THE WILLINGNESS AND LIKELIHOOD OF FARMERS PARTICIPATION IN FRESH PRODUCE SUPPLY CHAIN MANAGEMENT: SPECIAL FOCUS ON THE HAWAIIAN AVOCADO INDUSTRY.

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I would like to dedicate this personal achievement to my late father T. Narayan.

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1.1. Outline of the Thesis

This study focuses on the willingness and likelihood of the Hawai'i growers' participation in fresh-produce supply chain management which has been explored by specifically focusing on the Hawaiian avocado industry. This thesis comprises of five chapters. The first chapter introduces the background and statement of the problem. Chapter two, the review of literature, describes in detail the historical background of supply-chain management, discusses some of its important concepts, conventional models of supply chain management, the role of supply chain management in agribusiness, some of the challenges and limitations faced by small farmers, particularly in the case of fresh produce, how the conventional supply chain management models are ineffective for fresh produce production and distribution. It also describes a modified conceptual model of supply chain management introduced by the researcher which forms the basis on which the objectives of this study will be accomplished. Chapter three is the methodology, where it details the hypotheses, the research questions, description of the statistical models used, the sampling, and data collection for meeting the specific objectives of the study. Chapter four is the data analysis, describes and presents the analysis and results of the data collected and chapter five is the conclusions and recommendations, which covers the lessons learned, recommendations for improvements that the Hawai'i avocado industry needs to adopt and some of the limitations of the study.

CHAPTER I
INTRODUCTION

1.1. Outline of the Thesis

This study focuses on the willingness and likelihood of the Hawai'i growers' participation in fresh-produce supply chain management which has been explored by specifically focusing on the Hawaiian avocado industry. This thesis comprises of five chapters. The first chapter introduces the background and statement of the problem. Chapter two, the review of literature, describes in detail the historical background of supply-chain management, discusses some of its important concepts, conventional models of supply chain management, the role of supply chain management in agribusiness, some of the challenges and limitations faced by small farmers, particularly in the case of fresh produce, how the conventional supply chain management models are ineffective for fresh produce production and distribution. It also describes a modified conceptual model of supply chain management introduced by the researcher which forms the basis on which the objectives of this study will be accomplished. Chapter three is the methodology, where it details the hypotheses, the research questions, description of the statistical models used, the sampling, and data collection for meeting the specific objectives of the study. Chapter four is the data analysis, describes and presents the analysis and results of the data collected and chapter five is the conclusions and recommendations, which covers the lessons learned, recommendations for improvements that the Hawai'i avocado industry needs to adopt and some of the limitations of the study.

1.2. Background and Statement of the Problem

The fresh produce distribution system has evolved dramatically in recent years. As one of the most dynamic sectors of the food supply system, the produce industry is constantly challenged by new demands. The agriculture sector is undergoing major transformations in terms of modern technology, production, procurement, distribution, and co-ordination (Boehlje, 1996; Duval et. al., 1998). Industry structure has changed at virtually all levels and, as a consequence, roles and responsibilities of the industry stakeholders such as suppliers, buyers and consumers also have changed in an effort to keep pace. One of the major institutional changes has been the adoption of new forms of coordination in supply and demand to replace the traditional commodity marketing system (King, 1997). Strategic, operational, and tactical decisions (Yang et.al., 2002) made by the stakeholders are becoming increasingly interdependent and price and production risks are being replaced by risks surrounding relationships between stakeholders on the basis of food health, food security and safety (Drabenstott 1994; Boehlje, 1996). At the same time, the value of fresh produce moving through the distribution channels has continued to grow in nominal and real (inflation-adjusted) terms (Perosia et.al., 2001)

Studies show that effective development of a well managed supply chain throughout the fresh produce system is crucial for growth and profits (Perosia et.al., 2001). Supply chain management (SCM) therefore has become an increasingly important topic to agribusiness managers. The distinguishing feature of SCM is that they are dependent upon information sharing between the buyer and seller and it has become a prime source of control and

power (Drabenstott 1994; Boehlje, 1996; Dooley et. al., 1998). Perhaps the greatest benefit, but most overlooked in the fresh produce industry, is the change that arises from working closely with customers who include the buyers and the consumers. Close and trusting relationships between the producers and the customers can lead to fewer product defects, improved forecasting accuracy, thus improved product quality and in meeting consumer demand (Dooley et. al., 1998).

In fact, food safety and maintenance of profits are issues that are high priorities within the produce supply chain. In the fresh produce industry, supply chain management is rapidly evolving as a result of new technology and a system-wide focus on improved efficiency, quality, and safety (Perosia et.al., 2001). While aspects of SCM are quantitative or analytical in nature (inventory management, forecasting, production scheduling), a successful SCM relationship relies heavily on the human element. (Dooley et.al., 1998). This is where the concept of Efficient Consumer (or Customer) Response (ECR) becomes significant. It describes a customer-oriented and integrated view of the supply chain in which all parties involved work together. Its purpose is to integrate supply chain management with demand management to create smooth flows of product through the supply chain to satisfy consumer demand more cost effectively. It involves coordination and information sharing between producers, markets and customers giving rise to competitive advantage while satisfying consumer needs.

However, according to Boehlje (1996), farmers appear resistant to abandon the open traditional market systems of supply and demand. It was observed that institutional change in the form of SCM has met resistance from farmers, mostly because these new ways change relationships and frequently substitute interdependence for the much-

cherished independence. Hence a better understanding of farmers' attitudes, willingness, knowledge, and preferences concerning the use of new forms of institutional arrangements is crucial as such an understanding would allow for the design of more efficient arrangements (Duval et.al., 1998).

In Hawai'i 46% of the total land area (1,185,816 acres) is situated within the State Land Use Agricultural district with a high potential for agricultural use. Approximately 27% of the total acreage is presently being used for agriculture. With the demise of sugar in the mid-1990s and reduced production volumes within the ranching industry since the mid-1980s, independent growers producing a wide variety of commodities, in other words, diversified agriculture, have played an increasing role in the continued growth of the agriculture industry (Hawai'i County Report, 2005)

Diversified agriculture, has the potential for continued progress, however, there are problems which need to be overcome before the potential can be realized. These problems include, but are not necessarily limited to: land cost, cost/availability of water, cost/availability of transportation, cost of labor, marketing, developing and maintaining quality standards, disease and pest control and (Hawai'i County Report, 2005).

poor knowledge of consumer preferences and no information flow between the growers and the consumers

The diversified agriculture sector in Hawai'i comprises of various commodities such as flowers and nursery products, vegetables and melons, macadamia nuts, seed crops, livestock and poultry, hogs and all tropical fruits except pineapple. Among these commodities, the market value for agricultural products sold, according to the 2004-2005 Hawai'i Census, tropical fruits excluding pineapples were ranked seventh among the

diversified agricultural commodities comprising 5.9% of the diversified agricultural sales in Hawai'i. Of the different tropical fruits, avocados comprise 27% of the Hawai'i market share in fruits. Hawaiian avocados constitute about 27% of the total demand and there is a decreasing trend compared to imports. However the total local production for avocados is showing an increasing trend from 640,000 pounds in 2000 to the current production of 800,000 in 2005 along with an increase in commercial value of $371,000 in 2000 to a current $600,000 in 2005. At the same time during 2005 Hawai'i imported two million pounds of avocados (Statistics for Hawai'i Agriculture, 2005; National Agricultural Statistical Service, 2005). These figures clearly show there is a demand for the fruit in the local market and the local avocado farmers will be benefited by tapping into this opportunity.

One of the main challenges faced by the Hawai'i avocado industry is increased imports from Chile and Mexico which are forcing the domestic industry to become more aggressive in its sales. Starting in 2007, fruit from south of the U.S. border will be sold in all 50 states (Walker, 2006). This could be an even more serious setback to the local avocado industry. However, according to Chris Tully, the New York Representative of the Avocado Producers & Exporting Packers Association of Michoacan, Mexico " In terms of magnitude, Hawai'i is not as big a potential market as California and Florida, but there will still be opportunities and Hawai'i cannot be dismissed." United States representative Neil Abercrombie believes specialty fruit industry is one of Hawai'i's real success stories, "exhibiting dramatic growth and amazing promise in just a few short years and so it has to be protected from any threat of unfair competition" (United States House of Representatives, Report, 2006). Avocados also can considered specialty fruits

with versatility in their potential for value-added niche markets, such as canned guacamole and avocado oils. According to recent reports, researchers also are exploring the use of avocado oil as a potential bio-diesel source and it's byproducts as cattle feed (Leidemann, 2007).

The recent passing of the important Agricultural Land Bill which promises incentives to landowners to remain in agriculture and lure more people towards farming has increased the potential further and to improve the avocado industry status (Patty,2004; Burris,2004). Additional advantage for Hawai'i is the ability to supply different varieties of avocado to cater to unique tastes and different uses of the product. However, according to the Hawai'i Avocado Association inadequate delivery of new production and marketing information to the industry is severely hindering its expansion. A lack of research, educational and promotional program for the avocado growers was also felt by the association members (Bittenbender et.al., 1989). Besides this there is also the limitation that arises due to poor coordination activities between the growers and the customers and weak to no information flow.

According to the industry stakeholders and experts, there are two major reasons why Hawai'i avocado industry failed to take advantage of a growing market. One is the inability to differentiate Hawai'i grown products to local consumers, tourists, hotels and restaurants. There is a lack of standardization in cultivars being grown and the grading system. The other is the lack of coordination among growers to supply year-round, consistent, high quality volume to the buyers (Bittenbender et.al., 1989). Lack of importance given to exploring and understanding customer preferences also could be another reason for the industry's ineffectiveness. Hawai'i growers are extremely

individualistic resulting in production of over 30 different varieties rather than a few excellent varieties (http://www.hawaiifruit.net). As a result, many products do not enter the market and almost 49% end up as waste. The reasons for this could be due to ineffectiveness or lack of crucial decisions being made in the farming enterprises

Many important decisions are made in farming management. Two of the important decisions made are tactical decisions and operational decisions. The tactical decisions comprise of the acres to be planted, irrigation and other farm scheduling aspects and shipment mode. The operational decisions comprise of the actual planting activities, the amount of fertilizers and pesticides to be used, and actual distribution and transport. However these two decisions cannot be considered in farm management until the strategic decisions are made. "The goal of strategic planning is to arrive at the most efficient, highly profitable supply chain system that serves customers in a market" (Jang et al., 2002). They include forming of cooperatives, decisions on what should be the size of the coop, product selection, quantity produced and quantity demanded. Any of these activities in the strategic decision making can be changed except the quantity demanded. Unfortunately, studies and papers related to strategic decision making , particularly for small farm enterprises is almost non-existent although it is available to a marginal degree in industrialized agriculture (Hobbs et al.,2000; Jang et al.,2002).

From the reviews presented by Cohen et al. 1997 and Ganeshan et al. 1999, it is obvious that little attention has been paid to strategic decision making. According to Jang et al., (2002) there is a need for appropriate models or tools to help in strategic decision-making (Jang et al., 2002) in agricultural supply chain systems.

Much of the success of the produce industry relies on a carefully choreographed supply chain. Planting appropriate varieties, size, quality, harvesting at the peak of ripeness, packing in customized cartons, transporting fresh produce thousands of miles, merchandising, marketing, promoting it at just the right moment and consistent supply, is a feat that relies on careful and detailed communication and coordination between growers and their customers (Toerien,1999, Perosia et al., 2001). The primary purpose for the existence of any supply chain is to satisfy customer needs and in the process generate profits for itself. However studies point out various limitations and challenges faced by small farm agribusiness and conventional supply chain management may be ineffective to meet these challenges (Perosio et al., 2001; Reviron et al., 2005; Cooper et.al., 1993; Reviron et al., 2005; Carter et al., 2003, 2006; Mentzer 2000, Ross,1998; Chopra et al., 2004).

Besides these, small island communities such as Hawai'i have a number of other constraints such as its geographic remoteness, small market size, vulnerability to natural disasters, invasive species and increased dependency on imports (FAO Report, 1999). However, there are indications that international trade regulations affect small islands through rise in prices of imported food and increased stagnation in the export markets. Due to these reasons it is crucial for small island communities to expand local production to meet the local demand thereby substituting imports and achieve self-sufficiency. According to Committee on Agriculture, FAO 1999, small islands are well suited for fruit and vegetable production and also have the potential to substitute imports. Therefore what is needed is the implementation of appropriate policies and infrastructural support

that will help geographically isolated islands like Hawai'i to tackle issues such as food security and accomplish self-sufficiency.

The present study attempts to put forth a modified supply demand integrated management model on the basis of which it will focus on determining the willingness and likelihood of producer involvement in fresh produce supply chain management with special focus on the Hawaiian avocado industry. It would also look into more efficient strategic aspects of fresh produce supply chain management which can ensure higher returns. The results from the study can be utilized to adopt the strategies suggested by the Hawaiian avocado growers to enhance their income and improve the industry by making them more competitive and be in a position to substitute import. The results may also be helpful in formulating policies benefiting the Hawaiian avocado industry producers in particular and also other key players in the fresh-produce supply chain and be in a position to substitute imports and attain self-sufficiency. Development strategies play a positive role in steering the economy to a sustainable path of development but care should be taken to deliver the highest benefit to the target group in line with the intended path of development. Therefore new development strategies need to be "congruent with farmers priority problems and felt news and fit the agro-ecological and socio-economic and geographic circumstances" (Bekele, 2006).

1.3. Objectives of the Study

Overall Objective: To find out the willingness and likelihood of Hawaiian avocado growers' participation in fresh produce supply demand integrated management as a step towards import substitution and self-sufficiency

Specific Objectives

1. To determine the current situation of the Hawaiian avocado industry and document key aspects of the local avocado industry's supply profile and their potential for import substitution

2. To explore the willingness and likelihood of Hawaiian avocado growers' participation in supply demand integrated management.

   a. To find out if there is coordination between buyer preference and what is being grown

   b. To determine the willingness and likelihood of growers to participate in supply chain management.

3. To find out, based on farmers' willingness if there is an incentive in selling through an avocado cooperative and if so, what should be the optimal size of cooperative

CHAPTER II
REVIEW OF LITERATURE

2.1. Introduction

The main focus of this study is to find out the willingness and likelihood of avocado growers to adopt the main practices specified under supply and demand chain management as step towards import substitution and self-sufficiency. The second chapter starts with a discussion on a brief history of supply chain management based on theoretical, philosophical and operational perspective. Following this, the role of supply chain management in the two business sectors is examined. First the role of supply chain management in the non-agricultural sector is presented briefly and then the role of supply chain management in the agricultural sector is examined, then the three typical management practices recommended under fresh-produce supply chain which are 1. Understanding customer preference and coordination; 2. Forming cooperatives and; 3. Adoption of branding in supply chain which signifies the importance of downstream information flow are examined. Following this, supply chain in the small farm sector is discussed. This is followed by presenting a background on the Hawai'i agriculture sector, the Hawai'i avocado industry, the steps and challenges faced by small farmers and the existing gaps using the conventional supply chain framework applied to the industry is explored. Finally, on the basis of literature reviewed, a contemporary, modified, analytical framework of supply chain management called the supply-demand integrative management (SDIM) framework has been put forward which is intended to improve the competitive advantage of the supply-demand chain specifically for fresh agricultural

produce supply chain. The SDIM analytical framework will form the basis on which the objectives of this study will be achieved.

2. 2 Supply Chain Management: Theoretical, Philosophical and Practical Perspectives

2.2.1 History of Supply-Chain Management – Theoretical Perspective

The term supply chain was first coined in the early 1980s to describe the range of activities coordinated by a business organization to procure and manage supplies and information for production and manufacturing (Oliver et al., 1982). This basically refers to the integration of internal business functions and the flow of materials and information coming into and going out of a business organization. Initially, it was limited to a single organization focusing only on its internal functioning until it reached its immediate customer (Harland, 1995; Macbeth et al., 1990). Later on, this idea of focusing only on the internal functioning was found to be insufficient and the importance of integrating with the external environmental influences was recognized (Christopher, 1992).

Later studies focused on the "dyadic aspect" or the two-fold relationship between suppliers (input suppliers, producers or distributors) and buyers (wholesalers or consumers) or in other words the relationship between the two entities interacting and mutually influencing each other are recognized (Heide et al., 1992; Lamming 1993). This recognition of dyadic aspects between the key players also lead to the question as to why is managing a supply chain so important. Reasons suggested include the number of product choices that are available to the customers or consumers from the different competitors i.e. more competition and the potential delays in not coordinating supply

channels which will lead to delay in satisfying the end-users (Barney 1999; DeWit et.al., 1998; Leidecker et.al., 1984).

2.2 .2 Evolution of Supply Chain Management

Table 1 below illustrates chronologically the evolution of supply chain management field of discipline. It was developed principally from the three foundation disciplines: marketing, operations management and product/process management. Table 1 also shows how supply chain theories and concepts (SCM and SCS) are developed from the three fields of disciplines.

From pre-1939, marketing as a discipline was established and developed, the operations management discipline developed with tasks involving clerical and purchasing and overall "management" including product flow and process became the focus. Following this from 1939-1946 inventory logistics was included under operational management and at the same time management focus shifted to a functional approach involving materials management, manufacturing management and distribution management in which continued to 1969. In the 1970s marketing underwent a paradigm shift where it was viewed as more of a strategic activity rather than purely a functional approach and this continued until 2000. Around the same time, from 1970s-1980s logistics management was integrated to firm manufacturing operations, and management evolved to focus more on internal organizational integration where materials management, manufacturing management and distribution management were integrated. This gave rise to the development of supply chain management. Later in 1990s and up until 2000, under operation management discipline, strategic marketing management was integrated to logistics and operational management. Also, overall management focus included external

environmental factors such as the input suppliers and the customers along with an internally integrated organization. This move in supply chain management came to be referred to as supply chain strategy (See Table 1).

Table 2.1. Chronological Evolution of Supply-Chain Management

	Foundation Disciplines			
	Marketing	**Internal Operations Management**	**Management Focus (Product flow and Process)**	**SCM*** → **SCS***
Pre-1939	Discipline Established and Developed	Purchasing administration		
1939-1946		Inventory logistics	Functional Approach (Materials Mgmt, Manufacturing Mgmt, Distribution Mgmt)	
1947-1969	Marketing concepts development	Materials management		
1970s-1980s	Marketing paradigm shift. It is viewed as strategic activity not a functional process	Integrate logistics and firm operations	Internal organizational integration	
1990s-2000		Strategic marketing management was incorporated to logistics and firm operations		Internal organizational and External environment integration

***Supply Chain Management; ** Supply Chain Strategy* (Hines, 2004)**

Accordingly supply chain management was defined by Jones et.al. , (1985) where *supply chain management dealt with the total flow of materials from suppliers through end users.* Much research has gone into understanding the dynamics of supply chain management since its conception. Also, some operational supply chain concepts got

classified as (Harrison et al., 1996) new wave manufacturing (NWM) one of which is Quick Response (QR) (Hunter 1990; Hunter et al., 1992). Quick Response stresses the importance of meeting customer demand satisfaction by producers and suppliers by reacting quickly to customer demand through efficient supply chain (Harrison et al., 2002). Efficient Consumer Response (ECR) was later developed as a tool which is an extension of QR. It describes the importance of a customer-oriented and integrated view of the supply chain in which all parties involved worked together. ECR in essence implies a new way of doing business which requires a complete integration of supply management and consumer demand through effective information flow to create smooth transfer of products through the supply chain to satisfy consumer demand efficiently). ECR concepts are very much in line with Supply Chain Strategy. It is a new principle stressing the importance of collaborative management intended to make the supply chain stronger and efficient , particularly in agricultural fresh produce sector (*http://www.ecraustralasia.org.au/what)* where the importance of customer satisfaction with business organization integrating internal operation management with related external environmental factors are stressed.

The SCM generally includes many different players and the successful implementation of the SCM includes a set of antecedents and consequences for it to be successful (Mentzer, 2000). The antecedents include values and qualities such as trust, commitment, organizational compatibility, interdependence, vision and leadership. The consequences include increased customer value and satisfaction, increased revenue, profitability etc. Based on these supply chain management concepts, it can now be more appropriately defined as (Mentzer, 2000):

"The systematic, strategic coordination of the traditional business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole".

2.2.3 Philosophical and Operational Perspectives of SCM

Based on literature, from a philosophical perspective, supply chain management comprises of the following characteristics: 1) It is a systems approach to view and manage the channel as a whole from the supplier to the final customer; 2) A strategic orientation towards cooperative efforts; 3) Customer focus and creating unique and individualized efforts leading to customer satisfaction (Mentzer, 2000)

To adopt the supply chain philosophy, with the characteristics stated above, firms must establish management practices that are in congruence with the philosophy. Some of the main suggested management practices include: 1. Integrated Behavior/Coordination; 2. Mutual Sharing of Information 3. Mutual sharing of channel risks and rewards; 4. Cooperation; 5. Having the same goal and the same focus of customer satisfaction; 6. Integration of processes and; 7. Partners to build and maintain long-term relationship (Cooper et al., 1993; Cooper et al., 1997; Cooper et al., 1997; Elleram et al., 1990; Novack et al., 1995)

These are also known as supply chain strategic moves associated with the flow and transformation of goods from the initial design stage through to the end user (Hines, 2004).

To have a better understanding of how SCM are coordinated across functions and how they are coordinated across companies, the following integrated conceptual framework of

supply chain management has been put forth (See Figure 1).It comprehensively lays out the philosophical, practical, functional aspects and end-user oriented outcomes of a well developed supply chain with strategies.

Figure 1 represents the directional flows of all supply chain management activities, based on philosophical and practical aspects towards ultimately providing value and satisfying the customer. This model basically represents the supplier(s) at one end and the final buyer(s) at the other end coordinating inter-corporately. Based on the philosophical characteristics stated previously they participate in the seven management practices mentioned earlier. The entire process is based on effective inter-corporate coordination among the suppliers and buyers and at the same time coordinated with intra and inter-functional activities between the players. The inter-functional activities among the firms which includes both internal (intra-firm) as well as external (inter-firm) coordination and these are based on the antecedents and consequences stated earlier such as values and qualities of trust, commitment, risk, dependence and other behavioral or human aspects with consequences of customer satisfaction, value and profitability.

The intra and inter-functional activities within the supply chain include marketing, sales, research and development, forecasting, production, purchasing, logistics, information systems, finance and customer service.

