adjacent buildings. A further site of over 100 acres was purchased nearby and includes a village of houses for farm workers, HARC offices, and an area leased to a number of commercial agricultural companies. It is surrounded by several hundred acres of land that has been designated by the State of Hawaii as agricultural lands in perpetuity. These lands are being developed for leases to small farmers who will benefit from the proximity to HARC and the other agricultural businesses. A farmers market is also planned as a local outlet for their produce.

HARC's current activities

Meanwhile, HARC continues to provide pathology, breeding, and agronomy services to the remaining sugarcane plantation on Maui. The HARC Maunawili breeding station continues to make sugarcane crosses and produce seedlings each year with the additional aim of developing more energy canes as well as high sucrose canes. The Maunawili station has greatly diversified its scope to include research in forestry, coffee, cacao and even bee keeping. Sugarcane breeding work has broadened its scope, taking advantage of Hawaii's unique environment favorable for sugarcane flowering. Sugarcane cultivars are being imported from research institutions outside of Hawaii, grown to flowering size, and crossed to produce fuzz that is then sent back to them. This requires expertise in import – export regulations and quarantine regulations in mainland US states and foreign countries. HARC maintains its own sugarcane quarantine facility for this purpose.

Along with molecular biology research in sugarcane, anthurium and papaya, HARC has expanded its micropropagation business to a profitable level. Techniques for micropropagation and meristem tip culture have been developed for a number of crop and forestry plants. Pathology, agronomy and microbiology services are available to Hawaii growers of the many diverse crops now grown on acreage once in sugarcane.

A word about Hawaii's quarantine regulations

Hawaii has quarantine barriers between foreign countries and also the mainland USA. The import regulations are made and enforced by the Hawaii Department of Agriculture, Plant Quarantine Branch. All plant material coming into the state is inspected and any shipment contaminated by pests or diseases is destroyed. Sugarcane, other grass species, and coffee imports are prohibited. However, HARC has special arrangements with the state to import sugarcane seed. All cane to be imported from foreign countries or other US states must first be sent to the USDA Sugarcane Quarantine Station in Beltsville, Maryland. It is grown there for 12 months and tested for diseases. After that time, HARC can obtain an import permit and bring the cane into the state where it is planted in HARC's sugarcane quarantine field for another 10 - 12 months before testing and release.

Sugarcane exports out of the state are regulated, inspected and enforced by the USDA Animal and Plant Inspection Service (APHIS). Import permits must be obtained from the state or country it is being sent to. HARC must ensure that all treatments and requirements of those permits have been followed. The shipment is inspected and all documentation cleared before APHIS will allow it to leave the state. In addition, regardless of the import permit requirements, APHIS requires that sugarcane fuzz be given the regulation sodium hypochlorite treatments and seed cane be given long-hot-water treatment before it will be allowed to be shipped.

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