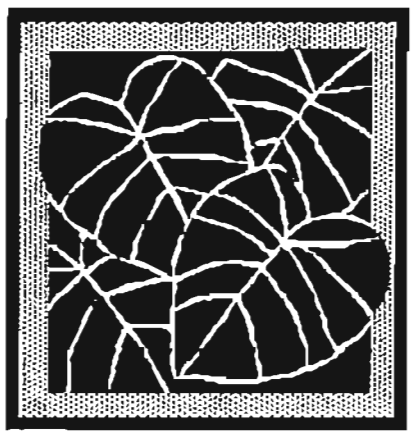
AGRICULTURAL INDUSTRY ANALYSIS
THE STATUS, POTENTIAL, AND PROBLEMS OF HAWAIIAN CROPS

TARO INDUSTRY ANALYSIS

Number 4



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PREFACE

As a step towards marshalling the resources available in the state of Hawaii for the development of the taro industry in a orderly and optimally successful fashion, representatives of the taro industry, interested members of the public and state and county agencies, and the College of Tropical Agriculture and Human Resources have worked together to prepare this Industry Analysis and Action Plan, which is a reasoned assessment of the industry by those in the community that can contribute. [1]

The analysis considers all the elements that constitute the taro industry. One such element is an assessment of the potential of the industry in Hawaii. Other elements are assessed in terms of this potential, bottlenecks in the achievement of the potential are identified, and the requirements to relieve each bottleneck are defined. From this base, an action plan is developed in which the units of the community best able to accept responsibility for relieving bottlenecks and the resources required are specified. In the action plan, bottlenecks are numbered by priority set by the wetland and dryland taro producers, as well as for the industry as a whole.

To continue to reflect the current potential and bottlenecks of the industry, this analysis and action plan will need to be revised periodically.

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PART I. THE STATE OF THE TARO INDUSTRY

I. SOME BACKGROUND INFORMATION ON THE TARO INDUSTRY

Taro forms the basis or is an integral part of many traditional diets worldwide. In its various forms, (e.g. baked, boiled, fried, whole or mashed) taro is a nutritious food consumed by millions of people everyday. According to the FAO Production Yearbook, 12.6 billion pounds of taro (*Colocasia*) were produced worldwide from 2,440,360 acres in 1987. Major producing areas are Africa (8 billion pounds), Asia (3.9 billion pounds), and Oceania (667 million pounds). Total production of Poi and Chinese taros from Hawaii was 6.2 million pounds in 1988. Taro is the 14th most consumed vegetable on a world-wide basis (Appendix 7).

A. Taro in Hawaii: A Brief History

Taro, like sweet potato, banana, breadfruit and sugarcane was an important food to the ancient Hawaiians. In fact, taro is considered by the Hawaiian people to be the progenitor of their ancestors. According to Patrick Kirch's 1985 book, *Feathered God's and Fishhooks*, taro was brought to Hawaii in the canoes of the first inhabitants from the Indo-Malaysian region. It was most frequently planted and most often flourished in the Windward areas of the Hawaiian Islands, yet drier Leeward and arid areas such as West Hawaii and Lanai were also extensively cultivated. The various taro production techniques, which had taken many, many years to develop were considered by the likes of James Cook in 1778 (and others of his time), as being extremely sophisticated and efficient for their time. Polyculture of small fresh water fish and shrimp and taro was also practiced in areas such as Molokai during this era.

Critical events which shaped in the development of the taro industry in Hawaii in the late 1700's and early 1800's include the deaths of many Hawaiians (many of them agricultural workers) from foreign-introduced diseases, the breaking of the *kapu* system by Ka'ahumanu and Liholiho, and the introduction of a competitive barter economy. The Great Mahele (the restructuring of land ownership concepts) in the mid-1800's also had an effect on production as it redistributed some taro patch area. With the influx of Chinese immigrants in the later 1800's, their demand for rice resulted in changing some taro patches to rice paddies. By 1870, the Chinese had begun to compete with the Hawaiian taro farmers and by the end of the century they were raising about 50% of all taro and milling about 80% of the poi. The Chinese were credited with choosing varieties which would mature earlier, and produce more, than the average taro. Poi shops were created by the Chinese to supply Hawaiian plantation workers and those who did not produce their own taro or who could not pound it themselves. The coming of the Japanese farm laborer to Hawaii again caused a shift in the balance of power in taro production and milling, and by 1937 most of the production was being done by Japanese farmers. By 1938, imported crayfish which were not endemic to the State, began to affect wetland production as they were burrowing holes in the sides of lo'i which in turn drained precious water (Patricia Kubo, *The History of Taro and Taro Products in Hawaii*, 1970, History 424 - UH). During WWII production of taro as with many other crops was closely controlled (Perry Philipp, pers. comm.). Through it all, taro shortages and thus poi shortages have been a part of the history of taro in Hawaii. While it is hard to substantiate, historians speculate that at one time or another weather and warfare have contributed to periodic shortages. In the last 100 years or so, weather and the low value of raw taro, relative to the greatly increasing cost of all other goods and services, has contributed to almost yearly shortages, of which 1990 is being touted as one of the worst in recent memory.

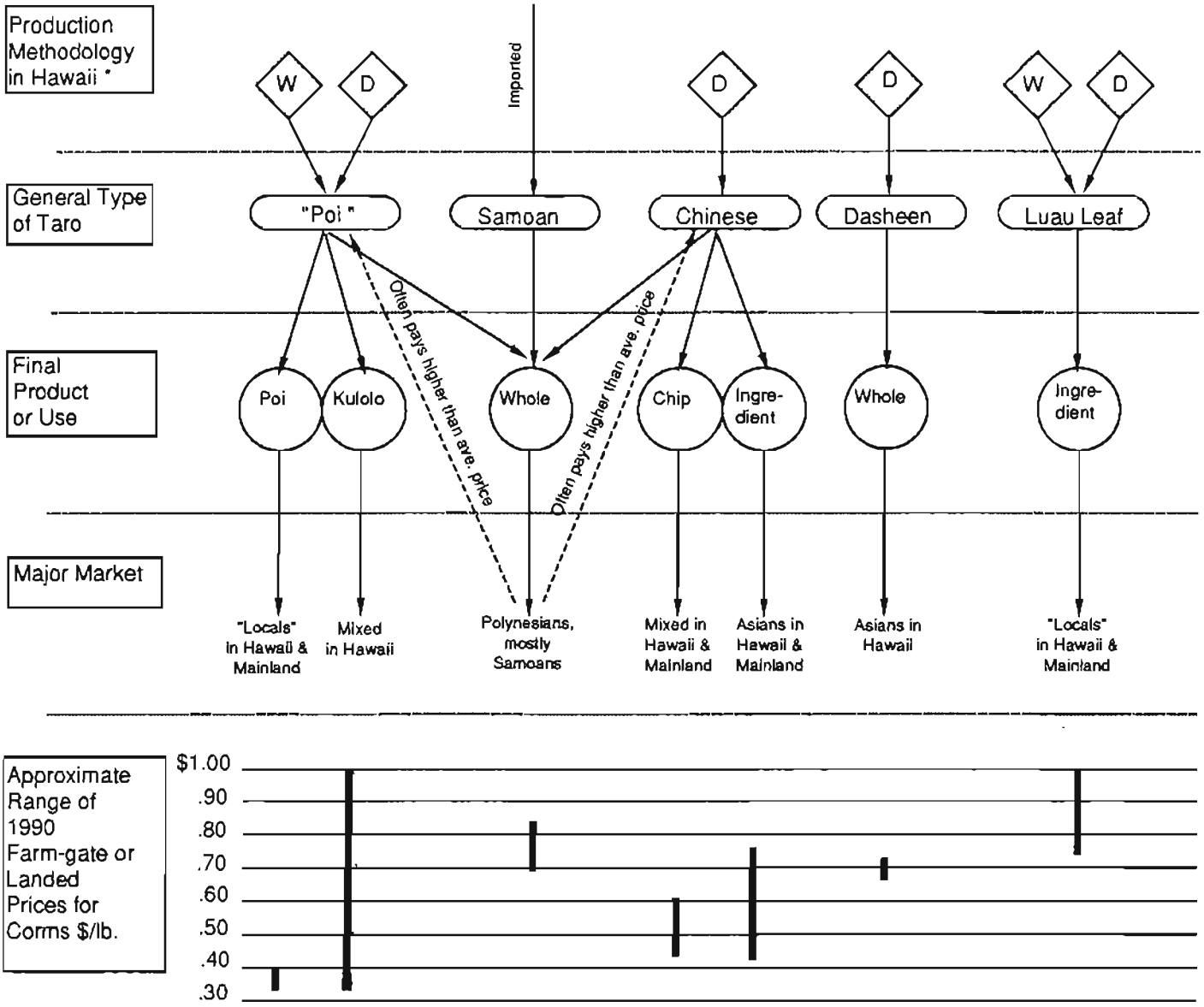
Since the late 1800's entrepreneurs were interested in marketing taro-based products, such as taro flour and taro-based milk, yet with mixed success. In the 1940's the first taro chip factory was started in Hilo. Highlights in other processing and packaging history include the introduction in 1948 of plastic poi bags which would eventually replace the more traditional muslin bags. In 1951 there were 51 poi mills Statewide. In the mid-60's the commercial potential of taro as a hypoallergenic or allergen-free food product was explored, but the studies that were conducted at the time were not sufficiently convincing to spur growth in production and processing. *(See Appendix 3 for more information).*

Taro as a vegetable, in its many unprocessed and processed forms, is still a very sought after commodity today. It is grown by representatives of most of Hawaii's ethnic groups. Currently, there is a renewed interest in taro production due to a number of factors including: a resurgence in interest in Hawaiian culture, a growing Mainland market composed of new Asian and Pacific Island immigrants, a growing snack food market, and a new recognition of the value of taro by the medical community.

B. The Current Taro Market in Hawaii: An Introduction

While there is some cross-over buying of raw taro by consumers and processors, there are basically four somewhat distinct markets for taro (and one for Luau leaf) in Hawaii: the dasheen, poi, Chinese, and Samoan markets (Figure 1).

Figure 1. Market Interaction and Range of 1990 Farm-gate Prices for Taro in Hawaii



* Notes:
W=wetland, D=dryland

Demand and Use

The demand for Hawaii grown taro depends on its price in each point in the marketing stream: farmgate, wholesale, processed and retail. Quality is also an issue which can sometimes even outweigh price as a buying consideration. Here are some others:

Poi

The "poi taro" (produced under both dry and wet cultivation conditions), usually the Lehua variety for commercial usage, is more often than not processed and is the basis for two primary products: poi (the traditional Hawaiian pudding-like starch-staple) and kulolo (a equally traditional fudge-like confection). Raw corm-to-poi/kulolo processing facilities presently number about 12 State-wide. The market for poi taro products is typically the "local" population, both in Hawaii and in pocket markets on the Mainland, and the local visitor industry as an introduction to traditional Hawaiian foods at staged luaus.

Chinese

Chinese taro is consumed in its cooked non-processed form; as an increasingly popular snack chip and in more traditional Chinese dim sum dishes, among others. Taro chippers currently number: 4 in Hawaii, 1 in California (previously chipping in Hawaii) and 1 in Colorado (does not use Hawaii-grown taros).

Dasheen

The dasheen (*C. esculenta* var. *globulifera*), Japanese, or "sato imo" type taro (the small cormels are eaten, but the mother corm is usually not), is consumed cooked, but unprocessed, primarily by oriental consumers and is typically eaten as a side vegetable to a meal.

Samoan

The Samoan taros (Niue [Samoan pink], Manu'a and Palagi) are consumed almost exclusively by the Samoan population in Hawaii and are very often eaten in a cooked whole form as a substantial part of a meal. There are about 5 importers for this particular industry segment in Hawaii.

