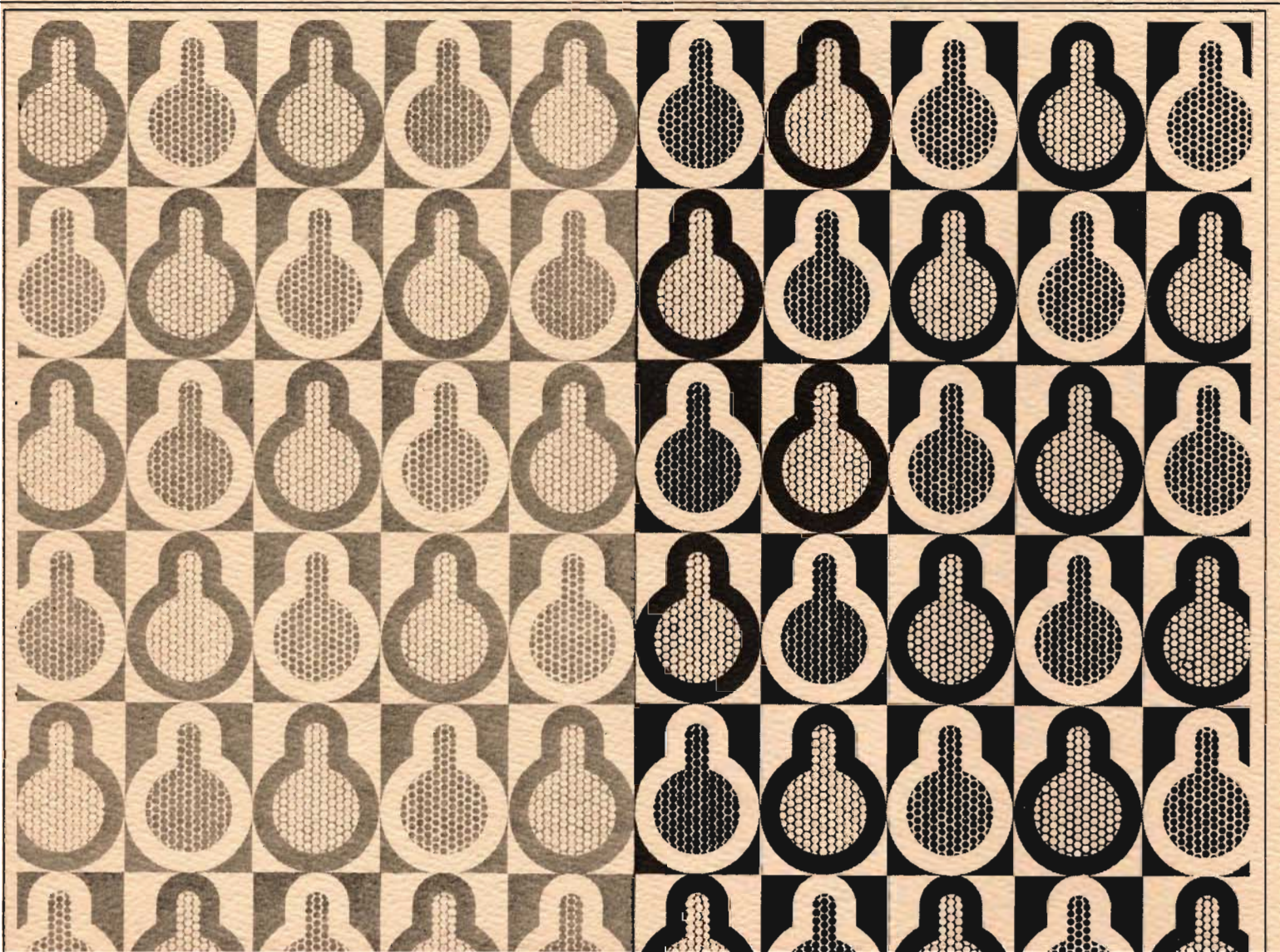
630 US ISSN 0271-9916 October 1987 RESEARCH EXTENSION SERIES 079

A METHOD OF ASSESSING NEW CROP POTENTIAL IN HAWAII

A Case Study of the Hawaiian Papaya Industry

Thomas A. Loudat, John C. Roecklein, and PingSun Leung

HITAHR • COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES • UNIVERSITY OF HAWAII



ACKNOWLEDGMENTS

The authors would like to acknowledge the individuals—retired and active—from the College of Tropical Agriculture and Human Resources, the Hawaii papaya industry, and the Hawaii Department of Agriculture who provided information for the historical overview and constructive criticism and comments about the treatise; Denise Loudat and friends for their support and encouragement; and Dr. B. Ray Horn, who proficiently edited the manuscript, making it clearer and more concise. In addition, we are grateful to Drs. L. J. Cox, P. V. Garrod, and P. F. Philipp of the Department of Agricultural and Resource Economics, who reviewed the document and provided many helpful suggestions. Mr. Robert Souza of the Papaya Administrative Committee and Dr. Ernest Akamine, emeritus professor of Plant Molecular Physiology at the University of Hawaii, also provided worthy advice. To all these individuals, we extend our heartfelt thanks.

AUTHORS

Thomas A. Loudat is an assistant professor in the Decision Sciences Department, College of Business Administration, University of Hawaii.

John C. Roecklein is a junior researcher, Department of Agricultural and Resource Economics, College of Tropical Agriculture and Human Resources, University of Hawaii.

PingSun Leung is an associate professor in the same department.

The Library of Congress has catalogued this serial publication as follows:

Research extension series / Hawaii Institute of Tropical Agriculture and Human Resources.—001-—[Honolulu, Hawaii]:
The Institute, [1980-
v. : ill. ; 22 cm.
Irregular.
Title from cover.
Separately catalogued and classified in LC before and including no. 044.
ISSN 0271-9916 = Research extension series - Hawaii Institute of Tropical Agriculture and Human Resources.
1. Agriculture—Hawaii—Collected works. 2. Agriculture—Research—Hawaii—Collected works. I. Hawaii Institute of Tropical Agriculture and Human Resources. II. Title: Research extension series - Hawaii Institute of Tropical Agriculture and Human Resources
S52.5.R47 630'.5—dc19 85-645281
AACR 2 MARC-S
Library of Congress [8506]

ERRATUM

On Page 27, the footnote should be preceded by a superscript 1 ([1]).

CONTENTS

Tables

Figures

A METHOD OF ASSESSING NEW CROP POTENTIAL IN HAWAII

Thomas A. Loudat, John C. Roecklein, and PingSun Leung

ABSTRACT

Soil and Land Use Technology, Inc. (SaLUT) formulated an analytical model, the production-marketing-consumption (PMC) decision matrix, that was found useful in assessing new crop development potential. This model was applied to the Hawaiian papaya industry to determine if a correspondence exists between the model's components and those involved in the development of the Hawaiian papaya industry. SaLUT's components were involved in the historical development of the Hawaiian papaya industry.

Further analysis showed that PMC components could be classified into three groups based on their importance to papaya development. The most important component combination was land and cultivar. The relationship between the tourism and papaya industries was important to development.

Results indicate that the SaLUT model is relevant for evaluating new crops in Hawaii. In using the model, it may be appropriate to address PMC components hierarchically, since, in the case of papaya, some components were rated more important than others. These components did not exist before the industry evolved and could not be borrowed from other PMC crop systems.

Keywords: Hawaii, papaya, crop development, crop assessment, SaLUT.

INTRODUCTION

Soil and Land Use Technology, Inc. (SaLUT)[1] developed an analytical model found to be useful in new crop studies to organize and evaluate information, diagnose the status of the production-marketing-consumption (PMC) system development process, and identify constraints to further development. Used with the Delphi technique, it was an effective instrument for information collection and synthesis from a wide range of experts. (SaLUT 1981).

The analytical model, called the decision matrix or the PMC system matrix, is considered to be applicable to any crop introduction and PMC establishment process. The matrix lists the components and interrelationships that move a crop and/or its products from production to consumption, identifying inputs, functions, and elements needed to assess the current and future status of a specific PMC system (Figure 1).

Each component in the PMC model is evaluated as to physical possibility, economic feasibility, and institutional permissibility. If the decision matrix indicates that it is physically possible to perform the function required, then the component is evaluated in terms of economic feasibility and institutional permissibility. The former requires that the function be performed as profitably for the new crop as for other uses to which resources can be put. The latter requires that neither legal nor sociological obstacles hinder the component's establishment (SaLUT 1981). A crop with no problem areas or bottlenecks is a crop for which each of the components is physically possible, economically feasible, and institutionally permissible.

Fifty crop categories, excluding sugar and pineapples, are important enough to have been published in "Statistics of Hawaiian Agriculture" in 1984 (ACLRS). The degree of development of and trade in these crops varies significantly. Some are local crops filling a distinct local market niche. Others are well-defined as industries.

For purposes of this study, a crop industry in Hawaii exists when activity or trade in a specific crop:

1. Has publicly known production, processing, and marketing principles.
2. Attracts workers or institutions full-time.
3. Consistently produces for local and export markets.
4. Has a significant effect on the local economy.

Item 1 means that the crop is interesting enough to have stimulated the use of public monies for basic and applied research and for promotion and development of the crop. Items 2 and 3 mean that the crop is of sufficient scale and level of operation to attract full-time participants, private as well as public, to produce, process, and market the commodity and provide institutional support. Item 4 means that the particular crop is important enough to the local economy that public institutions would assist the crop industry in a crisis. That is, the loss of the industry could affect the local economy.

---

[1]SaLUT is a company specializing in the development of soil and land-use technology. The firm conducted research under NSF Contract No. AFR 77-19462.

Papayas have recently evolved to "industry" status in Hawaii. Papaya production is about 75 percent of the value of all fruit crops, except pineapple, and 6 percent of the value of all agricultural crops grown in Hawaii, except sugar and pineapple (ACLRS 1983). Figure 2 shows the growth of the industry. Components influencing this growth have never been delineated. Identifying them will help policymakers understand and thus influence crop development.

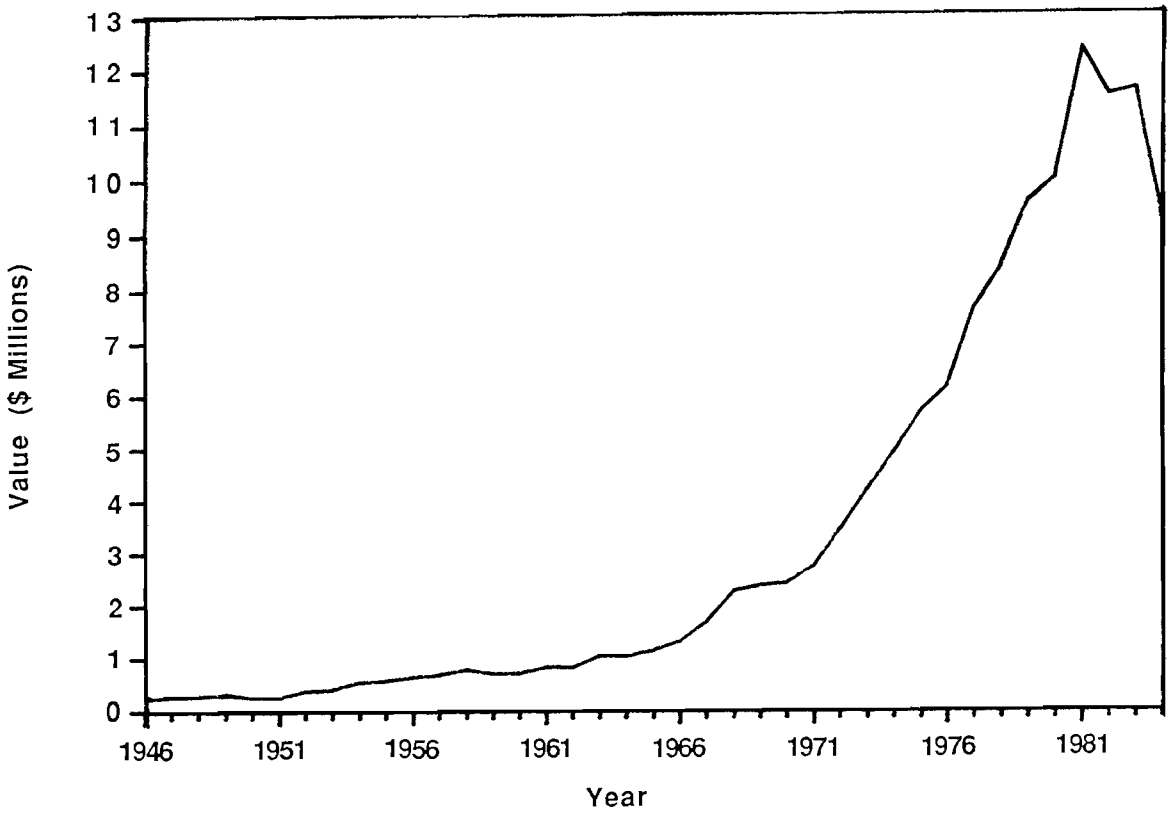
A correspondence may exist between the SaLUT components and papaya's actual development. A correspondence would help identify components involved in papaya development and validate the SaLUT model for assessing crop development and new crop alternatives in Hawaii.

