ANALYZING THE ECONOMIC AND ENVIRONMENTAL IMPACTS OF AGRICULTURAL ALTERNATIVES – THE CASE OF VIRGINIA'S EASTERN SHORE

by

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(ABSTRACT)

The evaluation of production alternatives in agriculture requires a close examination of their economic and environmental impacts. This study was conducted to identify the crops with the highest profit potential given terminal market prices over the last five years, evaluate the feasibility of adopting new crop alternatives, given historical price information and limited production resources, and determine the potential environmental impacts of adopting new cropping strategies in Accomack and Northampton Counties on the Eastern Shore of Virginia.

A database of daily terminal price information was created to identify the market windows for specific commodities, their respective high, median and low prices, and their price variability over the last five years. A linear programming model was used to determine optimal farming operations for those farmers that grow only wheat and soybean versus farmers who are willing and able to include vegetables in their crop mix. PLANETOR, an environmental impact computer program, was used to estimate the potential soil erosion, pesticide leaching and runoff, nitrogen leaching, and phosphorous runoff for different scenarios.

The model shows that some of the new vegetable commodities could substantially increase the net returns of the farming operations in question. Romaine and Boston Lettuce were consistently selected as the most profitable alternatives while the region's traditional crops offered little competition. Wheat and soybean production showed acceptable levels of soil

erosion, as defined by the T-values for the region, and low potential for nitrogen leaching. They did, however, exhibit a higher potential for water contamination, through leaching, or runoff, of high toxicity chemicals. Although lettuce production had higher than recommended soil losses, a well-diversified crop mix offsets its negative impacts at the farm level. Lettuce also uses low toxicity chemicals, decreasing potential health hazard from their leaching or runoff. The introduction of the new vegetable commodities is recommended on the basis of the high profits that they offer, as well as the more positive pesticide leaching and runoff potential. Their final adoption, however, should take place only after establishing a well defined marketing strategy and resolving potential marketing problems.

No crop exists that could offer both high profits and have no impact on the environment. Kenaf was thought to be one, but it was soon eliminated on both grounds. This study showed, however, that the new vegetable crops considered may offer better net returns, while they do not necessarily translate into environmental disasters.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter One – Introduction

1.1 Statement of Problem, Rationale, and Significance.

While differing in many respects, rural areas often are described by terms such as: declining economies, out-migration, under-employment, no competitive advantage and low capital investment. Indeed, many of these characterizations are true and they reflect a long process of economic transformation, as various areas have shifted from agricultural production to other alternatives. Whatever the economic history of rural America might be, the fact remains that there are also many regions that have built and continue to sustain their socio-economic environment on rural traditions. Presently, they find themselves in a quandary. On the one hand, they have to compete with the rates of economic growth enjoyed by the country at large. Quite often this translates into a more intensive use of the limited natural resources they have available. On the other hand, land and water have limited regenerative cycles. More intensive utilization today, often compromises future use.[1] Finding a balance between economic growth and sustainable development is a complex task - there are no easy or definitive answers. Nevertheless, this project attempts to evaluate the economic and environmental impacts of introducing alternative crops.

[1] Sustainability is discussed in the literature review section.

The focus of this study will be Virginia's Eastern Shore. The Accomack and Northampton counties, the narrow strip of land known as the Eastern Shore of Virginia, are among the less prosperous areas of the commonwealth. Data from latest census show a 9.4 percent rate of unemployment, considerably higher than 6.4 percent for the state and 7.3 percent for the nation (United States Bureau of the Census, 1992). The area's average weekly wage is the lowest among other districts in the state and 27 percent of the population lives below the poverty level. Education remains a problem. Over 43 percent of people over the age of 25 have less than a high school education. The dropout rate is higher than in any other district of the commonwealth (Center for Public Service, 1995).

These problems, and many others, illustrate the need for higher rates of economic growth in the region. that will eventually translate into higher incomes, higher revenues and higher levels of investment in human capital.[2] Few people disagree that economic growth is important. The question that remains unanswered, nevertheless, is how will this growth impact the traditional economic activities of the region? More importantly, how will such activities adjust to support higher growth with minimal adverse effects on the quality of life and the local environment?

Traditionally, agriculture has been a major source of income and employment opportunities for the population of the Eastern Shore. In 1995, farm and agricultural services accounted for 13.8 percent of total employment and the value of agricultural production, including livestock, was $83.3 million (Center for Public Service, 1995, p.36). The importance of agriculture in the area becomes even more apparent if one considers that agricultural activity sustains many other business activities, such as those dealing with farm-input purchases and local value-added products. Moreover, the impact of agricultural activities on the environment is much larger than that of many other sectors of the economy, such as services, trade or government. If the economy of the Eastern Shore will grow fast enough to close the gap with other regions in the state, agricultural activity will have to play a major role in it.

[2] Many empirical studies support the theory that those economies with a free flow of capital tend to converge toward the same rate of growth and income per capita. This means that poorer regions tend to grow faster than wealthier ones. Indeed, the rate of growth of income per capita in the Eastern Shore exceeds the State average, (Barro, 1993, pp. 285 – 293).

Agriculture on the Eastern Shore currently focuses on a few major agronomic crops (wheat and soybeans) and several horticultural crops including tomatoes, potatoes, cucumbers and snap beans. This combination appears to be both agronomically and economically satisfying, assuring good rotations and management of economic risk. Still, it is necessary to ask the question: How will this product mix respond to desired higher rates of economic growth? As a first approximation, it is reasonable to believe that most capital will flow into those activities that generate higher returns to the dollar invested. In 1993, vegetables occupied only 20.7 percent of the harvested cropland. However, vegetables account for 52.2 percent of total value of crops harvested. Similarly, nurseries covered a mere 1.3 percent of total acreage but contributed 19.6 percent of the gross income. Soybeans, on the other hand, provided only 17 percent of total value of crops harvested, although they covered 49.5 percent of total cropland (Sills, Alwang, and Driscoll, 1993, pp. 4 – 5). If higher growth means a shift into activities providing higher returns, then it is necessary to explore the feasibility of diversifying agricultural production.[3]

There is a consensus among extension specialists that if farmers were better able to evaluate alternative enterprises and market their product, the region could soon gain the economic vitality it needs to "return local agriculture to its historic level in a manner which sustains the industry at its full economic potential and maintains productive locally-owned farms" (Northampton County – SARE/ACE, 1996, p. 6). Initial work has been conducted in assessing the feasibility of producing alternative vegetable crops, as opposed to those that have been traditionally produced there. Sterrett, *et al.* (1996) developed a mathematical programming model to conduct this analysis. Fall and spring lettuce, broccoli, and watermelons were found to be economically viable additions to the current crop production mix on the Eastern Shore. Market window analysis provided information on when the markets were available and the estimated price range for individual commodities. However, their study imposed several restrictions on the amount of land that could be devoted to these new vegetable products. Removing these constraints allows us to observe the full potential of such alternatives.

[3] Soybeans and grains are likely to continue to occupy a major position in the economy of the region. They present less risk, as compared to vegetables, and farmers have extensive expertise in growing them.

Furthermore, areas such as value-added marketing and economically feasible management strategies need to be developed in order to increase the profit margin under which farmers are currently operating and provide for a competitive advantage over other producers.

1.2 Objectives

The overall objective of this project is to evaluate the economic feasibility of introducing some new agricultural alternatives into the current product mix on Eastern Shore farms. Various scenarios will be examined on the basis of their environmental impact and the potential economic and environmental tradeoffs of these scenarios. The alternatives to be evaluated were determined by consulting extension agents and other specialists in the area. Accomplishing the following goals will attain this objective:

1. Extend the model developed by Sterrett, *et al.* (1996), by evaluating additional production alternatives as well as removing some of the most constraining assumptions in that study, such as their acreage limit on the new crops.
2. Assess the feasibility of marketing the alternative crops by:

- incorporating costs of marketing to various outlets, such as transportation, cooling and brokerage fees,
- constructing a daily price database for the vegetable crop alternatives and conducting a thorough market window analysis to determine the potential profitability and price variability of individual crops, and
- analyzing the environmental impacts of the optimal solutions from the linear programming models and evaluate the economic and environmental trade-offs of various scenarios.

1.3 Literature Review

The following review will address the main points raised in the statement of the objectives and provide an overview of the current literature on those issues. The discussion is divided in three sections. The first section will discuss the rationale used in selecting and evaluating agricultural alternatives. This section will refer to the confusion in terminology that often arises in dealing with feasibility studies of agricultural alternatives and how the present analysis adds to and varies from general concepts such as sustainable agriculture and organic farming. The second section considers various studies that have evaluated the economics of conventional and alternative farming methods. Such analyses vary in their methods, their scope, and their objectives. Quite often, they provide insights that move beyond simple cost-benefit analyses and, therefore, provide a good perspective for the current work. The last section, reviews studies that evaluate the general impact that transition from traditional farming systems to alternative ones has on other sectors of the local economy. This type of analysis is crucial as it relates farm level results, however encouraging they may be, to regional linkages and their impact on the local community.

1.3.1. What is Meant by Agricultural Alternatives?

It has become a sad ritual that every discussion of alternative agriculture, sustainable development or organic farming begins with a definition of what these terms mean in the context of the particular study. If anything, this shows different philosophical approaches to what appear to be the same goal rather than the more cynical outlook that views such issues as "a solution looking for a problem" (Lockeretz, 1988, p. 175). Quoting from Lockeretz's (1988) extensive review of these issues:

- "Sustainable" has a time dimension and implies the ability to endure indefinitely, perhaps with appropriate evolution
- "Alternative" describes something that is different from the prevailing or "conventional" situation. Another implication of the word is that farmers should be able to choose among alternatives, or options, rather than having to follow a single prescription.
- "Low Input" refers to reduced use of the materials from outside.