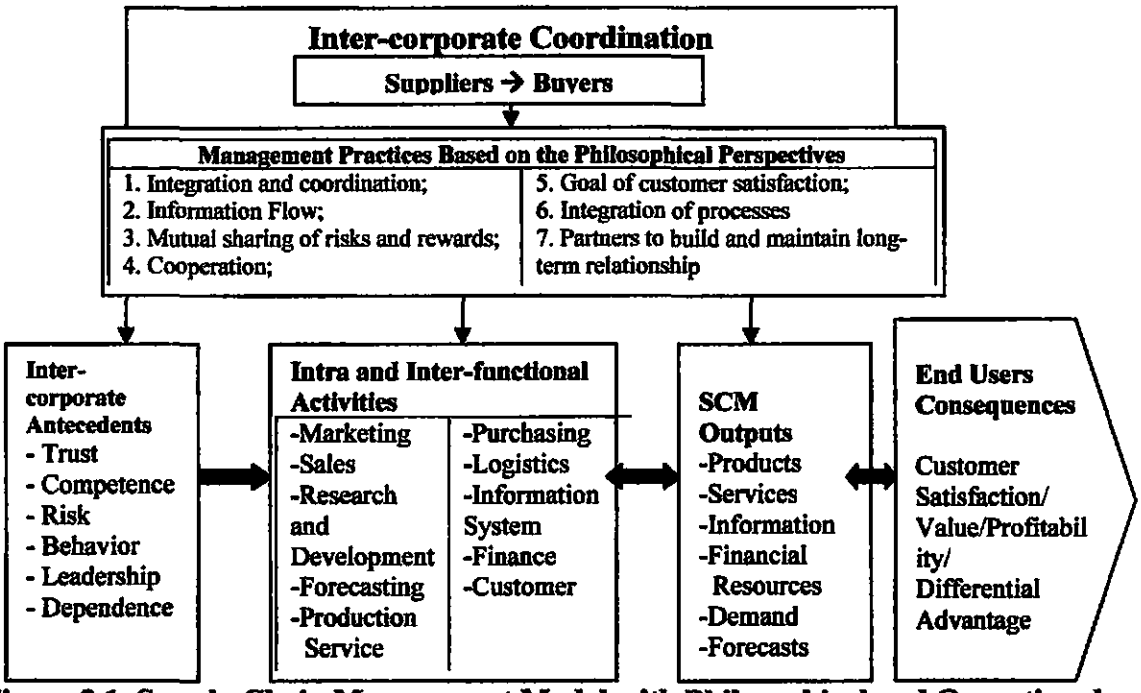


Figure 2.1. Supply Chain Management Model with Philosophical and Operational Perspectives (Mentzer, 2000)

These activities result in the to and fro flow of outputs such as products, services, information, financial resources, demand and forecast, between the producer/supplier and consumer/buyer. The final results or consequences are that it ensures customer/consumer or end-users satisfaction, value-added gains, profitability and differential advantage. Primarily supply chain management was initiated in the industrial sector and large business but later on, as it evolved and as its importance grew, supply chain management was adopted by other sectors such as agriculture and smaller business.

Since this study focuses on SCM and agribusiness and since non-agriculture businesses initially developed the SCM concept, a review of the literature on non-agricultural business SCM followed by the adoption of the SCM concepts to agribusiness has been discussed The following section 3 will briefly present the role supply chain played in

the two business sectors. Section 3.1 briefly discusses the non-agriculture sector followed by section 3.2 where the role of supply chain management in the agricultural sector will be discussed in more details.

2.3. Supply Chain Management in the Non-Agriculture and Agribusiness Sectors

2.3.1 Supply Chain Management: Non-Agricultural Sector

The role of supply chain management in the non-agriculture sector and how it has evolved to the present state is briefly discussed in this section. The literature on business process reengineering for intra-firm coordination (Hewitt, 1994) or later termed as supply chain management (Cooper et al., 1997; Lambert et al., 1996; Turnbull, 1990) suggests various possible components that must receive managerial attention when managing supply relationships. Lambert and Cooper identified the following nine components that require management attention for a particular firm. They are: 1) Planning and control, 2) Work Structure, 3) Organization structure, 4) Product flow facility structure, 5) Information flow facility structure, 6) Management methods, 7) Power and leadership structure, 8) Risk and reward structure, 9) Culture and attitude, almost similar to some of the management activities specified in Figure 2.1.However Lambert and Cooper's framework of supply chain components does not include product related research and development activities. For example, it does not include product data management (PDM) and other information such as market share, customer satisfaction, profit margins and returns to stakeholders (Baziotopoulos,2004) which were later understood as important to achieve desirable outcomes of SCM. Along with this, supply chain managers also had to focus on overall customer satisfaction and work collaboratively rather than competitively to achieve the desirable end.For example, the United States Defense

Logistics Agency, historically, has been commodity-focused and their intra business processes were in place however they were not vertically integrated effectively with each other and working competitively rather than collaborate. Subsequently with poor performances, the Agency is trying to revamp the system by using a supply chain management and strategic concepts integrating with their customers and suppliers based on the principles and concepts shown in Figure 2.1 and Table 2.1. Supply-chain management first emerged in the manufacturing industry and later was adopted by other industrial sectors and agribusiness is one such sector.

2.3.2 Supply Chain Management: Agribusiness

As mentioned previously, supply chain management in general aims at increasing efficiency, profitability and greater customer satisfaction. Agricultural supply chain has some similarities to "standard" production systems as seen in manufacturing industries. The similarity is that like all companies, farms/ farmers have to make operational decisions such as distribution, transportation, store inventory etc. However, the situation unique to farming is that it is better to hold on to the inventory if the prices go up or if there are shortages; but, at the same time if the commodity is perishable then the concern is to get it to the market as fast as possible or processes into a non fresh form such as frozen or canned product. In a nonagricultural setting these operational decisions are made based on the assumption that very little in the overall situation changes on a daily basis. The exact opposite is true for an agricultural supply chain (Jang et al., 2002). There are also some other major differences between the non-agricultural and agricultural sector supply-chains based on the structural differences resulting in different firm conduct and economic performances.

Table 2.2. Key Supply-Chain Management Differences between Agribusiness and Non-Agribusiness Sectors

Agribusiness Sector	Non-Agribusiness Sector
Structure	
1. 1. Number of firms are many and small thus mostly horizontal alliances are formed (Hobbs et.al., 2000) and limited coordination with the buyers. This results in poor bargaining capacity. Also, the number of buyers is many and the price elasticity of non staple foods such as vegetables and fruits are generally inelastic (USDA).	1. Number of firms in an industry are few and they are characterized mostly by vertical integration (Hobbs et.al., 2000). Much stronger and powerful with strong bargaining capacity Also the number of end users is large and their price elasticity generally shows high elasticity. (Hobbs et.al., 2000)
Conduct	
2. Some product sales and distribution carried out through open auctions, involving less regulated markets (Wang et al., 2007), thus farmers are price takers.	2. Markets are more regulated thus firms are price makers.
3. Less interaction between producers and customers which inhibit development of closer relationships (O'Keefe,1998)	3. More potential interaction and closer relationship between producers and customers which is conducive to practicing SCM
4. Since firms are small, there is limited to non use of information technology (Salin, 2000) along with lack research and development activities as it is unaffordable. Most research and information in agriculture highly depends on government to supply as they are public goods.	4. Extensive use of information technology and greater confidence among members in business. Also, research for development and information gathering are done internally and they are produced as private goods which are not available to the public sector i.e. intellectual property.
5. Perception of high costs and risks to form alliances and practice the SCM concept (Bailey et al., 2003) particularly in case of small-scale agribusinesses, hence alliances formed are often weak and inefficient.	5. Less obstacles to adopt supply chain management due to the higher possibilities of economies of scale.

Table 2.2. (Continued) Key Supply-Chain Management Differences between Agribusiness and Non-Agribusiness Sectors

6. Just in time production is less feasible to meet the changing demand due to lack of market intelligence information and the capacity to respond quickly. Planting and growing decisions are made generally way in advance so good market forecasts are valuable (Wang et al., 2007)	6. Just in time production concept was developed and practiced to reduce inventory and manufacturing costs in operation management.
7. Outputs affected by vagaries of weather, disease, natural disasters and uncertain foreign competition.	7. Outputs not affected by vagaries of weather, disease and natural disasters.
8. Product safety and consistent quality is important as ultimate use is human or animal consumption.	8. Product quality is not as critical.
9. High standards in handling and transportation to maintain quality and freshness is crucial (Jongen et al., 1998)	9. Not as important since product shelf-life is a less critical factor.
10. Ideally information flow both upstream and downstream with greater emphasis on downstream information flow via labeling, branding etc is beneficial. However, since the parties involved are small and many, information flow is too expensive to adopt and hence limited or none. (Dorp,2003; Jopngen et al., 1998; Wilson et al., 1998)	10. Focus is on upstream information flows signaling demand fluctuations.
Performance	
Economic profits to small farmers are usually very limited to sometimes none.	Demand from consumers high and so greater occurrences of economic profits
Economic profits mostly seen among the wholesalers	Profits are consistent and stable
Limited provisions of public goods due to poor lobbying capacity. Affects productivity and in turn profitability.	More tax breaks and credits due to powerful lobbying capacity. R&D results in patent production laws. Results in high productivity and high profitability.

Urbanization has increased the economies of scale in non-agricultural as well as large scale agribusinesses and resulted in an impressive increase in the volume of food being marketed and the associated institutional changes throughout the food-marketing chain (Dolan et al., 2001). This has also lead to the setting of higher grades and standards for food quality and safety affordable only by a few large market intermediaries thus threatening the existence of small scale agribusiness operations.

According to the Economic Research Services and National Commission on Small farmers, small farmers are those who have "noncommercial" or small farms with sales less than $50,000(ERS) or annual sales less than $250,000 (National Commission on Small Farms). In conventional small scale agribusiness supply chains the interactions between the buyers and sellers are limited due to the nature of their alliance which are mostly horizontal, weak to poor coordination between the producers and buyers and the nature of the market which in most cases are not regulated. This is also aggravated due to the lack of information technology for information exchange in small scale agribusiness supply chains even though there is a fair amount of literature related to the role of e-commerce and supply chains in industrialized large scale farming (Boger et al., 2001; Collins et al., 2001; Fearne et al., 1999; Hobbs et al., 2000; Mansden et al., 2000; Salin, 2000). There is also limited access to information from research and development as they are all unaffordable to small farmers. Whatever information based on research and development is available are in the form of public goods. All this also limit their bargaining capacity.

According to Kinsey et al., traditional patterns of farming will change and commodities will be produced with specific attributes and for niche markets. Decisions will be made

which are increasingly interdependent; price and production will not be the risk concerns anymore but it will shift to relationships and food health, safety and security dependent on information flow which will become a prime source of control and power (Boehlje 1996; Drabenstott 1994). This is implemented through downward information flow through appropriate labeling, standard setting and branding programs and this is where the agricultural and manufacturing industry differs with each other (Wang et al.,2004). Product quality is a critical concern in agribusiness, necessitating high standards in handling storage, and transportation as well (Jongen et al., 1998). These safety and quality aspects are crucial because there is a direct correlation between product quality, meeting customer standards or requirements and customer satisfaction. This in turn is linked to revenue generation. Also in the case of small farm enterprises, the business viability depends on the ability to respond quickly to product differentiation and establish niche areas of product (Klein et al., 2002).

Since commodities are becoming more diversified, there is increased pressure to meet the quality, size, safety and delivery standards of fresh produce. However, there is compelling evidence that increased transaction costs are daunting the entry of small farmers into competitive market and face these pressures. Besides this, private companies, in order to capture markets and differentiate their products, put ever more stringent conditions on suppliers and customers/consumers are increasingly willing to pay for product attributes that include convenience, taste, variety, high quality, and low caloric intake (Napier 2001). This is precisely why many small farmers are unable to meet the requirements demanded by modern food systems with prohibitive transaction costs. This is also the reason why economic profits to small farmers are usually very

limited and sometimes none except in the case of wholesalers. In order to tackle these problems first it is important to understand the transaction costs that specifically emerge from dealing with large numbers of small farms and they are (Hayes 2000): 1. The bureaucratic costs associated with managing and coordinating integrated production, processing, and marketing.2. The opportunity cost of time used to communicate with farmers and coordinate them. 3. The costs involved in establishing and monitoring long-term contracts. 4. The screening costs linked to uncertainties about the reliability of potential suppliers or buyers and the uncertainty about the actual quality of the goods. 5. The transfer costs associated with the legal or physical constraints on the movement and transfer of goods. They also include handling and storage costs, transport costs, and so forth. Besides these there are also the risk and vulnerability associated with vagaries of weather and natural disasters. So the principal challenge becomes ensuring that small agribusiness holders benefit from commercialization with interventions aimed at reducing transaction costs (Pingali et al., 2005).

There are a number of ways in which transaction cost can be reduced and market entry by small farmers can be developed. These include contract farming, development of farmer organizations or cooperatives for supply and marketing, development of the supply chain for high-value exports produced by smallholders through an appropriate mix of private and public sector initiatives, and facilitating private sector provision of market information via improved telecommunications (Kydd et al., 2004). Contractual arrangements with wholesalers or big retailers such as supermarkets can enhance farmer access to credit and finance, modern inputs, and technologies as well as access to managerial expertise. At the same time to be at a competitive advantage and meet

customer expectations small farmers will be successful forming strong alliances with each other. Therefore what is implied here is a combination of horizontal and vertical alliances. Small farmers are also affected by poor public good provision that hinders market exchange, further increasing transaction costs. This is mainly due to their poor lobbying capacity as a result of which their productivity is affected which in turn affects their profitability. Here the role of government is crucial in specifying property rights and enforcing contracts in order to promote specialization and reduce the costs of market exchange (North 2000). Moreover, government policy needs to create incentives that encourage private sector participation in developing rural economies.

Also, while economic growth and agriculture diversification have been the driving forces of agricultural commercialization, the move toward integration into the agriculture-food system is induced by globalization trends. Globalization has resulted in the rapid growth of agriculture world trade and production has become more international. It has also resulted in changes in the domestic demand for agricultural goods in terms of quality and quantity that stems from the indirect effects of increased international trade on the growth of nonagricultural sectors (Pingali et al, 2004).

All these clearly indicate that the structure of food systems is transitioning (Dooley et. al., 1998) and "the small contribution margins and perishable nature of many of its products make efficient supply chain management extremely important for food companies" (Stank et al., 1999). Recognition of the benefits of supply chain management has resulted in fundamental changes in the organization and coordination within some agricultural industries (Duval et al., 1998) towards building a stronger supply chain.

In an agribusiness environment, from a producer perspective, to buildup a successful supply chain, the producer and buyer must move to a partnership type of relationship. The two players in the chain must coordinate and streamline their logistics, and use information systems that would allow them to share key information, thereby improving communication, allowing quicker action, and better decision making. Improving the downward flow of information through the adoption of practices such as branding or labeling is also crucial for increasing customer satisfaction. All this can be achieved by strengthening the horizontal alliances such as cooperatives (Hobbs et al., 2000), commonly seen in the agribusiness sector along with vertical coordination most often found in the manufacturing industry. These forms of coordinated and cooperative arrangements will also be beneficial in tackling the problems that may arise when there are too many suppliers and not enough buyers. Besides this, it also helps in tackling risks arising from natural disasters and extreme climatic variations.

Therefore the three important strategies that can be narrowed down from the above discussion to build and strengthen an agriculture supply chain, with a focus on small scale agribusiness are: 1. Understanding customer preference and coordination; 2. Role of cooperation and farmer co-operatives or horizontal alliances; 3. Role of branding in supply chain or in other words the role of downward information flow. The first focuses on the coordination aspect of SCM, the second on the strategic aspect and third on the logistics aspect of SCM. The following sections 2.3.2.1, 2.3.2.2 and 2.3.2.3 explore these three aspects of the supply chain to get a better understanding of their significant role in fresh produce supply chain

2.3.2.1 Understanding customer preference and coordination

In majority of the conventional business models the most dominant goal of competition depends on the level of power a business has (Porter 1985).Supply-Demand chain on the other hand involves coordination between producers and buyers and together they create a position of strength in the market place which is based on the value that is delivered to the end users (Mentzer, 2000). Study by Slater et al., (1994) has shown that it is five times as expensive to acquire a new customer as to keep an existing customer and so investing in long-term relationships with the customers is an important strategy for business success and enhanced profitability. Therefore, for any business, it is key to understand the needs of the customer and what their product preferences are. Customer preferences are based on how much they value the products and this is influenced by their perception or experience of the products (Day 1994; Goodstein et al., 1998; Narver et al., 1990 ; Novack et al., 1995; Woodruff et al., 1996 ; Zeithaml 1988).

In agriculture, the application of supply chain management should start with the final consumer and reach back to the farm (Duval et al., 1998). Information from consumers pertaining to demand and preferences are crucial inputs for agricultural businesses. Hence the importance of coordination (Xu et al., 2006) cannot be overemphasized enough. Coordination is particularly crucial for an industry that has many small producers as it results in mutuality of benefits, rewards and risk sharing together with the exchange of information (Stank et.al.,1999; Barrat et al.,, 2001).

Information sharing if coordinated effectively among the small producers is particularly important as customer demand varies as to the following: 1. The quantity of the type of products needed by location; 2. The response time that customers are willing to tolerate

as there are close substitutes; 3. The variety of products and their quality; 4. the price elasticity of various products (Chopra et al., 2004). This information sharing among players along the supply chain for the agricultural sector will result in increased customer satisfaction for the products and increased profitability to the producers and buyers. These indicate the importance of coordination in understanding what the customer preferences are for which information sharing is key.

In conclusion, inter-firm supply chain coordination is a significant explanatory factor for performance outcomes. Specifically, the level of coordination is a significant predictor of respondents' perceptions of how their firm performs, what is the level of customer satisfaction, the flexibility in meeting customer requirements, and assessment of customer needs (Stank et al., 1999; Barrat, 2004). Cadilhon et al., (2005) in their paper presents insights from the Vietnamese vegetable supply chain and demonstrated the ease with which producer-customer coordination can work in an agricultural supply chain. The study demonstrated the importance of organizational culture and coordination particularly for a low value-high risk food category such as fresh produce, without major investments.

2.3.2.2 Role of cooperation and cooperatives in supply chain

Organizations with a strong sense of mutual dependence develop cooperative goals and these goals help them develop trusting, continuous improvement of relationships that result in customer satisfaction. In general the perception is that cooperation helps persons involved move toward goal attainment. The basic understanding is that one's goal attainment helps others reach their goals and as one succeeds, others succeed. So, the different entities in the supply chain such as the producers and the customers develop effective relationships where they feel they trust

and rely upon each other and actually assist each other by working for continuous improvement. These cooperative relationships in turn result in customer satisfaction. For example cooperating with its suppliers (such as wholesalers) can help farmers, farm organizations or farm cooperatives to strengthen its market (Wong et al., 2005) and supply chain researchers have argued that by strengthening cooperation both parties can meet competitive pressures of the market, maintain self-sufficiency during turbulent times or times of environmental changes (Dyer, 1996a, 1996b; Harrison et al., 1996; Hines, 1994; Kumar, 1996; Toni et al., 2000; Womack et al,1996; Crossan et al., 1995;). A study conducted by Wong et al., 2005, in china showed that in a supply chain, organizations (applicable to farmer organizations or cooperatives)) and suppliers (wholesalers, main buyers) who recognize each other's importance develop cooperative rather than competitive and independent goals. With cooperative goals, they come to trust each other and work for continuous improvement; these relationships in turn result in the products and service that satisfy customers. Results were interpreted as suggesting that cooperative goals are an important basis for developing effective supply chain partnerships.

A good example of successful cooperative partnership is a case in Andhra Pradesh where the development of labor-water exchange allowed marginal farmers to obtain irrigation water from neighboring farmers with tube wells and pay in labor services (Deshingkar et al., 2003). The availability of water also enabled year-round production of vegetables. Besides cooperation, from the studies mentioned earlier and studies on agricultural producers by Duval et al., (1998) and Dooley et al., (1998), conclude that new forms of alliances such as development of cooperatives and other forms of alliances are crucial for

agricultural industry to maintain profitability and customer satisfaction, particularly from a producer/farmer perspective. Cooperatives provide a critical link in the food and fiber supply chain. Agricultural cooperatives are typically classified according to the three major functions they perform: marketing, supply, and service. Many cooperatives combine all three types of functions in their operations (University of Manitoba and ARDI Report, 1999).

Cooperatives' can meet producers supply needs, also influence producers' input costs, and consequently their profitability. Likewise, the marketing functions that cooperatives perform influence farmers' ability to market their commodities and this directly affects the profitability of producers' operations (McNamara et al., 2001). These are some general advantages of cooperatives. However, forming such strong alliances with each other, specifically when there are large number of small farmers, farmer cooperatives in an agricultural supply chain increases the bargaining capacity of the farmers and is considered a crucial strategic move that can ensure stronger coordinated and collaborative linkages, consistency in supply, improve marketing capacity and enhance profitability (Yang et al., 2002) and reduce transaction costs (Pingali et al., 2005). Therefore alliances among farmers through cooperatives can assist farmers in achieving a stronger competitive advantage.

In conclusion, as pointed out by Cook et al., 2001, strategic partnering through cooperatives are emerging and strengthening the position of farmers' groups in agriculture supply chains, and vertical alliances are cementing sustainable partnerships throughout the supply chain (Zylbersztajn & Farina, 1999)

2.3.2.3 Role of branding in supply chain

Improvement of logistics in agriculture supply chain, through efficient information flow is another important aspect in forming and maintaining an efficient agriculture supply-chain. This information flow could be through multiple forms such as labeling, branding, advertising campaigns and use of information technology. These methods have been found to be highly beneficial in agriculture supply chain as it ensures quality standards; transparency and produce identify which were all found to be directly correlated to customer satisfaction. In the fast moving consumer goods industry, brand management has a long tradition and is an important marketing option. In this environment of increasing communication and information flows, customers view brands as an orientation guide for their buying decisions (Homburg et al., 2003; Nieschlag,et al., 1997; O'Shaughnessy, 1995)

In the case of edible goods search attributes such as price and color that are visible to customers prior to consumption are major determinants of food choice but for most food products, sensory attributes are also important, including color, texture, flavor, glossiness, oiliness, and fat content, depending upon the food and overall appearance (Bender, 1981; Francis, 1995; Caswell et al., 1996). All this makes food a "search good" and information is crucial as it helps customers discriminate between products. Customers are also said to be increasingly concerned about how their food is produced and where it is produced making them "credence goods". Most customers rely on these product claims provided through branding (Caswell et al, 1996).The brand owner has to guarantee for the genuineness of the characteristics throughout the whole food chain. Also consumers distinguish between strong and weak brands and so brands must cover dimensions like

trust, quality, risk reduction and traceability (Hanf et al., 2005). A good example is the comparison made between a breakfast cereal manufacturer and fresh commodity such as fruits producer. The key difference between these two situations is that the breakfast cereal manufacturer has somehow differentiated its product so that consumers view it as unique, whereas a farmer sells the fruit not differentiated from the product of any other farmer and long as consumers are offered a commodity product, they will make decisions based solely on price. However consumers might desire food products that are different from the commodity standard and if this is provided through appropriate branding and quality control they might be willing to pay a premium (Hayes et al., 2004). Therefore branding in food or agriculture supply chain helps in ensuring and maintaining quality standards which is very important from a customer perspective and also is regarded as a form of risk management. In case of large number of small farmers , adoption of branding may not be cost effective but in such instances either strategic alliances among the farmers through farm cooperatives or vertical alliances with a larger wholesaler or any other private entity who is capable of making such investments , or even government supported programs that either directly support farmers or farmer cooperatives in the supply chain or encourage partnerships in the supply chain are some potential options that needs to be explored.