Luau Leaves

Taro leaves are used in the making of *Laulau*, a traditional food made by wrapping fish, pork, squid, or chicken in the leaves before cooking them. The leaves are also eaten by other peoples from the Pacific and Caribbean region. *See below for more information.*

Taros for Other Markets

Taro for the production of gums or emulsifiers is now under investigation. The use of taro as a base for hypoallergenic or allergen-free products is also again under investigation. In both cases the variety of taro that best suits these markets has not been identified.

Supply

Needless to say, the price of taro at the farmgate is the greatest influence on supply, with labor playing a related close second, i.e. without a good farm gate price labor can't be hired. Labor needs to be affordable and available not just during holidays and weekends, but year round. While there are no monthly statistics kept on production, Table 1 provides at least some insight into availability of Chinese and Poi taros through shipping data. Note arrivals and production figures (given later) may not match due to on-site loss and usage or because the product does not pass through the market channels where statistics are being collected *(See Appendix 4 for more information).*

Table 1. Average Poi and Chinese Taro 'Arrivals' Within Hawaii by Weight, Month and Percentage

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total/Average Shipped
						Thousand Pounds							
1984	35	14	26	21	19	16	20	12	8	5	4	4	184
1985	24	16	17	18	15	16	20	16	13	12	5	12	184
1986	17	13	19	30	8	12	21	17	18	19	15	15	204
1987	8	10	21	10	7	9	12	18	30	10	16	19	170
1988	23	31	16	20	13	17	41	30	21	27	20	16	275
Percent= (5-year ave.)	11	8	10	10	6	7	11	9	9	7	6	6	203

Source: Market News Service, Honolulu Arrivals, Fresh Fruit and Vegetables 1984-1988, Tables 3 & 7.

The Suppliers -- The Farmer

Taro farming and taro lands have been passed down through the generations. Today, very few taro growers are full time farmers or receive the better part of the yearly income from taro production. Table 2 & 3 provide some additional insight into current farm-size characteristics which has some implications for supply potential. Below are some other factors affecting supply of specific varieties of taro.

Table 2. Percentage Distribution of Acreage and Number of Wet- and Dryland Farms Producing Taro for Poi in 1989

Acreage in Crop Intervals	Percentage of Total Acreage	Percent of Total Farms
More than 5.0 acres	58%	23%
1.0 to 4.9	41	66
Less than 1.0	1	11

Source: Ron Nakamura, HASS, July 1990.

Table 3. Percentage Distribution of Acreage and Number of Wet- and Dryland Farms Producing Chinese Taro in 1989

Acreage in Crop Intervals	Percentage of Total Acreage	Percent of Total Farms
More than 5.0 acres	42%	11%
1.0 to 4.9	52	58
Less than 1.0	6	31

Source: Ron Nakamura, HASS, July 1990.

Poi

The supply of poi taro is largely influenced by water supply conditions in the areas where they are usually grown. Too little water reduces crop growth and disease resistance, while too much water (flooding) destroys crops and damages fields, equipment and property.

Chinese

Chinese taro availability is governed by the supply of water, along with its own price, and (often) the price of ginger, i.e. as the price of ginger goes up, the supply of taro often goes down. Most Chinese taro

farmers, located in the Hilo-Hamakua area of the Big Island, grow the often more profitable ginger as well.

Dasheen

In the case of dasheen, some 80 percent of local demand was met by Hawaii farmers in 1989 (Hawaii Agricultural Statistics Service). *Dasheen will not be discussed further in this analysis as it is included in the Vegetable and Melon Industry Analysis.*

Samoan

Samoan taro demand is met almost exclusively by Western Samoa and to a lesser extent by growers in American Samoa. The demand for these varieties of taro appears to be greater than supply during most of the year, in which case both poi taros and Chinese taros are consumed by the Samoans (and other Polynesian groups) living in Hawaii. Some other Polynesian groups, such as the Tongans, grow taro for their own needs in places such as the North Shore of Oahu. There does not appear to be a constraint on the production end in the Samoas, more that the available air-cargo space is very limited, and boat-shipped taro is often considered undesirable as the taro often arrives in less than marketable shape. The Samoan taro market in Hawaii must compete for the limited supply with the much larger Los Angeles market.

Luau Leaves

Most of the leaves that are processed into commercial luau leaf-based products are from Oahu, however, each island has its own source of growers.

C. Market for Hawaii Grown Taro on the U.S. Mainland and Canada

Taro is consumed by various ethnic groups in North America; the primary type is the Chinese taro. The ethnic groups in the West Coast markets that eat Chinese taros include the Chinese, Vietnamese, Thais, Malaysians, Filipinos, and Laotians, among others. These people consume taro in much the same way as do their Asian counterparts in Hawaii. However, in the frozen section of the oriental markets in Los Angeles, nearly a dozen different processed taro-based products are available. These include taro bun, ice cream, ice bars, and tofu-like products. The major taro product that is consumed, however, is the corm itself. While the taste of the non-Hawaii taros are reported to be inferior to Hawaii-grown taros, price and availability are important strong points of competitive producers. Major competitors in this market include the Dominican Republic, Costa Rica, Florida, and Brazil. Imports of Chinese taro to the Mainland from foreign countries and Hawaii (estimated at 500,000 - 700,000 lbs in 1988) were at least 13 million pounds in recent years. Since the time these statistics were collected Mexico has entered the taro market in force.

Fresh taro leaves and taro stems are marketed in Hawaii and on North America. Taro leaves are a traditional part of Hawaiian luaus as Laulau, are eaten by Samoans as Palusami, and the peoples of the Caribbean region consume taro leaves (as a substitute for Amaranth leaves) in various types of soups, e.g. Callaloo. Taro stems are commercially produced in greenhouses in California and are eaten by the Vietnamese and other Asian groups there. The Vietnamese use the stems in soups as well as in other dishes. Countries exporting 293,000 pounds taro leaves to the U.S. in 1986 include Brazil, Dominican Republic, and Jamaica. Because inter-state statistics are not collected, it is unknown how much fresh and frozen taro leaves are shipped from Hawaii to North America.

II. CURRENT STATUS AND POTENTIAL OF THE TARO INDUSTRY IN HAWAII

The *Taro Industry* in Hawaii is composed of producers, shippers and processors. Taro production in Hawaii is currently undergoing a metamorphosis which is being driven by a combination of market signals and production conditions. The areas traditionally used for the production of wetland taro are being cultivated less and less each year, while acreage used for the production of taros under dryland conditions has increased over the same period (Table 4). Total taro production Statewide declined from 6.2 million pounds in 1988 to 6.0 million pounds in 1989. Despite the decrease in total production, the farmgate value (for the corms alone) increased slightly to $1,996,000 in 1989, up from $1,904,000 in 1988, due to the increased average farm price of taro per pound (Table 4) (Hawaii Agricultural Statistics Service, 1990).

Table 4. Acreage and Price of Hawaii Grown Taro in 1989 for the State

General Taro Type	Acres of Taro Commercially Grown in Hawaii	Percent and Direction of Change Over Year Previous	Farm Gate Price ($/lb)	Percent and Direction of Change Over Year Previous
Poi	290	-7%	$.285	+10%
Chinese	140	+21	$.401	+2%
Samoan	very little	n/a	$.790*	+ ??
TOTAL	430	+23		

Source: Hawaii Agricultural Statistics Service, 1990.
* This is the landed price in Hawaii: farmgate in Samoa + air shipping, industry contact is source.

The Island of Kauai remained the largest overall producer of taro with 64 percent of the State's total production in 1989; nearly all of it of the wetland type. However, Kauai's 1989 production of all types of taro was only 4.16 million pounds; 250,000 pounds less than in 1988. The Big Island was the major force in Chinese taro production in 1989, with 130 acres under cultivation (Table 5). The other 3 major islands, Oahu, Maui and Molokai, very important in a regional sense, contributed less than 50 percent by weight of the taros for the Statewide poi market and about 10 percent to Statewide Chinese taro supply.

Table 5. Acreage and Price of Hawaii Grown Taro in 1989 for the State and by Island

Area	Acres of Poi Taros Commercially Grown by Area	Percent and Direction of Change Over Year Previous	Acres of Chinese Taros Commercially Grown by Area	Percent and Direction of Change Over Year Previous
Kauai	180	-6%	[2]	[2]
Hawaii	35	-14	130	+23%
Maui/Molokai/Oahu	75	-7	10	0
STATE	290	-7	140	+21

Source: Hawaii Agricultural Statistics Service, 1990.
[2] Kauai combined with Maui, Molokai, and Oahu to avoid disclosure of individual operations.

Approximately 92 percent of taro corms produced in the State were processed into poi and taro chips. Most of the corms processed into poi were grown under wetland culture and those made into taro chips were grown under upland conditions. The *Honolulu Arrivals* for taro corms for chips increased from 289,000 pounds in 1988 to 560,000 pounds in 1989, an increase of 94 percent. Taro corms sold as fresh taro declined from 600,000 pounds to 500,000 pounds in that year, due it is thought to them being used as chipping stock (Hawaii Agricultural Statistics Service, 1990). Much of the taro that was used for table taro was shipped to Mainland markets by one of the 12-14 local shippers. According to a recent non-scientific telephone survey, retail prices are not available for taro products, such as poi and taro chips, except for the current year.

Foreign taro imports of 733,000 pounds, the most ever imported to Hawaii and mostly from Western Samoa, accounted for approximately 10 percent of the State's total taro supply in 1989 (Table 6). Imported taro corms were used mainly as table taro for the Samoans and other Polynesian groups.

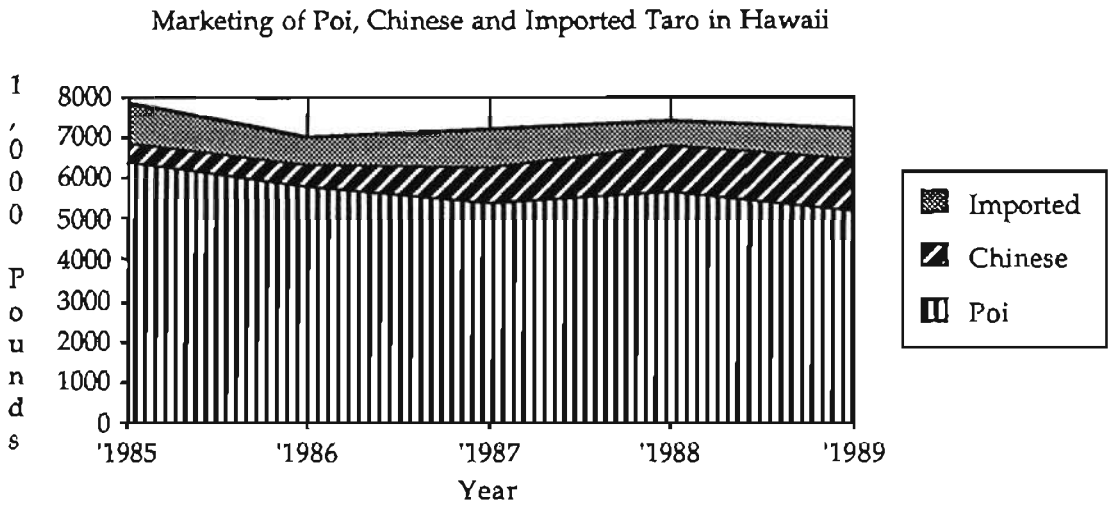
Table 6. Volume of Hawaii Grown Taro and Imports in 1989 for the State

General Taro Type	Amount Commercially Marketed in Hawaii (lb)	Amount Imported (lb)	Percent and Direction of Change Over Year Previous	Share of Hawaii Market 1989
Poi	5,270,000	0	-8%	73%
Chinese	1,230,000	0	+11	17
Samoan/	very little	733,000	+16	10

Source: Hawaii Agricultural Statistics Service, 1990 and per communication.