It is apparent, from the definitions stated above, that agricultural alternatives do not necessarily have to be sustainable or low input. On the other hand, sustainability can be a feature of conventional farming. Let us look more closely at how the current literature addresses these concepts.

The current drive towards what is often called alternative agriculture traces its roots to the environmental movement that started in the 1960s and has grown since then, as well as the disappointment with many of the side effects of industrialized agriculture such as "eroded soils..., increased flooding..., pollution from runoff..., depletion of aquifers..., contamination of environment from chemicals..., resistance of insects and weeds to pesticides, costly surpluses..., decline in farm exports, and increased production costs..." (Sauer, 1990, p. 184). According to Sauer (1990), all these consequences have increased the pressure on farmers, extension agents, agricultural specialists, and other institutions involved with agriculture, to find and implement alternative systems. These alternatives, besides being different from the conventional systems, may have characteristics that ameliorate the negative consequences of past practices. Often, they substitute knowledge and labor for machinery and chemicals. They rely on self-sufficiency and minimize purchase of inputs by making the best use of on-farm resources and they substitute land for chemicals and rely on complex agronomic processes such as crop rotations (Batie and Taylor, 1989, p. 130).

In this context of change, alternative systems are receiving increased attention. Above anything else, the new alternatives have to be sustainable. How we define sustainability, also determines what alternatives are proposed to replace the older ones. Dicks (1992) perceptively points out that society has come to attach increased importance to the preservation of the environment while food supplies have become quite abundant and secure. Hence, we are now facing a "movement toward defining sustainability with the objective of minimizing environmental disturbance, rather than maximizing food production with limited environmental disturbance" (Dicks, 1992, p.238).

Despite the antagonistic tones that sometimes accompany the debate between representatives of the environmentalist groups and agribusiness, there is a concerted attempt to make farmers, and others involved in agricultural activities, take part in the movement toward more sustainable systems. Faeth*, et al.* (1991, p. 16) make this quite clear when they state that:

> "In theory, US agriculture is a business enterprise like any other, so any decline of capital assets should figure in income calculations. In practice, however, farmers depreciate man-made assets such as tractors or silos, but make no allowance for the declining value of natural assets such as soil or water. To the extent that US farmers are living off their capital by allowing soils to erode and water to be contaminated, their income is overstated today - and at risk tomorrow."

Nevertheless, the push for sustainability, from longer rotations to best management practices and community-based development, comes with a warning. Sustainability and alternative systems need not only respond to the demands that the environmentalists put before them, but they should also be able to sustain current economic growth rates. As Ruttan (1988, pp. 128 – 131) points out, no system will become sustainable if it fails to provide higher productivity in agriculture and respond to increased demand. Furthermore, short-run considerations should also be taken into account. If an "alternative" system fails to assure the farmer's daily survival, then it is not much of an alternative.

This project employs both concepts of agricultural alternatives and sustainability. The objective, stated above, clearly indicates that the main purpose of this study is to evaluate agricultural alternatives: crops that are different from what is now being produced in the region. The selection process is, however, biased toward picking those alternatives that will provide for a sustainable development of the region at large. It should be emphasized that selecting for sustainability is a complex, long-term process and requires the input of farmers, extension agents and agricultural specialists. As such, this project is only part of the larger picture of sustainable development of Virginia's Eastern Shore. The first interdisciplinary meeting of many specialists working on a joint project to implement agricultural alternatives in the region, strongly suggested alternatives such as holly and woody perennials, hayman sweet potatoes, seedless watermelon, kenaf, flowers (dry flower, larkspur, delphinium), organic soybeans and snap beans, and so forth. Some of the goals sought to be achieved by this selection process included: reduce inputs, be sustainable and environmentally friendly, and make a profit.[4] Yet, it remains to be determined whether such proposed alternatives pass the test of fire - improve the sustainability of the current crop system, while at the same time increasing profitability. This can only be done through a rigorous analysis of both the economic and environmental factors involved.

1.3.2. Profitability Analyses of Conventional vs. Alternative Systems.

Various empirical studies have researched the economic implications of introducing agricultural alternatives into conventional farming systems. Most of these studies are concerned with isolated issues, such as lowering chemical input, or adding new rotations.

[4] Minutes from the 12-13, 1996 S.A.R.E Technical Team work-session. Machipongo Station, Hog Island, Northampton County, VA

There is a distinct void in the literature on the economics of introducing new crops. Cacek and Langer (1986) offer a good perspective on how to perceive existing efforts in this field. They suggest a division of such studies in three groups: actual farm studies, plot data studies and modeling comparisons. In this section, we will follow their approach in reviewing this literature

Lockeretz, *et al.* (1978) selected 14 organic crop and livestock farms and compared their economic performance with that of 14 similar conventional farms. The study showed that while conventional farming provided an 11 percent higher market value for the crops, the net returns balanced out because organic farmers experienced lower input costs. Cacek and Langner (1986) reviewed a study conducted by Roberts*, et al.* (1979). In this study data from 15 organic farms in the Corn Belt were compared to USDA data for representative conventional farms in the region. Their results were quite similar to those reported by Lockeretz (1978). Both studies stressed the lower production costs of organic farms.

Dobbs*, et al.* (1988) report on the economic potential of a small grain-growing region of the Northern Plains. The study compares two alternative farming systems that do not use any fertilizers or pesticides, with conventional or no-till farming systems. The alternative systems use various rotations of grains and legumes to make up for the absence of inorganic fertilizers. Dobbs concludes that the alternative system emphasizing small grain rotations has comparable net returns to the conventional or minimum tillage system. Sensitivity analyses also reveal that the first system becomes competitive at higher levels of fertilizer prices. The alternative system again experienced lower input costs.

Zhou and McGuirk (1996) conducted a survey of Virginia's non-traditional farmers engaged in activities such as Angora goat production and organic/biological farming. The answers provided by the surveys were compared to those of conventional farmers sharing similar characteristics such as: age, gender, formal education level, childhood background, and primary occupation. The results showed that only 11 percent of the alternative farmers viewed economic factors as important in their decision to produce alternative products. This was quite understandable since more than 77 percent of the respondents did not consider financial stress to be a factor in making them engage in organic farming and half of the respondents did no feasibility planning at all before converting. Consequently, profitability did not rank very high in the reasons for engaging in non-traditional practices for those surveyed.

The profit motive was quite significant among those reporting financial stress. Only 27 percent of the biological/organic producers made any profit from the enterprise, 32 percent lost money, and 41 percent broke even. The project focused on only one year (1993). Therefore, it does not account for any unfavorable climactic condition, such as a drought, particular to that year. Reportedly, farmers were enthusiastic about the future of organic farming. They regarded the lack of profitable outcomes for that year as simply a short-term cost of doing business. However, this claim is not substantiated by the reports cited above since philosophical convictions, rather than economic imperatives, motivated a large majority of the respondents.

Many studies report results derived from research plots. They are helpful as proof that a given objective, such as successful cultivation of new crops or the establishment alternative farming systems, can actually be achieved. At the same time, they usually lack the realism of a real farm setting. Helmers*, et al.* (1986) conducted an East-central Nebraska study that analyzed 13 cropping systems with respect to profitability and risk. The study developed rotational combinations of several crops. These systems were evaluated with regard to net yield and stability. Net returns were calculated using 8-year yield data and historic prices. Moreover, the study studied risk separately from diversification therefore deriving a better understanding of each aspect. Helmers reported that rotations had higher average net returns than continuously cropped systems. On the other hand, variations in chemical treatments did not have much impact on profits. Rotations also showed less yield variability than continuous cropped systems, thereby reducing producer’s risk.

King and Buchanan (1993) conducted a similar 7-year study. The study compared conventional management of chemical inputs with a reduced chemical input management system. The crop sequences consisted of continuous grain sorghum and corn, a two-year rotation and a four-year rotation of the two crops. Nitrogen was obtained by adding clover to the rotation, while weed control was accomplished by mechanical cultivation. With normal rainfall, both systems produced similar corn yields. Conventional management practices, on the other hand, provided higher yield for wheat, soybeans, and sorghum. The study concluded that while the no fertilizer treatment does produce lower yields, a combination of lower fertilizer rates and better rotations might actually provide higher yields.

To estimate the effects of various constraints, such as the inclusion of crop practices minimizing soil erosion on the objective function, Domanico*, et al.* (1986) analyzed the effects of soil erosion on income under a conventional farming system, a no till system, and an organic system. Profitability was compared among the three systems before and after soil erosion was constrained. Soil erosion was calculated using the Universal Soil Loss Equation. Without a soil erosion constraint, no-till was the most profitable option. The conventional system was second and the organic system was last in profits generated. After soil erosion was constrained, the model estimated the effect of less intensive rotations, cover crops and no till; all generated higher returns. While the no-till practice remained the most profitable system, organic farming became more profitable than the conventional system for higher constraints on soil erosion.

Diebel*, et al.* (1993) analyzed barriers to low input agriculture adoption in Richmond County, VA. The study compared the return of low input and organic production practices in an unrestricted scenario. They, then, gradually made the model more realistic by imposing various economic barriers to the adoption of such practices. The study focused on such potential barriers as poultry litter price, crop yields, labor requirements, and variable input costs. Low input agricultural practices did not respond significantly to changes in labor requirements, lower yield and higher variable costs, but the solutions were very sensitive to poultry litter prices, the only source of organic nitrogen in the study. While the study concluded that changes in any of the labor, yield or variable cost components did not adversely affect adoption of organic and low input practices, changes in a combination of them could very well prevent adoption. The study concluded that, given various economic penalties, the most profitable activity shifted from organic to conventional. Elimination of such penalties could lead to a natural transition to organic farming as the most profitable enterprise.