A study that was conducted in 2000 in South Africa and Netherlands, with farmers, fruit cooperatives, private companies and educational institutions, found that lack of accurate information on logistics flows and quality aspects of the fruit was a problem common among chain partners (from farmer to retailer).

As far as the food and agriculture industry is concerned, generic commodity promotions have been utilized by many farm organizations to promote the sale of their commodities. More recently in the United States, State commodity promotions which promote food and agricultural products produced within a state's borders are becoming widespread. Some examples are the Jersey fresh tomatoes from New Jersey, Vermont maple syrup, Virginia hams and Iowa interstate 80 beef (Hayes et al., 2003).

Therefore it can be summarized that to build a strong agribusiness, supply chain management incorporating the three management practices previously discussed of customer preference and coordination, forming cooperatives and adopting branding must be seriously considered and effectively incorporated.

2.4. Supply Chains in the Small Farms Sector

The strategy of enterprises in meeting the end user needs can be placed in two categories. One is the Product Oriented Enterprise where the focus is on the product. In this case the strategy of the enterprise is production maximization; however, planning, operational and information exchange among the chain players are limited. The other, which is shown to be the more effective type, is the Market Oriented Enterprise where the focus is on developing a product driven by the market. The aim of this strategy is to maximize product value, where planning is more strategic and information is shared among players along the supply chain (Roekel et al., 2002). Supply chain management fits more with the market oriented enterprise type.

To develop supply chains require a lot of effort in strategic planning and at the same time competencies of those involved in managing the supply chain must be demonstrated. The expected outcome of the supply chain should have performance measures such as

efficiency, flexibility, innovation and responsiveness, of which the target levels are set by the different players (producers and consumers) in the supply chain. Needless to say, the seamless coordination from the producers and to the consumers is a necessary and essential link in the supply chain that connects and unites each player all at once. The key aspect which sometimes are being neglected that the producer must remember is that in supply-chain management, consumer preference and demand is crucial and therefore their demand must be met effectively and quickly to ensure customer satisfaction. Various studies have been conducted indicating the benefits of adopting supply-chain management framework and strategies. Study by Roekel et.al.,2002 showed that benefits for having a successful supply chain in the produce industry are: 1. Increased sales; 2. Increased awareness among key players due to better flow of information regarding products, markets, consumer preferences and innovative technologies; 3.Transparency in activities with better chances of tracing and tracking to the source of problems and success; 4. Better control of product safety and quality and risk sharing; and lastly; 5. Result in increased investments. A study of the Vietnamese vegetable supply-chain by Cadilhon et al., (2005) demonstrated the strategy of applying the principles of collaborative commerce among the players, particularly if they already have an organizational culture conducive to collaboration and partnership. The study found that information sharing such as market forecasts and timely input replenishment and cooperative planning among trading partners along the supply chain with training on safe agricultural practices all lead to elimination of waste, a reduction in inventories, and possibilities of products running out-of-stock and increase in on-shelf availability, thereby strengthening supply-chain of the vegetable industry.

Dimyati et al., (2004) in their study on mangosteen in West Java, where they attempted to establish a supply chain to increase income and the bargaining position of the growers found that without SCM and practicing conventional method of marketing actually lowered the bargaining position of growers. Farm management practices such as fertilization and crop protection without effective coordination with downstream chain players did not improve their economic performances. Furthermore, it was found that financial support is a crucial aspect for the sustainability of the mangosteen agribusiness The formation of a mangosteen supply chain composed of growers, collector agents and other actors helped to capitalize on economies of scale and cost effective collaboration of up and downstream partners. It was also indicated in the study that the performance of the institution in the future will depend upon its creativity and motivation, and the support from the local government and other public institutions.

In 2001 and 2002 five country case studies on farm-agribusiness supply chain linkages as a FAO (2005) initiative was undertaken in Ghana, Nigeria, Kenya, Uganda and South Africa. The main purpose of the studies was to get an insight into current farm-agribusiness linking arrangements and the type and strength of linkages formed between different players. These linkages depended not only on their mutual interest in forming and maintaining agreements, but also on other factors including the physical and institutional environment, and the types of products or processes involved. For instance players in the supply chain such as wholesalers or major supermarkets could play a crucial role by forming collaborative alliances between each other. This form of alliance known as vertical alliance potentially enables many small farmers to overcome market failures and significantly reduce their transaction costs and also enhance farmer access to

credit and finance, modern inputs, and technologies as well as access to managerial expertise showing positive effects for small farmers (Reardonet.al., ,2002 ; Reardonet.al., ,2004). At the same time, in agribusiness, with its emphasis on quality, consistent supply and reduction in transaction cost, prefers large farmers to small farmers (Key et al., 1999). Small farmers however can overcome this by coordinating their activities through horizontal alliances. Examples of such horizontal strategic alliances are formation of organizations such as farmers' co-operatives (Pingalu et al, 2005). The studies also indicated that the existence of farmer's organizations such as producers' co-operatives or associations and agricultural lobby groups are beneficial to commercialization of agriculture and agribusiness development particularly in the case of small scale agribusiness supply chain linkages.

Also nature of the product is an important factor determining the nature of collaboration between producers and processors. Highly perishable, labor intensive crops, which do not have an alternative market, ensure very close collaboration between farmers and agribusiness firms. The case studies thus indicate that farmers, particularly with small holdings, must evolve strategies to enhance their market power. They point out that forming and strengthening farm-agribusiness supply-chain linkages can result in farmer benefits such as assured produce markets, low production risks, transfer of knowledge on the latest farming technology, supply with crucial agricultural inputs, increased transparency and a number of other positive developments such as increased incomes and investments in agribusiness across the region. The best examples are the horticultural and dairy sectors in Kenya and Uganda (Dannson et al., 2004).

In cases where the products are fruits, vegetables and other horticultural products the supply chain involves moving products along the chain but includes issues such as eating quality (such as appearance, taste, smell and consistency), food safety, integrity and traceability, in-store handling, presentation, consumer behavior, inventory management, storage, transportation, packaging and post harvest treatments, production practices and choice of variety and growing location (http://www.horticulture.com,2004) and all this can be accomplished through the development of appropriate and stronger alliances and adopting crucial supply chain management practices.

Since the focus of discussion in this section was on small farms and since the Hawai'i avocado industry comprises of a large number of small farmers, the steps involved in building a supply-chain in the small scale food and agribusinesses can be recommended for adoption by the Hawai'i avocado industry especially considering its potential benefits. This would help the avocado growers to revive the industry, enhance their income and substitute imports thereby becoming self-sufficient. The following sections 2.5, 2.6 and 2.6.1 briefly discusses the Hawaii agriculture sector and the Hawai'i avocado industry which is the main focus of this study, and this is followed by a discussion on the limitations and constraints faced by small farmers such as the Hawai'i avocado growers

2.5. Hawai'i Agriculture

Decline in sugarcane and pineapple industry has resulted in an increased scope and shift towards diversified agriculture in Hawai'i. In 2005, Hawai'i's Agricultural Farm Revenue the following Figure 2.2 clearly illustrates that diversified agriculture accounted for 76 % of the farm revenues followed by pineapples with 14% and raw cane sugar with 10% and as can be seen from Figure 2.3, diversified agriculture sector from 1995 to the present has shown an increasing trend.

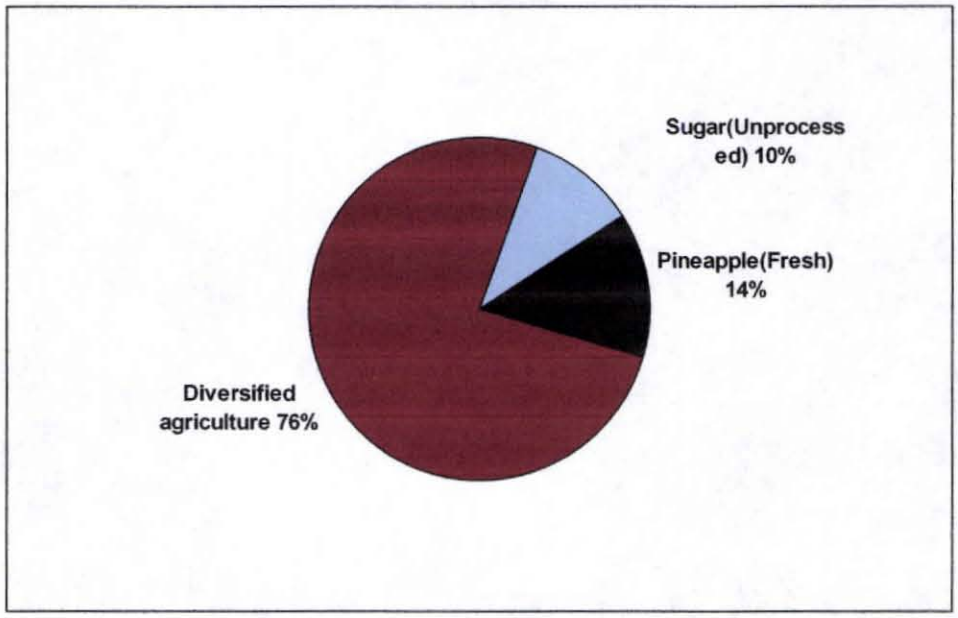


Figure 2.2. Hawai'i Agriculture Farm Revenue Percentage Distribution (2005)
Data Source: Hawai'i Agricultural Statistics 2005

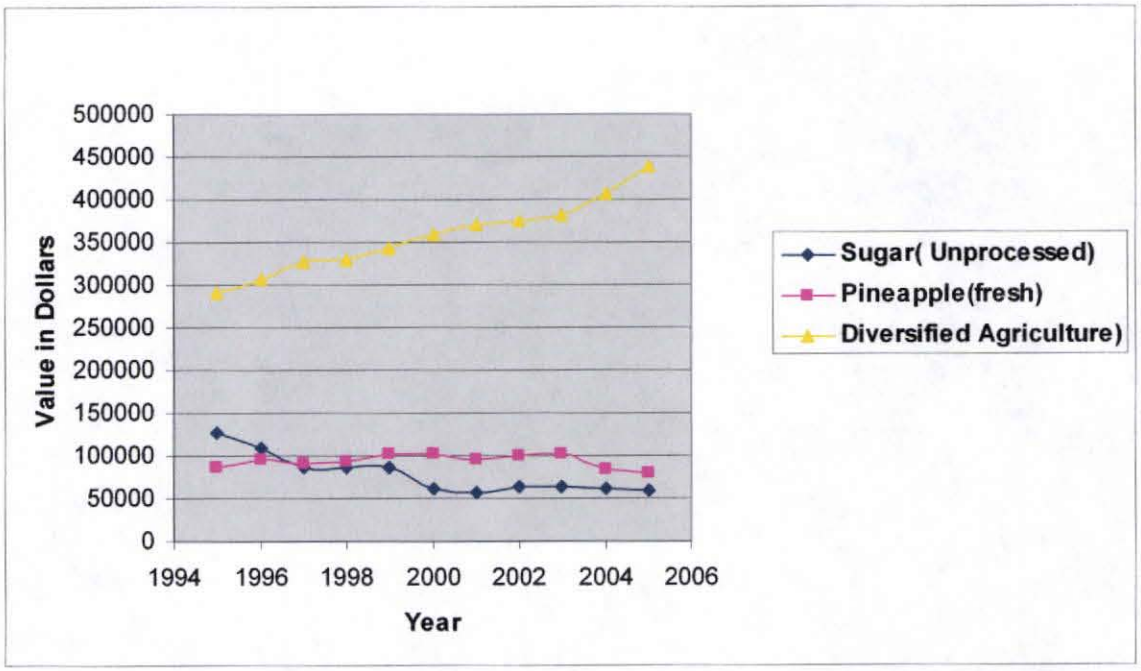


Figure 2.3. Hawai'i Agriculture Farm Revenue Distribution Trend (1995-2005)
Data Source: Hawai'i Agricultural Statistics 1995-*2005*

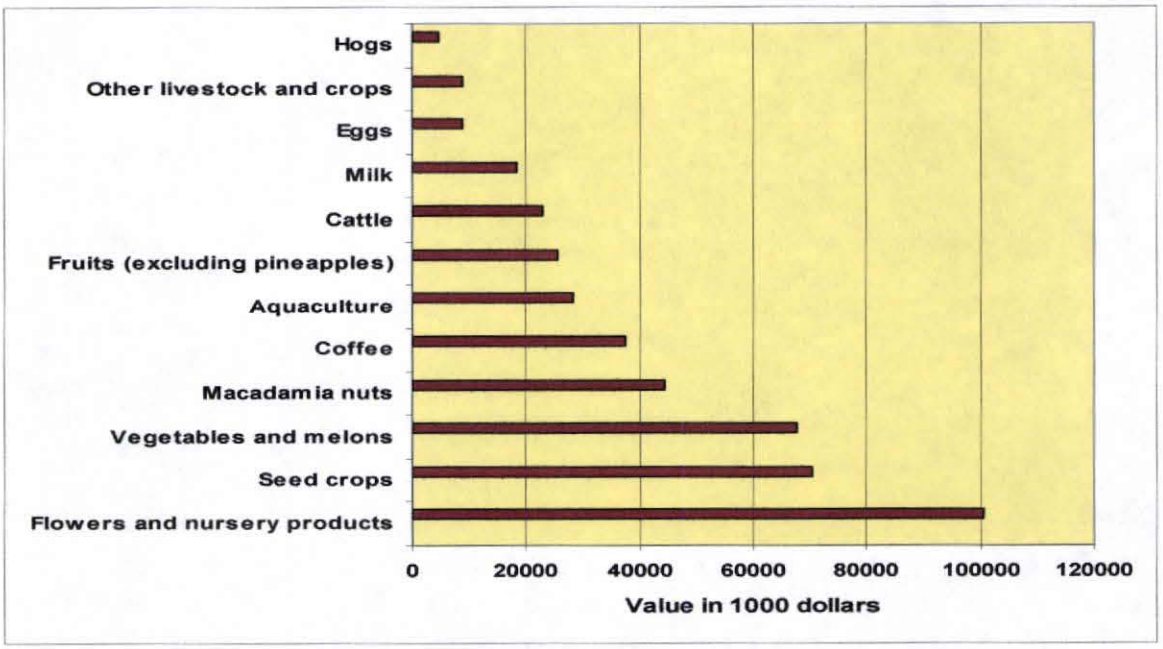


Figure 2.4. The Major Sectors of Hawai'i's Diversified Agriculture 2005
Data Source: Hawai'i Agricultural Statistics 2005

Figure 2.4 above illustrates the value of Hawai'i's diversified agriculture for the year 2005. Among them, the largest sector with maximum value is from the flowers and nursery sector which is more than $100 million. The fruits and vegetables is ranked seventh with a value of $25 million in 2005 and on the whole diversified agriculture production posted record high sales of $438 million in 2005.

2.6. Hawai'i Avocado Industry

According to the Hawai'i agriculture statistics, 2005 Census of the diversified sales in Hawai'i, tropical fruits excluding pineapple was ranked 7th comprising 5.9% of the total diversified sales. Of the different tropical fruits, avocados comprise 27% of the Hawai'i Market Share in Fruits. Hawai'ian avocados constitute about 28% of the total demand and is showing a decreasing trend compared to imports. From 1990 to 1995 (Figure 2.5) the local avocado production showed a declining trend but it started showing an increasing trend from 500,000lbs in 1995 to the current production of 800,000lbs in 2005 along with an increase in commercial value of $273,000 in 1995 to a current $600,000 in 2005. However during the same years Hawai'i's Avocado imports showed a decline in 1999 but went back to a greater increasing trend compared to local productions from 700,000lbs in 1995 to 2130,000lbs of avocados for the year 2005 (Statistics for Hawai'i Agriculture, 2005; National Agricultural Statistical Service, 2005).

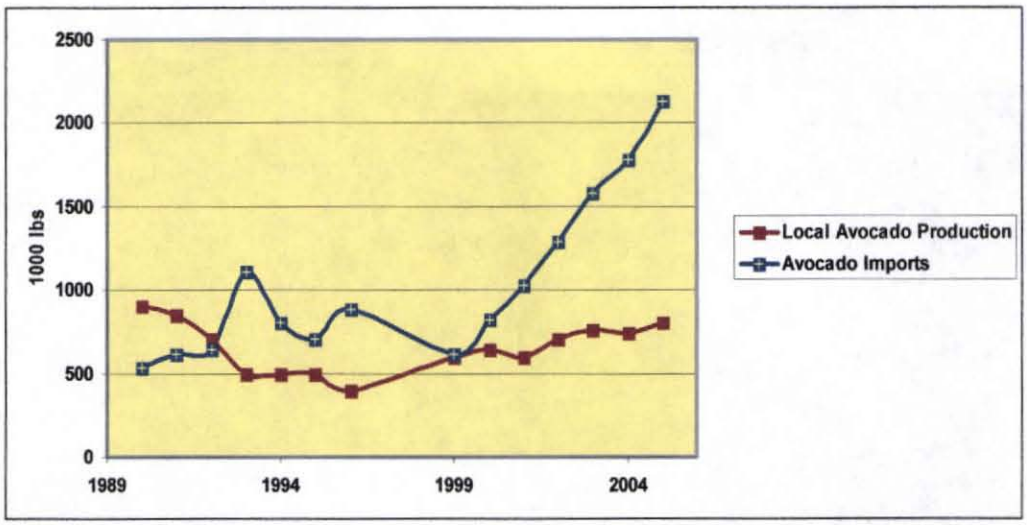


Figure2.5. Hawai'I Avocado Supply Trend 1990-2005
Data Source: Hawai'i Agricultural Statistics 1990-2005

Hawai'i produces some of the world's most valued agricultural products which include coffee, macadamia nuts, tropical fruits, flowers and sugarcane. Among the tropical fruits avocados is an important fruit with all the three avocado races available in Hawai'i and almost 30 known varieties grown locally (Table 2.3). The three avocado races include Guatemalan which has hard, tough, thick or pebbled skins and is medium to large in size, each weighing more than 150 grams. The Mexican race is thin and smooth skinned and smaller in size, with each fruit weighing less than 150 grams and lastly the West Indian race with smooth and thin skin of medium to large size.

Table 2.3. The General Characteristics of the Avocado Races Found in Hawai'i.

Race	Origin	Fruit Skin	Fruit Size
Guatemalan	Guatemalan Highlands	Hard, tough, thick, pebbled	M-L (>150g)
Mexican	Mexican highlands	Thin, smooth	S <150g
West Indian	South American and Mexican lowlands	Smooth-thin	M-L

Data Source: CTAHR Extension Services Report, Fruits and Nuts, 1999

Avocados were introduced to Hawai'i in the early 19th century, probably by the Spanish horticulturist Don Francisco de Paula Marin. A formal program of avocado selection began in Hawai'i with the initiation of the Hawai'i Agricultural Experiment Station (HAES) in 1901. Since then many known varieties were tested and found suitable for Hawai'i and they include Sharwil, Greengold, Kahalu'u, Nishikawa, Murashige, Ohata, Semil, Yamagata and, Malama (CTAHR Extension Services Report, Fruits and Nuts,1999).

Avocados are also considered nutritious and it has been newly included in the National 5 A Day Program due to recent changes in the NCI criteria (Cook, 2003). It is also a very versatile fruit with potential for niche markets such as tinned guacamole and avocado oils and more recently it has been considered as a potential bio-diesel source and its byproducts as cattle feed (Leidemann, 2007).

With the decline of sugar and pineapple industries in the mid-1990s and reduced production volumes within the ranching industry since the mid-1980s, resulted in a proliferation of small farmers. These were independent farmers producing a wide variety of commodities have played an increasing role in the continued growth of the agriculture industry. (Hawai'i County Report, 2005). The Hawaii avocado industry is one such specific industry under the Hawai'i diversified agricultural sector. Diversified agriculture comprising of small farmers, has the potential for continued progress; however, there are problems which needs to be overcome before the potential can be realized. These problems include, but are not necessarily limited to: land cost, cost/availability of water, cost/availability of transportation, cost of labor, marketing, developing and maintaining

quality standards, and disease and pest control (Hawai'i County Report, 2005). Besides these there is also the competition faced from imports. As the Figure 2.5 above illustrates avocado imports has been showing an increasing trend since the last 15 years ever since the introduction of large chain grocery stores such as Safeway. This is a critical issue that the local Hawai'i avocado industry cannot overlook. Another potential drawback of the industry could be the lack of customer involvement. The information gap that exists between the growers and customers resulting in limited to no knowledge on consumer preference may have possibly hindered the growth of the local avocado industry. The next section discusses in some detail these problems along with steps and challenges in overcoming these problems.

2.6.1 Forming and Strengthening Small Farm Supply Chain: Steps and Challenges

Small-farmers are often in a disadvantageous position to adjust to new market conditions as they are the least organized. They are low in capital, use traditional techniques, operate in small-scale, depend on family labor, and sell their produce individually (Roekel et al., 2002, Bittenbender et al., 1989, Jang et al., 2002). Above all this they are faced with severe competition from the big players in the field as well as imports (Roekel et al.2002, Bittenbender et al., 1989). Therefore to adapt to new strategies they have to understand markets, strategically plan their activities, have access to means to improve products and upgrade production systems.