Looking at a 5-year trend, consumption of taros in general is relatively flat (Figure 2). It is unknown how per capita consumption has changed with the increase in population from the areas which typically have taro eaters. While poi taros have decreased in availability, the Chinese and imported taros, the latter mainly from Western Samoa, are experiencing some growth due to the demand created by their specific markets.

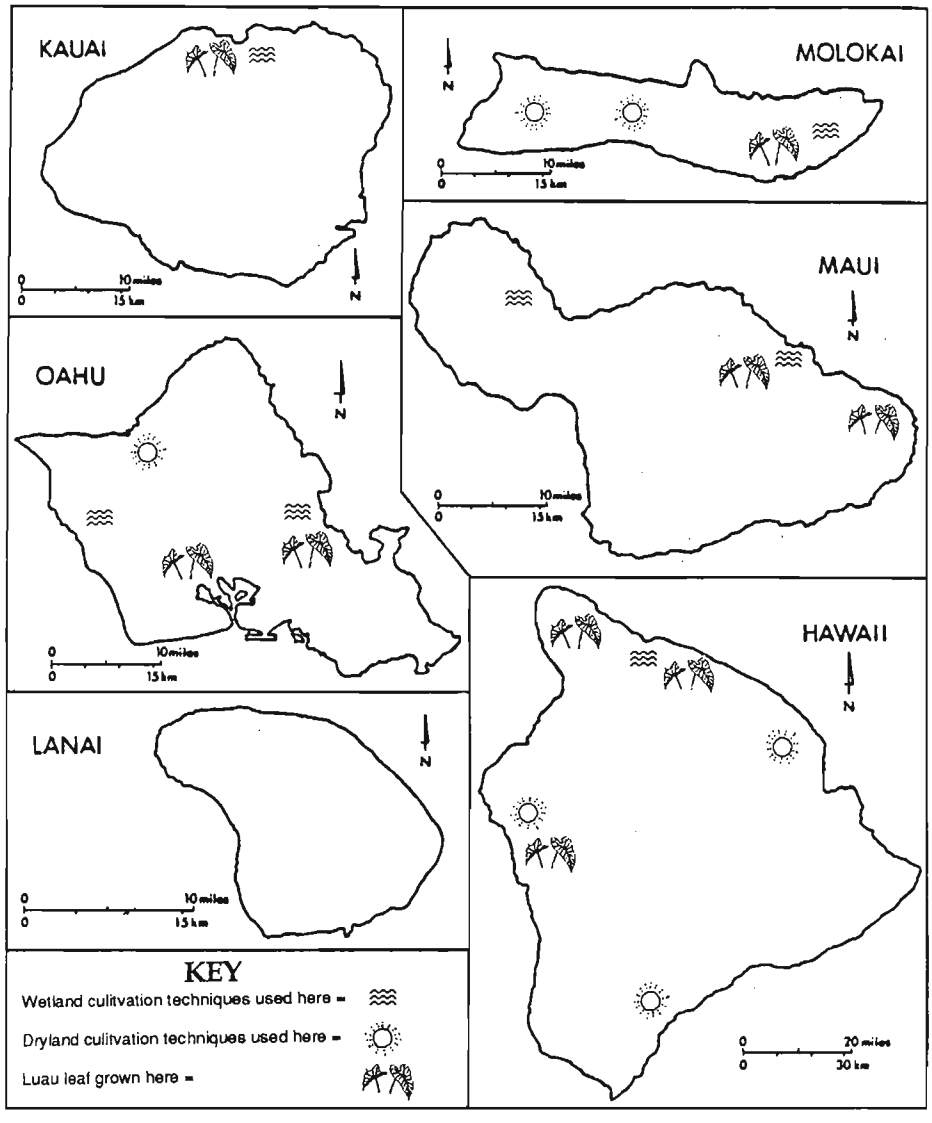
Figure 2. A 5-Year Trend of Marketings of Poi, Chinese and Imported Taro in Hawaii



A. An Island by Island Perspective of Taro Production Conditions

Production possibilities for taro are a very island-specific, area-specific and input-specific phenomena. For instance, in one area on one island, land and water may not be a problem, but the availability of affordable labor is (e.g. Hanalei Valley, Kauai). While in another area there are willing farmers, but little readily accessible capital for inputs (e.g. Molokai). In still another, land and farmers are available, but the condition of the watershed area limits water flow (e.g. Wailua area, Maui). Appendix 1 contains production information for all islands for poi and Chinese taros. General areas of current commercial production are indicated on Map 1.

Map 1. General, Concentrated Areas of Commercial Cultivation and Techniques Used for Corm and Leaf Production by Island



Kauai

Hanalei Valley has maintained its position as the center of wetland taro production in the State. Improvements in the irrigation system by the U.S. Fish and Wildlife Service is continuing to benefit local farmers, however, the lack of *affordable* labor, due to increased competition for labor between agricultural and non-agricultural industries, has started to affect taro production in Kauai and elsewhere. Much of the lands made available in Hanalei Valley as a result of the irrigation project of the U.S. Department of Interior Fish and Wildlife Service are still unused. These areas represent a potential increase of 125 acres if farmers are able to put it into production. A portion of Bishop Estate lands in Waipa Valley, Kauai is being farmed, but much still remains unused. Repairs and maintenance of the Waioli Valley water system will also enable farmers to increase the production in that area. Growers groups on this island are: Project Waipa and the Kauai Taro Farmers Association.

Hawaii

Production of Hawaiian taro in Waipio Valley has continued to decline. Some taro farmers in the Waipio Valley who have traditionally grown Hawaiian taros, have now started to plant Chinese taro in lo'i for the luau leaves. The recurring floods in the area continue to make wetland taro cultivation difficult. However, some of the previously established taro growers are starting to put some lo'i back into production. In the Hilo-Hamakua area, Chinese taro production is on the upswing; taking advantage of cleared lands and natural supplies of water. Limiting supply from that area is the concurrent growth of ginger by existing taro farmers. Some dryland cultivation of Hawaiian taros for poi is also taking place in the Hilo-Hamakua area. Often, the poi made from these taros is not very purple thus perhaps limiting its marketability. In the Kona area and as far North as Kapaau, both taro leaves and corms are grown on small farms. Industry groups on Hawaii are: the Hawaii Dryland Taro Association and the Waipio Farmers Association.

Molokai

This island has a great deal of farmable land, but, at the present time there is only a relatively small local demand for poi taros and only one poi miller. Some Chinese taro for chips is being grown in Kaunakakai, but on the few farms currently in operation the major products are poi corms (East Molokai) and luau leaves. For this Island to become a larger producer, farmers will need to secure start-up capital. Helping them are the Molokai Taro Hui and the West-Maui Molokai Taro Association.

Maui

On Maui there is considerable acreage that can be used for wetland taro cultivation if irrigation systems are improved. For instance, in the Wailua area the water delivery systems are clogged with debris and are in generally poor condition. East Maui streams are de-watered for plantation irrigation and municipal supply, which often reduces downstream water availability at existing and potential taro lands. In the West Maui area, traditional wetland growing areas are being revived. In all, some 200 additional acres of lo'i (wetland taro pondfields) could be put into production as the market demands. The West-Maui Molokai Taro Association is the only group on this island.

Oahu

As measured in acres, luau leaf is the dominant taro product on Oahu, with at least 4 major producers. Some lo'i are slowly going into production on Oahu despite the increasing difficulty to keep lowland fields under continuously flooded conditions. Production of Hawaiian taro under upland conditions is in the experimental stages on Oahu and the adoption of this method on all islands could help ease periodic shortages given coordinated efforts between grower and processor. The Honolulu Poi Hui based in Oahu has branches on some islands. The Opelu Project/Kaala Farm folks help farmers in the Waianae area of the Island.

B. Conclusions

Taro has a long and honored tradition in Hawaii as it has in many other parts of the world. Production techniques practiced by the *labor-rich* ancient Hawaiians were arguably brought to their relative highest state of efficiency by these pre-contact peoples. Life style and population-mix changes affecting markets, and increased competition for water, land, capital, and labor, by *both* agricultural and non-agricultural enterprises affecting production, have forced a change in the appearance of today's taro industry. A review of historical documents, including newspapers, reveals that these type of influences have always been a part of Hawaii's post-contact taro industry. The task at hand for today's taro farmers is to incorporate the impact of these changes into their current and future production and marketing. One example of where this is working is in the increased planting of taro varieties, which heretofore were considered only to be only suitable for wetland cultivation, under dryland-irrigated conditions. By using the dryland method it may be possible for the farmer to substitute capital (a scarce commodity) for labor (an even scarcer commodity) in the form of mechanization as is done by one 400 acre taro *(Xanthosoma)* farm in Florida. The following methods should also help today's farmer to increase profits and remain competitive:

- Vertically integrate farm and processing facility
- Diversify taro varieties (e.g. grow a little Chinese, poi, dasheen, Samoan, Tongan, etc.) and products (e.g. grow for leaf, stalk and corm)
- Plant for year-round crop availability
- Coordinate planning between producer and buyer and identify plans on a long range calendar
- Cooperate in the purchase and use of labor and equipment
- Replace some of the 13 million pounds of foreign-grown taro being imported to the U.S. Mainland by supplying a year-round, reasonably priced, QUALITY taro from Hawaii.

PART II. SECTION I. THE ACTION PLAN NARRATIVE

I. GENERAL OVERVIEW OF ANALYSIS PROCESS AND INDUSTRY PRIORITIES

On Friday, June 15, 1990 members of the *Taro Industry* and other interested persons from the GACC, the University of Hawaii and the community, gathered in Hilo to set Industry expansion goals and research priorities for the next 3 or 4 years. Results of the meeting indicated that the Industry would like to double its farmgate market value in the next 5 years. Input was also received on the wording and content of this document and a final vote on research needs was taken of those farmers who were present or represented at the meeting. Since there are two fairly unique cultivation techniques, which often sets the type of market the farmer wishes to service, there were three sets of rankings taken, one for the wetland (W), one for the dryland (D), and Industry-wide. Between the two technique's rankings none were judged more important nor less important than the other. As there was also some overlap in research needs it is difficult to sort the attached list in any meaningful manner, therefore, the original order of the presentation will stand, but the following list will provide a general overview of research needs for each production technique:

Wetland (W)

1. Mechanization
2. Water-distribution
3. Cultivar-indexing
4. Culture & Management-water use
5. Weed control
6. Insect control

Dryland (D)

1. Insect control
2. Weed control
3. Cultivar-indexing
4. Culture & Management-water use
5. Water-distribution

Industry-wide

1. Mechanization
2. Cultivar -breeding/nursery
3. Disease control
4. Post-Harv. Hand & Proc.
5. Land
6. Capital
7. Labor
8. Marketing, Econ., Proc.
9. Culture & Mgt - fert. use

Unprioritized-Information delivery system

Agencies that may be able to assist the industry with its problems were also identified in the analysis. They are referred to throughout the document by the following acronyms or names:

Acronym or Title	Name
Alu Like	
APHIS	Animal & Plant Heath Inspection Service
Attorney General	
County Councils	
County Planning Commissions	
County Planning Departments	
County Water Supply Departments	
CTAHR	College of Tropical Agriculture and Human Resources
DHHL	Department of Hawaiian Home Lands
DLNR	Department of Land and Natural Resources
DOA	Department of Agriculture
Geography Department - UH	
History Department - UH	
Hawaiian Studies Department - UH	
Industry	Taro Industry
Legislature	
Lending Institutions	
LUC	State Land Use Commission
Office of State Planning	
OHA	Office of Hawaiian Affairs
WRRC	Water Resources Research Center - UH

On August 29, 1990 this document was delivered by representatives of the Industry to the GACC at a meeting at the College (Appendix 5). The requests for research funding were reviewed in the subsequent weeks and on September 26, 1990 the GACC awarded over $100,000 for research out of their budget and an additional $90,000 from legislative appropriations for taro projects for FY 1990-91. Funded projects will be so indicated by having a number in the *Resource -- Allocated* column in the attached Taro Action Plan Tables.