1.3.3. Effects of Alternatives on the Rural Economy

Besides studying the farm level profitability of agricultural alternatives, many studies have also tried to assess the impact that conversion into such alternatives will have on the local rural economy. Goldschmidt, as early as 1968, reported on the impacts of the changing structure of agriculture on rural communities.[5] Goldschmidt (1968) compared two communities that differed in the scale of their farm operations but were alike in all other respects. He concluded that smaller scale farming, characteristic of the Dinuba community, provided a higher quality of life, superior public services and facilities, higher rates of social and political participation, less poverty, and a more diverse and stable business sector.[6]

The study by Goldschmidt (1968) reflects the impact that the form of the agricultural sector has on the rural community at large. Nevertheless, it does not show how transition from one form to another might impact this community in the short and long run. Lockeretz (1989) re-examined the results from five previously published studies to compare high input conventional crop production systems with low input alternatives which use cover crops, more diversified rotations, and no inorganic fertilizers. The previous studies were extended to account for each production system's contribution to the local economy, directly through payments for labor and interest as well as through the profits of enterprises serving agriculture. The report concluded that on a per acre basis, higher input systems provided higher or at least equal local benefits. On the other hand, four out of the five studies indicated that a greater portion of the value of production left the local economy under the higher input system than under the low input. This finding was considered to be quite significant if the areas' agricultural resources are considered finite. A higher outflow of

[5] See Lasley, Hoiberg, and Bultena (1993, pp.134-135)
[6] Study reviewed in article by Lasley, Hoiberg, and Bultena (1993)

production value implies that over time, the local economy will be on a path of diminishing resources, capturing a smaller share of the total productive value of those resources.

Dobbs and Cole (1992) estimated the effects of conversion from conventional to sustainable farming systems for five local economies in South Dakota. Several factors were considered in estimating such effects: changes in the income of agricultural households; backward linkages to input supply firms; forward linkages to transportation, processing, and marketing firms; and changes in consumer expenditures by agricultural and other households. The study used whole-farm economic models to estimate differences in input purchase and marketing patterns. These results are nevertheless case dependent and they are not statistically representative for larger areas. The results can be grouped as follows:

- Ignoring organic price premiums, on-farm income fell in four out of five cases. If such premiums are included, then incomes increased in three of five cases.
- Off-farm incomes connected with farm operations through backward linkages fell in all cases. Off-farm income connected via forward linkages fell in four out of five cases. The decrease was greater for those incomes connected through backward linkages.
- Total income (off- and on-farm) was higher for one case when organic premiums were not included and in two cases when organic premiums were accounted for.

The study also estimated second round multiplier effects and found additional negative effects on off-farm and total incomes form the conversion

What these and many similar studies suggest is that the present structure of farms and the rural economy does not relate to the demands of alternative agricultural production systems. Therefore, as the structure of the local economy changes to reflect the demands of alternative systems, the effects of these conversions may be more positive. Furthermore, when impacts of different systems on the status of natural assets are accounted for, alternative systems are shown to outperform conventional systems. On the other hand, while it is always important to include such considerations into any discussion of the long-term development of viable alternative enterprises on the Eastern Shore, their analysis is beyond the scope of this thesis. It is a good starting point for further research on this subject.

1.4 Methods of Study

The methods used in this project can be divided into: (a) evaluation procedure, (b) data collection, and (c) analytical methods. The first group contains the sources and methodology employed in collecting the data. The second explains the mathematical model developed to perform analyses of feasibility, risk and sensitivity.

1.4.1. Evaluation Procedure

Sterrett, *et al.* (1996) suggest a five-step procedure to establish and investigate the fundamental facts about any alternative enterprise. First, it is necessary to examine the production potential of the region for a particular crop. This examination must focus on and answer questions about the physical adaptability of the enterprise, suitability of the soils, presence of the required moisture parameters, pest infestations, and management potential to implement production.

Second, it requires a firm grasp of the production cost associated with the introduction of a new crop. This involves a detailed determination of the costs of production. It is important to know the seasonal amounts of labor, machinery, post harvest costs, and other resources that are required

Third, it is essential to perform a thorough investigation of the market potential for each alternative product. Such an investigation will encompass location, seasonality, availability, prices, volume, and price sensitivity of real and potential markets. It is important to determine those factors that best meet the needs of consumers, that are economically feasible, and that offer a real competitive advantage over other production areas. Market window analysis, which compares prices over several years with estimated per unit production costs, is a major tool used in determining the most efficient and profitable links between production and selling periods.

Fourth, the alternatives need to be profitable. Profitability analysis should be conducted to determine how new products compare to competing uses of the same resources. It should be noted that the alternative would not simply be used as a means for diversification per se, but rather as new ways to use the same resources more effectively and provide sustainable production.

In the end, it is essential to perform profit sensitivity and risk analysis to changing price, cost, and production conditions. The market potential for an alternative product is often very limited. Furthermore, prices for many products are quite sensitive to changing production conditions, thereby increasing the potential for high returns or ruinous losses. Risk analysis determines such relationships and enables individual farmers to make their own decisions regarding the trade-off between levels of income and variability of income.

1.4.2. Data Collection

The data used for this project was obtained in various ways. Such sources can be grouped as:

- Primary data – data provided by extension specialists working in the region.
- Secondary data - research conducted in other specific areas.

Primary and secondary data was used in developing production budgets, per unit costs, estimates of returns, as well as modify the crop information databases of the environmental impact computer program. The Virginia Cooperative Extension service provided estimates for the production budgets, but as Sterrett, *et al.* (1996) warn such data should not be taken as the actual cost of production, but as an approximation, not accounting for the individual characteristics of each farm. Other sources include data provided by USDA, the Agricultural Census, Virginia Agricultural Statistics and other research projects. USDA/Market News historic price data was used to conduct market window analysis.

1.4.3. Analytical Methods

a. Modeling

A mathematical programming model was used to conduct profitability analysis of the production alternatives and identify those alternatives that provide higher earning potential. The model employed a general profit-maximizing framework subject to various constraints such as:

- Limits on the amount of land available to a typical farm operation as well as on seasonal land use for individual crops
- Limits on the irrigation capabilities based on given assumptions regarding irrigation equipment resources and seasonal requirements for water for individual crops
- Limits on the crops that can be continuously cultivated on the same field
- Limits on the machinery resources available in a given time window and the seasonal machinery requirements for individual crops
- Limits on the labor resources available and the seasonal requirements for individual crops.
- Transfer constraints for input costs and individual crop needs.
- Transfer constraints on specific marketing costs for individual crops

b. Market Window Analysis

The market window analysis analyzed terminal market price data over five years from four terminal markets. It will be used to determine the potential profitability of individual crops based on budget estimates and historical price records. Price variability was used to evaluate the risk potential of each crop.

c. Use of Environmental Impact Computer Programs.

The trade-offs between the economic value and environmental impacts of several scenarios were examined using PLANETOR. This required modifications of the crop information database included in the original model. The plant physiological information on the non-traditional crops was collected from Virginia Tech Agricultural Experimental Stations and other research centers across the U.S.

Chapter Two - Methods

This chapter focuses on the basic methods and techniques used in this study. It consists of three main components. First, it documents the source of the data used and the manner in which this data was procured. Reliance mainly on primary data is one of the best features of this work and it was greatly facilitated by the integrated systems approach taken by all the people involved with the Eastern Shore sustainable development project. Second, this chapter traces, step by step, the general structure of the mathematical programming model, it articulates the theoretical justification behind some of the methods used, and it details the structure of the objective function and the constraints imposed. Third, the discussion focuses on the environmental impact analysis and the methodology used by the computer program to conduct this analysis. It points out its merits and shortcomings and also briefly charts the course followed in Chapter Three.

2.1 Site Description

Prior to discussing the particular features of the mathematical programming model, it is necessary to provide a brief description of the study site and its general physical and social conditions. Northampton and Accomack Counties are situated on the Delmarva Peninsula, between the Chesapeake Bay and the Atlantic Ocean (Figure 1). The counties are relatively flat with elevation not exceeding 50 feet above sea level. (Accomack and Northampton County Farm Statistics, 1982). Numerous bays, creeks, swamps and little islands generate many small and irregular plots of land. A long growing season and generous rainfall allow for the cultivation of almost any crop. In 1995, the frost-free growing season was 223 days for Northampton County and 214 days for the Accomack County - starting sometime in early April and ending in mid-November (Virginia Agricultural Statistics, 1996). Average annual rainfall for Northampton and Accomack is 41 and 43 inches a year, respectively - one of the highest in the entire state (Virginia Agricultural Statistics, 1996, p. 21-22). Such favorable physical and meteorological conditions make the Eastern Shore a very good candidate for the cultivation of new vegetable varieties as well as alternative crops.

Nevertheless, favorable physical conditions are only part of the reason why this project was undertaken at this location. The determining factor for this work is the commitment of the local community leaders to continually search for more viable paths to economic growth and environmental protection. Northampton County has been very active in promoting an agenda of sustainable community development and has taken various steps in that direction. The establishment of a farmer's market and development of an industrial park are but two examples.

This project grew out of the sustainable community development effort and it relies heavily on the voluntary collaboration of members of the community. The technical team assembled includes several specialists already working on the Eastern Shore.[7] Their input was crucial in selecting the alternative crops evaluated here. Farmers decided whether to experiment with a particular crop, based on their experience, their interest, and the resources available to them. Technical team members followed their progress and suggestions.