According to a study conducted by Bittenbender et al., (1985) on the Hawai'i avocado industry, inadequate delivery of new production and marketing information to the

industry is severely hindering its expansion. Along with this, insufficient on-farm visits and programs by the extension agents, slow production of extension bulletins, lack of promotion of technologies and new cultivars and marketing strategies & ideas have aggravated the situation. In addition there was also the growing competition from imports. During the 1980s, as a strategy to enhance the local avocado farmers' income, there was a drive to increase local Sharwil production and it was extensively propagated. The intention was to export the local Sharwils to Canada, Alaska, and other parts of mainland USA. However this move was not a success due to Animal and Plant Health Inspection Service (APHIS) regulations which permitted the exports of Hawaiian avocados to the mainland and other parts only if it was certified to be fruit fly free. This unfortunately proved to be cumbersome to the local growers. Most growers are not in a position to meet the regulations for packaging and transportation limiting their marketing and export potential. To tackle all this cooperative efforts among avocado growers were encouraged but it has not yet taken shape. Even though the Hawai'i Avocado Association was formed which is a statewide industry association, they lack resources to sponsor research, educational, promotional and other marketing support to its members. This also resulted in the absence of customer involvement and feedbacks. Also, inspite of the potential avocados has for value added niche markets, no necessary steps such as branding or labeling or any such consumer awareness programs has never been explored. This restricts information flow which in turn can affect decision making and cause inefficiency. A FAO report of 1999 stated that, "small islands tend to be remote and geographically-dispersed; their populations and markets limited; their resource base narrow, they are fragile and prone to disruption by natural disasters; and they have

limited local capital for productive investment". Hawai'i is a small island state and they are vulnerable to the above mentioned limitations. Small farmers in Hawai'i are also exposed to a number of other constrains faced by small islands, particularly by the agriculture communities such as lack of information and technological limitations with regard to farming activities leading to substantial losses (post and pre-harvest).

Efficient marketing systems are also limited due to the geographic remoteness of the place, poor infrastructural facilities such as roads and transport and poor market systems. The bargaining power of large scale farmers are not possessed by the number of small individual farmers in an island community. Then there are the limitations caused due to lack of investment in market research and knowledge of producers, buyers and consumers. However, recently there have been instances where small islands have started realizing and identifying these problems and prioritizing their needs (FAO Report, 1999) Also, two important decisions to be made in farming enterprises are operational decisions and tactical decisions. However these two decisions cannot be considered until the strategic decisions are made. "The goal of strategic planning is to arrive at the most efficient, highly profitable supply chain system that serves customers in a market" (Jang et al., 2002) and anything in the strategic decision can be changed except the external market demand. Unfortunately studies and papers related to strategic decision making , particularly for small farm enterprises is almost non-existent although it is available to a marginal degree in industrialized agriculture (Hobbs et. al., 2000; Jang et. al., 2002). Also effective strategic decision making and its role in conventional small scale agribusiness supply chain is not significantly stressed.

Most studies dealing with adoption of rural development and agricultural improvement programs by farmers , consider and evaluate the impacts on farmers only after the implementation of the program. Farmers are rarely consulted prior to the adoption of the programs about their specific circumstances, priority problems and their preferences for the type of intervention. Normally such adoption behavior studies come after the costs have been incurred and the new strategies diffused (Feder et.al.,1981).

Prior identification of farmers' preferences can help design more acceptable and cost-effective development intervention programs(Batz et.al.,2003) and it can also help to gear development intervention programs to the needs of different regions and group of farmers.The usefullness of this approach is that it is the farmers who are the ultimate users of the program and take decissions with the intention of maximizing thier benefits (Bekele,2006).

Failure of some of the development programs as indicated in the studies by Pankhurst 1990, Hoben 1996, Admassie 1995, Shiferaw and Holden 1998, it is clear that there is a genuine need to understand and address factors influencing farmer's preferences for different types of intervention programs(Bekele,2006).Also, according to Boehlje (1996), farmers appear resistant to abandoning the open market. It was observed that institutional change has met resistance from farmers, mostly because these new ways change relationships and frequently substitute interdependence for the much-cherished independence. Hence a better understanding of farmers' attitudes, willingness, knowledge, and preferences concerning the use of new forms of coordination would be informative to all supply chain participants. Such an understanding would allow for the design of more efficient arrangements (Duval et al., 1998).

In the produce industry, like many others, the principal communication between supplier and customer has been based on price. Price was the only subject of negotiation between buyer and seller. Although today, produce industry is not just influenced by the price but factors such as quality, variety, information, safety, taste and reliability (Perosio et al., 2001) underscoring the importance of downward information flow. National surveys have shown that origin is an important factor to fruit and vegetable consumers (the Packers, 1996). Studies have also shown that consumers perceive products of local origin to be of better quality than competing products from other regions (Patterson et al., 1999).

However, producers and buyers do not always have access to this non-price critical information that is required for effective negotiation. The way it can be achieved is by setting up producer-buyer partnership and setting up agendas that allow everyone involved to more fully appreciate the positioning, cultural practices, and unique features of fresh produce, including, for example, the high degree of perishability (Perosio et.al.,2001; Reviron et al.,, 2005) , in other words enhancing downward information flow through adoption of practices such as branding. Studies point out that there are increased worries among consumers with regard to uncertainty in quality and also there is a search for reduced logistical costs. Limiting the commercial partners and improved information tools may contribute to reducing logistical costs but it does not deal with quality management (Reviron et al., 2005).

As far as quality is concerned , consumers may be willing to pay a premium price for domestic produce if they perceive it to be of higher quality, but this opportunity will not

necessarily translate into higher grower profits unless the following two conditions are met 1) any distinguishing characteristics of the product must be maintained and made clear to consumers usually via promotion; 2) producers must be able to collectively restrict entry and control the supply of a branded product and there should also be restriction of supply of foreign-grown products by acting as a non-tariff barrier to trade and this is more likely to happen in a tightly defined geographic area (Carter et al., 2003, 2006).

Also, in the fresh produce industry time is a crucial factor and also the quickness of response (QR) in terms of delivery is important. Ensuring fresh produce to the customers with the least damage and the freshness intact is a crucial strategy for the fresh produce supply chain.

Conventionally, supply chain conjures up images of products moving from supplier to consumer along a chain but practically it is important to visualize information flow and product flow, to and fro between supplier and consumer. Conventional supply chain generally implies only the role of one player at each end and it was found to be ineffective (Chopra et al., 2004).

Considering all these limitations and challenges the applicability of conventional models of supply chain management, particularly on its effectiveness on the fresh produce industry needs to be re-considered. As studies indicate what is needed is a much closer coordination between producers and buyers for which supply coordination and demand (buyer) coordination must be closely integrated, be in a stronger position to exchange information, understand specific needs, reduce transaction costs , develop bargaining power and increase profitability and customer satisfaction.

This study attempts to put forth a more contemporary approach to fresh produce supply chain management integrating supply and demand management within and across companies. A modified conceptual model (Figure 2.6) has been suggested which represents the supply demand integrated management process designed specifically for the fresh produce industry with the specific case of the Hawaiian avocado industry in focus incorporating the three main management strategies of SCM to overcome the limitations and meet the challenges successfully.

2.7. Modified Conceptual Framework-SDIM

If the supply and demand chain management is coordinated effectively, as represented in the Supply Demand Integrated Management (SDIM) framework, it would improve the competitive advantage of the supply-demand chain. Broadly speaking, supply coordination involves efficient strategic tactical and operational decision making and demand coordination involves, coordination and integration of buyers in addition to the effective information flows through research & development to maintain strong coordination.

In Figure 2.6, the strategic decisions includes tactical decisions, comprising of decisions on how and when to sell-through cooperatives, product selection, the quantity demanded & quantity produced and overall farm management aspects such as number of acres to be planted, irrigation facilities, and scheduling of pesticides, fertilizers and harvesting .This incorporates the tactical decisions which include details such as number of acres to be planted, the scheduling of farm activities and finally operational decision which comprise of production and logistic arrangements. The production arrangements

comprise of activities such as planting of the right varieties, pre-harvest and post harvest arrangements, and other infrastructural arrangements taken into consideration. Logistics comprise of proper branding, packaging, distribution and transportation arrangements. These have been adapted from the agriculture decision making model put forth by Jang et al., (2002). Here the focus is on strengthening alliances which would result in advantages such as – competitive advantage, enhanced outputs, import S\substitution

The next component is Research and Development (R&D) which is an important component as it ensures essential information. R&D and the final component, incorporating buyer preference which involves understanding the needs and specifications of the main buyers(include chefs, wholesalers, regular consumers), ensuring quick response and fast delivery, or in other words reduced order cycle time would both result in further enhancing outputs, increase competitive advantage, help towards import substitution, improve quality, achieve greater consumer satisfaction, and trust thereby strengthening producer buyer coordination. All this in turn will result in developing long-term trust.

The other advantages of adopting SDIM is that it helps in forecasting and brings about change through developing a close and trusting relationship leading to fewer product defects, and improved product design. It also reduces uncertainty through more reliable transportation and helps in sharing cost and information which is crucial in identifying redundant costs (Mentzer,*2000;* Mentzer 2000; Cadilhon et.al.,2005).

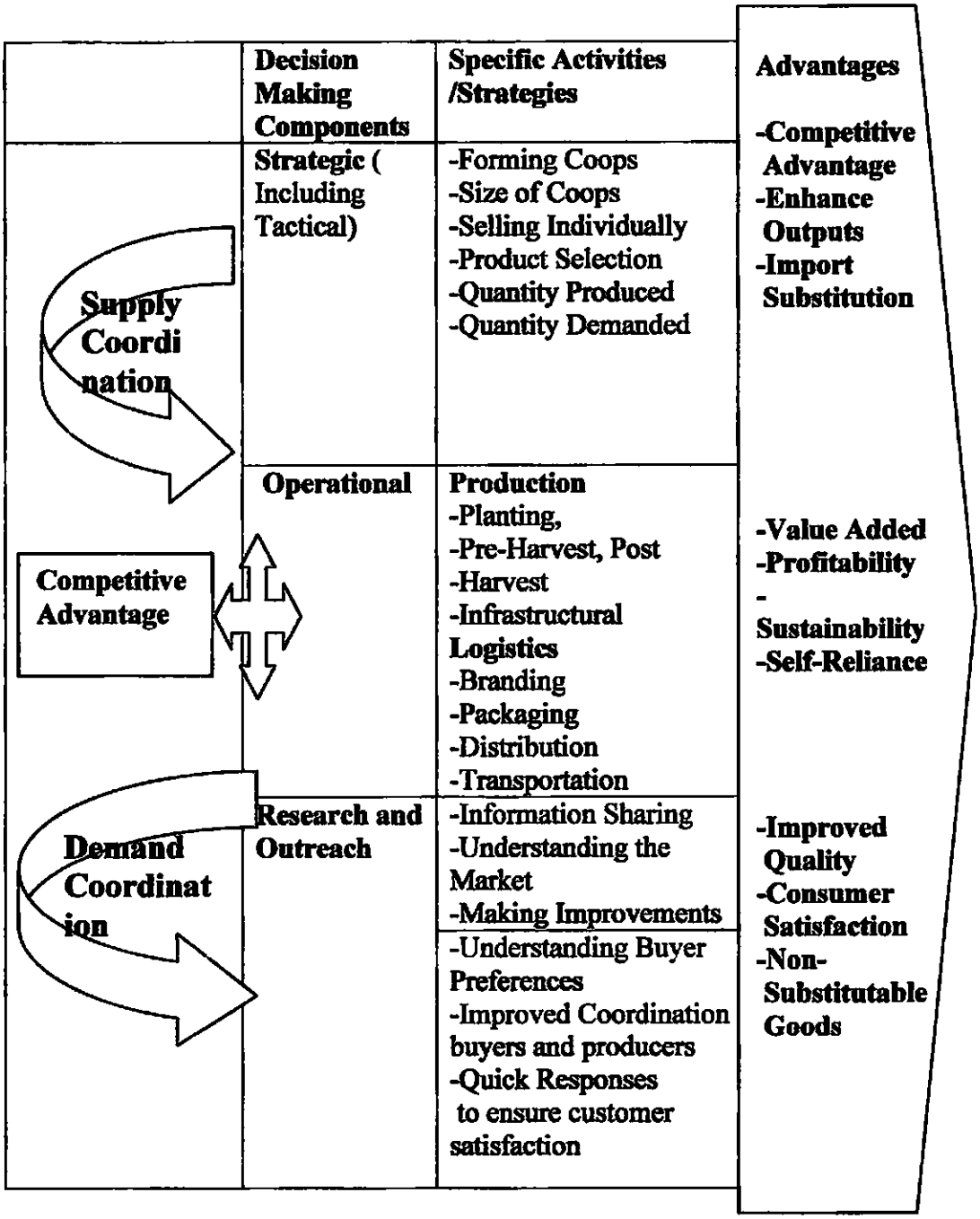


Figure 2.6. Fresh-Produce Supply Demand Integrative Management (SDIM) Framework

Also, competitive advantage as mentioned above, and profitability can be enhanced through strengthening supply chain management and this can be achieved through cost leadership and differentiation, and enhancing overall customer satisfaction (Bowersox et al, 1996, Monczka et al., 1998, Porter, 1980; Giunipero et al., 1996). In most supply chains value is strongly co-related with supply chain profitability and thus supply chain profitability is the total profit shared across all stages. So, higher the profitability, more successful will be the supply chain. All flows of information, products or funds generate costs within supply chain, and the only source of revenue is customer. Therefore customer satisfaction, and close coordination and integration is crucial and the SDIM model pays specific attention to this. The SDIM framework is different from the conventional supply chain in the sense that it proposes that both supply and demand coordination start at one end indicating very close integration and coordination between producers and buyers. This is unlike the conventional supply chain where buyers are at one end of the supply chain and the producers at the other. This distance can cause inefficiency and ineffectiveness in management and limits development of long term trust, resulting in poor customer satisfaction. The SDIM framework clearly specifies the four main components of the supply-demand chain that should be seriously considered by small farmers who wish to adopt this framework to enhance their income, profitability and get a competitive advantage in the market. It also helped in the development of long term trust due to the nature of coordination and cooperation resulting in various positive consequences. Therefore it can be concluded that the advantages of supply demand integrated chain management are improved customer value and satisfaction and profitability to achieve differential advantage.

In essence, the outcomes of such an integrative management scheme will be in the form of impacts that can be measured in terms of consumer satisfaction, profitability, competitiveness, self-sufficiency, value, sustainability and import substitution and that is the usefulness of the SDIM model.

2.8. Summary

The FAO committees report of 1999, suggested the following agriculture production strategies to be explored. An increased production which would be absorbed both in the domestic market (e.g. local tourist market) - either to meet increased demand or substitute for imports - and in export markets. In the latter case, the potential of these crops for niche markets should also be explored. Along with this joint marketing services, setting standards, information flow, coordinated decisions on buying raw materials, transportation, packaging, training, quality, etc. in order to be more competitive were also recommended.

Conventional supply-chain framework has not been very effective in meeting these suggestions and maximizing net returns due to gaps and ineffective strategies. What is required is a more contemporary approach to supply chain management encompassing the planning and management of all activities, mainly involving two functional components: i. Supply coordination and ii. Demand coordination under which there are strategic management, operational management; research and development; and focusing on buyer preferences. It suggests a much closer coordination and collaboration along with research & outreach with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers.

There are many small farmers in Hawaii due to the decline of the sugar and pineapple plantation. Also agriculture is in a period of evolving technological and institutional changes. Technological change is not new to agriculture, but institutional change is (Phumpiu et al., 1997). Two factors are driving this change. First, agriculture has become more demand oriented, and the Federal Agricultural Improvement and Reform Act of 1996 (FAIR Act) is moving agriculture farther and faster along that road. Second, recognition of the benefits of supply chain management has resulted in fundamental changes in the organization of and coordination within some agricultural industries. The major institutional change in Hawaii will be the adoption of new forms of coordination along with the production and marketing channels to replace the traditional commodity marketing system and branding *(*Packers 1996*)*.

Thus a "carefully choreographed" (Toerien,1999; Perosia et al., 2001), supply-demand integrated chain for the produce industry comprising of better marketing, understanding customer preferences, effective information sharing, incorporating strategic management aspects such as forming "farm co-operatives which would result in more stable demand and a larger customer base"(Jang et.al., 2002) with a greater focus on quality and place of origin or geographical identity through branding and higher net returns has been suggested.

According to Loureiro et al., 2000, customers' attitudes toward quality and desire for cultural identification have generated a growing demand for agricultural products that carry a strong identification with a particular geographical region. A study conducted by them on the customer's willingness to pay for fresh products that carry geographical identification label, they found that a premium up to a certain level of quality can be

obtained for the product. In recent years, an escalating demand for high quality and high status products and a desire for cultural identification have created a growing market for value-added products that carry a strong identification with a particular geographical region. This points out to the importance of local branding as brand label is an instrument that can reduce the asymmetric information problem between producers and customers, as well as the search costs for consumers (Loureiro et al., 2000, Caswell et al. 1992). Considering the local demand for avocados, and the potential to grow different varieties in Hawaii, branding can play crucial role in helping customers identify the specific variety they prefer. In the case of local avocados, information on the variety as well as the geographic identification has the potential to increase customer preference and create a positive impact on sales and therefore it is important to explore grower's willingness to adopt branding as an important management practice.

Also, according to Boehlje (1996), farmers appear resistant to abandoning the open market. Hence a better understanding of farmers' attitudes, willingness, knowledge, and preferences concerning the use of new forms of vertical coordination would be informative to all supply chain participants. Such an understanding would allow for the more effective implementation of the new arrangements and if needed further modification of the new arrangements (Duval et al., 1998).

However reports indicate that collaborative action brings with it a whole new set of transaction costs. It is likely that farmers associating will occur only if the benefits from collaboration cover the value of investment needed. Not enough is yet understood about the potential benefits and, particularly, costs. Benefits can be described in terms of increased productivity and increased negotiating power. More information is needed,

however, to understand an actor's rationale for participating in producer groups. From the reviews presented by Cohen et al., 1997,Ganeshan et al., 1999 and Jang et al., 2002 this was made obvious that little attention has been paid to strategic planning. Therefore, there is a need for models and tools to help in strategic decision-making (Jang et al., 2002) in agricultural supply chain systems and understand its impact.

Therefore this study attempts to explore the willingness and likelihood of Hawaiian avocado growers' participation in fresh produce supply chain management as a step towards import substitution and self-sufficiency on the basis of the SDIM framework. This is accomplished through the three specific objectives which include determining the current situation of the Hawaiian Avocado Industry and document key aspects of the local avocado industry's supply profile and their potential for import substitution; explore the willingness and likelihood of Hawaiian avocado growers' participation in supply chain management; and lastly based on farmers' willingness , determine if there is an incentive in selling through an avocado cooperative and if so, what should be the optimal size of the cooperatives.

CHAPTER III
METHODOLOGY AND MODEL SPECIFICATIONS

The previous chapter discussed supply chain management from its beginnings to how it evolved to the current form. It also discussed in detail the three main aspects that need to be considered by small-scale agribusinesses to build and strengthen the supply chain. Following this, a background on the Hawai'i agriculture and avocado industry is presented, what are some of the challenges faced by them and how these challenges can be tackled were presented. On the basis of the background literature on conventional supply chain management and its usefulness and limitations specifically, for small-scale agribusiness, a modified conceptual framework called the supply-demand integrated management model was put forth. Based on this framework, the specific objectives of the study will be accomplished. With this in focus, Chapter III discusses the methodology that was adopted and the statistical and mathematical model that was used to analyze the data collected for the purpose of meeting the objectives of the study. Section 3.1, "Research Questions and Hypotheses" states the research questions and the hypotheses to be tested. Following this, in section 3.2 "Data Collection", details the sources of data used in the study. It also describes the method and tool used for data collection which is a paper based questionnaire. Section 3.3 "Methods for Data Analysis" describes the statistical and other quantitative methods used to analyze the data under each objective. A logit regression model and a mathematical model were used for accomplishing objectives 2b and 3 respectively. A discussion on how these models were used is also presented in section 3.4.

3.1 Research Questions and Hypotheses

The overall objective of the study was to find out the likelihood of Hawaiian avocado growers' participation in fresh produce supply-demand integrated chain management and the potential of the role of farmers' cooperatives as a step towards import substitution and self-sufficiency. Three specific objectives were put forth to help achieve the overall objective of the study.

The following research questions were put forward based on the specific objectives and a set of hypotheses were also formulated on the basis of literature reviewed. Data was collected accordingly and the hypotheses were tested using statistical methods. All statistical analysis was carried out using Microsoft Excel and Statistical Analysis System (SAS) version 9 software programs. A mathematical model was also used in the study to achieve objective 3 which was calculated using MATLAB version 7 software programs. Based on each of the specific objectives the following research questions were put forward.

Objective 1 and Research Question:

Objective 1 was to determine the current situation of the Hawaiian avocado industry and **document key aspects of the local avocado industry's supply profile and their potential for import substitution. The research question put forth was-**

1) **What are the current socio-demographic-farm characteristics, including growing, supply and marketing details of the local avocado farmers?**

Objective 2 and Research Questions and Hypotheses:

Next, for objective 2 and the two sub-objectives under it, the following research questions were put forward to be answered. Objective 2 tried to explore the willingness

and likelihood of Hawai'i avocado growers' participation in the three important management strategic aspects of supply-demand integrated management. In order to achieve these objectives, the following five research questions were put forward to be answered. Under research question five, three hypotheses were also put forward based on avocado farmers' likelihood of adopting the three management aspects (questions 3, 4 and 5) suggested under supply-demand integrated management.

2. Is there currently, coordination between buyer preference and what is being grown, with regard to locally grown avocados?

3. Are majority of farmers willing to participate to switch and grow new varieties preferred by the customers?

4. Are majority of farmers willing to join a cooperative?

5. Are majority of farmers willing to adopt branding of locally grown avocados?

6. Do farmers' socio-demographic characteristics influence their likelihood to adopt the three management strategic aspects specified under supply-demand integrated management and if so what are the farmers' profile?