II. TARO INDUSTRY BOTTLENECKS

A. LAND

1. Analysis:

a. Taro requires land with an ample supply of water to produce efficiently.

b. Taro land must be relatively level with few stones. It should also have a deep soil profile and fine textured soil. Currently, wetland taro production is mostly limited to the large rain-fed stream valleys such as Hanalei, Waioli, Waipa, Waimea, Wailua and Hanapepe Valleys on Kauai; Windward Oahu; Waihee, Wailua, Keanae and Kahakuloa Valleys on Maui; Waipio Valley on Hawaii.

c. Kauai provides the key for the expansion of the wetland taro industry. There are lands currently available in Hanalei Valley which are suitable for taro production. The U.S. Fish and Wildlife Service has completed the irrigation project which has improved the water distribution system and opened up additional acres of taro land. The Hawaii Department of Land and Natural Resources repaired and maintains the water system in Waioli, and Hawaiian farmers have opened up some lo'i in Waipa.

d. On Oahu, high land prices, high lease costs and water shortages have discouraged large scale taro production. Upland taro production on former sugar lands, using traditionally wetland-grown varieties and others, has started to show the feasibility of expanding into this type of production for the poi market. While the relatively lower labor requirement of upland taro production will help encourage new taro farmers, it is still possible to expand wetland-cultivated areas as well.

e. On Maui, Keanae and Wailua will remain in taro production, along with newly rejuvenated lands in West Maui. The area under cultivation in both East and West Maui can be increased if more farmers obtain land and water, in many cases, with the help of Hawaiian support groups such as Alu Like. Expansion of taro lands in Keanae, and especially, Wailua requires improved watershed management and more efficient water delivery systems.

f. On Hawaii, land in the Hilo-Hamakua area is proving to be of sufficient quantity and quality for expansion of the industry. Waipio Valley also has an ample supply of unused land suitable for taro production.

g. Molokai has an abundance of land which may be used for taro production given the access to water resources.

h. Approximately 12 acres is an economically feasible and labor efficient farm unit for a full time family farming taro. With appropriate mechanization, 25 acres is a good economical unit for a full time farmer.

2. Bottlenecks:

a. Existing State and county policies do not adequately protect suitable taro lands from being bid away for private, municipal, commercial, industrial and military uses.

Overall priority <u>INDUSTRY-WIDE-5</u>

(1) Impact if this bottleneck is (is not) eliminated:

(a) If existing farm lands are not kept in production and if more lands are not made available, the industry cannot expand when and if the demand for taro and taro products increases. If a rational evaluation of taro lands can be completed, the State and counties will have

some of the information needed to establish proper land and water use policies.

(2) Action required and agency responsible for eliminating this bottleneck:

(a) Enforce State and county policies which protect the limited amount of lands suitable for taro production.

DLNR, DOA, LUC, County Planning Departments

(b) Compile information on former, current and potential taro producing areas from existing data sources.

DLNR, DOA, CTAHR, LUC, County Planning Departments, WRRC, Legislature

(c) Designate and protect taro lands as "unique agricultural lands" under LESA legislation.

DOA, Legislature

(d) Create taro parks on State land.

DOA, Legislature

B. WATER

1. Analysis:

a. On average, wetland taro requires approximately 0.2 inches (5,400 gallons) of new water per acre per day for growth. To this amount, additional water is required to compensate for seepage and evaporation from the paddy. Additional water is also needed to adequately cool the paddy. Water requirements are higher in the summer, and water requirements vary with location and farm. Studies show that the water temperature where Pythium rot grows the fastest is over 78°F, yet water that is too cold will retard growth.

b. Dryland taro requires a minimum of about 10,000-15,000 gallons of water per acre per day for optimal growth.

c. A study of the water availability and flood control requirements of major taro growing areas is needed.

d. On Kauai, many of the water leases are scheduled to expire soon. They involve sources which could be used for taro production.

e. Oahu farmers do not have enough water because their sources are being intercepted to provide domestic and irrigation water for other areas.

f. On Maui, the Wailua water delivery systems are clogged by sediments and debris, and are in generally poor condition, the Keanae system is somewhat better. Debris blocks the normal flow of water into the taro lo'i. More appropriate watershed management is need to reduce the amounts and effects of these materials. The 'auwai (irrigation ditches) need repair and clearing, or perhaps replacement. Almost all East Maui streams are de-watered for plantation agriculture and municipal supply, usually leaving less water available downstream for taro cultivation.

g. On Hawaii, the main problem of the Waipio Valley is flooding. The difficult road and poor accessibility of Waipio Valley is also a problem and is not conducive to the improvement of taro production on Hawaii. In the Hilo-Hamakua area water supplied by rain appears to be sufficient at times and other times too much rain makes it difficult to work in the fields.

h. The UH Department of Geography and Water Resources Research Center are currently involved with a number of projects which are related to taro water use. The goals of the projects include: 1) the monitoring of existing water use conditions in a variety of wetland taro cultivation systems; 2) estimating water requirements for wetland taro cultivation in any given area, and 3) quantifying the volume of water legally reserved to wetland taro cultivation in any given area.

i. The State Commission on Water Resource Management has directed its staff to make a survey of appurtenant water rights. This survey should shed light on lands where taro was grown at about the time of the 1848 Mahele. Currently, the project is in the planning stages.

j. The Office of State Planning is working on a State Geographic Information System. In the future this resource might be able to identify areas on where taro used to grow or is currently grown.

k. The Department of Water Resource Management is currently constructing a database based on information taken from the Water Use Declaration forms filled out in May 1989 (these forms need to be amended by October 1990). When complete the information will be able to identify some areas where water is currently being used to grow taro.

l. The Native Hawaiian Advisory Council (NHAC) is currently working with the same Water Use Declaration forms from over 800 people and has developed a database similar to that of the Department of Water Resource Management's. The NHAC database also identifies lands which may hold appurtenant and riparian water rights based on historical taro growing.

m. The State Survey Office, DLNR, has a wide variety of maps that give good detail of past lo'i and 'auwai locations. However, no catalog of the holdings is available making efficient searching somewhat difficult.

n. Records of historical water use from the Mahele can be found on microfilm in the UH Hamilton Library. The originals can be found at DLNR. Records of pre-Statehood water commission data is also found in the State archives.

o. Handy and Handy's works *The Hawaiian Planter* and the *Native Planters of Old Hawaii* give detailed information on many past taro growing areas.

p. The 1972 Islands of Hawaii -- State of Hawaii, USDA soil conservation service maps identify areas where soils suitable for taro growing are found and/or utilized.

q. The HNRIS system at the College of Tropical Agriculture could, among other possibilities, be used to identify areas suitable for taro cultivation.

r. There is a relationship between native and non-native Hawaii birds and wetland taro patches. Information on these relationships and water uses can be found in many publications including, Margaret Elliott's thesis *Wetlands and wetland vegetation of the Hawaiian Islands*, 1981; *An Ornithological Survey of Hawaiian Wetlands*, 1977 by Robert Shallenberger for the Army; *State Recreation Functional Plan: Technical Reference Document...: Wetland Resources Addendum*, 1988 by DLNR; and the U.S. Fish and Wildlife's *Master Plan Hawaiian Wetland NWR Complex*, 1983 document. There are also National Wetland Maps and Inventories at the U.S. Fish and Wildlife Service.

s. Other resources include: *Categorize, Cannibalize? Humanistic Quantification in Anthropological Research*, by Jocelyn Linnekin, American Anthropology, 89(4), 1987. This includes a database that can help to identify water and land use rights for taro cultivation that existed around the time of the Mahele (1848).

t. *A Taro Farmer's Guide to Water Rights in Hawaii*, by Dr. Williamson B. C. Chang, UH Law School, 1990, provide answers to a lot of water rights use questions.

2. Bottlenecks:

a. Less than optimum distribution and control of water (under- and over-supply) in the important taro production areas. Existing State and county policies don't adequately protect water sources for taro lands from being diverted or otherwise withheld from taro-producing areas.

Overall priority D-5, W-2

(1) Impact if this bottleneck is (is not) eliminated:

(a) An under-supply of water may hamper efforts to improve taro quality and yield or expansion efforts.

(b) Periodic floods and crop destruction can be reduced with appropriate flood control measures. Expanding existing areas of wetland cultivation is one such measure.

(c) Protection for water sources is essential to maintain present production. If more lands are made available, the water to service them must also be available.

(2) Action required and agency responsible for eliminating this bottleneck:

(a) Enforce water rights laws to provide sufficient water for taro-producing areas throughout the State. Coordinate water source protection in land use planning activities.

County Councils, County Planning Commissions, County Water Supply Departments, DLNR, Office of State Planning, LUC, Attorney General

(b) Develop a water system to provide sufficient water, especially in the summer, to allow Wailua and Keanae, Maui to improve and expand taro production.

County Councils, County Planning Commissions, Legislature, DLNR, Office of State Planning, WRRC, CTAHR, UH Geography

(c) Study the water distribution and control concerns of the important taro production areas so that the most important water-related bottlenecks can be specified and addressed for action. Maps of State land use districting, county zoning, and county community/development plans and amendments should identify, on the map itself, the amount of water allocated to various uses.

County Councils, County Planning Commissions, Legislature, DLNR, Office of State Planning, WRRC, CTAHR

(d) Identify and evaluate former, current, and potential water sources for taro production, including those recorded in the 1848 Mahele and those currently encumbered by water licenses.

County Councils, County Planning Commissions, Legislature, DLNR, Office of State Planning, WRRC, CTAHR

(e) Expand the planned DLNR survey of appurtenant water rights to identify more of the former taro lands (those not awarded by the Land Commission in 1850 aren't usually acknowledged to hold appurtenant water rights) and water, and to evaluate their present physical and institutional characteristics.

DLNR, Office of State Planning, OHA, DHHL, UH: CTAHR, WRRC, Geography, History, Hawaiian Studies

C. CAPITAL

1. Analysis:

   a. A new full time farmer would need working capital in order to start or a current farmer may need funding to expand. If land were purchased, this would be additional expense.

   b. Net income from taro production is usually near zero for the first two years and would not reach its potential until almost four years from the start.

   c. *"Sources of Agricultural Credit in Hawaii"*, Research Extension Series 067, by J. Halloran, P.S. Leung, and H. Marutani, is available from county extension agents. This 1986 publication reviews sources of credit and loan programs indicating requirements: purpose of loan, eligibility, veteran's preferences, terms, interest rates, and security.

2. Bottlenecks:

   a. The mechanisms to acquire start-up or expansion funding are limiting.

   Overall priority INDUSTRY-WIDE-6

   (1) Impact if this bottleneck is (is not) eliminated:

      (a) The industry may be closed to new farmers and expansion by existing farmers may be limited.

   (2) Action required and agency responsible for eliminating this bottleneck:

      (a) A comparative analysis of institutional loan systems should be performed and made readily available to clientele.

      (b) Joint ventures should be encouraged and supported.

      DOA, OHA, Alu Like,CTAHR, Industry, Lending Institutions

D. LABOR

1. Analysis:

   a. The taro industry needs an infusion of young people to insure a future for taro in Hawaii. New young farmers need practical training to adequately prepare them for taro farming.

   b. A shortage of affordable labor may be counteracted by mechanization of planting, harvesting, and cleaning procedures.

   c. The taro industry, as well as agriculture in general, has to compete for labor, and as more development takes place labor will become limiting. Better crop and business management by farmers is needed to insure maximum production will increase labor efficiency.

   d. The segment hardest hit by labor shortages is the small farmer.

   e. Pooling labor resources is one way to relieve labor shortages.

   f. Palauan woman are famous taro farmers. Some Palauans have been imported to work in other agricultural areas and in fast-food chains. Its possible that workers from this area would like to come to Hawaii to work in taro fields/patches.