[7] The technical team consists of specialists and representatives, Eastern Shore Agricultural Research and Extension Center of Virginia Tech, Nature Conservancy, Northampton County Cooperative Extension, Northampton County Sustainable Development Task Force, ODU Entrepreneurial Center, ODU Department of Oceanography, Virginia State University Cooperative Extension, , Virginia Eastern Shore Corporation, Virginia Department of Agriculture and Consumer Services, and the Department of Applied and Agricultural Economics at Virginia Polytechnic Institute and State University.

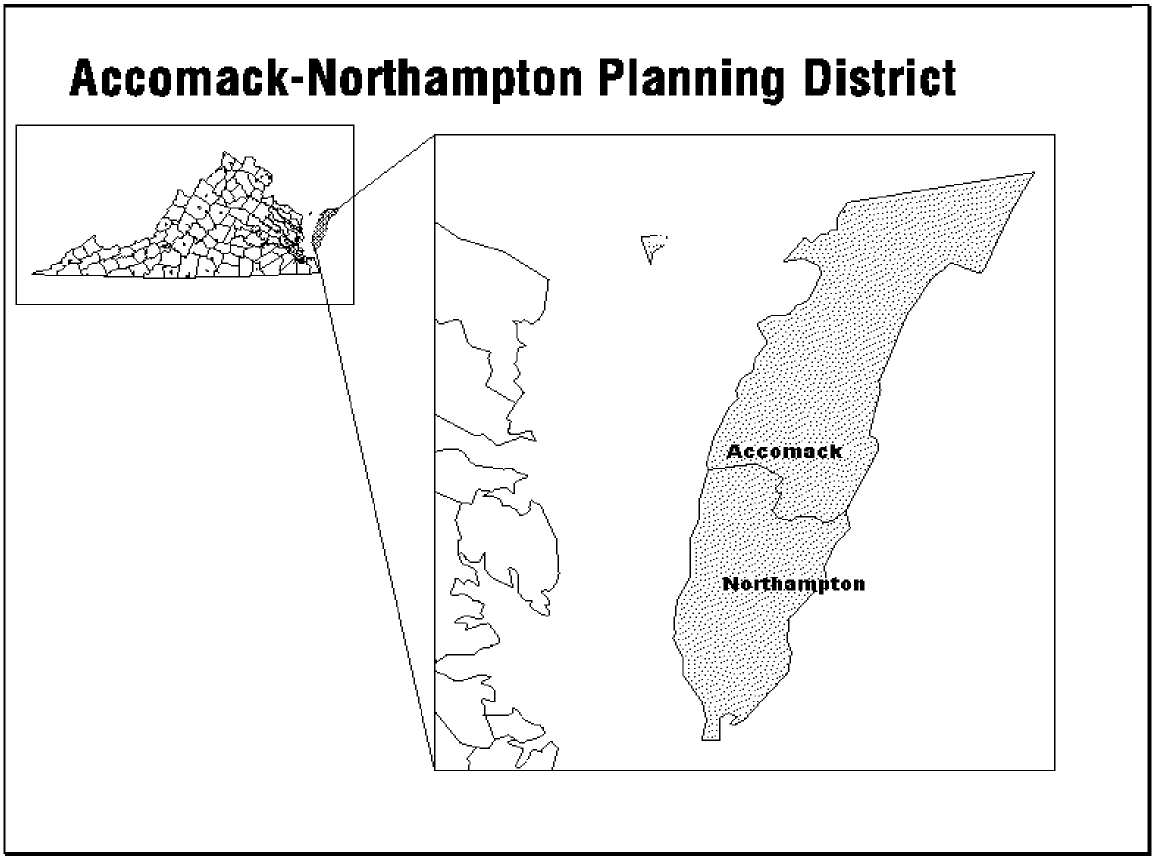

Figure 1 - Accomack-Northampton Planning District, (Geographic Information Center, 1996)

Periodic meetings allowed for a more broad-based discussion of the issues. Those new crops that were not selected for trials by farmers were cultivated at the Eastern Shore Agricultural Research and Extension Center. Participating growers come from diverse backgrounds, and are engaged in varied farming activities. The participation of such a diverse pool of farmers was invaluable since it allowed for a better and more realistic representation of the complex structure of agricultural production in the area.

2.2 Data Sources

This study contains an extensive amount of information. Much of the information is included either in the chapters of this thesis or the many appendices accompanying it. However, the nature of agricultural production necessitates periodic revisions and updates of the production budgets, price information or the empirical data on the biological processes and characteristics of various crops. Furthermore, most of the information describes typical situations and the results presented in this thesis are based on the present status of this information. Site specific data could generate more representative results for individual farmers. We suggest that the analysis presented in this thesis be treated as a framework of analyzing more specific data and situations in the future.

2.2.1. Primary Data

Most of the primary data used in this study concern the economics of growing new crops in the region. Specialists of the Virginia Tech Department of Horticulture, Horticulture Specialists at the Virginia Tech's Eastern Shore Agricultural Research and Extension Center and the Northampton County Cooperative Extension specialists contributed to the collection.[8] Production budget summaries are presented in Appendix A. Data collection for the new/alternative crops, such as kenaf, is a work in progress and more information is expected to come with the conclusion of the growing season and future, larger scale cultivation. A record keeping system, presented in Appendix B, was put in place in order to facilitate the data gathering process. It consists of five parts corresponding to the major stages of a complete growing cycle. Detailed information was collected on the operations in each stage and the corresponding quantities and costs for each of them. Extension specialists will continue to periodically interview the participating growers and account for all of the on-farm activities, as well as for the time segments when labor and equipment are employed.

Some of the physical data on the growing of the new crops was provided by plant physiologists and agronomists at institutions already involved in extensive crop experiments.[9] As explained at greater length in the last part of this chapter, this information was entered within the PLANETOR model database to conduct the environmental impact analysis.

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[8] Guy Sturt from the Virginia Tech Department of Horticulture developed all the vegetable budgets used in this thesis. Rikki Sterrett of the Virginia Tech Agricultural Experiment Station and Fred Diem of the Northampton County Cooperative Extension modified some of the information contained in them in order to reflect the specific production conditions of the farmers in the region.

[9] Some of this information was provided by the Mississippi State University Agricultural Experiment Stations and the Center for Farm Financial Management at the University of Minnesota.

2.2.2. Secondary Data:

The secondary data includes price information on the market windows available for various crops. This data was taken from the daily Fruit and Vegetable Market newswires released by the Federal-State Market News Service of the USDA.[10] It is used to identify the historical trends, if any, of the price of each commodity and determine the variability that those prices exhibit over a five year period. Also, specialists in other states have collected and published production budgets and price data for some of the new crops. These data were used as preliminary estimates in those cases where the actual data are not currently available. This allowed for the completion of the model and technical adjustments that might be necessary. As the rest of the information becomes available, it may be substituted in the linear programming model to generate more reliable results.

Secondary data will also be used when supplementing the RUSLE and NLEAP (explained later) crop information databases. Several parameters were not available for some crops therefore either data in specialized publications or information available on similar crops were used and substituted in consultation with specialists in the appropriate areas.

2.3 Linear Programming Model

This section will focus on the linear programming model that was used to conduct the economic feasibility analysis of various crop alternatives. It begins by first providing a brief overview of the linear programming model, its capabilities and the methods it used to find an optimal solution. We specify the objective function, provide detailed information on resource constraints, and explain our approach in dealing with seasonality and crop rotations.

[10] The historical archive of these daily newswires is available online as part of the Market Information System (MIS) established by Dr. John VanSickle at the University of Florida(UF) , Institute of Food and Agricultural Sciences (IFAS) , and Food and Resource Economics Department (FRED) @ http://gnv.ifas.ufl.edu/~MARKETING/MARKET.HTML

2.3.1. Brief Overview of Linear Programming

A Linear Program (LP) is a problem that can be expressed as follows (the so-called Standard Form):

$$\text{maximize } Z = \sum_{j=1}^{n} c_j x_j$$

$$\text{subject to } \sum_{j=1}^{n} a_{ij} x_j \leq b_I \qquad i = 1, 2, 3, \ldots, m$$

$$x_j \geq 0$$

where x_j is the vector of decision making variables to be solved for, the a_{ij}'s are the known technical coefficients, c_j are the objective function coefficients, and b_i are the resource limitations. The expression "$c_j x_j$" is called the objective function, and the equations "$a_{ij} x_j \leq b_i$" are called the constraints.

Simply put, linear programming is the process of finding the maximum or minimum attainable value of the objective function without violating the constraints. In this sense, linear programming satisfies the traditional economic maxim of the "efficient allocation of scarce resources."[11] The linear programming model also relies on a few basic assumptions:

> "*a) Proportionality*: This assumption states that the contribution of each activity to the value of the objective function, as well as to the left hand side of each functional constraint, is directly proportional to the level of that activity. This is apparent in the form of the $c_j x_j$ and $a_{ij} x_j$ terms in the objective function and each constraint respectively.
>
> *b) Additivity*: Both the objective function and all the functional constraints are the sum of the individual contributions of the respective activities.
>
> *c) Divisibility*: Factors of production can have any possible values including non-integer values. Since each decision variable represents the level of some activity, this activity can also be performed at some fractional level. When this assumption violates restrictions on the proper use of some resources, then mixed integer programming should be used instead.
>
> *d) Certainty*: Linear programming is deterministic as it assumes perfect knowledge of each parameter and treats it as a given constant. Risk is not accounted for and other methods are used to incorporate uncertainty in mathematical programming models " (Hillier and Liberman, 1990, pp.31 – 37).