A set of hypotheses was formulated for this study to be tested mostly based on literature review of previous studies that indicated the role of socio-economic-demographic characteristics and farm characteristics of farmers (Diederen et al 2003 and Feder et al .1985,Bekele, 2006; English et al.,) and their influence on farmer decisions. This has been extensively described in section 4 under "model specification". The following are the hypotheses that were put forward:

i. Full-time farmers, who are younger, educated, with large farm size & high production, less years in farming, and with lands owned by them are more likely to switch to grow varieties most preferred by the buyers.

ii. Full-time farmers, who are younger, educated, with large farm size & high production, less years in farming, and with lands owned by them are more likely to switch to join cooperatives.

iii. Full-time farmers, who are younger, educated, with large farm size & high production, less years in farming, and with lands owned by them are more likely to adopt branding

Objective 3 and Research Question:

And lastly under objective 3 which was to find out, based on farmers' willingness if there is an incentive in selling through an avocado cooperative and if so, what should be the optimal size of the cooperative, the following research question was put forth.

7. Would selling through cooperative yield greater revenue?

3.2 Data Collection

Primary source and numerous secondary sources provided the data to find answers to the research questions presented in the previous section under each of the specific objectives. There were two phases involved in the data collection -one directed to the Hawaiian avocado growers and the other directed to the local chefs who are one of the high-end buyers in Hawai'i. The Hawaiian avocado growers were the prime focus of this study and data was collected from them in order to get answers to research questions 1, 2, 3, 4, 5 and 6. But, in order to find out if currently there is any coordination between buyer

preference and what is being grown, with regard to locally grown avocados (research question 2) the local chefs from Kona (east side of the Big Island)) where the avocado production is the highest were targeted as they are considered as one of the main buyers. Therefore, two sets of surveys were conducted to collect data and the two categories of respondents to this study were 1. The Hawaiian avocado farmers 2.The local chefs from Kona (east side of the Big Island).

The Hawai'i Agricultural Statistics (2005) indicated a total of 150 avocado farms in Hawai'i (National Agricultural Statistics Services, 2005). For the purpose of conducting the survey, a list of the Hawai'i avocado growers was obtained from the Hawai'i Avocado Growers' Association. Following this, the growers on the list were contacted via the telephone and through emails and 55 avocado growers agreed to participate.

For the second phase of the data collection, the target respondents were the local chefs from Kona. Data was collected from them through a taste testing event that was held on February 2007 in conjunction with the monthly chef's meeting of the Kona-Kohala chapter of the American Culinary Federation (ACF). It was held at the Kona Village Resort and a total of 30 chefs who were present agreed to participate in the survey. The reason why chefs from Kona were surveyed was because 80% of the avocado farmers in the state are in Kona (east side of Big Island) and being a popular tourist spot many of the high end restaurants have branches in Kona. Therefore it was considered important to get feedback from the chefs on the Kona side as they may be important potential buyers of local avocados.

Phase I:

A survey based data collection, using a questionnaire, directed towards the local Hawaiian avocado farmers comprised the first phase of the data collection. A face-to face survey administration method was used. There are several positive benefits of having an interviewer use the face-to-face survey method. First, the interviewer can ensure that the correct respondent, the local avocado farmer in this case, responds correctly to the survey presented, something over which there is no control over in a mail survey. Second, the interviewer can assist if the respondent does not understand the question. The interviewer can also correct the respondent if s/he overlooks a question or otherwise fails to follow the instructions in the questionnaire. Third, the interviewer can motivate the respondent to keep going if her/his interest flags and also record verbatim comments made by the respondent, if relevant.

With these potential advantages the survey questionnaire was designed focusing on three broad areas. One part focused on farm related information such as the farm size, number of years in farming, the nature of land ownership (leased or owned), part-time or full-time employment, the cost of production and the farm income. The next part focused on marketing information, post and pre-harvesting information, the quantity sold, the different selling outlets, the prices received and their willingness to switch or adopt the three management strategies suggested under supply-demand chain management. The final part focused on the socio-economic and demographic information of the farmers. The survey instrument was designed to analyze the current avocado industry situation and to find out the farm and farmer related information, their socio-demographic profile and their willingness and likelihood of adopting the three supply-demand integrated

management strategies suggested. The questionnaire was pre-tested and it identified some potential problems such the length of the questionnaire, questions regarding the costs which was broken down into too many categories and it was found to be cumbersome and issues such as the wording and order of a few questions. The suggestions were incorporated into the final version of the questionnaire, (please refer to Appendix A) The majority of the data from the respondents were collected via face-to-face interviews and some interviews had to be collected via the telephone. This was mainly because some of the farmers were not available for a face-to-face interview and due to financial limitations it was not possible to travel many times to different islands. The questions were asked directly from the questionnaire. Meeting appointments were fixed with each of the growers before hand and farmers were met personally at their farms and were interviewed. About 75% of the surveys were collected via face-to-face interview and the remaining 25% were collected via the telephone. Of the farmers who were interviewed about 90% of the growers were from Kona (west side of the Big Island) and the remaining growers were spread out over with 6% in Hilo (east side of the Big Island) about 5% on the other islands (2% from Kauai, 3% from O'ahu). There were no respondents from Maui.

Phase II:

The second phase of the data collection was targeted towards the chefs, one of the main buyers of avocados in Hawai'i. The main intention behind this was to get an idea of the presence or absence of coordination between farmers and buyers by finding out if the local avocado production is similar to what the customers actually prefer. This is an important aspect under the supply-demand integrated management model. The chef's

survey was conducted as part of a taste testing event where they were provided with a variety of locally grown avocados and were each given a set of scoring sheets (please refer Appendix B), which was designed in collaboration with Ms Jean Hull who is a retired professor of Hawai'i Community College Food Service Program located at the University of Hawai'i Center in West Hawai'i on the Big Island. The chefs were asked to score the fruit on the basis of five characteristics: ripeness, peeling characteristics, taste, texture, and color and they were also asked to provide additional comments if any. The overall average score for each characteristic was then compared to get an idea of the variety they found most desirable based on the composite scoring of the five characteristics.

3.3. Methods for Data Analysis

3.3.1 Objective 1 and Objective 2 (a):

Descriptive statistics was used to get a clearer understanding of the socio-economic and demographic characteristics and farm profile of the Hawaiian avocado growers. General Linear Modeling along with Duncan test was used to explore if there is a lack of coordination between the buyers (the chefs in this case) and the farmers or information gap regarding buyer preferences and what is currently being grown. These were key points that needed to be explored under the supply-demand integrated management model.

3.3.2 Objective 2(b):

To determine the willingness and likelihood of growers to participate in the three management strategies suggested under supply-demand integrated management model, an economic model was developed for statistical testing, which will be explained later on,

in detail, under the "model specifications" section. Regression analyses were used to examine the relationship between the selected independent variables and the three dependent variables to identify positive and negative relationship. The following were the three dependent variables which represented the three management strategies: i) Farmers' willingness to switch and grow varieties preferred by the buyer; ii) Farmers' willingness to join a cooperative; iii) Farmers' willingness to adopt branding their avocados.

3.3.3 Objective 3

Objective 3 was to find out, based on farmers' willingness if there is an incentive in selling through an avocado cooperative and if so, what should be the optimal size of cooperative. A mathematical model proposed by Jang et.al., 2002 was used and its details are presented under "model specifications" below.

3.4. Model Specifications

3.4.1 Objective 2(b):

3.4.1.1 Logistic Regression Analysis

Logistic regression is part of a category of statistical models called generalized linear models and are often said to predict more accurately than other models (Agresti, 1996, Kastens et al.,1996). Logistic regression is commonly called logit regression and it is used when the response variable (dependent variable) is a binary variable such as 0-1,(or Bernoulli variable). The response or the dependent variable can take the value 1 with a probability of success θ (theta), or the value 0 with probability of failure 1-θ (1-theta), where θ is the probability of the event happening. The independent variables can take any form such as continuous, discrete, and dichotomous or a mix of any of these. Logistic

regression does not make any assumption about the distribution of the independent variables. They do not have to be normally distributed, linearly related or of equal variance within each group. The goal of logistic regression is to correctly predict the category of outcome for individual cases using the best fit model. To accomplish this goal, a model is created that includes all predictor variables selected on the basis of previous studies done and used it for this study's purposes in predicting the selected response variables. There are two main uses of logistic regression. The first is the prediction of group membership where logistic regression calculates the probability or success over the probability of failure. The second is that logistic regression also provides knowledge of the relationships and strengths among the variable (Internet source*http://online.sfsu.edu*; Agresti et al 1986). Agresti (1996) stated that the likelihood-ratio test is more reliable for small sample sizes than the Wald test. The log transformation of the likelihood functions yields a chi-squared statistic which is the recommended statistics for identifying the best model fit.

3.4.1.2 Justification for using logistic regression in this study.

Studies on farmer preferences (Bekele, 2006; Napier et.al.,1991 , Tucker et al., 2000 and Pompelli et al., (1997); Schnitkey (1992); Diederen et al 2003; Carter et al., 1993) indicates the use of different forms of logistic regression such as simple logistic regression, nested logistic regression and multinomial regression. Nested logistic and multinomial regressions could not be used for this study. Nested logistic regression is generally used for finding nested relationships and multinomial regression is used in cases where the response variable has more than two categories. This study does not involve finding nested relationships , so nested logistic regression is unnecessary and also

since the response (dependent) variables for this study were categorical data in a binary format and when response variables are categorical data in a binary format then non-parametric measures such as logistic regression can only be used and not multi-nominal logistic regression. According to Bekelel (2007), the logit model is more appropriate to study factors influencing farmers' preference "when the explanatory variables consist of individual specific characteristics and these characteristics are the determinants of the choice". In a study involving Tennessee farmers, logit regression models were used to estimate the probabilities of different farming counties adopting various precision farming technologies and identifying the determinants of the model which were to determine the factors that influence farmer decision (English et al.,). Schnitkey (1992) who studied on information preferences by the farmers; and Carter and Batte (1993) who studied identifying needs in farm management, outreach and education also using logistic regression. Literature on adoption of new innovative programs such as new farm practices or adoption of new agricultural technologies suggests that a number of factors contribute to farmer decisions or preferences. The farmer's decision to invest in an innovative venture is related to maximization of expected net farm income over time, which depends on factors influencing costs and revenues in a geographic area. Other than socio-demographic factors such as education, age, income , factors that influenced farmers to adopt new innovative ventures were dependent on factors such as sufficient crop acreage, farm size, market position , production costs (Bekele, 2006; Diederen et. al 2003; English et al.,). These were generally classified as farm characteristics. There are many studies that showed the relationships between farm characteristics, costs and socio-democratic profiles of farmers and their decision on adopting innovative ideas, programs

or technologies. On examining these studies closely, they indicated that the farmer's likelihood of adopting new innovative programs were influenced by a set of socio-demographic factors such as age which showed the younger the age, the more likely they were to adopt new ideas . Level of education also indicated a positive significant influence which meant the more years in formal education, the more likely they were to adopt. In the study by Diederen et al. 2003, farm size showed a significant and positive influence on farmers' decision, but it showed a negative significant influence on the farmer's decision in the study by Bekele, 2006. Also input costs showed a negative significant influence and general income (Diederen et al 2003 and Feder et al .1985) showed a positive significant influence over decisions. Based on this and other similar studies, logistic regression is an ideal statistical procedure to be used in this study to find out the likelihood of farmers' adopting the three management strategies

Based on the reasons explained above logistic regression analysis was used to explore the relationship between farmer's preferences and their determinants. The likelihood model with the best fit was identified, where the independent variables or determining factors influencing the three selected SDIM dependent variables: i. Willingness to switch and grow varieties currently preferred by the consumers; ii. Willingness of farmers to join a cooperative and; iii. Willingness of farmers to adopt branding. To do so, the three dependent variables which were based on yes or no response, were constructed as a binary variable with a value of 1 for 'yes' response and 0 for 'no' response. The independent variables chosen were on the basis of evidences indicated from previous studies. They included two broad sets of independent variables 1) farm characteristics and 2) socio-demographic factors.

Logistic Régression Model:

$P(Y) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_i X_i$

$$Y = \frac{e^{\alpha+\beta_1 X_1+\beta_2 X_2+\ldots+\beta_i X_i}}{1+e^{\beta_1 X_1+\beta_2 X_2+\ldots+\beta_i X_i}}$$

$$= \frac{\exp(\alpha+\beta_1 X_1+\beta_2 X_2+\ldots+\beta_i X_i)}{1+\exp(\alpha+\beta_1 X_1+\beta_2 X_2+\ldots+\beta_i X_i)}$$

where

X1 … Xi : independent variables such as socio-demographic factors, farm characteristics

β1 … βi : coefficient of these socio-demographic and economic factors

α : constant

Y : probability of willingness to adopt, join a cooperative or branding

P : odds of choosing Y

Model specification for objective 2b:

Objective 2b tried to explore the Hawaii avocado growers willingness and likelihood to adopt the three important management strategies such as 1. Willing to switch and grow varieties currently preferred by the customers; 2. Willing to join a cooperative; 3. Willing to adopt branding.

Logistc regression analysis was used to identify the farmer profiles that were more likely to adopt the three management practices. Based on the literature survey a set of

independent variables were identified and logistic regression was run to find out the influence of these variables on farmer decisions. Below the models are described in detail.

Model 1: Probability of willingness of avocado farmers to switch and grow varieties preferred by the buyers.

P (Y)= α+ β_1 farmer type +β_2 farm ownership + β_3 number of years in farming +β_4 avocado production /farm + β_5 farm size$_+$ +β_6 farmer age + β_7 educational level.

Model 2: Probability of willingness of avocado farmers to join cooperatives

P (Y)= α+ β_1 farmer type +β_2 farm ownership + β_3 number of years in farming$_1$ +β_4 avocado production /farm + β_5 farm size$_+$ β_6 cost of production +β_7 farmer age + β_8 educational level.$_i$

Model 3: Probability of willingness of avocado farmers to adopt branding

P (Y)= α+ β_1 farmer type +β_2 farm ownership + β_3 number of years in farming +β_4 avocado production /farm + β_5 farm size$_+$ β_6 cost of production +β_7 farmer age + β_8 educational level.

Where X_1 to X_8 are as follows:

1. Farmer type has been categorized as part-time and full-time where part-time is represented as 1 and full-time is represented as 0. Full-time was the reference variable and the expected sign for part-time was negative.

2. Farm ownership has been categorized into tenants and owned, where tenants is represented as 1 and owned is represented as 0. Farm owned was the reference variable and the expected sign for tenant was negative.
3. Number of years in farming has been input as a continuous variable with an expected sign of negative.
4. Avocado production/farm has been categorized into low production and high production where low production is less than 2,000 pounds/farm and greater than or equal to high production. High production was the reference variable and the expected sign for low production was positive.
5. Farm size was categorized into small farms, medium sized farms and large sized farms where small farm is less than 5 acres, medium sized farm is between 5 and 15 acres and big farm is more than 15 acres. Big farm was kept as the reference variable and the expected signs for both small and medium sized farms were given as positive.
6. Cost of production was categorized into low cost, medium cost and high cost where low cost of production is less than $1,000, medium cost of production is between $1,000-5,000 and high cost of production is more than $5000. High cost of production was kept as the reference variable and the expected sign for both low cost and medium cost of production were given negative.
7. Farmer age was categorized into younger farmer, middle aged farmer and older farmer where younger farmer is less than 40 years of age, middle aged farmer is between 40-55 years of age and older farmer is more than 55 years of age. Middle

aged farmer was kept as the reference variable and the expected sign for younger farmer was given positive and older farmer was given negative.

8. Education level was categorized into high school, undergraduate (at least four years of college education), post graduate (more than four years of college education), where high school was kept as the reference variable and the expected sign for both undergraduate and postgraduate were given positive.

Logit analysis was run to find out the influence of the above mentioned independent variables on the three dependent variables and overall model fit was based on .05 confidences for the likelihood ratio since the sample size was 55.

The models were tested for probability value of likelihood ratio less than .05, at the 95 percent confidence level. The concordant percentage value of the models was also checked at a value greater than 50% which shows high predictive ability. The logistic regression coefficients were considered and tested for significance at levels less than .05(*) level and at less than .01 (**) level. Odds ratio were also considered and those with value above 1 indicated a positive effect and ratio less than 1 indicated a negative relationship between the variable and the odds of adopting the strategies and this were represented by the expected signs and actual signs that the SAS analysis generated. The role of each independent variable on influencing the dependent variable including the odds ratio and signs generated by the SAS outputs were carefully examined.

3.4.2 Objective 3:

For objective 3, which was to find out based on farmers' willingness, if joining a cooperative generated economic incentive compared to selling individually and if so what

should be the optimal size of the cooperative. A mathematical model proposed by Jang et al. 2002 was modified and used for this objective. The mathematical models addressed the above based on two assumptions

1. Farmer produces quantity (Q)to meet the wholesale/ institutional demand D
2. Farmers in the cooperative only sell the entire lot to the wholesaler at a given price which is generally considered lower than selling individually. In other words there is no excess production to sell individually after selling through a cooperative.

The models are presented below under two case scenarios. To explain the two cases, the following variables are used:

Q = Production Quantity/farmer

D = Demand from Wholesalers and Institutions

x = Stochastic nature of demand faced by farmer selling individually

$\Phi(x)$ = Probability Density Function of this x is

p_1 = Price received when selling individually

p_2, = Price received when selling through a cooperative, ($p_2<p_1$)

n = Number of members in a cooperative

f(0) = Revenue generated selling individually

f(n) = Revenue generated selling through cooperative

Two case scenarios were considered in this study where the overall objective was for Hawaiian avocado farmers to adopt an effective strategy that would help them, produce more, gain higher revenues and substitute imports.

Case Scenario One:

In the first case the farmer faced the wholesale/institutional demand (D) and sold through a cooperative to meet the demand D, producing at Q, and receiving a lower price p_2. Equation 1 specified below was used to calculate the revenue for the total cooperative membership (n) under the condition where n*Q > D and the farmer sells part of his produce to the cooperative, whose revenue is calculated using the first part of the equation p_2*D/n. The remaining produce (n*Q - D), the farmer sells individually and the revenue is calculated using the second part of the equation. However, for the purpose of this study since the farmers are producing only the quantity enough to meet the demand D, i.e. n*Q = D (assumption one mentioned above), and selling only to the wholesalers through the cooperative (assumption 2 mentioned above), the second part of the equation becomes zero. The reason for this is because the Hawaiian farmers are not currently producing enough to meet even the institutional demand and so it is more practical to assume that they would be in a position to meet at least the institutional demand which they rather sell only through a cooperative and avoid the unstable nature of demand when selling individually. Therefore to calculate the revenue for selling through a cooperative, where the demand is considered to be stable, Equation 2 was used.

The mathematical equations for calculating the first case scenario (selling everything through a cooperative) are represented by:

$$f(n) = p_2 D/n + \int_0^{Q-D/n} p_1 x \phi(x) dx + \int_{Q-D/n}^{\infty} p_1 (Q - D/n) \phi(x) dx \qquad \text{(Equation 1)}$$

$$f(n) = p2 * D/n \qquad \text{(Equation 2)}$$

Case Scenario Two:

As per the model specification, in the second case the farmer sold individually at a higher retail price p_1 to meet the demand D.

Theoretically, since they are selling individually they face a stochastic demand and hence the probability density function of demand was incorporated.

The mathematical equation for calculating the second case scenario was represented by

$$f(0) = \int_0^Q p_1 x\phi(x)dx + \int_Q^\infty p_1 Q\phi(x)dx \qquad \text{(Equation 3)}$$

Here the equations or models helped in empirically finding out the more attractive of the two case scenarios on the basis of revenue generated and accordingly the farmers could be recommended to adopt the best strategy.

As mentioned earlier, since the demand faced by the farmers when selling individually is stochastic, the probability density function of demand had to be incorporated in the second model where revenue generated from selling individually f (0) was calculated. In order to calculate the probability density function of the demand, it was necessary to find out the type of probability distribution for historical avocado demand.

3.4.2.1 Probability Distribution

The probability distribution of a variable provides a listing of the probabilities of the various possible occurrences. A family of probability distribution is a set of distributions whose dispersion is dependent on the values of different parameters. Some probability distribution is important because they give a good approximation for the distributions of

variables in the real world and some of them are useful for statistical inferences (Agresti et al. 1986).

3.4.2.2 Normal Distribution

The distribution of many test statistics is normal or follows some form that can be derived from the normal distribution. In this sense, philosophically speaking, the normal distribution represents one of the empirically verified elementary "truths about the general nature of reality," and its status can be compared to the one of fundamental laws of natural sciences (*http://www.statsoft.com)*.

A continuous variable with a probability distribution having a certain bell shaped graph is said to be normally distributed and its dispersion is determined by two parameters: the mean and the standard deviation. The normal distribution is important because it gives a good approximation for the distributions of variables encountered in the application of statistics in social sciences. Also some of the fundamental statistical procedures are based on the assumption that the variables beings analyzed are normally distributed and thus the prominence of normal distribution in many inferential statistical methods (Agresti et al. 1986).

3.4.2.3 Probability Demand Distribution of Avocados in Hawaii

To find out the probability demand distribution of avocados in Hawai'i, available demand data (45 years from 1960 to 2005) of avocados was collected from official publications of the Hawa'ii Agricultural Statistics Services. Since normal distribution was considered as the most commonly used and important of all the distribution, and on the basis of evidences presented in previous studies (Leung et al 1986; Emery et al 1997; Agresti et al. 1986) the demand data was fitted to a theoretical normal distribution

using MATLAB software package to determine if the data was normally distributed. To reconfirm the nature of distribution the data was then analyzed based on the theoretical estimates of occurrences for a normal distribution also known as the empirical "rule of thumb" (Emery et al., 1997;Agresti et al. 1986). According to this rule, data is said to be normally distributed if the mean and +/- standard deviation spans approximately 68% of the measurements; and if the mean and 2* +/- standard deviation spans approximately 95% of the measurements (Emery et al 1997; Agresti et al. 1986). Graphically it is represented as follows (Harnett et al, 1975).

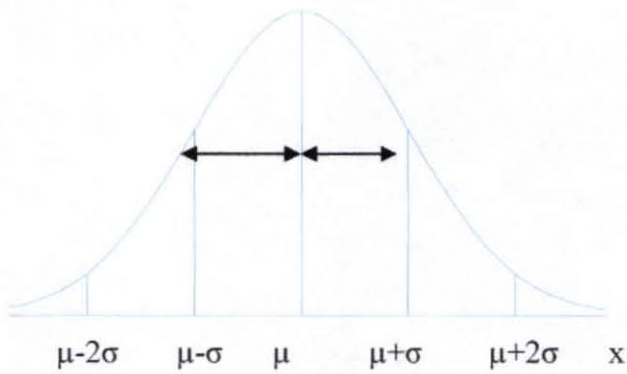


Figure 3.1. Normal distribution for mean μ and standard deviation σ of the random variable X

Once it could be established that the demand data of Hawaiian avocado industry is normally distributed, the probability density function for the normally distributed demand was calculated using the formula given below and incorporated into the equation to calculate the revenue generated when the farmers sell individually.