2. Bottlenecks:

   a. Potential farmers are not receiving an adequate introduction into the business of taro growing.

   Overall priority INDUSTRY-WIDE-7

   (1) Impact if this bottleneck is (is not) eliminated:

      (a) Given present trends, the number of farmers could be drastically reduced in coming years, thus continuation and expansion of the industry are uncertain.

   (2) Action required and agency responsible for eliminating this bottleneck:

      (a) Some emphasis on farming should be included in school and prison curriculums.

      (b) Farmers need to pool resources.

      (c) The idea of importing labor should be investigated.

      DOA, OHA, Alu Like, DOE, Industry

E. CULTIVARS

1. Analysis:

   a. There are many different cultivars or varieties of taro available in various nurseries throughout the Pacific, Asia and Africa (at IITA).

   b. A relatively large number of taro varieties can be found in the following gardens: UH Kauai Agriculture Station (at least 130); Lyons Arboretum, Kanewai Cultural Garden, Waimea Arboretum-Oahu; Keanae Arboretum-Maui, and the Amy Greenwell Gardens -Hawaii.

   c. A comprehensive program to evaluate host resistance to diseases including Pythium soft rot, hard rot (guava seed), Phytophthora leaf blight under both upland and lowland conditions needs to be established.

   d. Efforts to find varieties with high yields is continuing. A breeding program to develop varieties with the specific qualities and characteristics which meet the demands of processors and market outlets needs to be established.

   e. Preliminary results from a College isozyme survey of an extensive collection of taro germplasm suggest that virtually all the taro cultivars in Polynesia and parts of Micronesia and Melanesia share the same, or very similar, genetic background. For breeding purposes, it may be possible to generate much more variable segregating populations by including germplasm from India and Indonesia in the breeding program, rather than exclusively inter-crossing closely related Polynesian materials.

   f. *Taro Varieties in Hawaii*, by Whitney, Bowers and Takahashi, UH Hawaii Agricultural Experiment Station Bulletin No. 84, 1939, is a good resource for those interested in taro varieties.

   g. A small grant by the Cook Foundation has been awarded to Dr. Isabella Abbott of UH-Botany so that she and others can catalog varieties of taro.

2. Bottlenecks:

   a. There is no comprehensive system to classify and index currently known varieties for disease and insect resistance, quality and yield.

   Overall priority D-3, W-3

   (1) Impact if this bottleneck is (is not) eliminated:

      (a) If improved varieties are developed or found, taro farming can be made more profitable. Farmers will enjoy higher yields and less loss to pests and diseases. The market for fresh and processed taro can be expanded if varieties with longer shelf life are available.

   (2) Action required and agency responsible for eliminating this bottleneck:

      (a) Establish a program to screen, classify, index and breed, taro varieties for yield, resistance to diseases and insects, acridity, optimal growth characteristics, starch content, and acceptability for fresh and processed markets.

      CTAHR, Industry

b. There is no breeding program to develop new varieties with qualities such as longer shelf life, better chipping recovery, etc. No program to develop a nursery system for taro to handle future expansion needs.

Overall priority INDUSTRY-WIDE-2

(1) Impact if this bottleneck is (is not) eliminated:

(a) If improved varieties are developed and produced, taro farming can be made more profitable. Farmers will enjoy higher yields and less loss to pests and diseases. The market for fresh and processed taro can be expanded if varieties with longer shelf life are available.

(2) Action required and agency responsible for eliminating this bottleneck:

(a) Establish a program to breed and cultivate taros for acceptability for fresh and processed markets.

(b) Encourage the development of huli nurseries on currently producing farms.

(c) Develop a State or College taro nursery along the lines of the existing seed bank.

CTAHR, Industry

F. INSECT and OTHER ANIMAL PEST CONTROL

1. Analysis:

   a. Root aphids are a major problem on dryland taro on the Island of Hawaii. Because of this, HRS, Title 4, Subtitle 6, Chapter 72, 4-72-8 of Plant and Non-domestic Animal Quarantine Plant Intrastate Rules, states that corms may not be transported off island unless they are for immediate processing only. Oxamyl™ is a possible candidate for chemical control for this pest, yet no chemicals are cleared at this time.

   b. Taro leafhopper (*Tarophagus proserpina*) is a serious taro pest but can be controlled with predators. Most of the farmers are satisfied with this control method. At times, it may be necessary to transfer or introduce the predators into leafhopper infested areas.

   c. There are no major uncontrollable insect pests of paddy taro at this time.

   d. Slugs are pests of dryland taros. The only molluscicide registered for use in cropping areas is Mesurol™, which is limited to non-bearing fruit trees and ornamentals, yet it is found in a bait form (*Urban Pest Press, Vol 1, No. 3, 1988, Slugs and Snails by J. Yates*). Non-chemical control methods also appear to be a method of slug and snail control.

   e. Grasshoppers are pests of dryland taros. Researchers at the Grasshopper Integrated Pest Management Program in Boise, Idaho are working on virus-based eradication systems for grasshoppers and encourage planting trap crops and using traps (*Organic Gardening*, 1989). Methomyl™ is a possible candidate for chemical control for this pest.

   f. Chinese rose beetle are pests of dryland taros. *CTAHR Cooperative Extension Bulletin No. 10* by David Marsden, gives some information on how to deal with Chinese or Fuller Rose Beetle. Methomyl™ and Oxamyl™ are possible candidates for chemical control for this pest.

   g. Crayfish and snails are pests of wetland taros. There are no pesticides registered for control of this pest. However, *Control of Nuisance Populations of Crayfish with Traps and Toxicants*, by Bills and Marking, *The Progressive Fish-Culturist* 50:103-106, 1988, provides some insight on crayfish removal by other means.

   h. Safer™ makes a non-specific insecticidal soap and Fairfield American makes Pyrenone Crop Spray™ which are cleared for use on taro. *See Appendix 2 for more information on cleared chemicals.*

   i. Introduction of new insects or animal pests from intra- or inter-state sources could have devastating effects upon the industry.

   j. The Department of Agriculture reviews SLN requests submitted by chemical manufactures or industry. Residue, phytotoxicity, and efficacy data to support the SLN are either generated by the manufacturer, CTAHR, or industry. Before a pesticide can be registered for use on a food crop a tolerance (legal amount of pesticide residue which may remain on the crop) must be established on that particular crop. Residue data must demonstrate that the proposed use pattern will result in residue levels well within the established tolerance.

2. Bottlenecks:

   a. Lack of effective biological, cultural and chemical controls for root aphids, slugs, snails, grasshoppers, Chinese rose beetle and crayfish which are pests in both dryland and wetland taro production.

Overall priority D-1, W-6

(1) Impact if this bottleneck is (is not) eliminated:

(a) Without effective control of insect and other animal pests on taro, production could be reduced by nearly 75% in some cases.

(2) Action required and agency responsible for eliminating this bottleneck:

(a) Identify effective biological, cultural and chemical methods for controlling root aphids.

CTAHR, DOA, Industry

(b) Identify effective biological, cultural and chemical methods for controlling snails and slugs.

CTAHR, DOA, Industry

(c) Identify effective biological, cultural and chemical methods for controlling grasshoppers.

CTAHR, DOA, Industry

(d) Identify effective biological, cultural and chemical methods for controlling crayfish (wetland only).

CTAHR, DOA, Industry

(e) Identify effective biological, cultural and chemical methods for controlling the Chinese rose beetle.

CTAHR, DOA, Industry

b. Lack of sufficiently enforced regulations on the movement of taro and soil.

Overall priority NOT PRIORITIZED

(1) Impact if this bottleneck is (is not) eliminated:

(a) Could have serious consequences for many small farmers as well as the industry State-wide.

(2) Action required and agency responsible for eliminating this bottleneck:

(a) Implement and more effectively enforce stricter restrictions on interisland movement of plant and soil materials

APHIS, DOA, Industry

(b) Implement and more effectively enforce stricter restrictions on movement of plant and soil materials

APHIS, DOA, Industry

G. DISEASE CONTROL

1. Analysis:

   a. Diseases which affect the corm are important in both wetland and dryland cultivation of taro.

   b. In wetland taro culture, the most serious corm diseases are Pythium soft rot and hard rot ("guava seed").

   c. The epidemiology of Pythium soft rot is not well understood. The environmental component of soft rot needs to be elucidated and incorporated into tests before the efficacy of fungicides may be reliably stated. Some varietal resistance to soft rot has been observed. Reduced pathogen populations may be expected by a dry fallow (at least 3 months) of the paddy between crop plantings and by careful selection of planting materials. Reduced infestation can be achieved by appropriate management of water and soil temperatures. A wet fallow is useless for pathogen reduction.

   d. Hard rot (guava seed) is of unknown etiology and epidemiology. Control of this disease is difficult to study because of inability to reproduce it on demand.

   e. The corm diseases of dryland taro, although not well defined as those of the wetland crop, include black rot (*Ceratostomella fimbriata* and *Endoconidiophora* sp.), Southern wilt (*Sclerotium rolfsii*), Pythium root and corm rots (*Pythium aphanidermatum, P. splendens, P. myriotylum, Pythium* spp.), bacterial/fungal/nematode rot and others.

   f. Epidemiology and etiology of root and corm rots in dryland taro cultivation are not well known. They have not been studied intensively. Since impact on aquatic flora and fauna are minimal, fungicide identification and registration in the dryland crop should be more expeditious.

   g. Foliar diseases of taro are sometimes devastating. Corm yield and quality could be negatively affected and leaf yield could be drastically reduced by leaf diseases. High rainfall areas, such as Windward sides of all islands, are vulnerable to great losses in a short time from diseases such as leaf blight (*Phytophthora colocasiae*) and leaf spot (*Phyllosticta colocasopphila*). This is due to the fact that water sits in the cup of the leaf for a long time and the disease is water borne.

   h. There is some abiotic leaf damage being reported as a result of volcanic ash settling on wet leaves.

   i. At the present time there are no chemicals cleared for foliar disease control. However, Redomil™ is a potential candidate. *See Appendix* 2.

   j. Virus diseases do not appear to be a problem at present. The quarantine on taro from the Solomon Islands and Papua New Guinea will reduce the chances of *alomae* and *bobone* from entering Hawaii. Dasheen mosaic virus is wide-spread in taro here. Yield loss resulting from dasheen mosaic virus infection of commercial cultivars is not known.

   k. The introduction of new diseases could have devastating effects on the industry.

   l. The Department of Agriculture reviews SLN requests submitted by chemical manufactures or industry. Residue, phytotoxicity, and efficacy data to support the SLN are either generated by the manufacturer, CTAHR, or industry. Before a pesticide can be registered for use on a food crop a tolerance (legal amount of pesticide residue which may remain on the crop) must be established on that particular crop. Residue data must demonstrate that the proposed use pattern will result in residue levels well within the established tolerance.

2. Bottlenecks:

a. Lack of sufficient integrated control measures (biological, cultural and chemical) to control diseases on wetland taros.

Overall priority INDUSTRY-WIDE-3

(1) Impact if this bottleneck is (is not) eliminated:

(a) Both growers and processors will continue to suffer from insufficient and poor quality product.

(2) Action required and agency responsible for eliminating this bottleneck:

(a) Determine host resistance, cultural, biological and chemical controls for soft rot, hard rot and other taro corm and root diseases.

CTAHR, Industry, UH Geography, WRRC,

(b) Study etiology and epidemiology of root and corm rots with emphasis on Pythium root and corm rot and hard rot.

CTAHR, Industry

(c) Determine the etiology of corm rots developed during transit and storage.

CTAHR, Industry

(d) Implement and more effectively enforce stricter restrictions on the interisland movement of plant and soil materials.

DOA, APHIS

(e) Determine the etiology and control of foliar diseases.

CTAHR, Industry

b. Potential danger of chemical build-up in taro products.