[11] Russell and Wilkinson eloquently summarize this perspective when they write: "Most of the problems with which economics is concerned can be traced to the fact that a society's resources - land, labor, capital, etc., - are limited, or scarce, relative to the uses to which these resources can be put. Given this fundamental situation of scarcity, the allocation of the available resources to the multitude of potential uses becomes the central problem of economics. Indeed, a long-standing definition of economics is "the study of the allocation of scarce resources" to satisfy unlimited demands. (Russell and Wilkinson, 1979,p.1).

2.3.2. Model Specification

As stated in the first chapter, this model will evaluate the economic feasibility of bringing alternative crops into production on Eastern Shore farms. Linear programming, briefly discussed in the previous section, will be used to calculate the best crop mix that maximizes net returns to land, capital and management, given limited resources. Table 1 provides a schematic of the linear programming matrix, which has 944 activities and 998 constraints, and it shows the overall structure of the model. The columns and rows are represented in general terms and more detailed descriptions of variables are included in Appendix C. Lines represent the linkages between different activities and the transfer from the pool of resources to individual crop activities.[12].

In the following sections we will refer back to Table 1 and explain its two main components: the objective function and resource constraints. Each is discussed separately and we continue to summarize the parameter values for all the variables involved. Furthermore, within the context of resource constraints, we focus on the seasonality component of resource use in agriculture, its implications, and the impact it has on the structure of the model.

[12] The schematic representation of the problem was based on a similar work by Hoepner and Wade (1995)

Table 1 - Schematic of the Linear Programming Relationships Between Production Activities and Resource Constraints

Constraints	Production Activities	Accounting Activities: Total Crop Acreage	Total Crop Sales	Total Irrigation Hrs. Used	Total Mach. Hrs. Used	Farm supply Purchases	Irrigation Use	Labor Use	Land Use	Machinery Use	Other Supplies	Marketing	Crop Sales
Objective Function		Zero Values				Unit costs							Unit Prices
Transfer Constraints													
Labor Use Transfers (24-bimonthly constraints)	⇧							⇩					
Land Use Transfers (24-bimonthly constraints)	⇧								⇩				
Machine Use Transfers (24-bimonthly constraints)	⇧									⇩			
Irrigation Use Transfers (24-bimonthly constraints)	⇧						⇩						
Farm Supply Purchases Transfers	⇧					⇩							
Other Supply Purchases Transfers	⇧						⇩				⇩		
Harvest Transfers for Market	⇩												⇧
Marketing Costs Transfer	⇧											⇩	
Accounting Constraints													
Total acreage for each activity	⇩	⇧											
Total sales for each activity			⇧										⇩
Total Irrigation Hrs. for each activity				⇧			⇩						
Total Mach. Hours for each activity					⇧					⇩			
Land Constraint	⇦ ⇩												
Rotational Constraint	⇦ ⇩												

Legend

——	transfers from ones activity to another
⇧	destination of activity flows
⇩	source of activity flows

a. The Objective Function

An economic feasibility analysis of agricultural production alternatives evaluates the profitability of these alternatives vis-à-vis traditional practices. The benchmark of this approach is the assumption that economic decision-makers rely on these activities for their livelihood. Therefore, their major concern is to maximize net returns, for a fixed land, capital, and management resource base, so that over time farmers increase their well-being. On the face of it, this assumption is quite rational. On the other hand, research has shown that Virginia farmers currently practice activities different from the traditional ones for reasons other than profit.[13] This study will take the first path (profit maximization) rather than the second (utility maximization). This choice is conditioned by the purpose of this project - the discovery of potentially *profitable* alternatives for Eastern Shore farmers, while at the same time improving upon the environmental impact of the current production mix. Furthermore, it would be disingenuous to argue in favor of environmental sustainability without offering alternatives that also ensure the economic viability of current farm businesses. Eastern Shore farmers depend on the production of traditional crops (wheat and soybeans) for their survival and they operate within tight resource constraints. Consequently, this model will focus mostly on the short-term economic impact of production alternatives.

As mentioned earlier, the objective function maximizes net returns to land, capital and management. The model schematic presented above, incorporates the prices of farm inputs, labor, hourly machine use, interest, water use, and marketing (including storage, packing and handling, transportation, and brokerage fees). Much of this information was drawn from the production budgets for each of the crop alternatives considered. Table 2 details the information for romaine lettuce. The price column in this table shows the parameter values for the objective function variables. For instance, variable irrigation costs are $12.00 per acre-inch, fixed labor costs are $6.00 per hour, and the variable machinery costs for repairs during the production season were estimated to be $22.46 per hour. The objective function includes variable costs of all inputs and also fixed costs for hired labor. It does not,

[13] Indeed, this point was one of the main conclusions of the study conducted by Zhou and McGuirk. (1996). This study was discussed more at length in the literature review section of the first chapter.

Table 2 - Production Budget Estimates for Growing Romaine Head Lettuce on the Eastern Shore.

Romaine Head Lettuce (overhead irrigation)

Yield (crt)	Historical Price Window (crt)* $9.67	$12.03	$14.32
500	$4,835.00	$6,015.00	$7,160.00
700	$6,769.00	$8,421.00	$10,024.00
900	$8,703.00	$10,827.00	$12,888.00

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Seeds	Pounds	0.50	$160.00	$80.00
Fertilizer:	Nitrogen	Pounds	95.00	$0.35	$33.25
	P2O5	Pounds	70.00	$0.30	$21.00
	K2O	Pounds	70.00	$0.18	$12.60
			1.00	$6.00	$6.00
Lime:		Ton	0.17	$38.00	$6.46
Herbicides	Kerb	Pounds	2.00	$24.35	$48.70
Insecticides	Pounce (2X)	Gallons	0.05	$172.95	$16.19
Fungicides	Rovral 50W (2X)	Pounds	1.50	$22.85	$68.55
Irrigation:		Acre Inches	2.00	$12.00	$24.00
Machinery					
Production	Repairs				$22.46
	Fuel				$13.27
Harvest	Repairs				$9.64
	Fuel				$7.10
Interest:			402.48	5.00%	$20.12
Crop Supplies:					$20.00
Crates		Crates	700.00	$1.45	$1,015.00
Custom Thinning					$10.00
Custom Harvest Labor		Crates	700.00	$0.90	$630.00
Miscellaneous:					$40.00
Marketing:	Haul to Market		700.00	$0.04	$28.00
	Transportation Fee		700.00	$1.05	$735.00
	Packing, Handling and Sales		700.00	$1.00	$700.00
	Brokerage Fee	20.00%	700.00	$2.41	$1,684.20
Labor Charges:	Production		9.72	$6.00	$58.32
	Harvest		7.00	$6.00	$42.00
Land Cost:					$0.00
Irrigation	Fixed Costs		0.50	134.83	$67.42
Machinery					
Production					$42.88
Harvest					$24.48
Total Cost:					$5,486.64
Cost per Sale Unit:		Crates	700.00		$7.84

		Annual Hours Used		Cost per Hour		Cost per Acre	
Machine	Freq.	Man	Machine	Variable	Fixed	Variable	Fixed
Plow 3B		0.80	0.75	2.24	2.06	1.68	1.55
Disk 7'	4X	1.32	1.20	1.20	1.84	1.44	2.21
Tractor 50 Hp			1.95	5.18	6.41	10.10	12.50
Planter 2R		2.00	0.75	2.40	2.94	1.80	2.21
Tractor 50 Hp			0.75	5.18	6.41	3.89	4.81
Cultivator 2R	2X	1.50	1.32	0.84	0.58	1.11	0.77
Sprayer		0.60	0.38	3.50	3.86	1.33	1.47
Spreader		0.50	0.20	8.00	11.01	1.60	2.20
Tractor 50 Hp			1.90	5.18	6.41	9.84	12.18
Trailer		6.00	3.00	0.40	1.75	1.20	5.25
Tractor 50 Hp			3.00	5.18	6.41	15.54	19.23
Pick-up Truck		3.00				3.00	3.00
Total						52.53	67.36
Production						35.79	42.88
Harvest						16.74	24.48

* Spring Planting Price Information

however, include a land charge or the fixed costs of machinery and other farm equipment – hence farm profits are defined as net returns to land, management, and capital.[14] Consequently, net returns cover both the use of the farmer's management capabilities and the ownership of land. As mentioned earlier, Appendix A includes the production budgets for the crops studied. They include estimates of both variable and fixed costs and such estimates can be easily incorporated in the model should this be considered in the future. Gross income from each activity will be calculated using the price information from the market window analysis.

b. Labor Constraint

The amount of labor that is required at a particular time of the year may vary. Also, the requirements of each activity for this resource will be different at various time periods. The model schematic presented the flow of the labor resources, here referring to full-time labor, (seasonal labor will be hired as necessary) required by the production activities as a transfer constraint. The general mathematical form of these constraints is:

$$\sum_{j=1}^{17} L_{ij} X_j - LC_i = 0$$

$LC_i \leq CV(L)$ where i = 1,2,…,24 and (L) refers to labor resources

Table 3 illustrates the above expressions. In that context, X_j corresponds to the vector of the crop production activities. L_{ij} is the matrix of labor requirement coefficients for each production activity in 24 semi-monthly periods. LC_i is the labor used in each semi-monthly period and CV(L) is the availability of labor resources in each semi-monthly period based on given assumptions for a particular scenario. As it will be shown in Chapter Three, we

[14] We decided not to include fixed machinery costs, despite the fact that estimates of such costs exists. This is due to the fact that there is no information available on the condition as well as the initial rate of utilization of such machinery on a typical farm on the Eastern Shore. Including the estimated fixed costs could bias the final results. Land costs were also not included as a result of current disputes in the region on the exact land value estimates.