Code	Component Description	
P 1	Land & water resources	Production Subsystem
P 2	Production financing	
P 3	Pest control	
P 4	Seed availability	
P 5	Fertilizer needs	
P 6	Input procurement	
P 7	Farmer's risk-taking	
P 8	Farm machinery needs	
P 9	Farm energy requirements	
P 10	Input information	
P 11	Government services & regulation	
P 12	Ag research programs	
P 13	Ag information programs	
P 14	Crop organizations	
P 15	Farm labor needs	
P 16	Market info for farmer	
Ma 1	Procurement resources	Procurement
Ma 2	Dependable supply	
Ma 3	Procurement financing	
Ma 4	Government services & regulation	
Ma 5	Market intelligence	
Ma 6	Transport & storage	
Mb 1	Processing resources	Processing
Mb 2	Processing equipment	
Mb 3	Commodity institutions	
Mb 4	Processing energy	
Mb 5	Processing research	
Mb 6	Processing info programs	
Mb 7	Processing byproducts	
Mb 8	Managerial ability	
Mc 1	Distribution resources	Distribution
Mc 2	Distribution financing	
Mc 3	Product market information	
Mc 4	Product transportation	
Mc 5	Market research & development	
Mc 6	Government services and regulation	
C 1	Market penetration	Consumption Subsystem
C 2	Market size	
C 3	Consumer awareness	
C 4	Product versatility	

Marketing Subsystem

Source: SaLUT, 1981.

Figure 1. The PMC system matrix.



Source: Statistics of Hawaiian Agriculture 1984.

Figure 2. Value of papaya production, by year.

Objective

The primary objective of this study is to determine if use of the SaLUT PMC system is valid to assess new crop potential in Hawaii. To accomplish this, the history of the papaya industry is reviewed to identify major technical and economic milestones. Once reviewed, the system is applied to assess how the model fits actual papaya development. As all of the components for a successful PMC system have been developed and many have been implemented, it is inappropriate to assess each in terms of physical possibilities, economic feasibility, and institutional permissibility originally designated by SaLUT. Rather, the role played by each component and its importance to papaya development are discussed.

Method

Data acquisition is difficult, as published information dealing with papaya development *per se* is limited. In addition, no important events or components—or their roles or importance to development—are identified. Fortunately, several individuals have information about the history of Hawaii papayas, and such information can be gained from them.

In this situation, personal interviews are a useful way to collect and synthesize data. For the study, interviewing consisted of one set of primary personal contacts using an unstructured survey with feedback. Questions were formulated to stimulate discussion about the history of Hawaii's papaya industry (Appendix A). The feedback provision allowed additional telephone contacts to clarify or correct information not corroborated by other respondents. The historical overview by the respondents was reviewed for accuracy as a final information verification and synthesis. Supplementary information was obtained from the Hawaii Papaya Industry Association (HPIA) Annual Proceedings, from records maintained by the Papaya Administrative Committee (PAC), and from unpublished manuscripts.

The first section identifies the major historical events of the Hawaii papaya industry. The second maps those events into the PMC model. The model helps identify components affecting papaya industry development. The role played by each component is addressed and its importance identified and rated. Component ratings are based on comments of the respondents and analysis of information from HPIA

proceedings. Components requiring considerable attention to resolve issues related to their development or implementation—or specifically designated by respondents as "critical" or "most important"—are given the higher ratings.

The rankings are "significant," "important," and "other." "Significant" components are those that were problem areas or bottlenecks to industry development. Each prevented, or was required as a stimulus to promote, industry development. That is, their lack was a limiting factor or they were "critical" issues requiring resolution for development to proceed. The lack of the right combination of land and cultivar was an industry bottleneck. Market size was a necessary stimulus to industry development. These three components were "significant."

"Important" components were significant to papaya development but not as critical as the first group. "Important" components were neither bottlenecks nor stimulants to development. Such components were readily created, already existed, or could be borrowed from existent PMC systems. Production, procurement, and distribution financing are examples.

"Other" factors were components necessary for papaya development but not "significant" or "important" as described above. Almost always they were components not explicitly identified by information sources. Input procurement is an example: it has never been an issue but was most certainly a necessary requirement for papaya development.

In the final section, the degree of fit between actual papaya development in Hawaii and the PMC model is analyzed, and the model's validity is evaluated.

The effectiveness of the interview process in obtaining information depends upon analyst objectivity in processing the data and upon the willingness of experts to participate. Time and budget constraints limited the expert panel size, although more voiced an interest in participating. The resulting information is thought an accurate outline of major historical events of papaya industry development.

HISTORICAL OVERVIEW

This is a review of major technical and economic milestones during major periods of Hawaii's papaya development. It is not intended as a detailed, all-inclusive history of papaya.

1900–1925

Papaya was not a popular fruit in the islands at the turn of the century. The prevalent notion was that "it was a fruit fit only for hogs" (Crawford 1932). Interest in the fruit developed on the Mainland, however, which caused people in Hawaii to add it to their diet. Local consumption began to increase greatly (Crawford, 1932). Most production was from backyard operations, although there was some commercial production to supply the Honolulu market. The production marketed in Honolulu was primarily by street vendors (Nakasone interview).

The Hawaii Agricultural Experiment Station (HAES), under the supervision of the U. S. Department of Agriculture, began research in 1902 in response to commercial producers (Nakasone 1985; Chia 1985). Early studies included experimental papaya shipments to the Mainland and breeding experiments. The experimental shipments ended in 1914, when quarantine regulations were imposed on mainland-bound fruit shipments to stop the Mediterranean fruit fly *(Ceratitis capitata)* and the melon fly *(Dacus cucurbitae)*. This was the first major bottleneck to the development process. It stimulated research to eradicate the fruit fly larvae. This research continues.

A major event in 1911 was the chance finding of Solo seeds in Barbados (Chia, 1985). These seeds were brought to Hawaii and provided the genetic stock for all commercially important papaya cultivars here.

1926–1949

This was a period of successful experiment on production, processing, and exporting problems. The foundation was laid for the rapid development that was to come during the next two decades.

The field of papaya genetics was investigated by University of Hawaii researchers. This led to the breeding of various cultivars for commercial use. Studies by W. B. Storey of the genetics of sex inheritance revealed that a plant always produces female and hermaphrodite plants in a 1:2 ratio. This knowledge yielded the cultural practice of planting at least three seedlings per hole to obtain one hermaphrodite (Nakasone interview). This practice continues today.

A major production event occurred with the selection of the 'Kapoho' Solo by Hanichi Masumoto, a Hilo farmer interested in producing papayas commercially. Existing strains were considered unsuitable for the island of Hawaii, as they did not have desirable characteristics when grown there (C. Lyman interview). Consequently, papaya growing was not encouraged on the Big Island. Masumoto, however, was not to be deterred. He obtained seeds from the local extension agent and from his daughter in Honolulu. From his plantings he selected what is now known as the 'Kapoho' Solo (Higaki and C. Lyman interviews). This is the most important and successful cultivar to date, particularly for the export market (Akamine, Higaki, Nakasone, and Souza interviews).

Major breakthroughs also occurred in pro-

cessing and exporting. In 1935, the vapor heat treatment for insect disinfestation, already used outside the state on other fruits and vegetables, was found to be effective for papaya fruit fly (Chia 1985; Akamine interview). In 1938, experimental shipment of Hawaiian papayas—now vapor-heat-treated—was resumed. This stimulated widespread recognition of papaya as a commercial crop with export potential (Chia 1985; Crawford 1937). The early 1940s saw the first commercial shipment of papayas to the Mainland. This led to test marketings on the Mainland and research on papaya export potential, funded by the territorial government in the late 1940s (Akamine interview).

In 1940, methyl bromide was approved as an effective treatment for fruit fly (Chia 1985). In 1951, ethylene dibromide (EDB) was approved (Nakasone interview). Thus, by midcentury, three treatments for the major bottleneck to exportation, fruit fly infestation of papayas, were approved. EDB became the exclusive fumigation treatment for papayas, and its use was a prime factor in the development of the papaya industry. This was because methyl bromide injured the fruit during fumigation (Akamine interview) and because EDB was cheaper to apply than the vapor heat treatment (Nakasone interview). Also, vapor-heat-treated papayas could be half-green on the outside but ripe within (Nakasone interview).

Two other events during this period indicate the increasing commercial interest in papaya. In 1942, the HAES began to collect statistics on market unloads and prices, and in 1945 began to collect production, acreage, and value statistics. The Hawaii Department of Agriculture joined this effort in 1962, in conjunction with the U. S. Department of Agriculture (Omori interview). These statistics are used extensively by the industry.

1950–1959

Several events early in this period significantly altered development. On Oahu—the primary production center up to this time—demand increased for nonagricultural uses of land. This fact, coupled with the emergence of the ring spot (mosaic) virus, eliminated the possibility that this island would be the major producer of papaya (Chia 1985; Souza interview). At the same time, the feasibility of growing crops such as papaya on a'a lava fields in Puna (i.e., rock farming) was demonstrated. Lava lands, which had no other use, were made available to farmers in the Puna district by individuals interested in seeing this land developed (Hayashi, R. Lyman interviews). University and experiment station personnel did not perceive rock farming as a viable method at this time, so these same individuals had to develop the rock farming techniques (R. Lyman interview).

With large tracts of land available on the Big Island, the papaya production center began to shift there from Oahu. The first large commercial planting on Hawaii (100 acres) occurred about 1955 (Hayashi interview) using 'Kapoho' Solo seed obtained from Masumoto (Hayashi, Huananio, C. Lyman, Nakasone interviews). Development was rapid. By 1957, the Big Island was the center of statewide papaya production. This development was due in part to the 'Kapoho' Solo cultivar's desirable characteristics for export.

Another significant event in production was the design of a harvesting aid by Mr. Komatsu, a papaya laborer on the Big Island. The device, a plumber's helper attached to the end of a pole, allowed the harvesting of papayas beyond reach without damaging the fruit. Interestingly, the designing of this device was motivated by a cash incentive to find such an aid, offered by Komatsu's employer (Hayashi, Huananio interviews). The plumber's helper became the most widely used harvesting aid in the state. It is the most important piece of specialized harvesting equipment to date.

The value of surface shipments of papayas to the Mainland exceeded $1 million by 1956. With increased Mainland papaya shipments came increased shipping problems. As noted, EDB had become the most widespread fumigation treatment, supplanting the vapor heat treatment. Mainland-shipped papayas treated with EDB, however, were more susceptible to storage decay than vapor-treated papayas (Akamine, Nakasone interviews). This problem was much more significant in winter. The apparent reason was that in-field chemicals used for disease control were washed off during these months of increased rainfall. The approval of EDB as a fruit fly treatment occurred during the summer months. Thus, this potential problem was not originally noted (Akamine interview).

A post-harvest treatment for the storage decay problem for EDB-treated fruit was formulated by UH researchers at this time. This was the hot water dip treatment. It was not used as an export treatment with EDB until 10 years later, for reasons treated below (Akamine interview).

Transportation problems also existed. Loading and unloading of papayas on interisland ships was difficult and inefficient. Also, Matson had only one regularly scheduled Mainland-bound liner (Hayashi interview). These problems stimulated efforts to work out details for air shipment to the Mainland by Big Island shippers (HPIA 1965). Their efforts culminated in the first such shipment (Higaki interview).

Two other major events occurred during this decade. The first was in 1950, when quality standards were specified for papayas by the Hawaii Department of Agriculture. These standards have been consistently applied and have not changed appreciably over time (Chia 1985; Murashige interview). The second event, in 1959, was the startup of a promotional program for papayas by the state via the Department of Planning and Economic Development (DPED) (PAC Promotional Program records). This program is detailed in Appendix B.

1960–1969

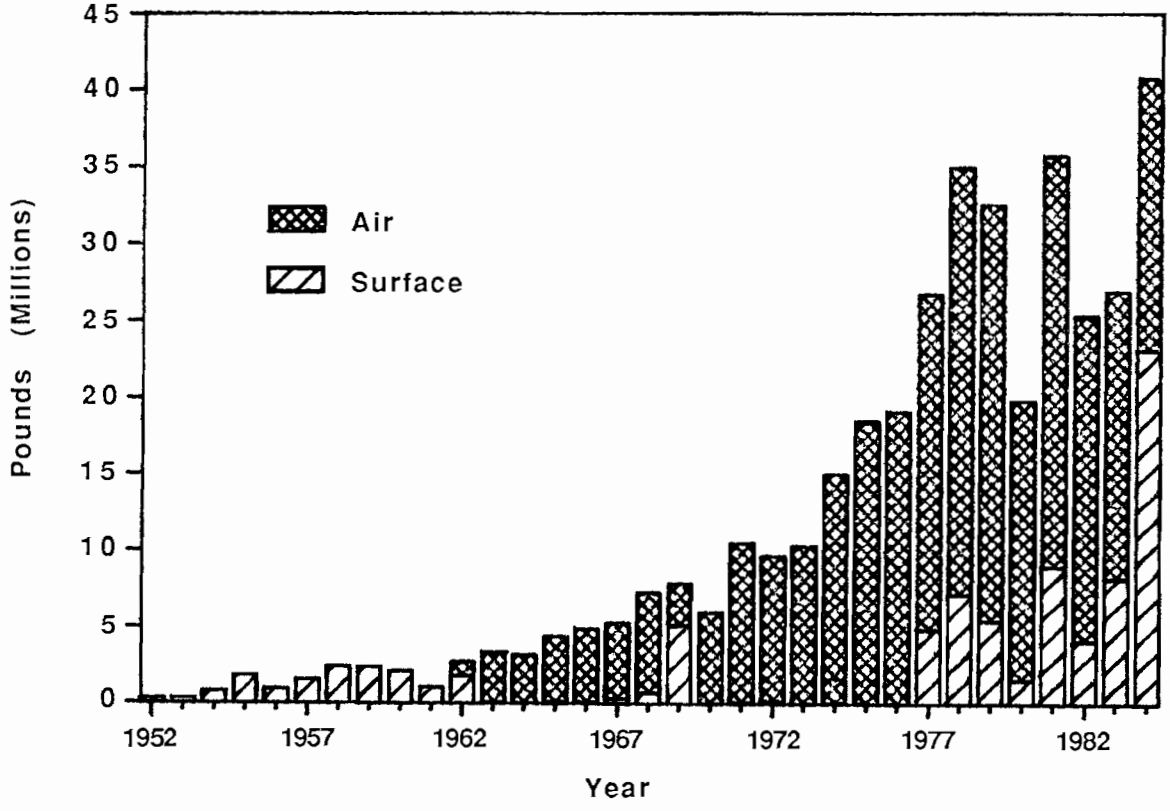
From 1960 to 1969, the focus was on transportation, the major development bottleneck in this period. The first air shipment of papayas to the Mainland at the beginning of this decade in large part removed this bottleneck. Air shipment provided a fast, efficient means of moving highly perishable papayas to export markets. This ensured the successful distribution of increasing volumes of Big Island papaya production (Akamine, Yamabe interviews). Air shipment has been the main transportation mode for papayas since shortly after it began (Figure 3).