$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-(x-\mu)^2/2\sigma^2}$$

All the computations were carried out using the MATLAB software package version 7.

3.5 Chapter Summary

This chapter details the methodology and instruments of data collection adopted and applied in the study. It presents the specific objectives , the research questions that were explored and the hypothesis that were tested .It also presents the types of statistical and quantitative analysis that was used to answer the research questions, test the hypotheses and accomplish the objectives. It provides justifications to the use of statistical and mathematical model that was used in the study and also presents a detailed explanation on the use and advantages of the models. In the next chapter the results of the data analysis using these methods are presented in detail.

CHAPTER IV
DATA ANALYSIS AND RESULTS

The study comprised of three specific objectives along with two sub-objectives under specific objective two. Based on the methods described in the previous section the data was collected and analyzed and results of the analysis are presented in this section. Results are organized according to the specific objectives. It begins with section 4.1 which presents the analysis and results of Objective 1 which was to determine the current situation of the Hawaiian avocado industry. Under these three aspects of the industry is covered: 1 Production, Imports and Sales of Hawai'i Avocados; 2. Farm characteristics of the avocado farmers and; 3. Socio-economic and demographic factors of the Hawaiian avocado farmers. Following this, section 4.2 presents the analysis and results of Objective2 under which there were two sub-objectives: 1.The analysis and results of first sub-objective, which was to explore whether there is a lack of coordination or information gap between farmers and buyers. This presented first followed by the next sub-objective which was to find out their willingness to adopt the three main supply chain related management practices and the farmers' likelihood to adopt the three main supply chain related management practices. The next section 4.3 presents the analysis and results for objective 3 which were to find out, based on farmers' willingness if there is an economic incentive in selling through an avocado cooperative and if so, what should be the optimal size of the cooperative and what are the returns. The final section 4.4 presents the summary of the results.

4.1. Objective 1:

Objective 1 was to determine the current situation of the Hawaiian avocado industry and document key aspects of the local avocado industry's supply profile and their potential for import substitution. The analysis for this section was done using descriptive statistical procedures such as finding mean values and frequency distribution using Microsoft Excel and Statistical Analysis System (SAS) version 9. In section 4.1.1 the Hawaii production, imports and sales data of the avocado industry is discussed. In section 4.1.2 the farm characteristics of the Hawaii avocado farms is discussed and in section 4.1.3 the socio-economic-demographic factors of Hawaii avocado farmers is discussed.

4.1.1 Production, Imports and Sales Data of Hawai'i Avocado Industry

All the results of survey data and analysis are presented in Table 4.1 and Table 4.2. Table 4.1 shows the production data of Hawaiian avocados for 2005-2006. The total production of Hawaiian avocados is currently at 800,000 lbs and this is the amount that reached the local market. However the avocado farmers' survey revealed that about 49 % of avocados that was produced did not reach the market. This was calculated by taking an average of the percentage of avocados the growers said they could not harvest and percentage of what they harvested but could not sell. This indicated that the actual current production of the local avocado farmers could be about 1.3 million pounds. Besides the local production, Hawai'i imported about 2 million pounds of avocados in the year 2005-2006. The average avocado acre/farm was found to be 1.9 acres and this multiplied by the number of farms gave the total avocado acres in Hawai'i which was found to be 286

acres. Total production was then divided by the total number of acres to estimate the yield/acre which was found to be 2,400 lbs.

Table 4.1. Production, Acreage, Wastage and Imports Data of Hawai'i Avocado From Survey2005-2006

Variables	Values
Number of Avocado Farms in Hawaii	150*
Avocado Acreage	286 acres**
Average Avocado Acre/farm	1.9 acres** Minimum: .1 acres Maximum : 18 acres Std.Dev : 3.1
Average Avocado yield/acre	2400 lbs**
Average Number of Avocado Trees/farm	95 trees
Total Production	800,000 lbs *
Amount Wasted (includes not harvested+ not sold)	392,000 lbs**
Percentage Wastage	49%
Actual Potential	1,293,350 lbs**
Avocados Imported	2,000,000 lbs*

**National Agricultural Statistical Services, 2005*
*** Data from survey*

Next the cost involved and the price and income data from the survey received by the Hawai'i avocado farmers for the year 2005-2006 is illustrated in Table 4.2. These data were collected from the survey and as noted, the average cost of production for avocado was $1,694 per farm of an average size of 1.9 acres with a standard deviation of $332 . This was calculated by totaling the different costs incurred by the avocado farmers' which are farm wages costs, farming costs, marketing costs and operational overheads costs. The average income received from avocados was $4,622 with a standard deviation of $1288.From the cost and income the margin per farm was calculated and it was

$ 2,928 per farm. Besides these overall figures, the prices received by the Hawai'i avocado farmers collected from the survey results are as follows: the average price received from wholesalers was $.86/lb; the average the price received from grocery stores was $.66/lb; the average price received from farmers' market was $1.05/lb;

Table 4.2. Cost, Price and Income Data of Hawai'i Avocado Farmers 2005-2006 from Survey

Cost-Price and Income Data	Mean	Standard Deviation
Average Cost of Production/farm	$1,694	$332
Average Annual Income from Avocados/farm	$4,622	$1288
Margin per farm	$2,928	
Average Prices Received From:		
Wholesaler	$.86/lb	$.45/lb
Grocery Store	$.66/lb	$.10/lb
Farmers' Market	$1.05/lb	$.43/lb

4.1.2 Farm Characteristics of the Hawai'i Avocado Growers

The data on Hawaiian avocado growers' farm characteristics collected from survey and descriptive statistical analysis on farm characteristics generated the following results (Table 4.3). Results showed that 67.27% of the Hawaiian avocado farmers/growers own their land; 29.09% of the Hawaiian avocado farmers farm on leased lands and about 3.64% have both owned and leased land. In other words majority of the avocado farmers in Hawai'i own their land. Frequency distribution also showed that 41.82% of the farmers are full-time farmers and 58.18 % are part-time farmers; and this means the majority of Hawaiian avocado farmers might have non-farm employment or other sources of income.

Table 4.3. Farm Characteristics of Hawai'i Avocado Farmers 2005-2006 from Survey

Farm Characteristics	Percent
Farm Ownership	
Owned Land	67.27
Leased Land	29.09
Both	3.64
Farmer Type	
Full-time	41.83
Part-time	58.18
Farm Size	
Small Farm (<5 acres)	43.64
Medium Farm (5-15 acres)	43.64
Large Farm(>15 acres)	12.73
Farm Sales	
Direct Sales	76
Wholesaler	24
Cooperatives	0

The farm size was analyzed for which the data was grouped into three categories-Small farm size where the farm is less than 5 acres, medium farm size where the farm is between 5-15 acres and large farm size where the farm is more than 15 acres and it was found that 43.64% of farmers had less than five acres, and equal percentage of 43.64 % farmers had between 5 and 15 acres, and the remaining 12.73% of farmers had large farms with more than 15 acres. Analyzing the responses to how the local farmers sell their avocados 76% indicated they sold through direct sales. Direct sales included selling directly at farmers' market, or to a wholesaler. Remaining 24% sold as wholesale.

4.1.3 Socio-Economic and Demographic Factors of the Hawai'i Avocado Growers

Data analysis through simple descriptive statistics revealed the following results as presented in Table 4.4. First the farmers' demographic profile was analyzed and it was found that majority of the farmers are males with 78.18% and the remaining 21.82% are females. Age was calculated from the farmers' survey where the respondents had indicated their date of birth. The average age was found to be 53 years old. It was further grouped into three categories such as younger farmers who were less than 40 years of age, middle aged farmers who were between 40 and 55 and the third category of older farmers who were above 55 years of age. As indicated in the table below 10.91% of farmers were less than 40 years of age, i.e. younger farmers, 38.18% of farmers were between 40-55 years of age , i.e. middle aged farmers, and the remaining 50.91% of farmers were more than 55 years of age i.e. older farmers. Next under the socio-economic profile, educational background was analyzed. This was grouped into three categories, high school or less; undergraduate degree or some years of college education; and post graduate.

Table 4.4. Socio-economic and Demographic Factors of Hawaiian Avocado Growers

Socio-economic and Demographic Factors	Percent
Farmer Gender	
Male	78.18
Female	21.82
Farmer Age	
Younger Growers (<40years)	10.91
Middle aged Growers (40-55years)	38.18
Older Growers(>55years)	50.91

Table 4.4. (Continued) Socio-economic and Demographic Factors of Hawaiian Avocado Growers

Farmer Education	
High School or less	31.11
College degree or some college	40.00
Post Graduate	28.89
Average Annual Income	
Less than $50,000 (L.Inc)	47.06
More than $50,000 - 90,000 (M.Inc)	33.33
More than $90,000 and above (U.Inc)	19.61
Average Years in Farming	
Five years and less	20.00
Five and Twenty	47.27
Twenty and Above	32.73

The results indicated that 31.11% of farmers have some high school or have a high school degree, 40.00% of farmers have an undergraduate degree or some years of college education and 28.89% of farmers have post-graduate. Annual income of the avocado farmers was also calculated. They were grouped into three categories:

Low income where the income is less than $50,000, middle income, where the income is more than $50,000 and less than $90,000 and the high income category and are with income more than $90,000. The analysis revealed that 47.06% of farmers belonged to the low income category, 33.33% of farmers belonged to middle income category and 19.61% of farmers belonged to the high income category.Finally considering the number of years spent in farming, the data was collected as a continuous variable and later put into categories. The results revealed that majority of 47.27% have been farming for five to twenty years, followed by 32.73% for twenty years and above and 32.73% have been farming for five years and less.

4.2 Objective 2

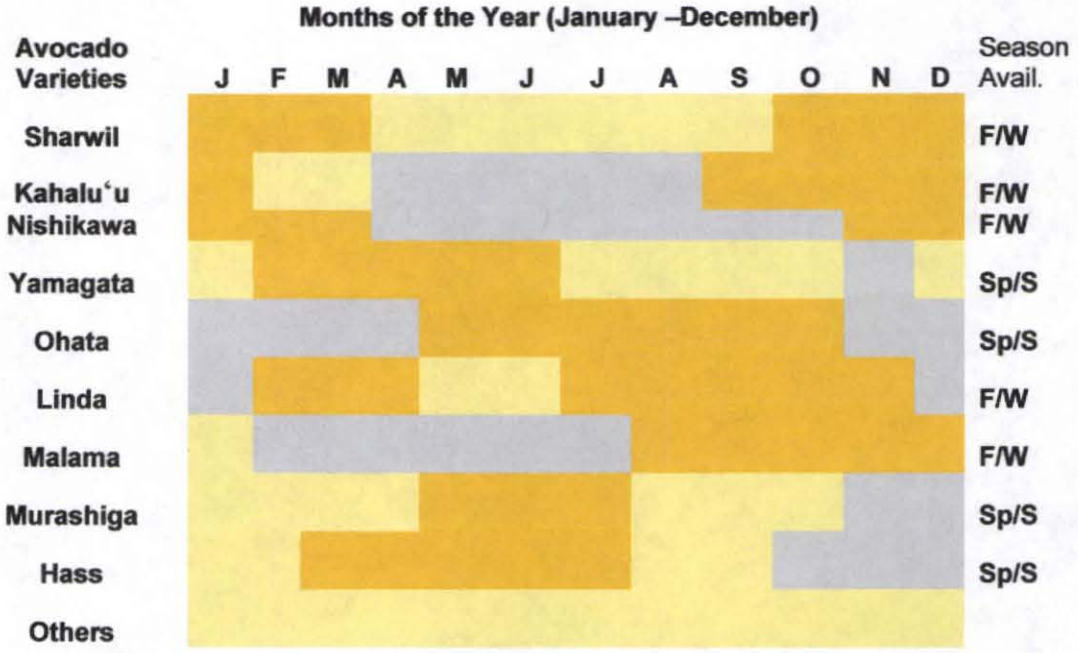
Objective 2 was to explore the willingness and likelihood of Hawaiian avocado growers participation in supply-demand integrated management approach. Under this there were two sub-objectives -a. To find out if there is coordination between buyer preference and what is being grown and b. To determine the willingness and likelihood of growers to participate in supply-demand integrated management strategies. To accomplish these objectives, data collected from the survey was analyzed using general linear modeling and Duncan test, followed by logistic regression model to analyze farmers likelihood of adopting the three management strategies suggested under supply-demand integrated management approach.

4. 2.1 Objective 2(a) -Explore the lack of coordination between farmers and buyers.

Production data pertaining to the varieties currently grown by the local avocado growers and its harvest month was collected first. Table 4.5 given below represents the different varieties currently grown by the local growers and it can be concluded that there is year round production of local avocados varying according to the seasons fall/winter and Spring/Summer. Sharwil, Kahalu'u, Malama, Linda, Hass and Nishikawa are the varieties available during fall/winter season and Yamagata, Ohata, Murashiga and locally grown Hass are available in spring/summer seasons. The dark yellow shades represent high season and the light yellow shades represent lean seasons for the specific variety of fruit. The grey regions indicate no availability of the particular variety of fruit. This

information can be crucial for coordinating the supply and demand of local avocado growers and buyers.

Table 4.5. Avocado Varieties Grown Locally and its Monthly and Seasonal Availability (*Dark Yellow: High Season; Light Yellow: Lean Season; Grey : Not Available)*



Based on the local avocados available according to seasonality, five local varieties of avocados were provided to the 30 chefs on February 2007 who agreed to participate in the survey and they were asked to evaluate the local varieties on the basis of five characteristics such as ripeness, peeling characteristics, taste, texture, and color. An eleven point rating scale was used with scores ranging from 0 to 10 where 0 is very undesirable and 10 very desirable. It was categorized as 0-2 undesirable; 4-2 fair, 7-5 good and 10-8 excellent. Five locally grown varieties which were seasonally available at the time of the survey were provided. They included Sharwil, Kahaluu, Malama, Linda

and Hass. The chefs' rating scores were analyzed using general linear modeling (GLM) with Duncan's multi-range test using SAS version 9, to find out if there are significant differences : (1) between the mean score of each characteristic by variety and (2) among the overall score for each variety. The results of the taste testing are presented in Table 4.6. The mean score having the same alphabet (A, B and C) shows there is no significant difference either for the characteristics by variety or the overall score for each variety.

Table 4.6: Results of Taste Testing of the Avocado Characteristics by Varieties and Overall Score of Each Variety by Local Chefs

Var*	Ripe P< .01		P.Char* P<.01		Taste P<.05		Texture P<.01		Color P<.05		Ove. Av. Sc* P<.0001
	MS*	+/- SE*	MS	+/-SE	MS	+/-SE	MS	+/-SE	MS	+/-SE	MS
1	8.30 A	0.29	8.50 A	0.23	7.43 A	0.42	7.87 A,B	0.33	8.60 A	0.20	8.17 A
2	8.61 A	0.23	8.23 B,A	0.32	7.43 A	0.39	8.13 A	0.29	8.40 A	0.23	8.08 A
3	8.22 A	0.24	8.09 B,A	0.26	7.50 A	0.33	8.08 A	0.34	8.33 A	0.38	8.13 A
4	7.30 B	0.35	7.41 B,C	0.32	6.43 A,B	0.41	7.04 B,C	0.31	7.81 B,A	0.29	7.17 B
5	7.30 B	0.26	6.71 C	0.48	6.31 B	0.39	6.73 C	0.35	7.34 B	0.34	6.78 B

** Var: Varieties- 1:Kahaluu; 2:Malama; 3: Linda; 4:Sharwil; 5:Hass*
P.Char: Peeling Characteristics; Ove. Av.Sc: Overall Average Score MS: Mean Score; SE: Standard Error

The mean scores for each of the taste testing characteristics indicate a significant preference for local varieties of Kahaluu, Malama and Linda over the imported one which is Hass. Sharwil, a local variety that was promoted extensively by the industry in the 1980s for export purposes due to its similarity to Hass in characteristics does not show any significant difference between the three other local varieties in terms of peeling, color

and taste characteristics. However, it was significantly less preferred from the other three local varieties in terms of ripeness and texture. For the overall mean scores taking into account all the characteristics by the varieties, the result showed that the three local varieties is significantly preferred over Hass and Sharwil. The following figures from 4.1 to 4.5 represent the preference score for each characteristic by varieties.