Table 3 - Semi-monthly Labor Schedules[15]

Crop	Jan 1 - 15	Jan16 - 30	Feb 1 - 15	Feb 16 - 28	Mar 1 - 15	Mar 16 - 30	Apr 1 - 15	Apr 16 - 30	May 1 - 15	May 16 - 30	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 -30	Aug 1 - 15	Aug 16 -30	Sep 1 - 15	Sep 16 - 30	Oct 1 - 15	Oct 16 - 30	Nov 1 - 15	Nov 16 - 30	Dec 1 - 15	Dec 16 - 30
Irish Potatoes					0.6500	2.3800	0.5300	0.9300	0.5300	0.9300	0.5300	0.5300	0.5300	6.0000										
Spring Cucumbers								3.1500	1.3500	0.9500	1.3500	2.0000	2.0000											
Fall Cucumbers														3.1500	1.6200	1.2200	1.6200	1.6250	1.6250					
Spring Snapbeans								3.1500	1.8800	1.5200	0.9500	5.4000												
Fall Snapbeans														3.1500	1.5200	1.5200	1.5200	5.4000						
Green Bell Peppers (over)														2.5400	11.5200	1.2000	1.2000	1.0000						
Green Bell Peppers (drip)							1.3250	11.7750	0.7000	0.5000	0.7000	0.5000	0.7000	0.5000	0.7000	0.5000								
Western Cantaloupe							2.2000	13.4500	0.7750	0.7750	0.7750	0.7750	0.5750	0.5750	3.0000	3.0000								
Spring Boston Head Lettuce				2.0600	3.7600		1.5500	1.5500	0.8000	3.5000	3.5000													
Fall Boston Head Lettuce																1.6300	1.1600	3.3300	0.7000	1.4500	1.4500	7.0000		
Spring Romaine Head Lettuce				2.0600	3.7600		1.5500	1.5500	0.8000	3.5000	3.5000													
Fall Romaine Head Lettuce																1.6300	1.1600	3.3300	0.7000	1.4500	1.4500	7.0000		
Watermelon							1.0250	1.6250	0.9250	0.5750	0.9250	0.5750	0.5750	0.5750										
Broccoli													2.13	1.1600	2.8300		6.2500	6.2500	0.9000	6.5000	6.5000			
Kenaf					0.4000	0.1500		0.1500	0.4000		0.2000													
Seedless Watermelon					0.8000	0.1500	0.1500		0.5500	11.0000	0.4000	0.4000	0.4000	0.4000	29.5700									
Hayman Potatoes					0.7500	0.2500	0.2500		1.0000	1.1300	0.0800	1.1300	0.0800											
Double Cropped Soybeans												0.2000	0.4000	0.0640	0.2640	0.0640	0.2640	0.0640	0.0640	0.0640	0.0640	0.0640	0.0640	0.6000
Full Season Soybeans										0.5000	0.5500	0.0830	0.6830	0.2830	0.0830	0.2830	0.0830	0.0830	0.0830	0.0830	0.0830	0.6820		
Wheat													0.3000	0.5500	0.1500	0.4000	0.2000		0.2000					

[15] Information provided by the Virginia Tech Eastern Shore Ag. Research and Experiment Station. 1997. Unpublished.

assume CV(L) values of 320 and 400 hours of labor available (corresponding to 4-5 full time employees) in each semi-monthly period.[16] However, the seasonal structure of the model allows us to change the specific CV(L) value for a particular semi-monthly perdiod. This may be the case when important field operations (planting or harvesting), require a higher utilization of labor. Thus, if the period March 1 – 15 is considered a crucial time for land preparation activities, then the CV(L) value for this period could be increased to 480 and 600 hours, depending on the type of farm. In this case, we no longer assume 40-hour weeks but rather 60- hour weeks. A similar procedure can be established for other time periods that reflect different circumstances. This is helpful in that it allows us to observe and solve potential bottlenecks with respect to this resource. However, it is not possible to assume 60-hour weeks throughout the year since this does not reflect realities of production in the region and, therefore, it can bias the results. Appendix D graphically shows the intensity of resource use for all the scenarios developed in the economic analysis section.

c. Land Constraint

The model structure schematic (Table 1) refers to two constraints that have to do with land resources: land use transfer constraint, accounting for the specific times when land is occupied by individual crops, and a total land constraint, ensuring that the supply of land available is limited. The mathematical expression of these constraints is:

$$\sum_{j=1}^{17} Ac_{ij} X_j - AcC_i = 0$$

$AcC_i \leq CV(Ac)$ where i = 1,2,…,24 and Ac refers to land constraint

[16] Chapter three outlines two baseline models that represent two types of farmers in the region. We have assumed different labor availability for each farmer. For more information, please refer to section 2 of the next chapter.

Table 4 - Land Use by crops[17]

Crop	Jan 1 - 15	Jan16 - 30	Feb 1 - 15	Feb 16 - 28	Mar 1 - 15	Mar 16 - 30	Apr 1 - 15	Apr 16 - 30	May 1 - 15	May 16 - 30	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 -30	Aug 1 - 15	Aug 16 -30	Sep 1 - 15	Sep 16 - 30	Oct 1 - 15	Oct 16 - 30	Nov 1 - 15	Nov 16 - 30	Dec 1 - 15	Dec 16 - 30
Irish Potatoes					■	■	■	■	■	■	■	■	■	■										
Spring Cucumbers								■	■	■	■	■	■											
Fall Cucumbers														■	■	■	■	■	■					
Spring Snapbeans								■	■	■	■	■												
Fall Snapbeans														■	■	■	■	■						
Green Bell Peppers (overhead))														■	■	■	■	■	■					
Green Bell Peppers (drip)								■	■	■	■	■	■	■	■	■	■							
Western Cantaloupe								■	■	■	■	■	■											
Spring Boston Head Lettuce			■	■	■	■	■	■	■	■	■													
Fall Boston Head Lettuce															■	■	■	■	■	■	■	■		
Spring Romaine Head Lettuce			■	■	■	■	■	■	■	■	■													
Fall Romaine Head Lettuce															■	■	■	■	■	■	■	■		
Watermelon								■	■	■	■	■	■	■	■									
Broccoli																	■	■	■	■	■	■		
Kenaf	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Seedless Watermelon					■	■	■	■	■	■	■	■	■	■	■									
Hayman Potatoes						■	■	■	■	■	■	■	■	■	■	■	■							
Full Season Soybeans										■	■	■	■	■	■	■	■	■	■	■	■			
Double Cropped Soybeans												■	■	■	■	■	■	■	■	■				
Wheat	■	■	■	■	■	■	■	■	■	■	■										■	■	■	■

[17] Ibid.

Table 4 shows the coefficient matrix for the land use constraint, represented by the first expression. Similar to the labor constraint, X_j is the vector of production activities, Ac_{ij} is the coefficient matrix of the i^{th} semi-monthly periods during which land is occupied by the j^{th} production activity and AcC_i is the acreage constraint for the i^{th} semi-monthly period. The CV(Ac) values for the acreage constraint are determined by the specific assumptions on the availability of land resources and these assumptions are presented in Chapter Three. The land use windows pertain to the semi-monthly periods during which land is occupied by a specific crop. Vegetable crops generally have a shorter growing season than agronomic crops such as wheat and soybeans. This may create some double-cropping opportunities and therefore increase the total acreage of the crops produced in any given year.

d. Rotational Constraints.

Rotational constraints coordinate the order in which crops are planted on the same field. This approach takes into account the fact that it is not a good agronomic practice to allow members of the same crop family to be planted after each other. This constraint is imposed only on vegetable crops, as they have the highest probability of being affected by continuous cropping. Consequently, members of a given crop family, as shown in Table 5, are constrained to grow on 210 acres of land available on any given year. More specifically, the model does not allow, for instance, a crop mix crops belonging to the Gourd Family (spring and fall cucumbers, watermelons, cantaloupes) to be grown on more than 210 acres. This constraint can be expressed as follows:

$$\sum_{j=1}^{13} Rc_{ij} X_j \leq \frac{1}{3} TAc$$ [18]

where: $i = 1,2,\ldots,6$

Rc_{ij} is the coefficient matrix for the j^{th} production activity of the i^{th} crop family, X_j is the j^{th} production activity and TAc is the total amount of land available for cultivation. The constraint is imposed on only 13 production activities. Excluded are the agronomic crops (wheat, soybeans) and kenaf.

[18] As shown later, total acreage is assumed to be 630 acres after leaving 70 acres of cropland fallow as a best management strategy. The typical farm is assumed to have 700 acres of cropland available.

Table 5 - Crop Families Used to Construct the Rotational Constraint

Crop Families	Specific Crops
Pulse Family	Spring and Fall Snap Beans
Root Family	Hayman Sweet Potatoes
Composite Family	Spring and Fall Boston Lettuce, Spring and Fall Romaine Lettuce
Gourd Family	Spring and Fall Cucumbers, Watermelons, Cantaloupes
Mustard Family	Broccoli
Nightshade Family	Irish Potatoes, Bell Peppers

e. Machinery and Irrigation Use Constraints.