Big Island production was sent to the Mainland via Oahu for air shipment. This required solving temperature and air circulation problems in papaya containers. Young Brothers interisland shipping company worked with industry persons to find solutions (HPIA 1965).

In 1967, the first direct Hilo-to-Mainland flights were inaugurated to accommodate tourist travel (HPIA 1967). By 1969, six airlines had direct flights from Hilo to the Mainland (HPIA 1969).

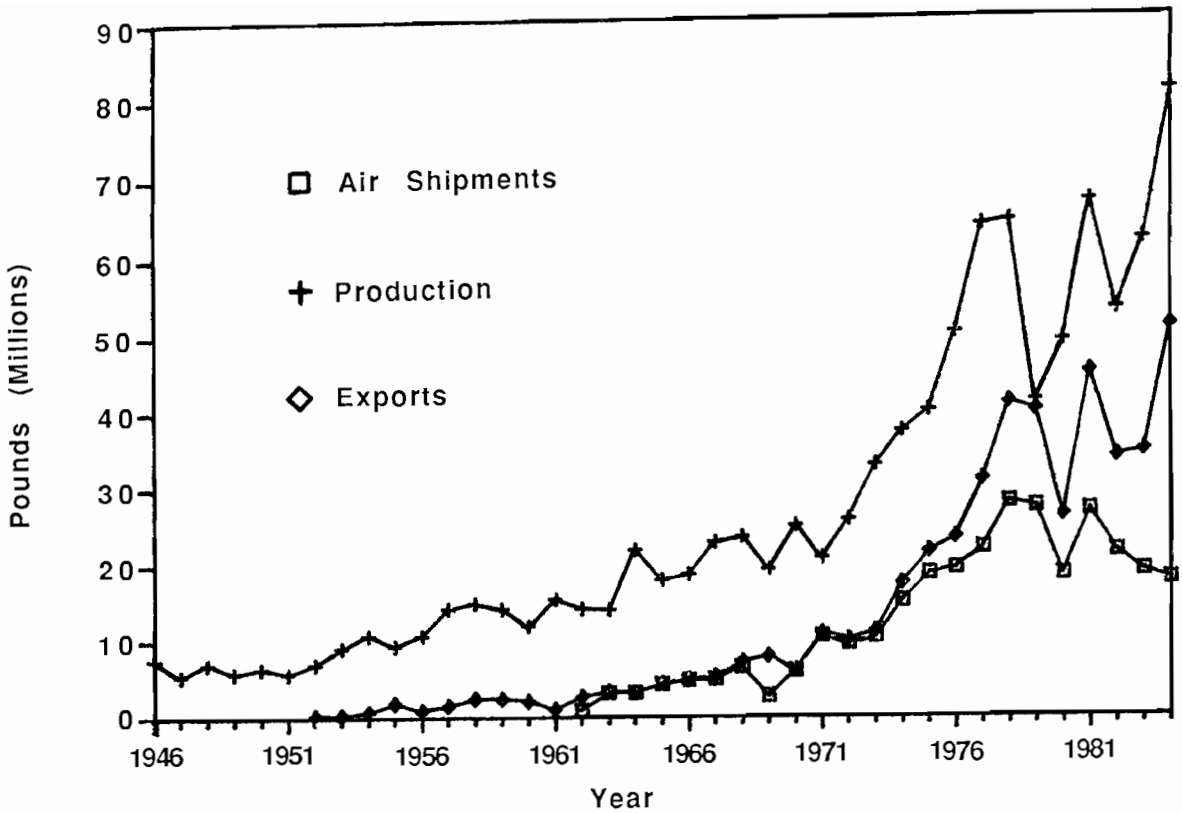
Significant quantities of papayas were air-shipped direct from Hilo to mainland markets. This direct air service is considered particularly important to papaya market development. In total, as air shipment increased, so did papaya production and export (Figure 4). Neither production nor export showed any significant gain before air shipment began. Air shipment also enabled the opening of the Japanese market, with preparations starting in 1968 and shipments beginning in 1969 (HPIA 1969).

Garrod (1984) maintains that air freight services were and are a byproduct of the tourist industry. Airline carriers use wide-bodied jets to handle the tourist volume. Cargo capacity on



Source: Statistics of Hawaiian Agriculture 1984.

Figure 3. Papaya shipment by mode, by year.



Source: Statistics of Hawaiian Agriculture 1983.

Figure 4. Papaya air shipments, production, and exports, by year.

such planes exceeds luggage requirements, allowing the airlines to sell the excess space to businesses serving their Hawaiian markets. Demand for cargo space on the return trip is not as great, resulting in a price that is less than average shipping cost. The tourist industry thus indirectly subsidizes papaya exports. Although airline cargo capacity has been insufficient to accommodate all export flows, this subsidy has been an important stimulus to industry development.

In 1969, fruit bruising caused by packing papayas in wooden crates brought the industry to formally identify the need for a sturdy one-way container. By the end of the decade, a one-way box was in use, providing a standardized shipping container for the first time (HPIA 1969).

The State of Hawaii began to help finance the papaya industry through an agricultural loan program during this decade. This program had begun in 1919 and was overhauled in 1959 (see Hawaii Revised Statutes Chapter 155). At this time, growers began to borrow money. The program's purpose was to fill any gaps in the federal loan program and in the private financial market for producers in Hawaii. Essentially, it established the state as "lender of last resort" for the agricultural sector. Growers are expected ultimately to secure other financing once they establish their production and markets. In terms of these criteria, the state loan program has been successful only on the Big Island. On all other islands, growers have not been able to secure other funding (Morimoto interview).

The HPIA, a product of the UH extension program, is a trade organization formed in 1965. Its primary purpose is to provide a forum for interaction among members of the industry, the university, and support industries. Growers voice concerns and problems at annual meetings, after which the organization approaches appropriate persons for action. Those attending meetings can also obtain latest research results and other information related to papayas.

A secondary purpose was to facilitate the formation of a statewide papaya marketing cooperative (Ishida interview). This was not achieved. The HPIA was instrumental, however, in drawing up the papaya marketing order, getting it passed by the legislature, and seeing it put into use (HPIA 1967–1970; Ishida interview). The order provided the means by which the industry could act in concert to control the quality and flow of product to markets. Before the marketing order was passed, the HPIA Marketing Committee addressed many of the issues surrounding marketing orders for HPIA members (HPIA 1968, 1969).

The communication process set in motion by the HPIA also resulted in the first papaya industry publication. This was the annual *HPIA Proceedings*, which is circulated within the trade and to interested individuals. It is funded by the Cooperative Extension Service (CES).

The promotional program to develop mainland markets also evolved significantly during this period, under DPED direction. Money spent for promotion rose from $12,000 to more than $100,000 over the decade (Morimoto interview).

Another program initiated in 1969 by the UH College of Tropical Agriculture was the Commodity Task Force for papayas. This program was a response to a legislative mandate for industrywide planning. Its purpose was to have UH and industry persons identify problems and set priorities to ensure that university and other funds or programs for papaya research were used most effectively. In essence, the task force was responsible for papaya research planning and development (Kefford interview). This program is now known as the Agricultural Industry Analysis for Papayas. The industry has put it to much greater use for planning than have other commodity groups with similar programs.

Other marketing problems appeared during this period. In 1963 the Food and Drug Administration (FDA) banned chemicals used in-field to control storage rot in shipped papayas. Fortunately, the hot water dip post-harvest treatment developed in 1952 by UH researchers was an approved treatment that served as an immediate substitute (Akamine interview). The availability of this alternative prevented a bottleneck. The USDA later showed that the hot water dip enhanced the effectiveness of the EDB treatment, and the dip was officially made an integral part of the fumigation process in 1972. For the next 12 years, the post-harvest treatment was EDB plus the hot water dip (Akamine, Nakasone interviews).

The 1963 FDA ban on various in-field chemicals used for disease control led to the establishment of a chemical residue lab at UH in 1967. The purpose of the lab was to develop agricultural chemical clearance programs that chemical companies were unwilling to undertake for such minor crops as papayas (HPIA 1967).

Another marketing problem that came to the fore during the latter part of this decade was "disorderly marketing" (Hayashi, Ishida, Souza interviews). This resulted from the cyclical (two-year) nature of papaya production. For example, in 1966 the industry was unable to supply established markets consistently (Chia 1985; Souza interview). By 1968, the complaint was overproduction causing significant price drops (HPIA 1968).

A measure of supply consistency is percentage change in production from year to year. The current industry rule of thumb, according to the PAC, is that the market can sustain 10 percent annual changes in production without adverse price effects. Year-to-year changes in production beyond this range pose problems for the consumption system.

Figure 5 shows annual percentage changes in production over the 1946–1983 period. The range –10 percent to +10 percent is the range of "stability," where production changes are manageable. As the figure shows, in all but 11 years production growth fell outside the stable range. In 17 years, the growth rate was above 10 percent, and in 9 years it was below. Thus, supply could only be considered consistent in 11 of the 37 years.

The inability of the industry accurately to predict short- and long-run supply led to a PAC request to the USDA's Economic Research Service to develop a forecasting model (Sousa interview). This work culminated in the early 1970s with the Papaya Objective Yield Survey, which is managed by the Hawaii Department of Agriculture in conjunction with the USDA's Statistical Research Service. The prediction of yield allows the industry to plan its marketing strategy in light of expected supply.

Another problem was the lack of intraindustry communication and the resulting inability of the industry to coordinate marketing activities (Hayashi, Higaki interviews; HPIA 1967). These factors were instrumental to the passage of the papaya marketing order.

Although marketing issues were the most pressing during this decade, production problems persisted. Primary among these was the papaya replant problem. Papayas planted in fields as a second or later planting may grow slowly or, in severe cases, die or fail to start. The problem is attributed to fungi such as *Phytophthara palmivara* and *Pythium aphanidermatum* (CES 1970). In 1967, the virgin soil technique was developed as a solution holding much promise (HPIA 1971). Progress was being made, but this problem and grower concerns about it continued well into the next decade (HPIA 1971, 1974, 1975).

One final event was the development of a mechanical harvester prototype in 1968. The idea for the harvester originated in Waianae with papaya grower Fushin Teruya (Chia 1985). Harvesting has been a major production cost (Muench et al. 1984), and the harvester was a response to this problem.

1970–1979

The major event of this decade was the organization and development of the Papaya Administrative Committee. The PAC was established to administer the marketing order

voted into existence by growers and processors in 1971. This state marketing order is the only one in Hawaii. Its establishment was an industry response to "disorderly marketing" brought about by the cyclical nature of papaya production and the lack of industrywide market planning. It identifies methods to facilitate orderly marketing and empowers the PAC to set policy and act as enforcer.