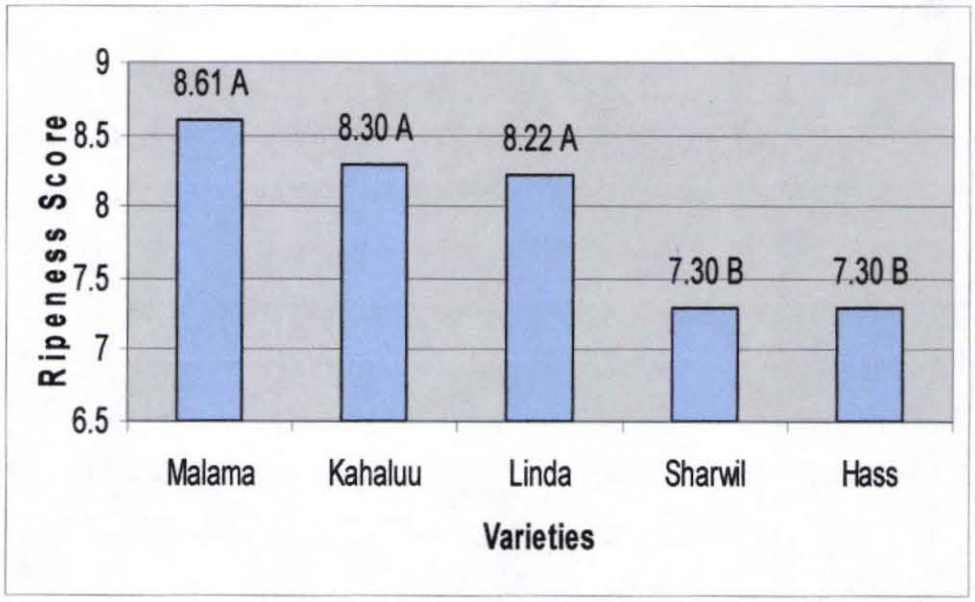


Figure4.1. Preference Score for Ripeness by Varieties

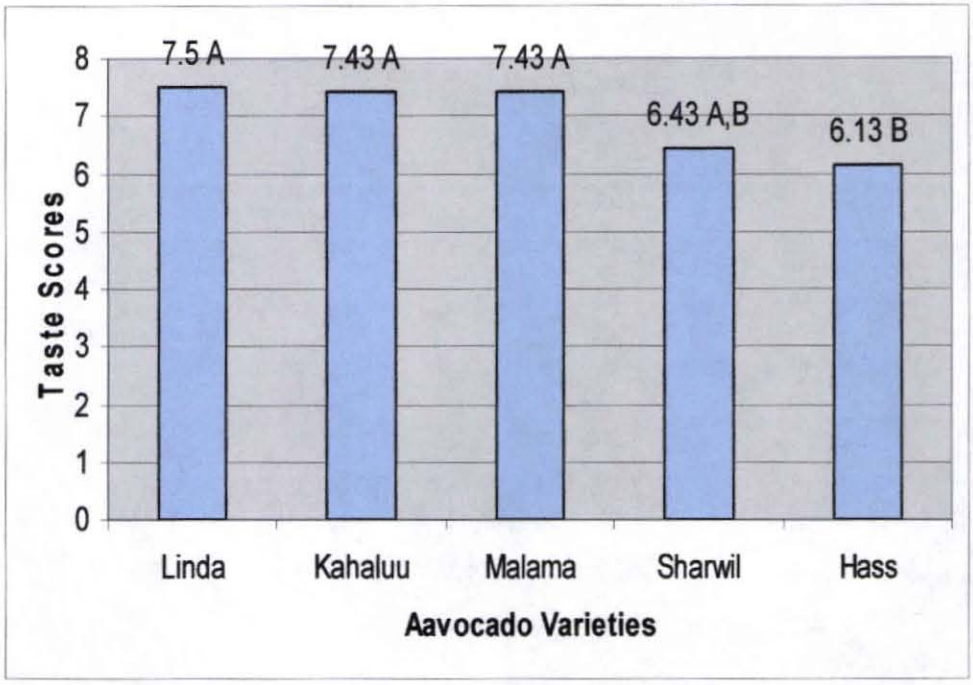


Figure 4.2. Preference Scores for Taste by Variety

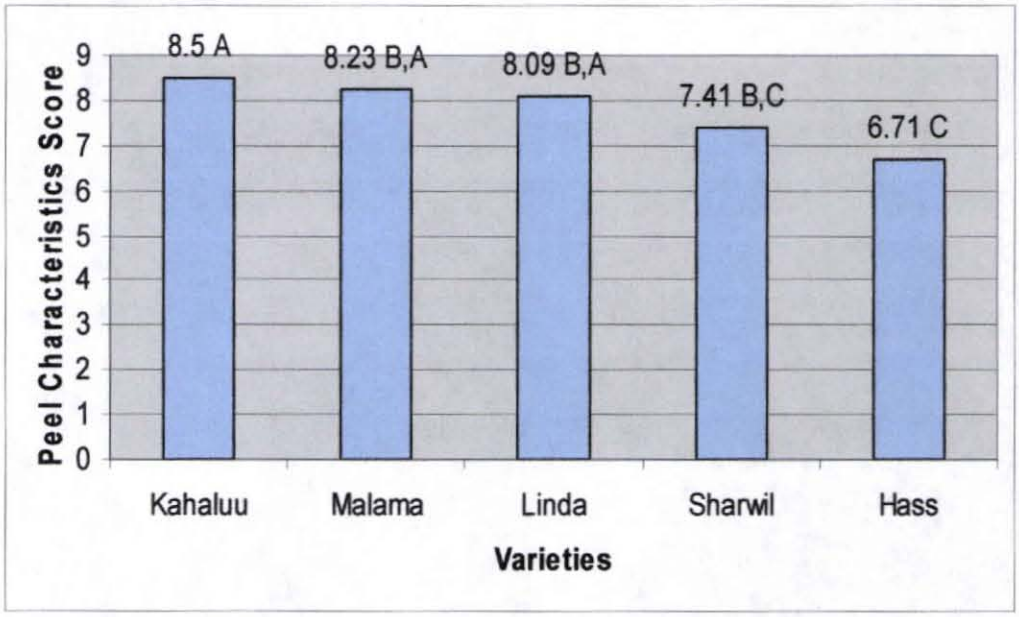


Figure: 4.3. Preference Scores for Peel Characteristics by Varieties

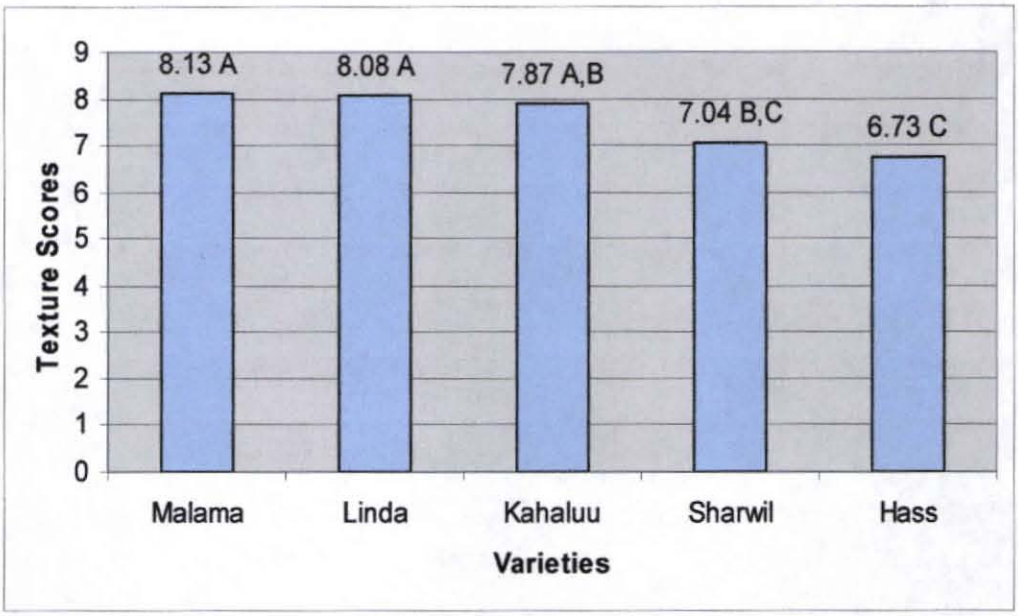


Figure: 4.4. Preference Score for Texture by Varieties

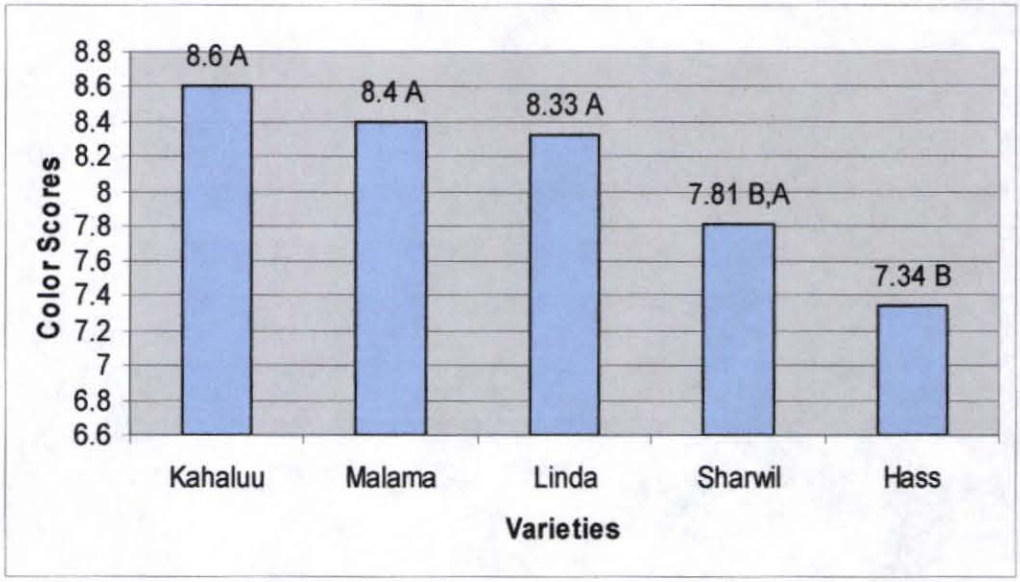


Figure: 4.5. Preference Scores for Color by Varieties

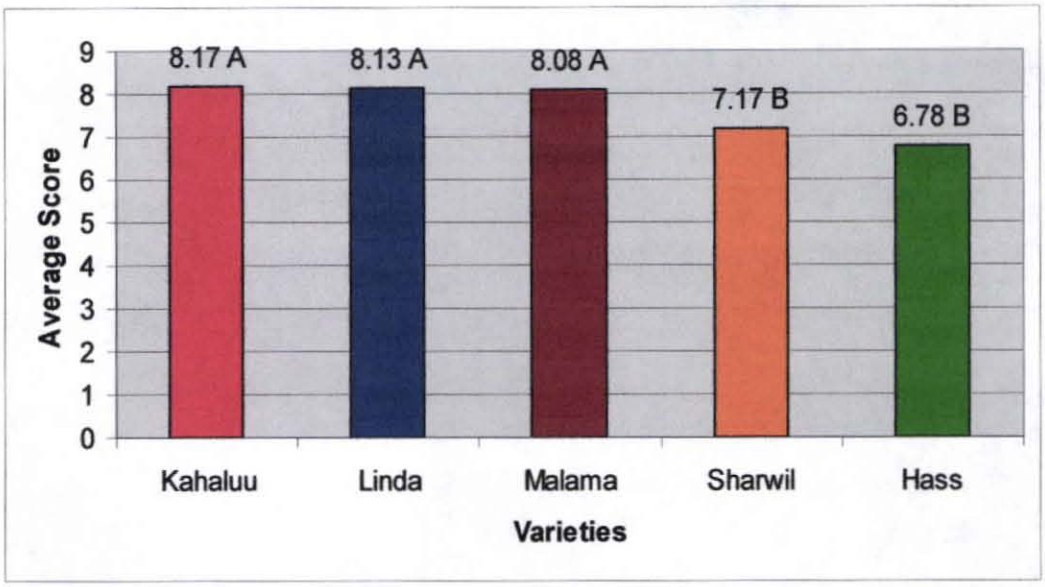


Figure: 4.6. Average Preference Scores for all Characteristics by Varieties

Figure 4.6 shows the overall average mean score in the order of preference starting with Kahaluu , the most preferred (8.17) followed by Linda (8.13), Malama (8.08), Sharwil (7.17) and Hass, the variety that is currently being imported to Hawai'i in large volumes which is the least preferred at 6.78.

Followed by this in order to find out if there is any coordination between what the buyers prefer and what is currently being grown, the total production for each of the different varieties obtained from the survey was calculated and the results revealed (See Figure 4.7). Sharwil is the most produced with 45% followed by Malama with 21%, Yamagata with 11%, Murashige with 3% and Hass .9%. This was calculated based on the values obtained from the avocado survey by eliciting from the farmers the different varieties they grow and what is the production/variety. An average value of production of each

variety was calculated and then multiplied by the number of farms to get the total production for each variety.

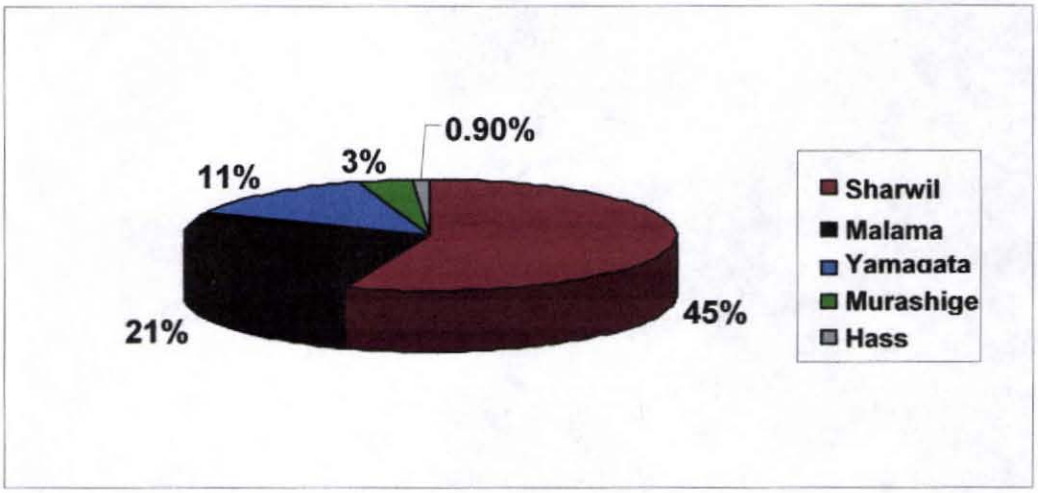


Figure 4.7. Top Five Varieties of Avocados Grown Currently in Hawai'i

The results from the two graphs (Figure 4.6 and Figure 4.7) gives some indication of lack of coordination that exists between the farmers and the buyers as the variety with maximum production, Sharwil is only fourth in the order of preference as the chefs rated Sharwil fourth among the five varieties.

4.2.2 Objective 2(b)

4. 2.2.1 *Willingness to Adopt Three Supply–Demand Integrated Management Strategies*

Based on the above findings and literature review, the avocado growers' willingness to adopt the three management strategies suggested under SDIM approach was explored. These strategies, if adopted, should incorporate greater coordination and information flow between farmers .The respondents on the question of the farmers' willingness to adopt the three strategies were analyzed using frequency analysis and percentage.

Table 4.7. Results on the Willingness to Adopt the Three Selected SDIM Strategies by Hawaiian Avocado Farmers

Strategies suggested under SDIM Approach	NO		YES	
	No. of Respondents	Percent	No. of Respondents	Percent
Willingness to Switch to New Varieties	18	32.73%	37	67.27%
Willingness to Join Cooperatives	17	30.91%	38	69.09%
Willingness to Adopt Branding	6	11.76%	45	88.24%

Results as indicated in Table 4.7 found that 67.27 % of farmers were willing to switch and grow new varieties that are preferred by the buyers; 69.09% of the farmers were willing to join cooperatives and a huge majority of 88.24 % was willing to adopt branding to improve sales.

4.2.2.2 Farmers' Likelihood to Adopt the Supply-Demand Integrated Management Strategies

Since the frequency analysis above revealed that majority of the farmers were willing to adopt the three strategies suggested under supply-demand integrated management it was important to get a better understanding of the independent variables that would influence the farmer's likelihood to adopt the three strategies. Logistic regression was therefore carried out and the following results were obtained. Results of the model parameters estimated by logit regression using the Statistical Analysis Software are reported in Table 4.12 and Table 4.13. The results helped in identifying the

farmer profile that are more likely to make the changes which in turn would be helpful in targeting them for awareness and training programs and other policy incentives or support programs. .. In the case of the third strategies-willingness to adopt branding, a large majority of the respondents (88%) was willing to adopt branding no significant results were found as expected as the variation of the dependent variable is minimal.

Model 1 Discussion: Likelihood of Hawaiian Avocado Growers to Switch and Grow Varieties currently preferred by the Customers:

As indicated in Table 4.8 the model has a probability value of likelihood ratio less than.001 which denotes that overall the model is significant. It also has a concordant percentage 95.6% which is much greater than the required minimum 50% and this shows high predictive capacity of the model. Results showed that all the parameters are significant at either the 0.05 or 0.01 level except for the variables Post Grad (those have more than a bachelors degree) and Older farmers (those who are older than 55. In examining the signs of the significant coefficients we found that they all have a positive relationship except for part-time farmers and younger farmers (less than 45 years old) .In other words, those respondents who indicated that they are willing to switch to grow other avocado varieties are, full-time farmers, who have leased lands, with more years into farming, low production of avocados (< 2,000lbs), and small and medium farm sizes, with at least four years of college education and who belong to the age category 40-50yrs.

Model II Discussion: Likelihood of Hawaii's Avocado Farmers to Join Cooperatives.

On examining the second model (Table 4.9), where the dependent variable is the farmers' willingness to join or form a cooperative and the role each independent variable plays on influencing the dependent variable, results showed only three independent variables that

are statistically significant in influencing farmers' decision to join a cooperative. Results showed that farmers with low cost of production a (i.e.less than $1000) are less likely to join cooperatives compared to those with High Cost of Production and farmers with medium cost of production ($1000- $5000) are more likely to join a cooperative compared to those with high cost of production, i.e. whose production cost is above $5,000 . Considering the age of the farmers, and those who are less than 40 years of age compared to those between 40 and 55 are less likely to join a cooperative and this variable showed a significant influence at .01confidence level on the farmer's decision. And farmers who are older i.e. the age are greater than 55 they are less likely to join a cooperative compared to those between ages 40-55. However, in this model only the variable Younger Far (i.e. age less than 40 years) was shown to be statistically significant at the <.01 level.

Table4.8. Logistic Regression Coefficients for Farmers' Willingness to Switch and Grow Varieties Preferred by the Customer

Variables DV	Willing to Switch and Grow Varieties Preferred by the Customer			
IV			Maximum Likelihood	Standard Error
Farm Characteristics	Reference Variables	Expected Signs		
Intercept			-4.6240	2.5798
Part-time	Full-time	-	-9.4740*	3.7776
Tenant	Own	-	+6.0968**	2.9628
farmyrs		-	+0.1180*	0.0507
L.Prd(<2000lbs)	HPrd	+	+6.0243*	2.7738
Smallfar(<5ac)	Bigfar	+	+5.4134*	2.6315
Medfar(5-15)	„	+	+7.8326**	3.1843
Socio-Demographic Factors				
Post Graduate	HSchool.	+	+.0369	.9767
Under Grad	School.	+	+3.7951*	1.7346
Younger Far(<40)	Midage	+	-9.2192*	3.7193
Older Far(>55)	Midage	-	-1.8751	1.2706
Likelihood Ratio (Pr >Chisq)			**<.0001*** **	
-2 Log L			**26.918**	
Percent Concordant			**95.6**	

** <.05, **<.01, ***<.001*
IV: Independent Variable
DV: Dependent Variable

Table 4.9. Logistic Regression Coefficients for Farmers' Willingness to Join Cooperative

Variables DV	General Model Willingness to Join/Form Cooperatives			
IV			Maximum	Standard
Farm Characteristics	Reference Variables	Expected Signs	Likelihood	Error
Intercept			1.7511	1.4143
Part-time	FT	-		
Tenant	Own	-		
farmyrs		-		
L.Prd (<2000lbs)	HPrd	+		
Smallfar(<5ac)	Bigfar	+		
Medfar(5-15)	„	+		
LCprod(<=$1000)	H.cost prod	-	-0.3379	0.9633
MCostprod ($1000-5000))	H.cost prod	-	+1.7605	1.3822
Socio-Demographic Factors				
Post Graduate	HSchool.	+		
Under Grad	School.	+		
Younger Far(<40)	Midage	+	-3.9820**	1.5848
Older Far(>55)	Midage	-	-2.0517	1.2186
Likelihood Ratio (Pr >Chisq)			019*	
-2 Log L			36.995	
Percent Concordant			77.3	

** <.05, **<.01, ***<.001*
IV : Independent Variable
DV : Dependent Variable

4.3 Objective 3:

Objective 3 was to find out, based on farmers' willingness, if there is an economic incentive in selling through an avocado cooperative and if so, what should be the optimal size of the cooperative. To accomplish this objective, data was analyzed using a mathematical model proposed by Jang et.al., 2002. The model proposed by the authors is a useful tool to make strategic decisions such as finding out the economic returns by joining a cooperative or selling individually. These decisions could be made on the basis of the total revenue based on the number of farmers and the stochastic nature of demand when selling individually vs. stable demand when selling through a cooperative. According to equation 3 to calculate the revenue when selling individually, the probability density function of the demand variable needs to be found out and since normal distribution is the most commonly occurring and universally accepted distribution probability distribution of the demand variable was checked to see if it was normally distributed. To check whether this is the case, 45 year of total demand data for avocados in Hawaii was collected to estimate the type of distribution explained in section 4.3.1. Once the distribution of the demand data was found then the revenue could be calculated incorporating the probability density function (pdf) of demand which addressed the stochastic nature of demand the farmer faced when selling individually. Under section 4.3.2, under a set of assumptions, the revenue generated while selling through a cooperative and selling individually is calculated. Finally section 4.4 summarizes the key findings of this chapter.

4.3.1 Estimating the type of probability distribution of avocado demand.

The 45 years of demand data from 1960 to 2005 for avocados was plotted against a theoretical normal distribution graph as shown below (Figure 4.8 to find out if the avocado demand distribution matched with the theoretical normal distribution graph and it was found that the avocado demand distribution indicated a normal distribution with slight skewness to the right. The mean is 1,469 pounds, standard deviation was 461 pounds and the skewness is .93. Since skewness has a positive vs. negative value it can be concluded that the normal distribution is slightly skewed to the right.

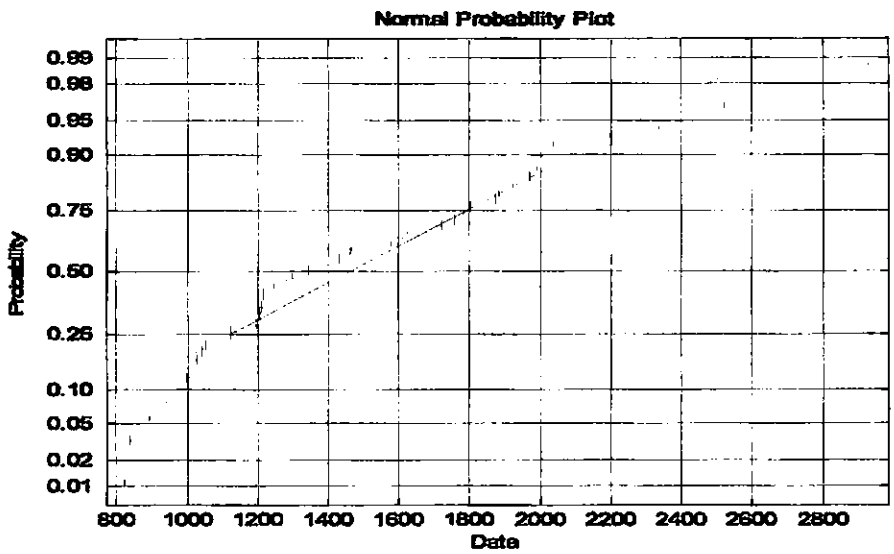


Figure 4.8. Illustrates the Normal Probability Plot of Avocado Demand (1960- 2005)

As mentioned previously, to reconfirm the nature of distribution, the data was analyzed based on the theoretical estimates of occurrences for a normal distribution and the results are as shown in the Table 4.9, below. Let mean be the average demand and σ the standard deviation. When inspecting the data, it showed the following results with the data given in Table 4.10. The occurrence between mean+/- one σ is 68%, the same as stated in the

theoretical occurrence and occurrence between mean +/- 2* σ is 94%, which is very close to the 95% stated in the theoretical occurrence.

Table 4.10. Distribution of 45 years of Hawaii Avocado Demand Data Based on Theoretical Estimates of Occurrences for a Normal Distribution

	Mean-2* σ	Mean-oneσ	Mean	Mean+ one σ	Mean + 2* σ
.Avocado Demand (000 lbs)	546.9	1,008	1,469	1,931	2,392

4.3.2 Calculating the Revenue Selling Through a Cooperative vs. Selling Individually for the Hawaiian Avocado Industry

In case of scenario one, the farmers are selling through a cooperative of size n, to the wholesalers at a price p_2 which is less than selling it individually at p_1 i.e. ($p_2 < p_1$), because wholesale prices are generally less than individual retail price. They also would have met the demand D which is considered stable when selling through a cooperative, producing Q, and the revenue was calculated for the Hawaiian avocado industry using the Equation 2 with the following values, based on the fore mentioned assumptions.

Average Demand (5 years): 2,281,200 lbs

Average price received from wholesalers, p_2 = $.86/lb

Average price received when individually sold, p_1 = $1.05/lb

If n = 103 (69.09% of the farmers who said they are willing to join a cooperative), then Q = D/n = 2,281,200/103 = 22,147lbs, and since the farmer is only producing to meet the demand and selling only to the wholesaler through a cooperative, the revenue was

calculated using Equation 2. The calculated revenue is for per year per farmer. The size of the farm is not considered in these equations.

$$f(n) = p_2 D/n + \int_0^{Q-D/n} p_1 x\phi(x)dx + \int_{Q-D/n}^{\infty} p_1 (Q - D/n)\phi(x)dx \qquad \text{(Equation 1)}$$

$$f(n) = p_2 * D/n \qquad \text{(Equation 2)}$$

In case scenario 2, where the farmers are selling individually at price p_1 and faces stochastic demand the revenue was calculated using Equation 3 which is:

$$f(0) = \int_0^{Q} p_1 x\phi(x)dx + \int_Q^{\infty} p_1 Q\phi(x)dx \qquad \text{(Equation 3)}$$

As a final step, the size of the cooperative in terms of membership was calculated to find out at what level of the cooperative membership, the revenue per farm starts declining. Figure 4.9 illustrates the revenue trend when sold individually versus when sold through a cooperative. The graphs indicate that from a cooperative size of 103, which represents the 69.09% of the farmers who said they are willing to join a cooperative, the revenue generated is higher than selling individually until the size of the cooperative reaches a size of 125 farmers after which it is better to sell individually as the revenue through cooperatives shows a decreasing trend (pink line) compared to revenue from selling individually (blue line).