These constraints are similar to the constraints for labor. Farmers have a limited number of tractors, or combines, that they can use during the growing season. They may also have a limited water resource. Crops have different requirements for each resource, both in the amount and the time period when they can be used. Therefore, we constructed 24 semi-monthly constraints for all the machinery and irrigation requirements (Table 6 and 7). Again, the rationale for this approach is the same as that for the labor constraint. It seeks to capture those time periods when crops are competing for the use of the same resource and suggests areas in which a higher utilization of the resource, within given physical limits, may be recommended. The following expressions summarize these constraints.

$$\sum_{j=1}^{17} M_{ij} X_j - MC_i = 0$$

$$\sum_{j=1}^{17} I_{ij} X_j - IC_i = 0$$

$$MC_i \leq CV(M)$$

$$IC_i \leq CV(I) \text{ and } i = 1,2,\ldots,24$$

Table 6 - Machinery Use Schedules for Individual Crop[19]

Crop	Machine	Jan 1 - 15	Jan16 - 30	Feb 1 - 15	Feb 16 - 28	Mar 1 - 15	Mar 16 - 30	Apr 1 - 15	Apr 16 - 30	May 1 - 15	May 16 - 30	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 -30	Aug 1 - 15	Aug 16 -30	Sep 1 - 15	Sep 16 - 30	Oct 1 - 15	Oct 16 - 30	Nov 1 - 15	Nov 16 - 30	Dec 1 - 15	Dec 16 - 30
Irish Potatoes	5b Plow					0.33																			
	12 Disk					0.2	0.2																		
	Potatoe Planter						0.25																		
	4r Cultivator								0.33		0.33														
	Sprayer							0.126	0.126	0.126	0.126	0.126	0.126	0.126											
	Potatoe Harvester														1										
	50 Hp Tractor							0.126	0.456	0.126	0.456	0.126	0.126	0.126											
	80 Hp Tractor					0.53	0.2																		
	110 Hp Tractor						0.25								1										
Spring Cucumbers	5b Plow								0.33																
	12 Disk								0.4																
	3r Planter								0.5																
	4r Cultivator									0.33		0.33													
	Sprayer									0.126	0.126	0.126													
	Fertilizer Spreader								0.2																
	Trailer												0.5	0.5											
	50 Hp Tractor								0.7	0.456	0.126	0.456	0.5	0.5											
	80 Hp Tractor								0.73																
Fall Cucumbers	5b Plow														0.33										
	12 Disk														0.4										
	3r Planter														0.5										
	4r Cultivator																0.33	0.33							
	Sprayer															0.2933	0.2933	0.2933							
	Spreader														0.2										
	Trailer																		0.375	0.375					
	50 Hp Tractor														0.5	0.2933	0.6233	0.6233	0.375	0.375					
	80 Hp Tractor														0.73										
Spring Snapbeans	5b Plow								0.33																
	12 Disk								0.4																
	3r Planter								0.5																
	4r Cultivator									0.66	0.33														
	Sprayer									0.252	0.252	0.126													
	Spreader								0.2																
	Bean Harvester												2												
	50 Hp Tractor								0.7	0.912	0.582	0.126	2												
	80 Hp Tractor								0.73																
Fall Snapbeans	5b Plow														0.33										
	12 Disk														0.4										
	3r Planter														0.5										
	4r Cultivator															0.33	0.33	0.33							
	Sprayer															0.252	0.252	0.252							
	Spreader														0.2										
	Bean Harvester																		2						
	50 Hp Tractor														0.7	0.582	0.582	0.582	2						
	80 Hp Tractor														0.73										
Bell Peppers (overhead irrig.)	3b Plow														0.75										
	7 Disk														0.3	0.6									
	Waterwheel Planter															4									
	Sprayer															0.345	0.345	0.345	0.345						
	Fertilizer Spreader														0.2										
	50 Hp Tractor														1.25	4.945	0.345	0.345	0.345						

[19] Ibid.

Table 6 - Machinery Use Schedules for Individual Crop (continued)

Crop	Machine	Jan 1 - 15	Jan16 - 30	Feb 1 - 15	Feb 16 - 28	Mar 1 - 15	Mar 16 - 30	Apr 1 - 15	Apr 16 - 30	May 1 - 15	May 16 - 30	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 -30	Aug 1 - 15	Aug 16 -30	Sep 1 - 15	Sep 16 - 30	Oct 1 - 15	Oct 16 - 30	Nov 1 - 15	Nov 16 - 30	Dec 1 - 15	Dec 16 - 30
Bell Peppers	Waterwheel Planter								4																
	7 Disk							0.3	0.3																
(drip irrigation)	Sprayer									0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875								
	Plastic Combo								0.5																
	Rotary Tiller							0.5	0.5																
	50 Hp Tractor							0.8	4.8	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875								
	110 Hp Tractor								0.5																
Cantaloupes	3b Plow							0.75																	
	7 Disk							0.3	0.3																
	Waterwheel Planter								4																
	Sprayer								0.1428	0.1428	0.1428	0.1428	0.1428	0.1428	0.1428										
	Plastic Setter								0.5																
	Trailer															1.25	1.25								
	Rotary Tiller							0.5	0.5																
	50 Hp Tractor							1.55	5.4428	0.1428	0.1428	0.1428	0.1428	0.1428	0.1428	1.25	1.25								
Sp. Bost. Lettuce	3b Plow			0.75																					
	7 Disk			0.3	0.6	0.3																			
	2r Planter					0.75																			
	2r Cultivator							0.66	0.66																
	Sprayer							0.126	0.126	0.126															
	Fertilizer Spreader					0.2																			
	Trailer										1.5	1.5													
	50 Hp Tractor			1.05	0.6	1.25		0.786	0.786	0.126	1.5	1.5													
Fall Bost. Lettuce	3b Plow															0.75									
	7 Disk															0.3	0.6	0.3							
	2r Planter																	0.75							
	2r Cultivator																		0.66	0.66					
	Sprayer																		0.126	0.126	0.126				
	Fertilizer Spreader																	0.2							
	Trailer																					3			
	50 Hp Tractor															1.05	0.6	1.05	0.786	0.786	0.912	3			
Spr. Rom. Lettuce	3b Plow			0.75																					
	7 Disk			0.3	0.6	0.3																			
	2r Planter					0.75																			
	2r Cultivator							0.66	0.66																
	Sprayer							0.126	0.126	0.126															
	Fertilizer Spreader					0.2																			
	Trailer										1.5	1.5													
	50 Hp Tractor			1.05	0.6	1.25		0.786	0.786	0.126	1.5	1.5													
Fall Rom. Lettuce	3b Plow															0.75									
	7 Disk															0.3	0.6	0.3							
	2r Planter																	0.75							
	2r Cultivator																		0.66	0.66					
	Sprayer																		0.126	0.126	0.126				
	Fertilizer Spreader																	0.2							
	Trailer																					3			
	50 Hp Tractor															1.05	0.6	1.05	0.786	0.786	0.912	3			

Table 6 - Machinery Use Schedules for Individual Crop (continued)

Crop	Machine	Jan 1 - 15	Jan16 - 30	Feb 1 - 15	Feb 16 - 28	Mar 1 - 15	Mar 16 - 30	Apr 1 - 15	Apr 16 - 30	May 1 - 15	May 16 - 30	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 -30	Aug 1 - 15	Aug 16 -30	Sep 1 - 15	Sep 16 - 30	Oct 1 - 15	Oct 16 - 30	Nov 1 - 15	Nov 16 - 30	Dec 1 - 15	Dec 16 - 30
Watermelon	5b Plow							0.33																	
	12 Disk							0.2	0.2																
	2r Planter								0.75																
	4r Cultivator									0.33		0.33													
	Sprayer								0.125	0.125	0.125	0.125	0.125	0.125	0.125										
	50 Hp Tractor								0.8575	0.455	0.125	0.455		0.125	0.125										
	80 Hp Tractor							0.53	0.2																
Broccoli	3b Plow													0.75											
	7 Disk													0.3	0.3	0.3									
	2r Planter															0.75									
	2r Cultivator																	0.33	0.33						
	Sprayer																	0.25	0.25	0.25					
	Fertilizer Spreader													0.2											
	Trailer																				4	4			
	50 Hp Tractor													1.25	0.3	1.05		0.58	0.58	0.25	4	4			
Wheat	5b Plow																		0.33						
	17 Disk																		0.15	0.15					
	Drill																				0.2				
	Sprayer																					0.15		0.15	
	Combine													0.25											
	80 Hp Tractor																			0.15	0.2	0.15		0.15	
	110 Hp Tractor													0.25					0.48						
Dbl-crop Soybean	4r Planter													0.33											
	Sprayer													0.126	0.126		0.126								
	Combine																					0.25			
	80 Hp Tractor													0.456	0.126		0.126								
Full Seas. Soybean	17 Disk										0.15														
	Fld Cult										0.18														
	Drill											0.2													
	Sprayer												0.2		0.2	0.2									
	Combine																			0.25					
	80 Hp Tractor											0.2	0.2		0.2	0.2									
	110 Hp Tractor										0.33														
Kenaf	5b Plow					0.33																			
	17' Disk						0.15		0.15																
	Drill									0.2															
	Sprayer											0.15													
	Tractor 80 Hp									0.2		0.15													
	Tractor 110 Hp					0.33	0.15		0.15																
Sdless Watermelon	3b Plow					0.75																			
	7' Disk						0.3	0.3		0.3															
	WW Planter 1R										4														
	Plastic Combo										0.5														
	Sprayer											0.4	0.4	0.4	0.4										
	Spreader									0.2						5.91									
	Trailer																								
	Tractor 50 Hp					0.75	0.3	0.3		0.5	4.5	0.4	0.4	0.4	0.4	5.91									
Hayman Potatoes	5b Plow						0.33																		
	Disk 12'							0.2	0.2																
	Transplanter 2R										0.75														
	Cultivator 2R											0.99		0.99											
	Sprayer											0.15	0.15	0.15	0.15	0.15									
	Tractor 50 Hp										0.75	1.14	0.15	1.14	0.15	0.15									
	Tractor 80 Hp						0.33	0.2	0.2		1.5	2.28	0.3	2.28	0.3	0.3									