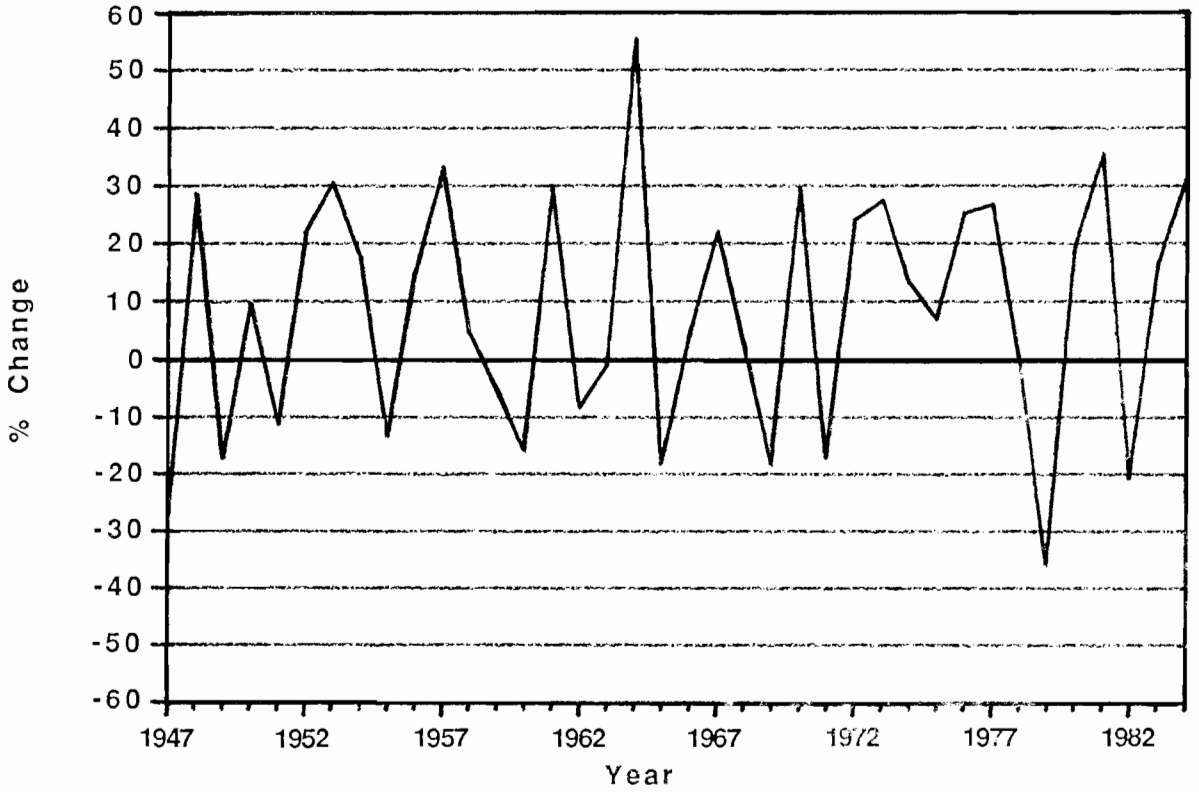
The PAC's most important tool is grade restrictions that can be placed on fresh papayas. These restrictions allow some control over flow of product to market by specifying that only Grade 1 can be exported and only Grade 2 or better can be sold locally (HPIA 1972).

The PAC took full responsibility from DPED for the continuation and further development of the papaya promotional program (Chia 1985). The program has been directly supported by the industry through statutorily required support payments from growers and processors to the PAC. The state has provided funds for the papaya promotional program, but the proportion of this funding has diminished with time (Souza interview).

In 1978, the size of the papaya industry dictated that the PAC manager give full time to his duties. Previously the manager, who was in the Hawaii Department of Agriculture, had given only half time to managing the PAC (Souza interview).

Establishment of the marketing order and creation of the PAC can be considered the first unified actions taken by the industry. The PAC has become the industry voice and the hub to which concerns are funneled and from which industry-sponsored actions are taken (Hayashi, Huananio, Souza interviews). It submits bills to the legislature for research and other project funding, manages the papaya promotional program, communicates industry problems and needs to relevant persons or organizations, and provides information to its members. The PAC also is the organization to which industry persons have come for problem-solving (Akamine, Souza interviews). The PAC has become the papaya industry vehicle to manage, plan, and promote itself. Unlike the HPIA, it has been empowered by the legislature to do so.

As the authority to make industrywide decisions has become more concentrated within the PAC, the traditional relationship between the papaya industry and the university and experiment station research community has gradually dissolved. The PAC has come to view it as one alternative in solving industry problems rather than the only choice (Souza interview). The main reasons for this trend are (1) bureaucratic red tape and (2) solution delays associated with UH-sponsored research (Hayashi, Souza interviews). In addition, the perception has grown within the industry that it must help itself and



Source: Statistics of Hawaiian Agriculture 1984.

Figure 5. Papaya supply consistency, by year.

not depend on any outside agency for solutions to its problems, that is, that the industry is solely responsible for its own success or failure (Huananio, Yamabe interviews).

The PAC has brought about more orderly marketing in terms of methods, product standardization, and more stable prices (Chia 1985; Higaki interview; HPIA 1978); however, it has not completely solved the problem of "disorderly marketing" (Hayashi interview). Packing houses do not yet coordinate their mainland marketing efforts, and this leads to intraindustry competition rather than competition with the growers of other fresh fruits. This is viewed as the major current problem by many industry persons, who look to the PAC for a solution (Hayashi interview; PAC First Quarterly Meeting 1985). Industry persons also have said that most papaya producers do not actively support the PAC (Huananio interview). The PAC is said to sponsor too few programs that help individual growers (Hayashi, Ishida, Nakasone, Yamabe interviews). The growers thus have little initiative to participate in industrywide planning and program development. Growers do have indirect representation via county association presidents, who sit on the PAC.

Despite any failures or shortcomings of the PAC, the industry consensus is that it has been an effective organization. Persons interviewed have said that the PAC is primarily responsible for "holding the industry together through the EDB crisis" and that without it, the industry could not survive in its present form (Akamine, Hayashi, Huananio, Ishida interviews).

Another papaya organization was formed during this decade: the Moloa'a Cooperative on Kauai. Its purpose was to acquire enough retired pineapple lands to produce sufficient papaya volume to support a packing and shipping plant operated by the cooperative. Three years after its formation, the first container of papayas left Kauai (Souza interview). To date, it is the only papaya cooperative operating in the state.

In 1972, Alexander and Baldwin, Inc., began planting its Princess Papaya Orchards on Maui. A&B was the first large, publicly owned agribusiness firm to grow papayas. The resulting production increased statewide output by almost 30 percent in one year (Souza interview). This production was diverted to mainland markets, which were unable to absorb the increased supply without a significant price drop (Hayashi, Huananio, Souza interviews). A&B's venture into papaya production was short-lived because the variety grown was soft when green, did not ship well, and was generally too small for export markets (Hayashi, Nakasone, Souza interviews). Further, A&B had shipping problems from Maui to Honolulu and to export destinations beyond the West Coast, and had management problems (Nakasone, Souza interviews; HPIA 1974). By the end of the decade, Princess Papaya Orchards were no longer in production.

Generally, large publicly owned agribusiness firms have not gone into papaya production. Besides the Princess Papaya venture, the only other large-scale agribusiness venture was American Factor's (AMFAC) Puna Papaya operation, which began during this decade. The apparent reason for the lack of corporate interest was the high risk of growing papayas (Hayashi, Huananio, Ishida interviews). Puna Papaya's current plan to phase out production and concentrate on distribution (PAC First Quarterly Meeting 1985) lends credence to this view.

Transportation problems were accentuated during this decade as production volumes increased. The mid-decade energy crisis raised fuel costs, and thus transportation costs, significantly (HPIA 1975). This in turn renewed interest in controlled-atmosphere storage for surface shipment of papaya to the Mainland. Controlled-atmosphere storage offered the promise of significant increases in shelf life over then-current methods of surface papaya shipment (Chia 1985; HPIA 1967, 1969). Nothing developed so far, however, has proved as effective as air shipment for maintaining quality and shelf life of exported fruit.

A second transportation problem was the dropping of most direct Hilo–Mainland flights because of low passenger volume. United was the only carrier to continue such service (HPIA 1982). Consequently, papayas destined for the Mainland by air had to be shipped via Oahu, which increased in-transit time.

EDB continued to be the export treatment for papayas to eradicate fruit flies. The Environmental Protection Agency (EPA), however, raised warning flags that EDB's tenure might soon be over. In 1974, the EPA established a 10-ppm bromide residue restriction for papayas (HPIA 1974). In 1977, the EPA announced a Rebuttable Presumption Against Registration (RPAR). It followed this in 1980 with announcement of intent to cancel EDB's approval for use as a post-harvest treatment of papayas (HPIA 1981). The primary reason was that EDB causes cancer in laboratory animals. In response to the RPAR, university and industry persons established an EDB advisory committee in 1978 to investigate alternatives (Kefford interview).

The papaya replant problem was still a major production issue, but the virgin soil techniques, when carefully used, proved effective in avoiding this problem (HPIA 1975).

Other production issues arose during this period. Early in the decade there was interest in a mechanized papaya harvester. A prototype had

been developed at UH in 1968. Development continued, but by the end of the decade interest in the machine waned and it was generally no longer in use. Disinterest apparently stemmed from high cost and from the difficulty of operating on the rocky soils of the Big Island (Ishida, Souza interviews).

Another production issue was the high cost of labor, particularly for small growers, who felt this problem was aggravated by corporate growers offering higher wages to attract laborers. High labor costs remain a major obstacle to industry expansion.

1980–1986

The major event to date in this decade has been the ban on EDB as a fumigant for postharvest fruit fly treatment. Remedial action was taken first in the form of the EDB Industry Advisory Committee, which investigated EDB alternatives. Then, in 1981, the USDA Agricultural Research Service (ARS), at the request of the PAC, performed research to find an effective alternative to EDB (Souza interview). Through these efforts the double-dip hot water treatment was developed. It replaced the EDB fumigation treatment for fruit flies in September 1984. Interestingly, the basis for this treatment was information derived from experiments using microwaves as a papaya fruit fly treatment. Though ineffective, microwave treatment did demonstrate that heating the interior of the papaya would provide effective fruit fly control (Akamine, Souza interviews).

Research results indicated that the double-dip treatment was an effective fruit fly treatment without adverse effects on the fruit. By December of 1984, however, the market reported that the flesh of exported papayas had hard spots. Fruits were inedible. The ARS immediately conducted research to solve the problem. By January 1985, preliminary results indicated that changing the temperature of the water and duration of the dip would give effective fruit fly control without adverse effects on the fruit, if processing procedures were strictly followed (PAC First Quarterly Meeting 1985).

A current production problem related to the double-dip treatment is the fact that fruits must be harvested at the quarter-ripe stage. This had been required previously, but the application of this requirement became more stringent with the new treatment method. The quarter-ripe stage has not been clearly delineated, and growers have had problems identifying quarter-ripe fruit for harvest (PAC First Quarterly Meeting 1985). The requirement also puts particular pressure on part-time farmers. Historically, these farmers harvested only once a week; they must now harvest twice a week. If they do not, they risk losing up to 30 percent of their marketable yield (Huananio interview).

Another production problem is availability of suitable land for expansion of papaya acreage. Available lands on the Big Island are generally at too high an elevation or in areas of inadequate rainfall to be suitable for production (PAC First Quarterly Meeting 1985).

The traditional papaya marketing problems persist. In 1984, there was a 50 percent increase in production over that of the previous year. This fact, coupled with the hard fruit problem, forced prices down (Souza interview). Transportation problems also persist. There are few Hilo–Mainland flights for direct papaya shipment. Air service between Hilo and Honolulu is poor, and the industry has had scheduling and other difficulties with the interisland barge system (HPIA 1982).

The promotional program for papayas continues in earnest. The most noteworthy event during this decade has been the hiring of a full-time papaya merchandising agent on the Mainland. It is hoped that this will solve many of the handling and display problems of exported papayas (Souza interview).

Summary

Papaya development progressed through three phases. The first was production system development, in which an exportable cultivar was identified and basic research in plant physiology, genetics, and cultural practices was expanded. In addition, processing research led to the first approved method of controlling fruit fly for exported papaya.

The second phase focused on distribution. Transportation and marketing methods and channels for papaya export were developed. Also, organizations were formed to spread information, handle promotion, resolve problems, and provide managerial expertise for industry planning and development.

The third phase centered on market development. It included programs to educate handlers and consumers and to promote papayas in export markets. The industry's goal was effective, extensive market penetration and management. This was achieved primarily through the papaya marketing order sponsored by the PAC.

Within each phase, the seeds for the next were planted. Market promotion efforts began at least a decade before they became an industry priority. As the industry moved from stage to stage, work continued on what had been the focus of earlier phases, as new problems and technological advances occurred. Processing methods provide an example. EDB had been used for decades, but new processing methods had to be developed when the FDA banned it. Market

potential was thought significant from the onset, providing the stimulus to solve problems as all the phases progressed.

COMPONENTS AFFECTING INDUSTRY DEVELOPMENT

This section places papaya development events into the context of the PMC model, enabling an assessment of the degree to which PMC matrix components have been relevant in papaya's development.

Figure 6 identifies historical events in the development of the Hawaii papaya industry and the estimated time of occurrence from 1900 to 1986. "Significant" events had a major effect on papaya development and are indicated by an asterisk (*). Corresponding to each event is the PMC Decision Matrix code number from Figure 1. This correspondence between event and PMC codes assists the identification of PMC components affecting papaya development.

Figure 7 is a reproduction of Figure 1, with importance ratings added. The ratings are S, I, and O for "significant," "important," and "other" factors, as described earlier. The components' contributions to papaya development are discussed in the context of the production, marketing, and consumption subsystems.

Production Subsystem: "Significant" Components

Eight significant components are involved with production system development.

Land and Water Resources and Seed Availability (P 1, P 4). Land and water resources include altitude, water, temperature, and other environmental conditions associated with the land. Seed availability refers to the availability of seed producing cultivars with desirable marketing and consumer demand characteristics. These two components are discussed together because they are interrelated.

The availability of lava lands in the Puna district of the Big Island, where the 'Kapoho' Solo could be rock-farmed, capped the evolution of the papaya production system and resolved a critical issue forestalling papaya development. For the first time, a papaya with both a high production level and a durable fruit could be grown. The fruit could be processed and transported and still arrive on the market shelf in desirable condition (Akamine, Higaki, Huananio, C. Lyman, R. Lyman, Nakasone, Souza interviews).