Overall priority *NOT PRIORITIZED*

(1) Impact if this bottleneck is (is not) eliminated:

(a) Consumers may be harmed by any accumulated chemicals and thus the market for corms and leaves and associated products would be affected by negative publicity.

(2) Action required and agency responsible for eliminating this bottleneck:

(a) Assist interested farmers in monitoring disease/management relationships. Establish protocols for data collection to maximize consistency between farmers, agents, and researchers.

CTAHR, DOA, Industry

(b) Monitor the accumulation of chemicals in taro plants.

CTAHR, DOA, Industry

(c) Enforce regulations on chemical usage. This includes effects of drift on taro crops.

CTAHR, DOA, Industry

H. WEED CONTROL

1. Analysis:

   a. Preplant cultivation and wetland preparation are effective weed control measures.

   b. Chemical control of weeds is possible, but no post-plant herbicide is registered at this time. The herbicide Goal ™ is very promising for dryland cultivated taros and will be an effective chemical for pre-plant weed control if properly applied. If it is applied improperly it may reduce yield of mature corms. *See Appendix* 2

   c. *Azolla* (is an aquatic fern which hosts a blue-green algae), a nitrogen fixer, is an effective weed control in wetland cultivation if introduced in appropriate amounts at the beginning of the crop cycle. Its effectiveness can be disturbed by the necessity for free circulation of water through and among lo'i.

   d. The introduction of new weed species should be avoided.

   e. Roundup ™ is a legal herbicide under dryland cultivation if applied no less than 30 days prior to planting. *See Appendix 2*

   f. No-till (no chemical) methods of weed control are available and can be taught effectively and efficiently using video media.

   g. Biodegradable plastic mulch paper is an effective weed control measure.

   h. The Department of Agriculture reviews SLN requests submitted by chemical manufactures or industry. Residue, phytotoxicity, and efficacy data to support the SLN are either generated by the manufacturer, CTAHR, or industry. Before a pesticide can be registered for use on a food crop a tolerance (legal amount of pesticide residue which may remain on the crop) must be established on that particular crop. Residue data must demonstrate that the proposed use pattern will result in residue levels well within the established tolerance.

2. Bottlenecks:

   a. Lack of effective control measures for weeds.

   Overall priority D-2, W-5

   (1) Impact if this bottleneck is (is not) eliminated:

      (a) Weed control is a major operation in taro production. The average cost of weed control amounts to 15 to 20 percent of the total cost of production. This cost increases with the increase in cost of labor.

(2) Action required and agency responsible for eliminating this bottleneck:

(a) Register herbicide for weed control in dryland and wetland taro production.

(b) Publicize the weed control possibilities of no-till farming and mulch management with video programs.

(c) Develop and publicize procedures for Azolla inoculation and management with video programs.

(d) Implement and more effectively enforce stricter restrictions on the interisland and international movement of plant and soil materials.

CTAHR, Industry, DOA

I. CULTURE and MANAGEMENT

1. Analysis:

a. Under optimal conditions it is possible to harvest one crop of Chinese taro every 9 months with a net yield of 40,000 lbs/acre/crop, and Lehua (Poi) taro every 12-14 months with a net yield of 48,000 lbs/acre/crop. Luau leaves can be produced at the rate of 15,000 lbs/acre/annually. Average yield for Chinese and poi taro is between 8,000 to 20,000, and 24,000 to 36,000 pounds per acre per crop, respectively. Luau leaf grows under both dry and wet cultivation conditions, with the latter condition allowing farms to harvest every 2 weeks or so.

b. Many farmers are satisfied with their current cultural practices. However, some farmers do not know what the optimum cultural practices are, and still others are unwilling to change from a less than efficient production system.

c. Optimum water management practices for wetland and dryland taro production are not well known. Optimum fertilizer practices (through the irrigation system or broadcast application) need to be determined as well as the effect of paddy flooding or drying on fertilizer uptake and use.

d. There are some who feel that large future expansion of the industry will occur on dryland because more of this type of land is available and it is easier to mechanize dryland taro production, thus production costs are reduced. Under ideal conditions, dryland and paddy taro yields are about the same on a per month basis.

e. Taro responds to fertilizer and lime applications well and the need to develop techniques of predicting nutrient needs through plant and soil analysis should be given serious considerations. Taro requires fairly high levels of calcium also.

f. Planting material such as huli, is saved from harvested corms. Hulis and planting-cormels should be selected for vigor and overall corm quality.

g. There is a limited availability of planting material which limits industry expansion. Some farmers will give away huli in exchange for help with harvesting and others will not give or sell their huli. Huli sells for between $0.10 - $1.00 depending on variety and island.

h. Most farmers don't know their cost of production.

2. Bottlenecks:

a. Optimum water management for wetland and dryland taro production are unknown.

Overall priority D-4, W-4

(1) Impact if this bottleneck is (is not) eliminated:

(a) If the water requirement of wetland and dryland taro are more accurately known, farmers can make more efficient use of the available water. These decisions can be facilitated with the collection of hard data concerning water requirements.

(2) Action required and agency responsible for eliminating this bottleneck:

(a) Determine the optimum water management for wetland taro production in paddies. Assist interested farmers in establishing stations for monitoring their own water use. Develop a protocol for this so that data is as consistent as possible.

CTAHR, WRRC, Industry

(b) Determine the optimum water requirement for dryland taro production. Assist interested farmers in establishing stations for monitoring their own water use. Develop a protocol for this so that data is as consistent as possible.

CTAHR, WRRC, Industry

b. Optimum fertilization and liming practices are unknown.

Overall priority INDUSTRY-WIDE-9

(1) Impact if this bottleneck is (is not) eliminated:

(a) If optimum fertilization and liming practices can be determined, some farmers will be able to increase their per acre production. Farmers who are over-fertilizing will be able to lower their cost of production.

(2) Action required and agency responsible for eliminating this bottleneck:

(a) Determine optimum fertilization and liming practices for wetland and dryland taro.

CTAHR, Industry

(b) Determine optimum or critical levels of nutrients in dryland and wetland taro tissue.

CTAHR, Industry

J. MECHANIZATION

1. Analysis:

   a. Planting, harvesting and washing machinery must be developed for dryland and wetland production. Several existing machines show promise, but some modifications are necessary.

   b. A small and easy to handle tractor for the harvesting machinery is needed.

   c. One Florida taro farm is fully mechanized and plants, harvests and packs production of 12-20 acres per day on a 400 acre farm with a crew of 6-8.

   d. Smith, M. R, and H. Shen have published *Pickup Mechanism for Harvesting Wetland Taro,* American Society of Agricultural Engineers Transactions, 1972.

2. Bottlenecks:

   a. Lack of machines that can be used in all taro production for planting, harvesting, and cleaning.

   Overall priority INDUSTRY-WIDE-1

   (1) Impact if this bottleneck is (is not) eliminated:

      (a) Many operations could be mechanized, thus leading to more productive labor and better management through operation scheduling if useful machines could be found or developed.

   (2) Action required and agency responsible for eliminating this bottleneck:

      (a) Evaluate and modify existing machines from the mainland and foreign countries.

      (b) Work closely with companies which specialize in the development of these types of machines.

      CTAHR, Industry

   b. Inaccessibility of lo'i to conventional machines and lack of sufficient traction in available machines for use in lo'i.

   Overall priority W-1

   (1) Impact if this bottleneck is (is not) eliminated:

      (a) Farmers would be able to use wider selection of tractors if the traction of existing tractors can be improved or the accessibility of the paddies can be improved.

(2) Action required and agency responsible for eliminating this bottleneck:

(a) Examine ways to improve traction of tractors and accessibility of paddies to existing machines. Evaluate and modify existing machines from the mainland and foreign countries and work closely with companies which specialize in the development of these types of machines.

CTAHR, Industry

(c) Develop new structural orientations for lo'i dikes which may facilitate the harvesting of corms from outside of the lo'i.

Industry, CTAHR

K. POST-HARVEST HANDLING and PROCESSING

1. Analysis:

   a. Corm losses after harvest depend on the time of the year and the area the corms came from. Dipping taros in a chlorinated solution after harvesting helps reduce infections.

   b. Corms can be stored for 3-4 weeks if they are refrigerated after they are allowed to dry. However, most farmers do not have a refrigerator. Corms can be stored for a lesser time if they are kept in a covered, cool, dry, well ventilated area.

   c. Surface transportation of all types of taro causes losses due to disease and dehydration.

   d. Refrigerated shipping would probably reduce transit and storage rots. The best temperature range for holding and shipping taro is from 45 - 52^{o} F. The cost benefit ratios of refrigerated shipping are not known.

   e. Localized poi processing can greatly reduce disease and dehydration losses in taro to be produced into poi.

   f. Buyers in Los Angeles have expressed an interest in having the tops of the taro left on and also to have the corms sized for home and restaurant markets.

   g. The use of boxes in place of bags may help reduce damage on taros.

   h. Some farmers and shippers either do not know proper handling techniques or are not applying them.

   i. The following are observations about Hawaii-grown Chinese taro in Los Angeles by buyers:

Positive Attributes	Negative Attributes	Marketer's Suggestions for Change
♦ Unique aroma		
♦ Good flavor		
♦ Some name recognition		
♦ Slightly better shelf-life than competitors	.....	See suggestion below for "Rotten corms"
	♦ Short weight bags	Pack a little extra to cover shrinkage
	♦ Rotten corms in shipment	Harvest <u>at most</u> 2 days before shipping, final wash corms in chlorinated water, let dry, keep corms cool (put in cooler 42-52 ^{o}F), export only quality uncut corms. Sort corms by size. Try boxes.
	♦ High price	Pool materials and manpower with other farmers to reduce costs
	♦ Inconsistent supply	Plan your production with your shipper so that you produce/sell all year
	♦ Not enough product definition ...	Develop promotional materials and advertise in ethnic media
	♦ Little nutritional data on products (especially fresh taro leaves)	Contact University nutritionists for data, look at store for examples

Source: Interviews with L.A. shippers by James Lee of May Produce and by Jim Hollyer.

2. Bottlenecks:

a. Disease and dehydration can cause expensive losses for taro producers.

Overall priority INDUSTRY-WIDE-4

(1) Impact if this bottleneck is (is not) eliminated:

(a) Losses of 50 to 100 percent occasionally occur during transportation of taro corms from the Neighbor Islands to Oahu. However, on average it is nearer to 10% by the time relatively good quality taros are off loaded from air containers on the Mainland. Better post-harvest handling and/or treatments can eliminate or reduce serious losses and deterioration of taro corms during shipment and storage. The U.S. Mainland market for taro corms cannot expand if better and proper handling techniques are not used to increase the shelf life and storage of taro corms from Hawaii.

(2) Action required and agency responsible for eliminating this bottleneck:

(a) Evaluate better post-harvest handling practices to reduce losses in transportation. For instance, determine the optimal temperature, packing methodologies and associated costs necessary for reducing losses.

CTAHR, DOA, Industry

(b) Investigate methods to increase post-harvest life of shipments from Hawaii to U.S. Mainland.

CTAHR, DOA, Industry

(c) Look more carefully at the overall implications of localized poi processing.