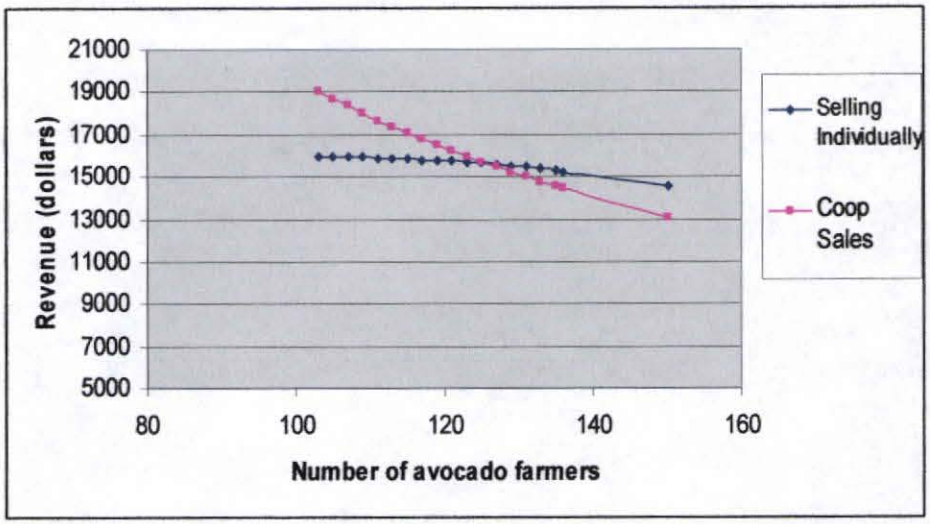


Figure 4.9. Estimated Revenue Trend per Farmer: Selling individually vs. Selling Through a Cooperative

The following Table 4.11represents the results of the revenues comparing selling through a cooperative vs. selling individual by cooperative membership size.

Table 4.11. Comparison of Revenues Generated from Two Different Selling Strategies by Cooperative Membership Size

Number of members in the cooperative	Revenue when selling through a cooperative per farm per year	Revenue when selling individually per farm per years
103	$ 19,046	$15,945
125	$ 15,694	$ 15,627
135	$14,532	$15,286
150	$ 13,078	$14,575

As is clear from Table 4.11, the revenue generated from the cooperative ranged from $19,046/year/farmer to $ 13,078/year /farmer with a cooperative size of 103 to 150 respectively. From the cooperative membership size of 103 to 125, the revenues are much higher at $19,046/year/farmer vs. $15945/year/farmer and $ 15,694 vs. $15,627

As the size of cooperative membership increased beyond 125, the revenues obtained from cooperative started declining when compared with the revenues obtained from selling individually. This result suggests that the optimal size of the cooperative can be 103 or less since farmers have the highest revenues at that size of the cooperative and this is the number of avocado farmers who said they were willing to join a cooperative. The revenue from cooperatives compared to selling individually is expected to change with a change in price, or a decrease in the number of farmers joining a cooperative. Also one potential limitation of this result is the assumption that Hawaiian avocado farmers are producing to meet the demand and they are all selling the same amount through the cooperative.

4.4. Summary of Results

Objective 1 was to determine the current situation of the Hawaiian avocado industry and document key aspects of the local avocado industry's supply profile and their potential for import substitution. It was found that the Hawai'i production was at 800,000 lbs which is much less than the additional 2 million lbs that is being imported into the state. At the same time results revealed that the Hawai'i avocado farmers are facing a wastage of 49% which indicates the actual potential of the industry to be 1.3 million pounds reducing the gap between Hawai'i production and imports to Hawaii at .7 million lbs.

Considering the second objective which was to find out if there is coordination between what the growers are growing and what the buyers prefer, descriptive statistic results revealed that there is somewhat a lack of coordination between the two based on the varieties presented to the chef. This lead to the next objective which was to find out if the growers would be willing to adopt the three management strategies suggested under the supply-demand integrated management model. The results showed a majority of the respondents are willing to switch and grow varieties that the customers prefer, they are willing to form a cooperative and they are willing to adopt branding. Logistic regression analysis revealed the Hawaii avocado farmers' socio-economic-demographic and farm characteristics that influenced these decisions. With regard to the farmer's willingness to switch and grow varieties that are preferred by the customer, the model results revealed that full-time farmers, who have leased lands, with more years into farming, lower production of avocados (< 2,000lbs), and small and medium farm sizes with at least four years of college education and who belong to the age category between 40-55 years have a significant influence on the farmers decision to switch and grow varieties that are preferred by the .With regard to the farmer's willingness to join a cooperative only three variables such as farmers with high and medium cost of production, i.e. whose production cost is either above $5,000 or between $1,000- $5,000, in comparison with higher production cost of more than $5000 and those who are less than 40 years relative to those between 40 to 55 were less likely to join cooperatives. However, in this model only age of less than 40 years was shown to be statistically significant at the <.01 level.

Lastly, the third objective, which was to find out the best strategic move that would benefit the Hawaii avocado growers the most, it was found that avocado farmers who

were willing to join a cooperative under the conditions they sell all their produce to the wholesaler would receive higher revenue compared to selling individually when the size of membership is less than 125. In the following chapter the potential implications of these findings will be discussed in detail.

CHAPTER V

CONCLUSIONS AND POLICY IMPLICATIONS

This chapter begins by revisiting the literature reviewed and the conception of the modified supply demand integrated model in section 5.1. Following this in, in section 5.2., the potential of the Hawaii avocado industry to substitute imports is discussed based on the results under objective 1.Section 5.3 discusses the importance of adopting the three management strategies suggested under supply demand integrated model such as the role of coordination, forming cooperatives and adopting branding by the local avocado industry based on the results of objective 2. Next, in section 5.4 the advantage of taking strategic management decision as part of the supply-demand integrated model, such as forming a cooperative is discussed based on the results of objective 3.Following this in section 5.5 the summary and policy implications are discussed and finally in section 5.6 the scope for future research is presented.

5.1 Supply Demand Integrated Model-Revisited

To begin with this chapter draws conclusions from the review of literature. From the extensive review of literature, it was possible to establish the importance of supply chain management and its effectiveness in the case of small-scale agricultural farms to enhance their income and capacity. However some limitations and gaps were found in the conventional supply chain management framework for small-scale agribusiness and so a modified framework called the supply demand integrated model was put forth which stressed on the importance of integrated supply–demand coordination involving a set of management practices resulting in positive consequences. The three important

management strategies which are part of the supply demand integrated model, crucial for enhancing the industry, increasing revenue and satisfying the customers were highlighted. These management strategies include 1. Understanding customer preferences and importance of coordination among growers and buyers; 2. Joining cooperatives; 3. Adopting branding for improved downward information flow and value added markets. On the basis of this modified supply demand integrated framework the three objectives of the study were met in order to achieve the overall objective which was to find out the willingness and likelihood of Hawaiian avocado growers' participation in fresh produce supply demand integrated management as a step towards import substitution and self-sufficiency.

5.2. Potential of the Hawai'i Avocado Industry To Substitute Imports

Objective 1 was to determine the current situation of the Hawaiian avocado industry and document key aspects of the local avocado industry's supply profile and their potential for import substitution. To begin with, an overview of the Hawai'i avocado industry was presented and from the results it was clear that the current rate of local avocado production is insufficient to meet the local demand. Considering the amount that is being imported, which is about 2 million pounds, the local production of avocados that reached the market, which is about 800,000 pounds, is clearly insufficient to substitute imports. This points out to the potential for increased production by the local Hawaiian avocado growers to be able to entirely substitute the imports. However, data analysis also revealed that the local growers' actual potential to produce is about 1.3 million pounds of avocados. This is incorporating the wastage which was reported to be 49% that the Hawai'i avocado farmers face due to poor pre and post harvesting techniques and lack of

good marketing knowledge and information. This is a key factor that cannot be overlooked. If the wasted 49% is incorporated into the current local production considerably decreases the gap between the current local production and imports. This highlighted the need for increasing grower awareness and active role of agriculture extension personal in educating the growers on appropriate harvest techniques and methods to reduce wastage,

The analysis also provided a detailed socio-economic and demographic profile of the Hawaiian avocado growers. One of the main observations here was that majority of the farmers are part-time farmers. This implies that at the current status, farming alone does not provide sufficient income for the small avocado farmers to make a living and also since the cost involved in farming is high any idea of expanding production at an individual farm level remains a challenge. This puts the growers in a vicious circle with a seemingly less chance to escape.

In order to get out of this vicious circle and be in a position to substitute imports and become self-sufficient, production needs to be increased further and considering the high cost involved the government and policy makers have an important role to play in assisting the farmers to bring down their costs, produce more and substitute imports. Literature review revealed that following a supply- demand integrated framework into which the three management strategies has been incorporated, can be beneficial to the local avocado farmers. Literature review also revealed that a combination of vertical and horizontal alliances is more effective to enhance small-scale agribusiness. In this regard the government can play a key role in establishing these vertical alliances for the local avocado growers or assist any private group or entity that may wish to undertake this

venture. Simultaneously the small farmers can be encouraged to form horizontal alliances such as forming farmer cooperatives. Along with this, coordinated activities between the growers and buyers and good information flow through adoption of branding can further enhance the industry situation. However in order to achieve all this, support and incentives must be provided to the Hawai'i avocado growers.

5.3 Importance of Coordination, Forming Cooperative and Adopting Branding

The ultimate aim of this study was to find out if the Hawaiian avocado growers had the potential to improve production levels, replace imports, increase farm revenue and attain self--sufficiency. As mentioned earlier, from the extensive literature review it was clear that adopting the three main management practices incorporated into the supply demand integrated management framework, there is a potential for small farmers to enhance their income. With this in mind, the current situation of the local avocado industry was analyzed and evidence from data analysis indicated a lack of coordination between the growers and the buyers. The reason for this could be because no studies or market analysis had been done previously to inform the farmers or the buyers about the importance of coordinated efforts and information sharing, which also perhaps explain the poor performance the industry has been facing for so long.

According to the Hawai'i avocado industry analysis that was done in 1989 (Bittenbender et.al., 1989), the industry has been facing many challenges, and some of the recommendations suggested then was to capture the export market. With this in mind policies were recommended to relax the export regulations of locally grown avocados, to the mainland. APHIS (Animal and Plant Health Inspection Service), in this regard proposed to admit Hawaiian avocados, if handled in the same manner as those exported

to Alaska, which is via a fruit fly-proof packinghouse system. The College of Tropical Agriculture and Human Resources had recommended three varieties of avocados, Greengold, Sharwil and Murashige based on estimated productivity, ease of peeling, appearance, flesh texture, color, seed size and flavor. With these in mind the industry then promoted one particular variety of avocados named Sharwil. The Hawai'i Avocado Association (HAA) expected the mainland demand for Sharwil to surpass supply as soon as the permission to ship was granted by the APHIS. The proposal by the APHIS was expected to be resolved sometime in 1989, but it didn't get through. Besides this the cost involved in getting fruit-fly free certified was expensive and many farmers couldn't afford it. According to the study the focus of the industry was on capturing the export markets and not enhancing the local market or substituting imports.

However, now there is a general change in trend with regard to the agricultural industry as indicated in the literature analysis in the form of shifting of focus from exports to ideas such as import substitution, self-sufficiency, food safety and security. These ideas become all the more relevant while considering a small island like Hawai'i with its physical vulnerability and geographical isolation.

With this in mind the farmers were asked if they were 1) willing to take part in coordinated efforts and meet customer preference by switching to grow varieties preferred by the customers; 2) willing to form a cooperative as an important strategic move to reduce cost and increase revenue; and 3) willing to adopt branding as an important operational approach ensuring steady downward information flow that enhances customer satisfaction and profitability through value-added niche markets. Results of the study indicated that majority of the local avocado farmers had responded

positively. Followed by this, specific farmer profiles that were more likely to make these changes were also identified. This would be beneficial in terms of targeting them for appropriate training, support and financial incentives by the extension workers, policy makers or the government to assist them. With these new strategies for import substitution in focus, the results of this study further presented some interesting possibilities and suggestions for change

5.4. Advantages of Strategic Decision Making

From the results it could be concluded that there are some inefficiencies such as lack of coordination and information gaps that exist between the farmers and the buyers and in order to tackle these, the farmers were willing to adopt new management practices. One of them is their willingness to form a cooperative. Literature review indicated forming cooperatives as an effective strategic decision under supply demand integrated management which can play a key role in bringing down costs, improving sales and marketing and help farmers face stable demand there by enhancing income. With this in mind, using a mathematical model proposed by Jang et al., 2002, based on a set of assumptions an attempt was made to find out if selling through a cooperative or selling individually would generate greater revenue to the local avocado growers particularly with regard to those who had said they were willing to join a cooperative (69.9% of the total growers or 103).

The results from the mathematical model showed that it was beneficial for the Hawai'ian avocado growers to sell through a cooperative with a cooperative membership size of 103 farmers since it generated greater revenue at the current wholesaler price which is lower than the price when selling individually and this trend would continue till the cooperative

size reached 125 . These results show a clear indication that forming a cooperative can generate higher revenue and, since majority of the farmers (103 avocado farmers) are willing to join a cooperative, forming horizontal alliances through cooperatives must be considered as a potential choice to adopt by 0 the local avocado farmers . However, support and assistance to reduce wastage and increase the production capacity of the local avocado growers must also be provided.

5.5. Summary and Policy Implications

In essence, if these recommended initiatives are not taken and the current situation is allowed to continue, the actual potential of the industry and its scope to substitute imports and become self-sufficient will remain elusive. Those farmers who wish to expand their operations and are willing to adopt recommendations necessary for improvement and success must be encouraged. Adopting the supply demand integrated model, and the specific activities suggested for adoption by the farmers should be carefully considered and decisions to assist the local growers to adopt them has to be made as early and as effectively as possible.

Also policies such as the New Agricultural Land Bill which is designed towards encouraging farming and agricultural activities must be encouraged and more such policies benefiting and encouraging the local growers must be passed and implemented. The United States Department of Agriculture has listed out a number of policies that are intended to benefit small farmers who wish to revive and expand their operations. There are also existing federal and state polices that provide support to farmers who wish to get involved in branding their local produce. This is a good operational strategy suggested under supply demand integrated management and it would also ensure higher values.

In summary it can be stated that state and federal policy makers have a crucial role to play in supporting small farmers, particularly belonging to a geographical isolated small island state like Hawai'i. Also policies must be designed such that it is congruent with farmers' priorities and their socio-economic and farm characteristics.

It is important to initially target growers who are more willing to adopt new strategies and provide them with appropriate information, training and support.

The importance of agricultural self-sufficiency and food security cannot be stressed enough and farmers must be encouraged to continue with farming and also expand to reach self-sufficiency. High dependency of food on imports must be discouraged as in the long run it can prove to be too costly for the State and its people.

Import substitution is a possibility in Hawai'i, particularly in the case of the Hawaii avocado industry based on the findings of this study, provided farmers are given appropriate state and federal support, particularly in bringing down costs.

This study has suggested some good strategies that have been proven to be effective if appropriately targeted and implemented and therefore policy makers must consider these recommendations seriously. Other than the targeted farmer population, it is also important to educate the other farmers who may be less willing to adopt these strategies. The reason for their unwillingness may be lack of information or awareness, and so it is important to inform them of the current industry situation, and discuss the potential of new strategies such as supply demand integrated management to improve the overall local avocado industry and also enhance their individual farm incomes.

Beside this the role of researchers and extension workers is very important as they play a crucial role in educating and informing the farmers on proper pre-and post harvest

techniques, techniques that can make farming more efficient and productive and propagate and grow varieties that are most preferred by the customers or buyers. For this a complete marketing analysis encompassing all the different consumers has also been recommended which would be the next phase of this project.

5.6 Scope for Future Research

This study has attempted to put forth a modified supply demand integrated management framework with the intention of benefiting small scale Hawaiian avocado farmers and based on this framework the study attempted to understand the current situation of the Hawai'i avocado industry, This study was also able to explore the lack of coordination that exists between the producers and the buyers by surveying the farmers and chefs and following this the willingness and likelihood of Hawaiian avocado farmers to adopt the three management strategies incorporated into the modified supply demand framework was found. Following this the potential benefit for the Hawaii avocado farmers to form horizontal alliances was explored and it was found that forming cooperative can be beneficial to the local avocado farmers. However, in order to get a much clearer understanding of the market and improve upon some of the recommended strategies brought out on this study, it is important to get feedbacks from other buyers such as the wholesalers and the final consumers or the general public. Before policies and programs to support the avocado farmers can be formed and implemented and in order for them to be effective an overall understanding of the market based on the supply demand integrated framework is needed and this presents a scope for future research.

APPENDIX A

AVOCADO PRODUCER SURVEY

Project Title: Avocado Supply-Demand Integrative Management Approach to Sustainable Agriculture and Import Substitution.

Name of the Interviewer: Date:

Location:

Questionnaire No :

Gender M/F

Farm Location:

Questionnaire to Producers

1) What is your total farm size? ——— acres

2) How many acres in avocado ? ——— acres

3) How many avocado trees do you have? (Please specify)

a) Total———— trees b) Fruit Bearing———— trees.

4) Do you own or lease the land you farm on? (Please check one. If "Both" answer question
5, else skip to question 6).

a) ☐ Own b) ☐ Lease c) ☐ Both

5) If both, then

a) How many acres do you lease? .....acres

b) How many acres do you own? .....acres

6) For how many years have you

a) Owned the land ———years

b) Leased the land ——— years

7) What other crops other than avocado or livestock do you produce?(Please specify)

a) ———————————— e) ————————————

b) ———————————— f) ————————————

8) Are you (Please check one. If "part-time" please go to question 9, else skip to question 10)

a) ☐ Part-time farmer b) ☐ Full-time farmer

9) If part time, do you have another source of income? (Check all that apply)

a) ☐ Pension b) ☐ Investment c) ☐ Other Jobs

10) State the costs you incur in farm production and estimate the % cost for avocados. (Please Specify)

Types of Costs	Total Cost $ in 2005	% Cost for avocado in 2005
a. Farm Workers' Wages		
b. Farming Costs *(This includes Fertilizer Cost, Weed Control, Pest (rodents)Control, Pruning, Irrigation and Harvesting)*		
h. Marketing		
i. Operations overhead		
j. Total Costs		

11) What is your gross farm income in 2005? ————————$

12) What is your gross farm income from avocado 2005? ————————$

13) What would your projected avocado production be 5 years from now? ———pounds

14) On an average what price/lb did you get for avocados in 2005 (Please specify)

a) Wholesaler ----------$/lb
b) Grocery Stores ----------$/lb
c) Farmers Market ----------$/lb
d) Others (to whom and how much) ----------$/lb

15) Please provide the following information for the variety of avocado grown in your farm. Please specify the variety and provide the required information under 'Others" if it is not listed below.

Variety of Avocado grown in your farm	Number for trees for each variety	Total Production (lbs)	When do you harvest? Please Check the appropriate months											
			J	F	M	A	My	J	Jl	A	S	O	N	D
Sharwil														
Kahaluu														
Nishikawa														
Yamagata														
Ohata														
Linda														
Malama														
Murashige														
Hass														
Others (Please Specify) 1) 2) 3) 4)														

16) In Honolulu, the retail price of imported avocado is about $4.85. If you get that price how much more in pounds would you be willing to produce? ------- lbs

17) Would you be willing to produce a particular variety that you are currently not growing?

a) Yes /No (Please circle one)

b) If yes, why? ----------

c) If no, why? ----------

18) What percentage of your avocado production do you harvest? ----------%

19) What percentage of the avocado harvest do you sell? ---------- %

20) Where do you sell your avocados to? (Please check all that apply and indicate the percentage)

a) ☐ Direct Sale ----------% (Under Direct Sale please specify below)
   i) To farm stands ---------- %
   ii) To groceries ----------%
   iii) To wholesalers ----------%
   iv) Other (please specify) ----------%
   Sub Total 100 %

b) ☐ Wholesale ----------%

c) ☐ Through Co-ops ----------%
   Total 100%

21) How do you sell the fruit? (Please check one)

a) ☐ As whole fruit

b) ☐ Processed product

c) ☐ Both

22) If both, then indicate the percentage

a) As whole fruit ----------%
b) Processed product ------- %

23) Would you be willing to sell all your fruit to a co-operative/ farm organization at a higher price? (Please circle one)

a)Yes /No
b) If yes, at what price? ---------$/lb of whole fruit.

24) Are you a member of any fruit grower's association?

a)Yes /No

b) If yes, please specify.....

25) What product attributes, such as ripeness, cut stems, do buyers request? (Please list them)

1) ---------- 5) ----------
2) ---------- 6) ----------
3) ---------- 7) ----------

26) Do buyers request special labels?

a) ☐ Yes b) ☐ No

27) Please describe how buyers ask for your products (Please check all that apply).

a) ☐ Generic term such as avocado b) ☐ By variety such as Sharwil

c) ☐ By the name of your farm d) ☐ Locally grown

28) Do you use any form of brand label on the produce that you grow and sell?

a) ☐ Yes/ No (Please circle one)

b) If yes, please specify the brand name used by you----------

29) Would you be willing to sell your produce as a Hawaiian brand with the name of the type of avocado? (eg: HI Ohata or Malama)?

a) Yes/No (Please circle one)

b) If Yes, why? ----------

c) If No, why? ----------

30) Is your farm certified organic?

a) ☐ Yes b) ☐ No

31) What year were you born? ----------

32) Please indicate the highest level of education completed (Please check one)

a) ☐ High school or equivalent b) ☐ Undergraduate c) ☐ Post Graduate
d) ☐ Others (please specify.).....

33) What is your annual income (Please check one)

a) ☐ below 20,000 b) ☐ 20,000 -29,999 c) ☐ 30,000- 39,999
d) ☐ 40,000-49,999 e) ☐ 50,000-59,999 f) ☐ 60,000- 69,999
g) ☐ 70,000 -80,000 h) ☐ 80,000-90,000 i) ☐ 90,000 and above

With this you have come to the end of the questionnaire. If you have any questions or comments, please specify.

Mahalo for your co-operation

APPENDIX B
CUSTOMER (Chefs') PREFERENCE SURVEY
Avocados Grown in Hawaii:A Tasting

A University of Hawaii at Manoa project to brand locally grown avocados that were selected by ACF chefs and growers for quality and consistency. The goal of which is for growers to be able to provide locally grown high quality avocados year around.

Avocado Number ----------

Name (Optional) ---------- Location: ----------

Rate this avocado from 1 to 10 being the best:

	Excellent [10-8]	**Good** [7-5]	**Fair** [4-2]	**Undesirable** [2-0]
Ripeness -firm yet yield under pressure when held in your hand before peeling				
2. Peeling characteristics -ease of peeling -no dark spots on flesh				
3. Taste **-exceptional flavor, nutty**				
4.Texture -smooth, creamy, firm enough to hold a shape				
5. Color -lime green flesh near skin fading to a very light green color in center				
6. Seed to meat ratio				

Comments: Add here or in specific categories if you find this variety to have other characteristics not mentioned such as buttery, watery, sweet, bitter, and visually appealing.

How would you serve this type of avocado?

--------Sliced

--------Used in guacamole or another similar recipe

--------Other uses: ----------

--------Would not use.

Comments----------

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