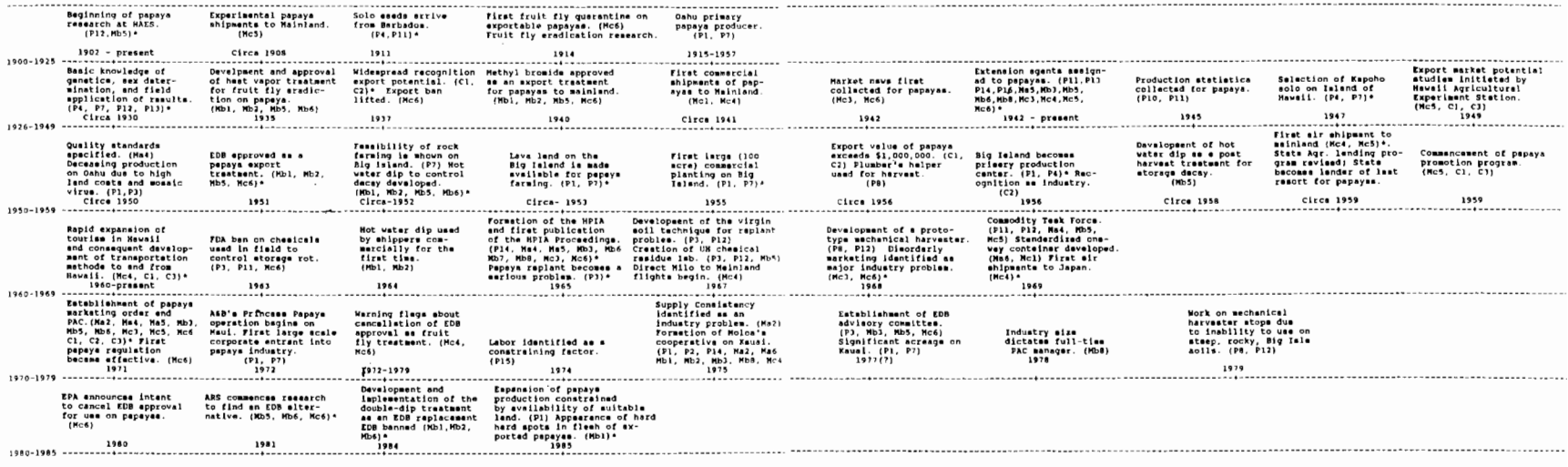
Pest Control (P 3). Pest control refers to control of papaya diseases, including post-harvest problems, and pests. The most important papaya pests have been the papaya mosaic virus, replant diseases, and the fruit fly. Control programs have been formulated and/or resistant varieties developed. These measures have allowed large tracts of land to remain in production. Discovery and use of the hot water dip treatment has quelled problems related to post-harvest handling. (Fruit fly control is discussed in the marketing systems section.)

Farmers' Risk-Taking (P 7). This category refers to farmers' and other individuals' risk-taking activities during the development of the papaya production system. Risk-taking individuals experimented with different growing techniques, cultivars, and processing methods, particularly between 1935 and 1950 when most major breakthroughs occurred (Figure 6). Efforts to develop an effective, profitable production system ultimately succeeded when the 'Kapoho' Solo was planted in the Big Island's Puna District. Risk-takers were responsible for cultivar selection and development of rock-farming methods.

Government Services (P 11). The Cooperative Extension Service at UH has started papaya information programs, stimulated the development of papaya organizations, and been a link between the industry and the public. The CES has been instrumental in fostering cooperation among growers; this has been a problem, given the distance between islands, ethnic diversity, and the existence of strong industry personalities (Hayashi, Ishida interviews). The CES also has spurred growers to use more efficient, cost-effective technologies and to initiate problem-solving among responsive individuals and institutions. (Appendix B gives more detail on the historical role of the CES.)

Agricultural Research Programs (P 12). Agricultural research programs refer to basic and applied research by individuals and institutions. The Papaya Research Program was important in the early development of papayas. The program provided information about papaya physiology and biology, and ultimately formulated papaya cultural practices. Researchers supported the private individuals who investigated and obtained approval of fruit fly treatments for papayas exported to the Mainland, serving as the first link between the developing industry and the public (Chia 1985).

The research program has been important throughout the evolution of the papaya production system in anticipating and removing bottlenecks. This has been especially true for disease and pest control. (Appendix B gives a more detailed discussion of the program.)



*Indicates a key factor instrumental to the development of the papaya industry.

Figure 6. Major historical event chart.

Code	Component Description	Ranking	
P 1	Land & water resources	S*	Production Subsystem
P 2	Production financing	I	
P 3	Pest control	S	
P 4	Seed availability	S	
P 5	Fertilizer needs	O	
P 6	Input procurement	O	
P 7	Farmer's risk-taking	S	
P 8	Farm machinery needs	O	
P 9	Farm energy requirements	O	
P 10	Input information	O	
P 11	Government services & regulation	S	
P 12	Ag research programs	S	
P 13	Ag information programs	S	
P 14	Crop organizations	S	
P 15	Farm labor needs	I	
P 16	Market info for farmer	I	
Ma 1	Procurement resources	O	Marketing Subsystem
Ma 2	Dependable supply	S	
Ma 3	Procurement financing	O	Procurement
Ma 4	Government services & regulation	S	
Ma 5	Market intelligence	O	
Ma 6	Transport & storage	O	
Mb 1	Processing resources	S	
Mb 2	Processing equipment	S	
Mb 3	Commodity institutions	S	
Mb 4	Processing energy	O	
Mb 5	Processing research	S	Processing
Mb 6	Processing info programs	S	
Mb 7	Processing byproducts	I	
Mb 8	Managerial ability	S	
Mc 1	Distribution resources	I	
Mc 2	Distribution financing	I	
Mc 3	Product market information	I	
Mc 4	Product transportation	S	Distribution
Mc 5	Market research & development	S	
Mc 6	Government services and regulation	S	
Mc7	Tourism	I	
C 1	Market penetration	S	Consumption Subsystem
C 2	Market size	S	
C 3	Consumer awareness	S	
C 4	Product versatility	S	
C5	Tourism	I	

* S = Significant; I = Important; O = Other.

Adapted from SaLUT 1980.

Figure 7. Revised PMC system matrix.

Agricultural Information Programs (P 13). Agricultural information programs spread research and other information. The CES, researchers, the Hawaii Department of Agriculture, and papaya organizations have been the primary information sources. Various publications have provided periodic statistics and information about papayas. These include "Statistics of Hawaiian Agriculture," "Honolulu Unloads," *Market News*, industry proceedings, and occasional papaya newsletters or circulars.

Crop Organizations (P 14). Crop organizations have played a major role in the evolution of the system. County-level extension-sponsored organizations have spread information and stimulated problem-solving by growers. Statewide organizations have served this purpose and other functions. The HPIA was the first statewide organization to provide a direct link between the industry and public institutions and agencies. It was instrumental in encouraging an industry perspective and industrywide planning (Higaki, Ishida interviews). This culminated in the passage of the papaya marketing order and the formation of the PAC.

Production Subsystem: "Important" Components

Production financing (P 2), government regulation (P 11), farm labor needs (P 15), and market information (P 16) were important components of the system. While each might be considered consequential, none could be called a bottleneck. Issues were quietly solved within existing frameworks or simply resolved over time without special attention. For example, in production financing, both private and public financial institutions provided credit to the emerging industry. Such institutions were on hand, having developed earlier to service the sugar and pineapple industries (C. Lyman interview). These sources of short-term money have been used extensively by the papaya industry (Ishida, C. Lyman interviews). The state, as the lender of last resort, has loaned only $2 million to the industry from 1961 to 1984 (Morimoto interview). Given the state, federal and private loan programs, adequate financing has never been a constraining factor.

Production Subsystem: "Other" Components

Other components involved in the development of the papaya production systems are fertilizer needs (P 5) (specification of papaya nutritional requirements), input procurement (P 6) (obtaining inputs except land, water, and seed required for papaya production), farm machinery needs (P 8), farm energy requirements (P 9), and input information (P 10). Each played a role in papaya development, but none was noteworthy. All were readily formulated or borrowed from other PMC crop systems.

Marketing Subsystem: "Significant" Procurement Components.

Marketing procurement refers to the factors responsible for the transference of papayas to market institutions for distribution to ultimate markets and consumers.

Dependable Supply (Ma 2). Dependable supply means the industry's ability to consistently supply levels of production to support the consumption system. The industry's criterion for dependable supply is to produce within 10 percent of the previous year's level. Although the industry infrequently meets this criterion, annual production changes have been greater than 10 percent twice as often as they have been less than 10 percent (Figure 5). Thus, the industry has consistently supplied its markets, even to the extent that overproduction and market coordination problems sometimes ensued.

Government Services and Regulation (Ma 4). Government regulations have had a significant effect on procurement development. The export ban on fruit fly-infested papaya stimulated continuous research and development. Regulations prohibiting the in-field use of some herbicides caused major changes in processing methods. The marketing order, with quality restrictions on exports, dealt directly with overproduction and market coordination problems. Selective use of these restrictions regulated flow of product to market and helped stabilize prices. These restrictions required more stringent handling practices, not only while transporting the product to market, but also while harvesting. Government services, primarily the CES, also played a significant development role, discussed under "Commodity Institutions and Managerial Ability," below.

Marketing Subsystem: "Other" Procurement Components

Procurement resources (Ma 1), procurement financing (Ma 3), market intelligence (Ma 5), and transportation and storage (Ma 6), are other components. None has been significant or important. Existing methods, resources, and institutions either were in place for each or were readily provided or developed. Thus none was ever a development bottleneck or required special attention.

Marketing Subsystem: "Significant" Processing Components

Processing components were involved in transforming papayas through processing and packaging into a marketable form. A product in marketable form is one that meets all regulations and packaging requirements for shipment to export markets. Six "significant" components are involved with processing system development (Figure 7).

Processing Resources, Equipment, and Research (Mb 1, Mb 2, Mb 5). The fruit fly has been the single most important problem facing the papaya industry. Researchers have found effective methods of treating papayas and designating the resources and equipment needed to apply the treatment. This has been hard, because changing regulations have required alternative processing methods and equipment. The recent EDB crisis clearly demonstrated this. These components were all critical to the processing subsystem, which in turn is critical to maintaining export markets.

Processing Information Programs (Mb 6). Processing information programs are a major requisite, given the changing regulatory environment. Such programs came from the CES and, more recently, via PAC and HPIA meetings. These programs have effectively communicated the most recent processing methods and have assured that papaya exports have met both regulatory and consumption system requirements. The programs have extended to both the production level—specifying fruit harvest requirements such as size and color—and to the packer-processor level.

Commodity Institutions and Managerial Ability (Mb 3, Mb 8). The role played by the CES is similar to that of the commodity institutions, so it will be discussed as such.

The role played by the CES and papaya organizations in helping development is similar to their role in the production system. These organizations fostered cooperation and communication among growers and packers, and between the industry and the public. They also contributed directly to marketing system development. Extension agents initiated air transport of papayas from Hawaii to the Mainland and fostered the development of organizations such as the PAC. In short, they consciously nurtured an industry perspective.

Papaya organizations themselves have become more directly involved in the development of the marketing system. The PAC takes a leading role in making financial and other provisions for development to continue. It provides managerial ability to deal with bottlenecks, a function clearly exemplified during the recent EDB crisis. The PAC has also stimulated more orderly and efficient marketing of papayas through the execution of the papaya marketing order and the merchandising program.

Marketing Subsystem: "Important" Processing Component

The sole factor in this category is papaya byproducts (Mb 7): pureed and dried papayas. Puree is the most important, used primarily to make juices. Byproduct growth has paralleled the growth of papaya production (Figure 8). Although papaya byproducts have made a significant contribution, industry personnel do not view them as instrumental to development or survival. They feel industry development has been due primarily to the successful marketing of fresh papayas (Hayashi, Huananio, Ishida, Souza, interviews). Nonetheless, the marketing orders' grade restrictions created a second class of papaya that generates substantial income for the industry through byproducts.