Industry, CTAHR

L. MARKETING, ECONOMICS and PROCESSING

1. Analysis:

   a. There is an even greater potential for exporting fresh taro corms to the Mainland. Specially designed export bags and bag tags are available to help increase product awareness.

   b. The market for taro used for non-traditional products, especially taro chips, have become strong and there seems to be lack of raw materials to keep up with the demand.

   c. Local processors and College researchers have developed taro products that require market testing.

   d. Some farmers are reluctant to tell processors how much and when they planted, thereby causing processing scheduling problems.

   e. Some farmers are reluctant to grade corms.

   f. Some farmers are reluctant to enter into forward contacts, thereby adding to the instability in the market.

   g. The fact that there are so few millers per island gives millers, in general, the ability to set farm gate price with some authority.

   h. Some poi millers are selling their product on the Mainland, which may have implications for local supply and prices.

   i. Many poi taros which are less susceptible to Pythium than Lehua are not well accepted by processors because the poi made from them is not what their customers are accustomed to.

   j. "Poi" made from Ulu or breadfruit is available at certain times of the year.

   k. Research on the technical/commercial qualities of taro is currently being done at the University.

   l. There may be certain cultivars of taro which are of significant taste-quality, but which are not put into commercial production for a variety of reasons including lack of huli and final consumer acceptance of the finished product.

   m. Poi is usually sold on consignment to retail outlets, which in times of a glut causes much to go to waste.

   n. *Cost and Return of Chinese Taro Production in the Hilo Area*, by PingSun Leung and Dwight Sato, in Proceedings of Taking Taro into the 1990's: a Taro Conference, 1990, Research Extension Series 114, provides some cost of production data.

   o. *U.S. Imports of Fruits and Vegetables Under Plant Quarantine Regulations*, by the USDA's Commodity Economics Division, provides import data on countries competing for the U.S. market. The annual, fiscal-year based document is published about 2-3 years behind.

2. Bottlenecks:

   a. Insufficient information on market potential and little coordination between producers and processors.

Overall priority INDUSTRY-WIDE-8

(1) Impact if this bottleneck is (is not) eliminated:

(a) Farmers may have problems in marketing taro during some periods of the year. Farmers may not be able to expand production without causing an over supply on the market during those periods.

(2) Action required and agency responsible for eliminating this bottleneck:

(a) A consumer test market study for new and current products, such as poi made from varieties other than *Lehua*, should be performed.. The study, could be coordinated by State and in conjunction with processors currently making taro-based products or those wishing to get into the business. An economic feasibility study would then follow if indicated. Finally, the processor can contract with farmers to grow the necessary taro for economically viable products.

CTAHR, DOA, Industry

M. INFORMATION DELIVERY SYSTEM

1. Analysis:

   a. Each island has at least one agent whose responsibility is taro production.

   b. There is a College newsletter, *The Taro Tattler*, which provides growers, shippers, and processors with timely information on a variety of topics. It is open to all who wish to contribute.

   c. Festivals centered around taro have taken place on Oahu in the past few years. They provide layperson and industry person alike with timely information.

   d. College publications and other media of recent note are found below and in Appendix 6.

   Taking Taro into the 1990's: A Taro Conference--The Video Tape, by Doug Hamasaki, Lisa Ferentinos, and Joe DeFrank, Department of Horticulture, 1990.
   Proceedings of Taking Taro into the 1990's: A Taro Conference, by James R. Hollyer and Dwight M. Sato, HITAHR Research Extension Series 114, 1990.
   Taro Economic Fact Sheet #1, by Kevin Yokoyama et al., Department of Agricultural and Resource Economics, 1989.
   Vegetable Crop Budget Template, Lotus 1-2-3 template and manual, by Cox et al., Research Extension Series 091, 1988.
   Upland Taro, by Ramon S. de la Peña, Hawaii Cooperative Extension Service, Home Garden Vegetable Series No. 18, 1978.
   Taro: A Review of Colocasia esculenta and its Potentials, edited by Jaw Kai Wang, 1983.
   Categorize, Cannibalize? Humanistic Quantification in Anthropological Research, by Jocelyn Linnekin, American Anthropology, 89(4), 1987. This is a data base that may help to identify water and land rights for taro that existed around the time of the Great Mahele (1848).
   A Bibliography of Kalo (Taro) in Hawaiian Culture, by Maile B. Davis, Zerox paper in Hamilton Library, 1986.
   A Taro Farmer's Guide to Water Rights in Hawaii, by Dr. Williamson B. C. Chang, UH Law School, 1990.

   e. A joint project by the Department of Agronomy and Soil Science and the Department of Agricultural and Resource Economics has produced a 3,300 citation bibliographic computer database for taro research. This database is scheduled for continuous biannual updates.

   f. Coconut Telegraph, CTAHR's computer bulletin board system (tel 956-0559), is being developed by Scott Campbell (956-6971). The system is accessible with computer modem and contains the *Taro Tattler* and the *Taro Economic Fact Sheet* among other items.

2. Bottlenecks:

   a. Lack of a long term funded information source.

   Overall priority <u>*NOT PRIORITIZED*</u>

   (1) Impact if this bottleneck is (is not) eliminated:

      (a) The industry will continue to develop in a haphazard fashion.

   (2) Action required and agency responsible for eliminating this bottleneck:

      (a) Keep industry apprised of current research activities through newsletters and meetings.

      <u>CTAHR, DOA, Industry</u>

APPENDIX 1

Table 7. Production and Marketing Data for Poi Taro only *

Hawaii Agricultural Statistics for Poi (Wetland) Taro ^

STATE-TOTAL

Year	Number of Farms	Acreage Harvested/ Marketed	Marketings 1,000 lbs	Avg. Marketed Production Per Acre	Farm Gate Price $/lb	Value of Sales $1000
1982		340			0.214	
1983		350			0.224	
1984		350			0.222	
1985		340	6,400	18,824	0.216	1,404
1986		330	5,800	17,576	0.222	1,282
1987		330	5,430	16,455	0.242	1,313
1988	75	310	5,700	18,387	0.258	1,471
1989	68	290	5,270	18,172	0.285	1,503

^ Survey conducted in Nov. of each year. Does not include acreage used primarily for leaf production.

HAWAII

Year	Number of Farms	Acreage Harvested/ Marketed	Marketings 1,000 lbs	Avg. Marketed Production Per Acre	Farm Gate Price $/lb	Value of Sales $1000
1982		45			0.224	
1983		45			0.225	
1984		45			0.234	
1985		35	620	17,714	0.234	145
1986		35	400	11,429	0.226	85
1987		45	470	10,444	0.238	112
1988	77	40	480	12,000	0.253	121
1989	75	35	450	12,857	0.270	122

KAUAI

Year	Number of Farms	Acreage Harvested/ Marketed	Marketings 1,000 lbs	Avg. Marketed Production Per Acre	Farm Gate Price $/lb	Value of Sales $1000
1982		210	4,304	20,495	0.223	972
1983		215	3,411	15,865	0.221	762
1984		225	4,310	19,156	0.211	918
1985		210	4,720	22,476	0.214	1,032
1986		215	4,450	20,698	0.224	1,010
1987		200	4,140	20,700	0.243	1,017
1988		190	4,410	23,211	0.261	1,155
1989		180	4,160	23,111	0.290	1,211

[2] Kauai combined with Maui, Molokai and Oahu to avoid disclosure of indiv. ops.
[3] Not shown separately but accounted for in State total.

MAUI/MOLOKAI/OAHU [4]

Year	Number of Farms	Acreage Harvested/ Marketed	Marketings 1,000 lbs	Avg. Marketed Production Per Acre	Farm Gate Price $/lb	Value of Sales $1000
1982					0.228	
1983					0.226	
1984					0.213	
1985		95	1,000	7,000	0.214	227
1986		80	910	9,000	0.210	187
1987		85	790	12,000	0.238	184
1988	18	80	810	10,125	0.246	195
1989	11	75	660	8,800	0.265	170

[4] Oahu combined with Maui and Molokai to avoid disclosure of ind. oper.

* Note: These figures were derived by subtracting known data found on the Chinese Taro table below from the data found in the Statistics of Hawaiian Agriculture for various years.

Table 8. Production and Marketing Data for Chinese Taro only *

Hawaii Agricultural Statistics for Chinese (Dryland) Taro ^

STATE-TOTAL

Year	Number of Farms	Acreage Harvested/ Marketed	Marketings 1,000 lbs	Avg. Marketed Production Per Acre	Farm Gate Price $/lb	Value of Sales $1000
1982		10			n/a	
1983		20			0.350	
1984		20			0.342	
1985		60	460	7,667	0.379	174
1986		60	530	8,833	0.339	180
1987		70	870	12,429	0.419	363
1988	80	110	1,100	10,000	0.394	433
1989	82	140	1,230	8,786	0.401	493

^ Survey conducted in Nov. of each year. Does not include acreage used primarily for leaf production.

HAWAII

Year	Number of Farms	Acreage Harvested/ Marketed	Marketings 1,000 lbs	Avg. Marketed Production Per Acre	Farm Gate Price $/lb	Value of Sales $1000
1982		10			n/a	
1983		20			0.35	
1984		20			0.342	
1985		50	390	7,800	0.372	145
1986		50	440	8,800	0.342	151
1987		65	810	12,462	0.42	340
1988	77	100	1,050	10,500	0.393	413
1989	75	130	1170	9,000	0.401	469

KAUAI

Year	Number of Farms	Acreage Harvested/ Marketed	Marketings 1,000 lbs	Avg. Marketed Production Per Acre	Farm Gate Price $/lb	Value of Sales $1000
1982		[2]			n/a	
1983		[2]			[2]	
1984		[2]			[2]	
1985		[2]			[2]	
1986		[2]			[2]	
1987		[2]			[2]	
1988		[2]			[2]	
1989		[2]			[2]	

[2] Kauai combined with Maui, Molokai and Oahu to avoid disclosure of indiv. ops.

MAUI/MOLOKAI/OAHU [4]

Year	Number of Farms	Acreage Harvested/ Marketed	Marketings 1,000 lbs	Avg. Marketed Production Per Acre	Farm Gate Price $/lb	Value of Sales $1000
1982		[6]			n/a	
1983		[6]			[3]	
1984		[6]			[3]	
1985		10	70	7,000	0.405	29
1986		10	90	9,000	0.323	29
1987		5	60	12,000	0.379	23
1988	3	10	50	5,000	0.404	20
1989	7	10	60	6,000	0.400	24

[3] Not shown separately but accounted for in State total.
[4] Oahu combined with Maui and Molokai to avoid disclosure of ind. oper.
[6] Less than 5 acres

* Source: Per. communication with HASS, 1989, 1990.

APPENDIX 2

Registered Pesticides for Use on Taro

Table 9. Registered Pesticides for Use on Taro for year ending 12/31/90 *

Group	Trade Name	Crop Cultivation Type or Area	Target Pest Organism	Manufacturer
Insecticide				
	Dipel Worm Killer	Dryland	Loopers	Abbott Labs.
	Dipel Worm Killer	Dryland	Other caterpillars	Abbott Labs.
	Pyrenone Crop Spray	Dryland	Insects (All, general)	Fairfield American
	Dipel Worm Killer	Wetland	Loopers	Abbott Labs.
	Dipel Worm Killer	Wetland	Other caterpillars	Abbott Labs.
	Dipel Worm Killer	Taro leaf	Loopers	Abbott Labs.
	Dipel Worm Killer	Taro leaf	Other caterpillars	Abbott Labs.
	Pyrenone Crop Spray	Taro leaf	Insects (All, general)	Fairfield American
	Insecticidal Soap for Fruits & Vegetables	Taro leaf	Insects (specific)	Safer
Herbicide				
	Roundup	Wetland (ditch banks and walkways only)	Other weeds	Monsanto

Note: * This list is only provided for general information and is not an endorsement, see labels of chemicals for correct usage. Information provided by College researchers Joe DeFrank and Cathy Tarutani, and Lance Kobashigawa of DOA.

Table 10. Chemicals Currently Under Investigation (I) or Pending Federal Registration (R)for time period after July 1, 1990 *

Group	Trade Name	Crop Cultivation Type or Area	Target Pest Organism	Manufacturer
Insecticide				
Herbicide				
	Gramoxone Super (R) (Paraquat)	Dryland	Weeds	ICI Americus
	Goal (R)	Dryland	Emerging weeds	Rohm Hass
	Terr-O-Gas67 (I)	Dryland	Weed seeds	Great Lakes Chemical

Note: * This list is only provided for general information and is not an endorsement, see labels of chemicals for correct usage. Information provided by CTAHR researcher Joe DeFrank.