Marketing Subsystem: "Other" Processing Component

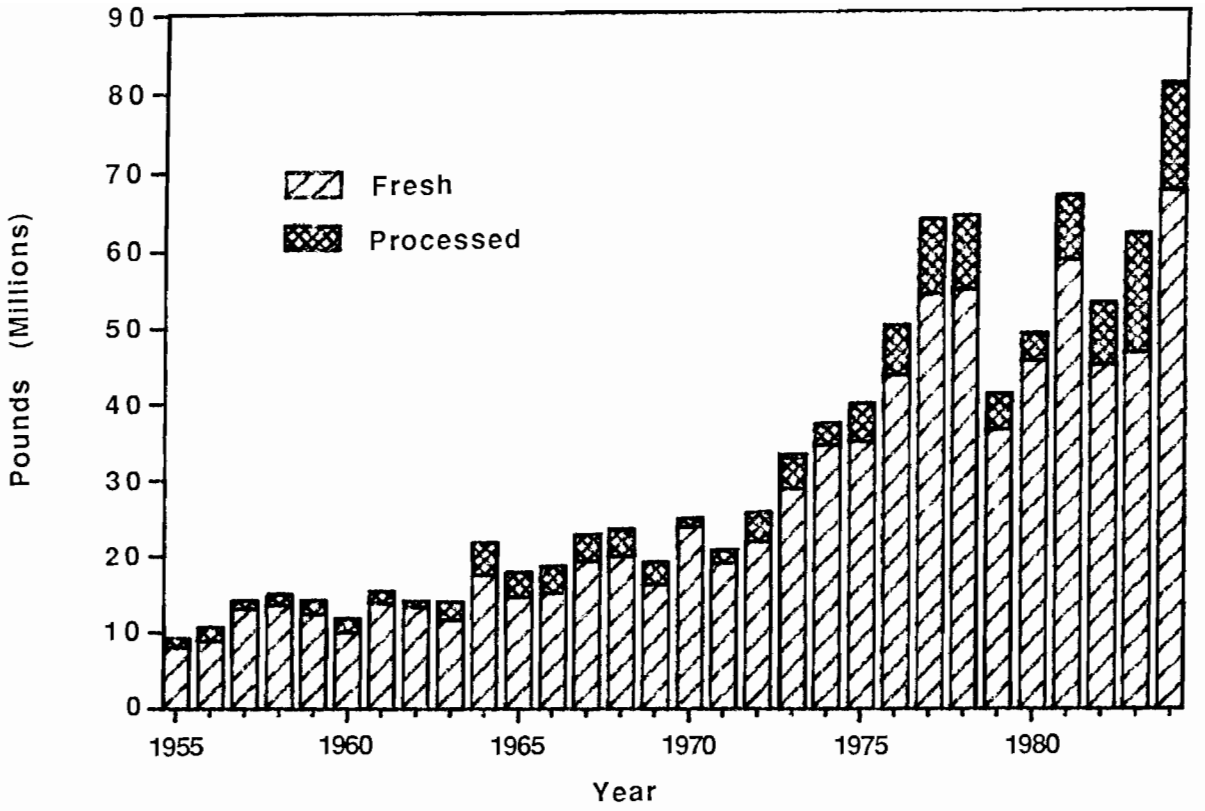
Processing energy (Mb 4) requirements have never been an issue nor a constraint to development.

Marketing Subsystem: "Significant" Distribution Components.

The distribution system refers primarily to export marketing. Three "significant" components were involved in its development.

Product Transportation (Mc 4). Effective transportation of papayas to mainland markets was a major bottleneck. Until 1960, Matson Lines, which provided only ocean freight service, was used almost exclusively (Figure 3). By 1963, air shipment was used almost exclusively. Transit time critically affects fruit quality and thus limits in-store shelf life. For air shipments, door-to-door elapsed time is about three days, whereas eight days are required for surface shipments to the West Coast. Air shipment thus allowed producers to expand their markets. As the proportion of air shipments to total shipments increased (Figure 3) so did the level of papaya exports (Figure 9). Export targets included Japanese as well as mainland markets after 1969. Air shipments to Japan in relative and absolute terms have increased since the opening of the market (Figure 10). The air-sea split is approximately equal now.

Market Research and Development (Mc 5). Low consumer awareness in export markets and the need for well-designed marketing strategies to tap both mainland and Japanese markets



Source: Statistics of Hawaiian Agriculture 1984.

Figure 8. Papaya production disposition, by year.

constrained development. These constraints were largely overcome by market research and development and the papaya promotional program. Appendix B gives details of each.

Government Services and Regulation (Mc 6). (Discussed above under "Commodity Institutions and Managerial Ability.")

Marketing Subsystem: "Important" Distribution Components

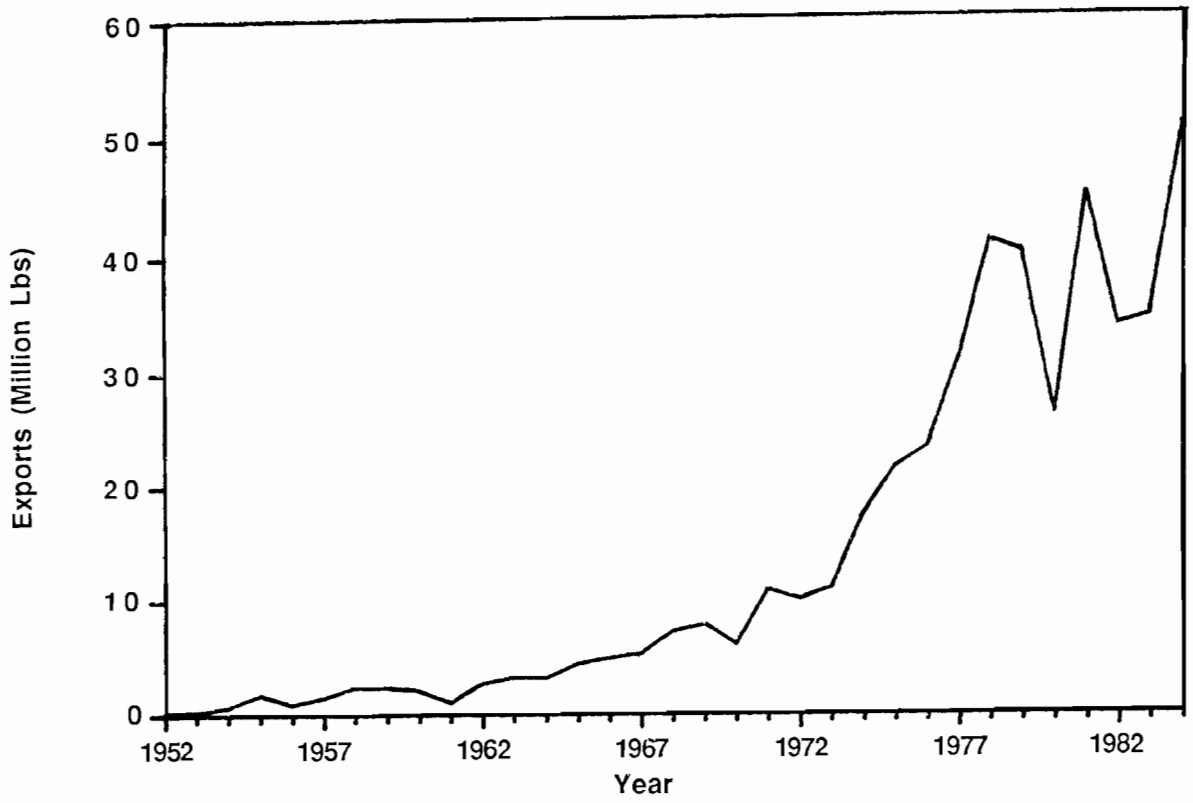
Distribution resources (Mc 1) (e.g., packaging containers, shipping containers), distribution financing (Mc 2), and product market information (Mc 3) (e.g., "Honolulu Unloads" and *Weekly Market News*) were important PMC distribution factors. Each has been adequately provided or did not have noteworthy effect.

Tourism (Mc 7) has spurred an interdependency between the agricultural sector (papaya industry) and the transportation sector (air freight service) that should not be overlooked. It has fostered less-than-average-cost air shipment of agricultural goods for more than 20 years. Without tourism, air cargo space would have been unavailable at the price it was to move the large volumes of papayas to export markets.

Consumption Subsystem: "Significant" Components

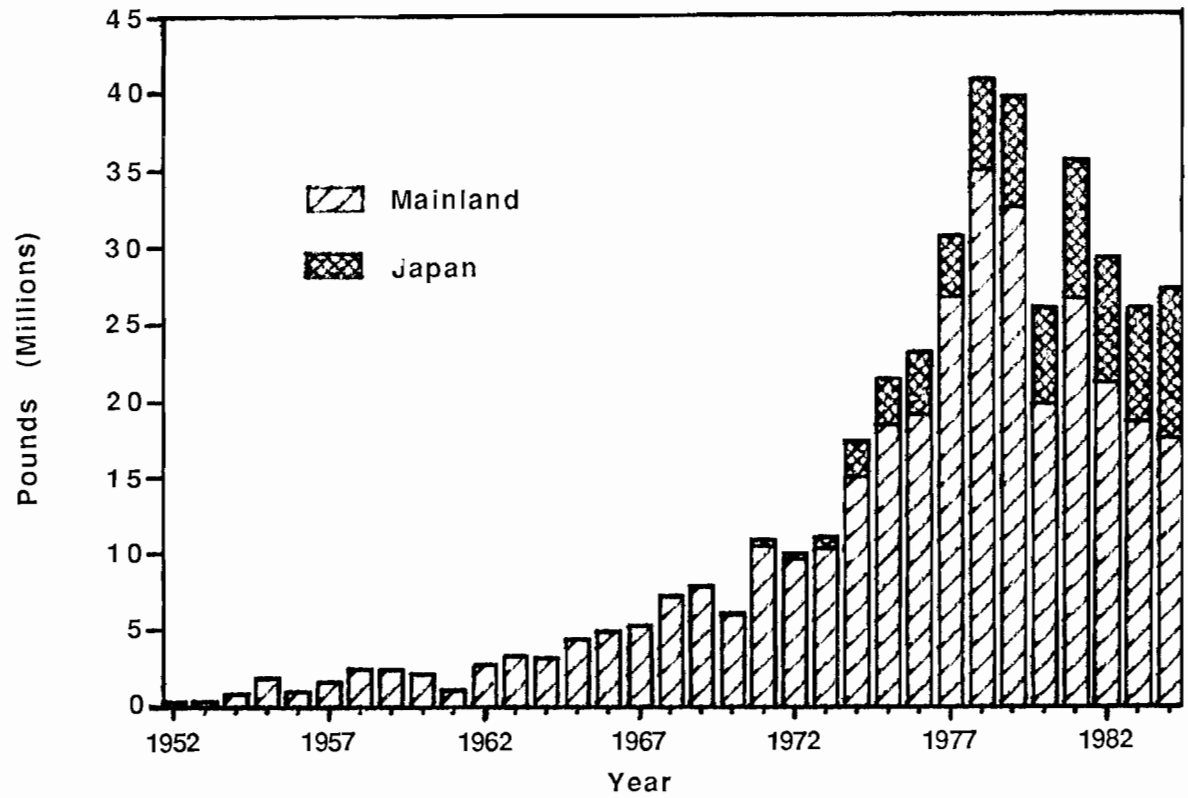
All PMC consumption system components except tourism were significant to the development of the papaya industry (Figure 7).

Market Penetration (C 1). Market penetration refers to the ease and ability of papayas to enter markets. Exportable cultivars had to be found, processing and transportation methods developed, and handling and display methods formulated and implemented in export markets. This last factor has been particularly important to market penetration. Improper stacking or storing, or excessive handling, affects quality (PAC promotional program records; Hayashi, Souza interviews). When first exported, papayas were new to wholesalers and retailers, who did not know how to handle and display them properly. Hence, quality suffered, impeding market promotion efforts (PAC promotional program records). The merchandising program was the primary means to overcome this problem, and it ultimately ensured the successful delivery of a quality papaya to retail shelves. Each of these quality-related components affects market penetration (Spielmann 1977; Huananio, Ishida, Nakasone interviews).



Source: Statistics of Hawaiian Agriculture 1984.

Figure 9. Total exports .



Source: Statistics of Hawaiian Agriculture 1984.

Figure 10. Papaya exports, by market destination.

Market Size (C 2). Market size refers to market potential. It was the most significant consumption factor. As early as 1932, papayas were seen to have export market potential (Crawford, 1932). The ability to export papayas could open a market big enough to support an entire industry, not just a local crop. This potential market has historically motivated work in the production, marketing, and consumption systems. Individuals and institutions were stimulated to seek breakthroughs and resolve problems because the export market was waiting to be exploited. It was clearly recognized within the industry that without a significant export market, the industry could not develop.

Consumer Awareness (C 3). The higher the level of consumer awareness, the larger the number of possible consumers. Low consumer awareness in export markets was a major constraint to initial penetration. Relative to other fruits, papayas were not widely recognized on the Mainland and in Japan (Hayashi, Ishida interviews). For development to occur, the level of consumer awareness had to increase. The promotional program has been the primary vehicle for achieving this. (Appendix B details the papaya promotional program.)

Product Versatility (C 4). Product versatility has a dual meaning. It refers not only to the ability of a fresh product to withstand the rigors of processing and marketing, but also the ability to arrive as a desirable product on retail shelves. The second ability refers to the number of uses that can be found for a product. Hawaii-grown papayas are the only ones grown to date that withstand the rigors of processing and long-distance shipment and arrive as quality fruit on mainland market shelves (Nakasone interview).

This versatility has been critical to consumption system development. It may also be a key factor that will protect the industry from foreign competition. Papayas grown in Mexico, for example, are not versatile in the sense used here (Nakasone interview). The 'Kapoho' Solo, when grown in the Puna District, is the only papaya having this type of versatility. It is unique.

Papayas have also proved versatile in the second sense. Papaya byproducts have been developed, and papayas can be marketed in both ripe and green forms to different ethnic markets.

Consumption Subsystem: "Important" Component

Tourism (C 5) has played an important role in the growth of papaya consumption. Tourist exposure to papayas when visiting Hawaii has increased consumer awareness. This exposure has effectively been the equivalent of educational, promotional, and advertising programs to do the same, but at no cost. Overnight visitors and papaya production have increased similarly over the 1955–1983 period (Figure 11), suggesting a positive correlation between tourism and papaya consumption levels.