APPENDIX 3

A Brief History of Taro in Hawaii

James R. Hollyer and I. Scott Campbell
College of Tropical Agriculture and Human Resources
University of Hawaii at Manoa

Before - Taro (originally from the Indo-Malaysian region) brought to Hawaii by first inhabitants.

1778 - Arrival of Captain Cook. Taro production techniques are considered sophisticated for their time. Foreign diseases and competitive barter economy affect taro production over the ensuing years. Crops other than taro are being grown to address foreigner-driven market desires.

1819 - Kapu system broken by Ka'ahumanu and Liholiho thus lessening restrictions on types of taro that can be eaten.

1848 - The Great Mahele causes the reallocation and disappearance of some taro patches.

1855 - 1882 - Sugar dominates Island's agriculture.

1861 - Rice goes into commercial production.

1870 - Chinese start competing with Hawaiians in growing taro.

1876 - 1882- Completion of Waihee, Hamakua and Spreckles ditches. Proves feasibility of large scale inter-basin water transfers.

1884 - King Kalakaua opens lands for homesteading, project not totally successful.

1885 - 1893 - Pineapple intensively introduced to diversify the Island's agricultural base.

1886 - King Kalakaua authorizes the payment of $20 to Alden Fruit & Taro Co. for each ton of taro flour exported. 1887 and 1891 some 4,230 and 5,100 pounds exported, respectively -- project loses money.

1900 - Chinese grow 50% and mill 80% of all taro. Started selecting high yielding/short cycle varieties. Establish poi shops to supply Hawaiians in cities and plantations.

1900 - Taro-Ena (taro flour) and Mi-O-Na (dried taro meal) marketed on Mainland with little success.

1920's - Taro Mano (a taro flour based product) is unsuccessfully introduced.

1937 - Japanese farmers become largest producers of taro.

1938 - Crayfish became agricultural menace of taro.

1938, 1941, 1943, 1946, 1950, 1959, 1967, 1979, 1988, 1990 - **POI SHORTAGES OCCUR**. Shortages have occurred throughout history especially in times of war, famine, tsunamis, and bad weather. Supply and demand cycles have also created "apparent" shortages.

1937 - HSPA sponsored Hawaiian Taro Products Company produces Tarolactin - a poi lactate paste (baby food) is available but is gone by the end of WWII. Taroco a milk bar drink is also tried.

1941 - Hawaiian Civic Club of Kauai planned to form a cooperative and sell poi in Honolulu.

1941 - First commercial taro chipping in Hilo.

1943 - Plan to have school boys work in taro patches to produce more taro.

1946 - 90% of factories close due to taro shortage.
1. Tidal wave destroyed acreage on Molokai and Big Island.
2. High price of transportation.
3. Shortage of available affordable labor.
4. Crayfish problems.

1946 - Governor Stainback orders 200 acres of prison land to go into taro production. Tractors are introduced to speed land preparation.

1948 - Plastic bags for poi introduced to replace muslin.

1950, 1959 - Flooding on all islands produced poor crop.

1952 - *Some Dietetic Factors Influencing the Market For Poi in Hawaii (with emphasis on a survey of the use of poi by the medical profession and allied institutions)*, Derstine and Rada, Ag. Econ. Bull No. 3 , 1952 released.

1958 - Honolulu Poi manufactures about 100 tons of taro "flour" (ground dehydrated poi).

1951 - 51 poi mills in operation.

1965 - TARO CONFERENCE. The Taro Conference, attenders include Gerber, Ralston Purina, Carnation, Pillsbury, Beatrice Foods, Mead Johnson Inter., Beechnut Lifesavers. Topics include Dr. Glaser's work with poi and infants. Proceedings 1967, UH Misc. Pub 35.

1967 - Planting timing poor, floods, fertilizer shortage, lack of available labor, urbanization land reduction.

1968 - TARO CONFERENCE - The Potential of Poi as a Baby and Health Food. A follow-up meeting to the 1965 conference. Proceedings 1969, UH Misc. Pub 54.

1980 - Taro root aphid discovered on Big Island, quarantine imposed.

1980 - CTAHR/GACC Taro Industry Analysis #1.

1982 - TARO CONFERENCE. Conference on Taro, jointly sponsored by DOE, CTAHR, OLG, OHA, OED at East-West Center. No proceedings.

1983 - Wang, J-K. Taro: A Review of *Colocasia esculenta* and its Potentials. University of Hawaii Press, Honolulu, HI, 1983 released.

1983 - CTAHR/GACC Taro Industry Analysis #2.

1986 - CTAHR/GACC Taro Industry Analysis #3.

1987 - State Water Use Commission puts new focus on taro water rights and use.

1988 - Taro supply low due to poor growing conditions.

1989 - AMFAC contacts Gerber but they have rice-based product for hypo-allergenic market. No need for taro.

1989 - TARO CONFERENCE - "Taking Taro into the 1990's: A Taro Conference." CTAHR, HDTA. Proceedings 1990, UH Research Extension Series 114.

1989 - Windward Community College and Waianae Taro Festivals.

1990 - CTAHR/GACC Taro Industry Analysis #4.

1990 - Windward Community College Taro Festival.

1990 - TARO SYMPOSIUM - "White Taro: Another Opportunity, Allergen-free Foods from Hawaii" DOA, CTAHR, DBED.

1990 - TARO CONFERENCE - Molokai.

Source: Advertiser and Star Bulletin. Hawaii's Crop Parade.
Portions after: Kubo, P. *The History of Taro and Taro Products in Hawaii*. University of Hawaii. (photocopy term paper for History 424); 1970. 45p.

The History of Poi as Seen Through the Pages of the *Honolulu Advertiser* and *Star Bulletin* 1930-mid 1990

POI
Poi manufacture S 11/22/30 p1 sec 2
Poi making today by mod means S 9/3/32 sect 3 p1
Less poi eaten S 7/15/33 p1 sec 3
Hawaii poi supper menu S 1/12/34 p9
May make poi for mainland S 5/7/35 p12
Wailua, Molokai, may relieve shortage S 7/15/35 p7
Hawns knew their poi, recalls 'Taro King', Lum Yip Kee, of monarchy days S 7/30/36 sect 3 p5
Poi's value stressed at sci acad meet S 11/17/39 p11
Dwight heads grp to probe shortage S 6/4/41 p1
Recommds to end shortage S 7/10/41 p13
Poi sit to be probed by Civic club S 7/31/42 p5
High poi cost to be studied A 8/1/42 p1
Price set at 12½ cents lb A 9/26/42 p2
Ruling on poi clarified S 10/7/42 p2
Gov asked to take action on shortage 6/28/43 p5

POI
Ceiling price set A 8/9/43 p5
Dillingham asks change in poi law S 9/21/43 p5
Shortage may be relieved by law change S 10/16/43 p2
Full time poi inspector voted S 11/24/43 p6
Poi question up before bd again S 5/27/44 p19
New taro crop may solve shortage S 5/30/44 p9
Sub-standard poi sold, warrant A 6/18/44 p7
Pub hearing on mosquito, poi control A 6/23/44 p9
Bd of health approves sub-standard poi S 6/23/44 p2
Tempest in a poi bowl at hearing A 7/7/44 p3
Sub-standard poi sale opposed S 7/7/44 p8
Poi bill deferred A 7/12/44 p4
Poi still poi, result of health bd rule A 7/21/44 p5
Bd of health won't adopt poi reg change S 7/21/44 p6
Poi bill tabled: standard enforced or Lui fired A 7/26/44 p5
Lui holding sack, empty A 8/4/44 p8
Stainback asked to make poi standard 26% solids A 8/30/44 p3
26% solid poi may be sold A 9/3/44 p12
City to legalize so-called substandard poi A 9/13/44 p2
Poi, dehydrated, good as baby food S 2/5/45 p3
Substandard poi used in restaurants A 2/23/45 p3
New prod preserves nutritional value A 8/7/45 p3
Will be almost extinct in 3 wks A 4/21/46 p2
Poi price not too low: OPA S 4/22/46 p1
Scarcity surprises govt offls A 4/23/46 p6
Hilo bids capital envoys do something A 4/24/46 p1
Kauai poi gone; OPA says in Hon S 4/25/46 p1
No substitute, says food expert S 4/25/46 p3
Mormon crop rotation solves valley's poi prob A 4/30/46 p8
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APPENDIX 4

Farm Gate Prices and Acreages for Poi and Chinese Taro

Year	POI TARO Farm Gate Price	Acres in Prod.	Marketed Production	Estimated Yield Per Acre Mkt'd Production	CHINESE TARO Farm Gate Price	Acres in Prod.	Marketed Production	Estimated Yield Per Acre Mkt'd Production
	$/lb		'000	'000	$/lb		'000	'000
1929*		772						
1936	n/a	1,440	n/a	n/a				
1937	n/a	1,330	n/a	n/a				
1938	n/a	1,180	n/a	n/a				
1939	n/a	1,150	n/a	n/a				
1940	n/a	1,050	n/a	n/a				
1941	0.030	920	n/a	n/a				
1942	n/a	890	n/a	n/a				
1943	0.035	1,042	n/a	n/a				
1944	0.035	910	15,435	17.0				
1945	0.035	857	16,150	18.8				
1946	0.049	812	11,480	14.1				
1947	0.064	930	12,615	13.6				
1948	0.049	1,015	14,195	14.0				
1949	0.031	944	13,900	14.7				
1950	0.045	874	11,740	13.4				
1951	0.058	870	11,830	13.6				
1952	0.045	830	11,640	14.0				
1953	0.038	740	11,120	15.0				
1954	0.038	630	10,825	17.2				
1955	0.050	600	9,560	15.9				
1956	0.051	640	10,345	16.2				
1957	0.049	620	10,285	16.6				
1958	0.051	590	9,565	16.2				
1959	0.058	610	10,200	16.7				
1960	0.061	510	9,675	19.0				
1961	0.060	490	9,690	19.8				
1962	0.057	500	10,055	20.1				
1963	0.060	480	9,640	20.1				
1964	0.061	470	9,275	19.7				
1965	0.060	440	9,480	21.5				
1966	0.062	400	8,990	22.5				
1967	0.071	400	8,155	20.4				
1968	0.074	420	9,140	21.8				
1969	0.078	420	8,605	20.5				
1970	0.086	470	8,555	18.2				
1971	0.089	480	8,840	18.4				
1972	0.084	460	9,020	19.6				
1973	0.094	460	8,478	18.4				
1974	0.102	460	8,835	19.2				
1975	0.112	465	7,592	16.3				
1976	0.121	460	7,350	16.0				
1977	0.127	470	7,870	16.7				
1978	0.134	450	7,680	17.1				
1979	0.164	405	6,640	16.4				
1980	0.200	320	6,400	20.0				
1981	0.214	340	6,100	17.9				
1982	0.224	340	6,460	19.0	n/a	10	n/a	n/a
1983	0.222	350	n/a	n/a	0.350	20	n/a	n/a
1984	0.214	350	n/a	n/a	0.342	20	n/a	n/a
1985	0.216	340	6,400	18.8	0.379	60	460	7.7
1986	0.222	330	5,800	17.6	0.339	60	530	8.8
1987	0.242	330	5,430	16.5	0.417	70	870	12.4
1988	0.258	310	5,700	18.4	0.394	110	1,100	10.0
1989	0.285	290	5,270	18.2	0.401	140	1,230	8.8

Source: **1929 data by Philipp, *Diversified Agriculture of Hawaii*, 1953.
1946 - 1967 Data by Paul Wallrabenstein, 2nd Taro Conference Proceedings
Acres 1936-45 are as of Jan 1; 1946-present annual average of monthly est.
1968 - present data from *Statistics of Hawaiian Agriculture*, HASS.
* Note estimated yield is calculated using what is marketed not produced.