THE SaLUT PMC DECISION MATRIX AND PAPAYA INDUSTRY DEVELOPMENT

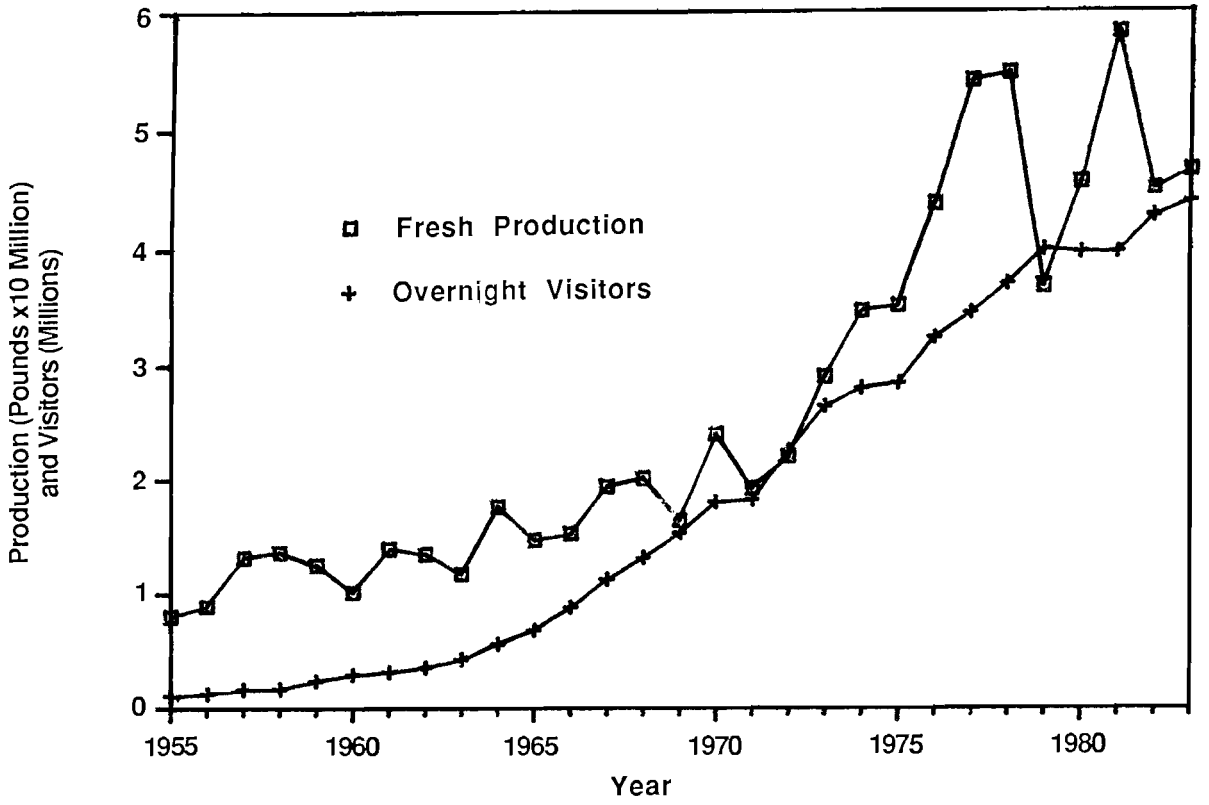
All of the components listed in Figure 7 affected development. Of these, 21 were rated "significant," 11 "important," and 10 "other."

Two features are noteworthy about papaya development. First, interdependency between the agricultural and tourist sectors is unequivocal. Tourism is primarily responsible for the provision of low-cost air freight space to mainland and Japanese markets. Thus, it fostered the development of the marketing system. Tourist exposure to papayas while visiting has served as a "no-cost" promotional program. Tourism may be said to have "aided and abetted" the papaya industry.

Second, no single SaLUT component can be considered the most important one. A combination of two—land and cultivar—was the *sine qua non.* As noted, Big Island production, total statewide production, and papaya exports increased concurrently during the 1961–1983 period. The Big Island's success may be attributed to a cultivar having desirable export characteristics, together with large tracts of low-cost land available in areas well suited for growing that cultivar. The synergy of these two components to produce an exportable papaya has been lacking on all other islands.

The 'Kapoho' Solo papaya is a very successful cultivar when grown in the Puna district. Industry spokesmen believe no export would exist without it (Akamine, Higachi, Nakasone, Souza interviews). Outside the Puna area, the 'Kapoho' Solo shows low yield and marketability. No cultivar giving simultaneous resistance to disease (ring spot virus) and desirable export characteristics has been found for production on Oahu. Kauai's 'Sunrise', even though exported, is not considered as good a shipper as 'Kapoho' Solo. It is also susceptible to *Phytophthora* blight, and it has darker flesh, which makes it harder to market. As mentioned, Princess Orchards, the only significant papaya farm on Maui, was closed because of cultivar unsuitability and ensuing cultural problems.

Historically, reasonably priced land that had no immediate alternative use has been available for production in the Puna district. Land for diversified agriculture on Oahu is in shorter



Source: Statistics of Hawaiian Agriculture 1984.

Figure 11. Papaya production and tourism, by year.

supply, with much higher rentals. It is unlikely that substantial papaya production would occur on Oahu even if a good cultivar could be developed. Without substantial yield increases, the land costs would make the venture uneconomic. Land is available and being used on Kauai. On Maui, production likely could be initiated if acceptable cultivars were found.

Other components played major roles in the historical development of the papaya industry, but they were not as singularly important as land and cultivar. Risk-takers have existed on all islands, but only on the Big Island have the risks consistently paid off. Research results, disease and pest control, accessibility to researchers and organizations, transportation methods and availability, and the advantages of the promotional program have all been equally accessible or the same for the different islands. All components related to the consumer system have been the same for all islands. With respect to transportation, the Puna region may be said to have a major disadvantage compared with other islands. The major distinguishing factor between the Big Island and the other islands is the ability to grow a cultivar in a region where it thrives, producing a fruit meeting all the requirements for exportation. This difference has led to the success of papaya production on the Big Island and ultimately to the successful development of the papaya marketing and consumption systems and thus the industry.

CONCLUSION

The SaLUT system is valid for identifying components involved in the development of the Hawaii papaya industry. All SaLUT PMC components affected papaya development. Relative importance designations for the PMC components indicated that some were significant or crucial with respect to development. The historical review pointed out that the intersectoral tie between the papaya and tourism industries is also important. The systematic combination of land and cultivar was the cornerstone to development.

Our conclusion is that the SaLUT methodology is valid for assessing new crop alternatives in Hawaii. All PMC components were involved in the development of the papaya industry. Given different component ratings, it is appropriate to address them hierarchically. For papaya, some components were more important than others in terms of effect on development, whether as a bottleneck or a stimulating force. The degree of component importance may vary for different crops,

depending upon problems inherent in production-marketing-consumption subsystems and the degree to which a potential crop system is able to use the PMC components of existing crops.

REFERENCES

Publications

ACLRS. 1960–1985. Statistics of Hawaiian agriculture. Agricultural Crop and Livestock Reporting Service, Hawaii Department of Agriculture, Honolulu.

Agricultural Extension Service. 1945–1948. Statistics of diversified agriculture in Hawaii. University of Hawaii. Ext. Circ's. 199, 217, 241, 267.

Agricultural Extension Service. 1949–1960. Statistics of Hawaiian agriculture. University of Hawaii. Agr. Econ. Repts. 1, 7, 11, 16, 22, 24, 27, 32, 35, 38, 46, 53.

Chia, C. L. 1985. Development of the papaya in Hawaii. Department of Horticulture, University of Hawaii. Unpublished manuscript.

Crawford, D. L. 1932. Hawaii's crop parade. Advertiser Publishing Co. Honolulu.

GACC. 1983, 1984. Annual report. Governor's Agricultural Coordinating Committee. Office of the Governor, Honolulu.

Garrod, P. V. 1984. Moving diversified agricultural products. *In* Proceedings—marketing transportation seminar: Exploring new marketing opportunities in agriculture. College of Tropical Agriculture and Human Resources, University of Hawaii. Res. Ext. Ser. 049.

HPIA. 1965–1984. Annual proceedings, Hawaii Papaya Industry Association. Cooperative Extension Service, College of Tropical Agriculture and Human Resources, University of Hawaii.

Muench, R., R. Roberts, and F. Scott, Jr. 1984. Economic viability of papaya farms in the Puna district. College of Tropical Agri- and Human Resources, University of Hawaii. Res. Ser. 027.

Nakasone, H. 1985. Papaya research, past, present, and future. Department of Horticulture, University of Hawaii. Unpublished manuscript.

Phillip, P. F. 1953. Diversified agriculture in Hawaii. University of Hawaii Press. Honolulu.

Roecklein, J. C., C. T. K. Ching, H. W. Hilton, R. Nishimoto, and R. V. Osgood. 1982. A method for evaluation of alternative crops for Hawaiian agriculture. Hawaii Department of Agriculture, Honolulu.

SaLUT (Soil and Land Use Technology, Inc.). 1978. Feasibility of introducing food crops better adapted to environmental stress, Vols. I, II. National Science Foundation, Washington, D. C.

_____. 1981. Feasibility of introducing new crops: Production-marketing-consumption (PMC) systems. National Science Foundation, Washington, D. C.

Shigeura, G. T., and H. Ooka. 1984. Macadamia nuts in Hawaii: History and production. College of Tropical Agriculture and Human Resources, University of Hawaii. Res. Ext. Ser. 039.

Spielmann, H. 1971. Demand characteristics for fresh and potentially gamma-irradiated papaya on selected U. S. mainland markets—an attitudinal approach. Hawaii Agricultural Experiment Station, University of Hawaii. Res. Bull. 149.

United Fresh Fruit and Vegetable Association. 1980. Fruit and vegetable facts and pointers. Alexandria, Va.

Yu, W., E. K. Akamine, G. M. Aoki, R. A. Hamilton, F. H. Haramoto, R. B. Hine, J. T. Ishida, J. T. Keeler, and H. Y. Nakasone. 1970. Papayas in Hawaii. Cooperative Extension Service, University of Hawaii. Circ. 436.

Interviews

Akamine, Ernest. Professor emeritus, Department of Plant Molecular Physiology, University of Hawaii. February 1985.

Chia, Chian Leng. Associate specialist, Department of Horticulture, University of Hawaii. January 1985.

Hayashi, Andy. Manager, Mr. Papaya, Hilo. January 1985.

Huananio, Peter. Papaya Growers, Pahoa. January 1985.

Higaki, Tadashi. Hawaii County Administrator, Cooperative Extension Service, Hilo. January 1985.

Ishida, Jack. Extension specialist (ret.), Department of Agricultural and Resource Economics, University of Hawaii. February 1985.

Kefford, Noel. Dean, College of Tropical Agriculture and Human Resources, University of Hawaii. February 1985.

Lyman, Clarence. Extension specialist (ret.), Honolulu. February 1985.

Lyman, Richard. Director, Bishop Estate, Honolulu. January 1985.

Martin, Don. Deputy state agricultural statistician, National Agricultural Statistics Service, Honolulu. January 1985.

Morimoto, Richard. Administrator, Hawaii Agricultural Loan Program, Hawaii Department of Agriculture, Honolulu. February 1985.

Murashige, Mitsuo. Hawaii district supervisor, Commodities Inspection Branch, Hawaii Department of Agriculture, Hilo. January 1985.
Nakasone, Henry. Professor emeritus, Department of Horticulture, University of Hawaii. February 1985.
Omori, James. Manager, Market News Branch, Hawaii Department of Agriculture, Honolulu. January 1985.
Souza, Robert. Manager, Papaya Administrative Committee, Honolulu. January 1985.
Wong, Ruddy. Administrative officer, College of Tropical Agriculture and Human Resources, University of Hawaii. February 1985.
Yamabe, Tom. Papaya Growers, Pahoa. Former president, Hawaii Farm Bureau, Honolulu. February 1985.

Other Sources

Hawaiiana Collection card catalog, Hamilton Library, University of Hawaii.
PAC. 1985. Notes from first quarterly meeting, Papaya Administrative Committee, Hilo.
_____. 1985. Promotional program records. Papaya Administrative Committee, Honolulu.

APPENDIX A: QUESTIONS

This appendix comprises questions developed before interviews were conducted. It is included to provide the reader with an understanding of the issues and concerns at the onset. Questions are divided into the production, marketing, and consumption topics used in SaLUT's PMC system.

Production System

1. How did the crop/product evolve? (If more than one factor is important, please indicate the order.)
   A. Through domestication of plants harvested from natural stands.
   B. Through domestication of plants previously unused.
   C. Developed new uses of existing crop.
   D. Commercialized a product previously used only in the home.

2. Who were the players involved in seeing the crop evolve?

3. Was the crop adaptable to Hawaii? If so, in its present range?

4. What were the problems encountered? In what order were they identified? Solved?

5. Did the government provide research help? If so, how was it financed?

6. How broad was the expertise needed to solve production problems?

7. Were private enterprises involved in the development of production systems? If so:
   A. When did they enter into the picture?
   B. What type of relationship existed between private industry and the research community?

8. Was specialized harvesting equipment necessary? If so, who developed it?

Consumer System

1. At the end-use level, did the industry evolve because of:
   A. Substitution for products produced domestically?
   B. Substitution for products produced in foreign countries?
   C. Development of export markets?
   D. Expansion of market area?
   E. Development of demand for a new product?

2. How big was the market initially? What has been the rate of growth?

3. Was the consumer well aware of the product's characteristics at inception?

4. Was any research conducted as to market potential? If so, how was it funded?

5. Has an attempt been made to differentiate the product?

6. Has the industry embarked on any consumer education programs? If so, how were they funded?

7. Does the industry develop product promotion programs? On what factors are they based, e.g., product novelty, price, quality?

Marketing System

1. Were there problems with supply dependability? If so, how were they resolved? Possibly forward contracts, cooperatives, etc.

2. Does the government provide any of the following services?
   A. Market information.
   B. Grading and quality standards.
   C. Financing.
   D. Storage.

3. Were there any processing problems? If so, who helped to solve them? How was this done?

4. Are byproducts produced? If so, were they always? Are they necessary to the industry for continued survival?

5. How long are the distribution channels? Have they changed dramatically since the inception of the industry? If so, how?

6. What functions do middlemen provide? Are cash advances among them?

7. At what point in the process is ownership of the product transferred?

8. Do government regulations significantly affect processing and packaging considerations?

Interface Mechanisms

1. Did special-interest groups evolve specifically to work toward the elimination of bottlenecks, to promote, or to inform? If so, when?

2. Are there or have there been periodic publications that focus on accomplishments, problems, new developments, etc.? If so, what is their frequency, source of funds, and circulation?

3. Were there significant developments along the time path that dramatically altered the picture? If so, what happened and when?

4. Did chance or luck enter into the development process at any time?

5. Who forged the links among the various sectors?

APPENDIX B: COMPONENT REVIEWS AND ASSESSMENTS

This appendix contains detailed reviews and assessments of various components involved in papaya development in Hawaii. Each has had a major effect on the historical development of papayas in Hawaii. The detail included here was not considered appropriate for the body of the report. However, policymakers and members of the papaya industry may find it helpful.

PAPAYA RESEARCH PROGRAM

The papaya research program has been extensive in terms of both the number of publications and the breadth of coverage. Since 1902, the UH has released 291 publications presenting results of papaya research. These studies cover the bulk of papaya research conducted. It does not include unpublished UH-sponsored research (e.g., theses and dissertations) or private, unpublished studies presenting results from papaya-related research.

Review and Assessment

A review of the papaya research program as indicated by papaya research publications over time reveals that as the papaya industry developed and grew in size, so did the amount of research. The number of publications for the designated periods increased as time progressed, except for the present decade, where only 15 research studies have been published to date. More than half the studies from 1906 to 1985 were conducted during the 1960–1979 period (Table 1).

Reviewing the types of research over the entire period reveals that production-oriented research has predominated, followed by processing research, general information, distribution research, and economic research This pattern has generally held true for the particular time period as well, with a few exceptions (Table 2).

Table 1. Papaya research publications, 1906–1985.

Research Area	Total Publications 1906-85	Number of Research Areas Covered Over Period						
		1906-39	1940-49	1950-59	1960-69	1970-79	1980-85	Total
Production	144	14	22	18	38	52	7	151
Processing	63	8	11	10	20	15	1	65
Distribution	33	3	6	11	4	9	3	36
General Information	38	7	4	6	10	11	1	39
Economic Factors	9	0	1	1	1	6	2	11
Total For Period	291	32	44	46	73	93	14	302
Publications Per Period		29	42	44	70	91	15	291

Note: In some instances one publication covered more than one research area.
Source: Papaya catalog listings, Hamilton Library, University of Hawaii.

Table 2: Percentage distribution of papaya research publications, 1906-1985.

Research Area	Total Publications 1906-85	Percentage Distribution of Research Areas Covered Per Period						
		1906-39	1940-49	1950-59	1960-69	1970-79	1980-85	Total
Production	49.48%	43.75%	50.00%	39.13%	52.05%	55.91%	50.00%	50.00%
Processing	21.65%	25.00%	25.00%	21.74%	27.40%	16.13%	7.14%	21.52%
Distribution	11.34%	9.38%	13.64%	23.91%	5.48%	9.68%	21.43%	11.92%
Gen'l Information	13.06%	21.88%	9.09%	3.04%	3.70%	11.83%	7.14%	12.91%
Economic Factors	3.09%	0.00%	2.27%	2.17%	1.37%	6.45%	14.29%	3.64
Total For Period	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Publications Per Period		9.97%	14.43%	15.12%	24.05%	31.27%	5.15%	100.00%

Source: Table 1.

Given the bottlenecks identified, it is surprising that so few economic and market-related research publications were located. Over the entire period, only 3 percent of all studies conducted have been related to economic factors, while 33 percent have been related to marketing. The latter fact is even more surprising in that it did not change significantly over the 1960–1980 period, when marketing advancements were so important to develop export markets and practices.[1]

Some research projects did not have immediate application or seemingly did not solve problems at which the research was directed. Interestingly, such research was found either to have direct application at a later date or to lead to the development of technologies that did solve problems. For example, the hot water dip treatment for storage decay was developed by UH researchers in 1952. It was not used until 1964, after in-field fungicidal treatments were banned (Akamine interview). Another example is microwave research, which proved ineffective as a control for fruit fly causing fruit damage, but which demonstrated the efficacy of heating the interior of papaya as a fruit fly treatment (Akamine, Souza interviews). This information led to the development of the double-dip treatment currently in use. Thus, the usefulness of papaya research cannot be measured by the immediacy of its application.

A frequent criticism of the papaya research program concerns the development of inappropriate technology, that is, new processes or practices that, although effective, are hard to use and therefore usually gain little acceptance. For example, the mechanical harvester was developed over a period of 10 years but never used much by growers. The primary reason given was its unsuitability over the rough terrain of Hawaii's Puna district. (Souza interview). Again, the virgin soil technique was developed for the replant problem. Research proved its effectiveness, but the problem continued on the Big Island after its introduction. The technique was too difficult for growers to apply as specified (HPIA 1975). And most recently, the double-dip hot water treatment developed by the research program for fruit fly treatments requires that only quarter-ripe fruit be harvested for processing. Papaya growers have had difficulty in meeting this requirement. Processors also have had difficulty meeting relatively stringent temperature control requirements specified by this treatment (PAC First Quarterly Meeting 1985; Huananio interview).

The burden of applying newly developed technologies to deal with industry problems falls on the grower and/or processor. If an experimentally proven technique fails in practice, the general conclusion is that growers or processors have failed to follow the guidelines set forth by the researchers (PAC First Quarterly Meeting 1985). In some instances at least, it appears that the

---

Private market research was conducted under the aegis of the PAC in the early 1970s. It was not included in the above tables.

specialists have failed to take into account the feasibility of successful adoption of new technologies in light of existing constraints, such as grower attitudes, physical or capital constraints, or ability to apply complex technologies. Perhaps a greater sensitivity on the part of researchers to the "givens" within the papaya industry is in order. A research program will not be able to solve all problems; however, appropriately designed packages might reduce the time needed to put new papaya technologies into practice.

The Extension Service

Review. The Cooperative Extension Service at the University of Hawaii is a federal-state program involved in the development of the papaya industry. In 1942, the first agent was assigned specifically to papayas (C. Lyman interview). Tasks included direct involvement with industry persons, administration and implementation of specific extension programs, creation of associations at the county and state levels, and market research on the Mainland. Associations include the advisory councils and grower associations at the county level, and, at the state level, the HPIA (Higaki interview).

The specific county advisory councils were started before 1960. They hold monthly meetings where growers and extension personnel meet to identify and solve problems (Higaki interview).

County grower associations are the countywide equivalents of the HPIA. They spread information to growers and other industry persons within their own counties. Meetings are well attended, a fact attributed to evening meetings, the serving of snacks, and a willingness to speak English and Filipino dialects (Huananio interview).

From 1940 to 1965, before any industrywide organizations existed, the CES provided the interface between the industry and the public and between industry groups and the research community. Functions included defining problems and their magnitude, and assisting in defining the needs of the growers more precisely (Nakasone interview). Extension agents know industry concerns and problems intimately through site visits and interaction with growers via county organization meetings. They relayed industry concerns and problems to extension specialists for consideration. If the specialists could not help, the agents would contact the UH research system to find solutions (Higaki, Huananio interviews).

Putting solutions into effect took the reverse path. A Hawaii Agricultural Experiment Station (HAES) newsletter would be sent to extension agents, presenting results and conclusions of the research. This would happen at least a year before any formal publication of the research results (Akamine interview). The time from the start of research to distribution of the mimeograph varied by type of research. Breeding research generally took the most time to complete, very specific distribution problems the least.

Once the extension agent had the research results, he would give demonstrations for appropriate persons (e.g. growers). These would be conducted at farms—for production problems, for example—of the "early adopters." Once the usefulness of the new procedure or practice was shown at the "early adopter" farm, theory held that its use would spread to other growers (Higaki, C. Lyman interviews).

Assessment The CES has generally been praised for its service throughout the development of the papaya industry (Higaki, Huananio, Ishida, C. Lyman interviews). Its role in the industry has changed over time, however. In the early stages, individual agents played a major role in helping the industry develop (Lyman interview). Once the industry was established, this role diminished. This trend coincided with the formation of industrywide organizations such as the HPIA and particularly the PAC, which increasingly assumed responsibilities previously carried by the agents (Higaki, Huananio, Souza interviews).

Organizations allow the industry to approach solution-solving institutions and individuals in a direct and unified manner. This has been more effective in obtaining appropriate and timely responses to industry problems (Akamine, Higaki, Souza interviews). This direct interface between research and industry persons may also have helped to diminish the role of the CES.

Papaya Promotional Program

Review. Before 1959, only minor promotional efforts (such as public relations releases, recipes, and point-of-purchase materials) had been started. Merchandising programs, in which island marketing specialists taught fruit handlers in the marketing chain proper storage and display techniques, also had been developed (Philipp 1953; Souza interview). From 1959 through 1984, a total of $1.75 million has been spent on the annual papaya promotional program (Hawaii Department of Agriculture). The PAC has spent additional funds, not included in this total, for noncontract promotional programs,

but this figure represents the bulk of monies spent to promote papaya. The source of these funds is the industry, with some aid from the state. The trend has been for proportionately less state funding, as noted earlier. Annual promotional dollar amounts have varied from $4,000 to $205,000 (Hawaii Department of Agriculture).

Until 1971, overall administration of the papaya promotional program rested primarily with the Hawaii Department of Planning and Economic Development (DPED). From 1971 to 1978, it was shared by the DPED and the PAC and executed by the PAC. In 1978, the PAC took full responsibility for the program. The state's role since 1978, aside from funding, has been primarily bookkeeping. In 1982, DPED involvement was transferred to the Hawaii Department of Agriculture.

The goal of the program has been to educate export market fruit traders, handlers, and consumers about papayas (PAC promotional program records). This education has included basic knowledge about the product and its virtues, how to prepare papayas, and how to handle and store the fruit. The specific vehicles used to achieve this education have been, in order of descending importance: conventions and merchandising; publicity releases; newspaper, magazine, radio, and television advertising; point-of-purchase materials; food service organization awareness and information programs; in-store sampling and demonstration programs; and other miscellaneous programs (such as display contests) (PAC promotional program records). This order may not be accurate for specific years, but overall it is representative.

The success of the promotional program depended on two things. First is the ability of the production system to consistently supply an exportable product. Second is the ability of the marketing system to maintain the quality of the product in transit to export markets.

Botchford, Ketchum and Associates in San Francisco has been the firm primarily responsible from the beginning for the formulating and implementing the papaya promotional program on the Mainland. The program has been applied nationally as well as in specific cities across the United States (PAC promotional program records).

Assessment. Papaya market development research conducted from 1965 to 1975 suggested specific areas of emphasis for a promotional program (Shigeura and Ooka 1984). First, since papaya was a new item bought on impulse, large, well-stocked displays were felt to be necessary. This was considered most important as it ensured availability of product, found to be the most critical factor affecting papaya sales. Also, because papaya was a new item, frequent direct product exposure (e.g., giving away samples) was recommended. Since both these recommendations involved the retail level, it was suggested that market development work be primarily retail-directed. Second, it was recommended that media advertising be kept to a minimum until later stages of market development. Research results suggested that the most effective advertising would be of the omnibus type, conducted by retailers (Spielmann 1971). To encourage such advertising was another reason for retail-directed market development. Third, it was recommended that a regional market be developed first to gain marketing experience and a proven marketing method before significant movement into other regions. This was reiterated by industry persons as late as 1978 as the most efficient way to use limited papaya promotional funds (HPIA 1978).

Contrast between the suggested guidelines and the program that actually developed point up a lack of coordination between research and action. In-store demonstrations and papaya giveaways have not been stressed until recently. Media advertising has been one of the mainstays of the promotional program since its inception.Finally, the promotional program has been in use from coast to coast for almost two decades (PAC promotional program records).

The apparent lack of coordination between papaya marketing research and promotion does not imply an ineffective program. Industry persons generally agree that the program has been instrumental to the development of the papaya consumption system (Hayashi, Ishida interviews). The promotional program may have been less effective, however, because of this lack of coordination. Some industry persons feel that consumer awareness in the papaya export market could have been heightened and a more effective merchandising program achieved if the original recommendations of the research program had been followed (Hayashi, Ishida interviews).

Hawaii residents may order **single copies** of this publication free of charge from county offices. **Out-of-State inquiries** or **bulk orders** should be sent to the Agricultural Publications and Information Office, College of Tropical Agriculture and Human Resources, University of Hawaii, 3050 Maile Way, Gilmore 121, Honolulu, Hawaii 96822. Price per copy to bulk users, $.95 plus postage.

Hawaii Agricultural Experiment Station
HITAHR, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa
Noel P. Kefford, Director and Dean

RESEARCH EXTENSION SERIES 079–10.87(2M)