Table 7 - Overhead and Drip Irrigation Use Schedules in Acre Inches[20]

	Crop	Jan 1 - 15	Jan16 - 30	Feb 1 - 15	Feb 16 - 28	Mar 1 - 15	Mar 16 - 30	Apr 1 - 15	Apr 16 - 30	May 1 - 15	May 16 - 30	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 -30	Aug 1 - 15	Aug 16 -30	Sep 1 - 15	Sep 16 - 30	Oct 1 - 15	Oct 16 - 30	Nov 1 - 15	Nov 16 - 30	Dec 1 - 15	Dec 16 - 30
Overhead Irrigation	Irish Potatoes						0.2190	0.4380	0.6570	0.4380	0.4380	0.4380	0.4380	0.4380											
	Spring Cucumbers								0.2270	0.4540	0.4540	0.4540	0.4540	0.4540											
	Fall Cucumbers														0.2780	0.5560	0.5560	0.5560	0.5560						
	Spring Snapbeans							0.6250	0.3125	0.6250	0.6250	0.6250	0.3125												
	Fall Snapbeans														0.3570	0.7140	0.7140	0.7140							
	Green Bell Peppers														0.3570	0.7140	0.7140	0.7140	0.7140						
	Spring Boston Head Lettuce				0.0770	0.1540	0.1540	0.1540	0.1540	0.1540	0.0770														
	Fall Boston Head Lettuce																	0.1250	0.2500	0.2500	0.2500				
	Spring Romaine Head Lettuce				0.0770	0.1540	0.1540	0.1540	0.1540	0.1540	0.0770														
	Fall Romaine Head Lettuce																	0.1250	0.2500	0.2500	0.2500				
	Broccoli															0.250	0.5000	0.5000	0.5000	0.5000	0.5000				
	Watermelon								0.3120	0.3120	0.3120	0.3120	0.3120	0.3120	0.3120										
Drip Irrigation	Western Cantaloupe								1.0900	2.1800	2.1800	2.1800	2.1800	2.1800											
	Green Bell Peppers									2.2200	2.2200	2.2200	2.2200	2.2200	2.2200	2.2200	2.2200	2.2200							

[20] Ibid. (1997)

Tables 6 and 7 illustrate the above expressions. M_{ij} and I_{ij} refer to the coefficient matrix for the machinery and irrigation use, respectively, of the j^{th} production activity in the i^{th} semi-monthly period.[21] MC and IC are the machinery and irrigation constraints that may not exceed constraint values for machinery CV(M) and for irrigation CV(I). As mentioned before, the CV values, for machinery (M) and irrigation (I), will be determined by the assumptions of the particular models or scenarios we chose to examine and they are discussed in detail in the third chapter.

2.4 Market Window Analysis

Market window analysis is part of the advance preparation needed in marketing agricultural products. Fundamentally, it tries to discern a trend in prices over a period of time, evaluates the variability of prices over time and provides the farmer with a measure of the potential profitability of an individual commodity. Modern agricultural marketing is consumer oriented. It mainly seeks to determine **when** and **how** to deliver the product to the consumer (Chafin and Hoepner, 1989). Market window analysis, on the other hand, is oriented towards the producer seeking to determine **whether** a particular commodity is a potentially viable production alternative. Surely, past performance cannot indicate future prices. However, the farmer may determine that a crop has good profit potential if in the last five years its median price, for instance, exceeded production cost estimates 95 per cent of the time.

In consultation with specialists in the area and other knowledgeable individuals,[22] four viable terminal markets were identified for the Eastern Shore, namely: Baltimore, Philadelphia, New York, and Boston. The price information came from news wires made available daily from USDA market information agencies. Four price quotes, the lowest(P1), the highest(P4), and the two most common prices of a market day(P3 and P4), are recorded each day in

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[21] The machinery and irrigation use estimates were developed by Guy Sturt and they are included in the production budgets, presented in Appendix A. Unpublished.

[22] Conversations with Fred Diem of the Northampton County Extension Cooperative and Dr. Charlie Coale of the Department of Agricultural and Applied Economics at Virginia Tech. Also see Sterrett, *et. al*. (p. 10, 1994).

order to capture the range of prices for a particular commodity. Table 8 shows the 1996-database information for spring romaine lettuce in the Philadelphia Terminal Market. This information is then used to estimate average low, high and median price levels for individual commodities. This analysis will use the median rather than the mean as measure of the central tendency of commodity prices. This choice seeks to avoid those cases when very high or low prices in a given range may provide a mean that is disproportionately high or low. It should also be noted that crop prices were collected from the daily bulletins rather than reports published at the end of the year. This allows us to calculate the standard deviations of the data for each week of the market window as well as the standard deviation of the entire market window. Standard deviations will then be used to analyze the relative variability of prices for a given commodity.

Table 8 – Sample of Database of Price Recordings for Vegetable Crop Market Window Analysis

		P1	P2	P3	P4
Week 18	Monday	8.00	9.00	10.00	11.50
	Tuesday	7.00	8.00	9.00	10.00
	Wednesday	7.50	8.00	9.00	10.00
	Thursday	8.00	9.00	10.00	10.00
	Friday	8.00	9.00	10.00	10.50
	WEEKLY AVERAGE	7.70	8.60	9.60	10.40
Week 19	Monday	10.00	11.00	12.00	12.00
	Tuesday	9.00	10.00	11.00	11.00
	Wednesday	10.00	12.00	13.00	13.00
	Thursday	9.00	10.00	11.00	12.00
	Friday	10.00	11.00	12.00	12.00
	WEEKLY AVERAGE	9.60	10.80	11.80	12.00
Week 20	Monday	8.00	11.00	12.00	12.00
	Tuesday	8.00	11.00	12.00	14.00
	Wednesday	8.00	12.00	14.00	14.00
	Thursday	11.00	13.00	14.00	14.00
	Friday	10.00	12.00	15.00	15.00
	WEEKLY AVERAGE	9.00	11.80	13.40	13.80
Week 21	Monday	12.00	13.00	14.00	15.00
	Tuesday	9.00	10.00	12.00	14.00
	Wednesday	10.00	12.00	13.00	14.00
	Thursday	10.00	12.00	13.00	14.00
	Friday				
	WEEKLY AVERAGE	10.25	11.75	13.00	14.25
Week 22	Monday	9.00	10.00	12.00	13.00
	Tuesday	9.00	10.00	11.00	12.00
	Wednesday	8.00	10.00	12.00	14.00
	Thursday	8.00	10.00	12.00	13.00
	Friday				
	WEEKLY AVERAGE	8.50	10.00	11.75	13.00
Week 23	Monday	11.00	12.00	14.00	14.00
	Tuesday	9.00	11.00	12.00	14.00
	Wednesday	11.00	12.00	13.00	14.00
	Thursday	11.00	13.00	14.00	14.00
	Friday				
	WEEKLY AVERAGE	10.50	12.00	13.25	14.00

Summary of Weekly Average Prices

	P1	P2	P.3	P4
Week 18	7.70	8.60	9.60	10.40
Week 19	9.60	10.80	11.80	12.00
Week 20	9.00	11.80	13.40	13.80
Week 21	10.25	11.75	13.00	14.25
Week 22	8.50	10.00	11.75	13.00
Week 23	10.50	12.00	13.25	14.00

2.5 Environmental Impact Analysis – PLANETOR

This section discusses the computer program that was used to conduct the environmental impact analysis. We provide an overview of the various methodologies incorporated in this program, their strengths and weaknesses, as well as show the site- specific information that was used to simulate typical farming conditions on the Eastern Shore. The environmental analysis is complementary to the linear programming model. It seeks to provide some measure of the potential environmental effect of the farm plan that maximizes net returns to the farmer. The analysis will accomplish this task by evaluating the crop mix suggested by the optimal solution and providing a qualitative assessment of the potential impact that each crop has on the local environment.

2.5.1. Brief Overview of PLANETOR

PLANETOR is a farm planning computer program developed by agricultural economists at the University of Minnesota. While PLANETOR does not perform an extensive economic feasibility analysis of several production alternatives, something that the linear programming model is much better suited for, PLANETOR does provide a wide range of information regarding various environmental parameters. Furthermore, the program utilizes approaches that are fairly well established in their respective disciplines. Two components of the model - the Revised Universal Soil Loss Equation (RUSLE) and the Nitrogen Leaching and Economic Analysis Package (NLEAP) - will be discussed in detail. These two components are most affected by the specific physical information from the study area. At this point, we simply offer a brief description of the environmental factors analyzed by PLANETOR.[23]

a) Soil Erosion - PLANETOR takes into account various factors, such as soil type, rainfall, slope length and steepness, tillage and plant growth impacts on crop cover, and specific field practices, such as terracing, contours, or strip-cropping, to estimate annual waterborne soil loss.

[23] The following information is presented, in more detail, in the user's manual accompanying the program. Much of that information is included in Appendix 5. See PLANETOR - Users Manual (pp. 2 –3, 1995).

b) Pesticide leaching and runoff - PLANETOR considers pesticide chemical properties, soil interaction, application method, and timing to develop a qualitative assessment of the impact of various pesticide uses in the field. This screening method should be used as a guide of the potential hazards of various pesticide applications.

c) Pesticide Toxicity - PLANETOR uses the information provided on the labels of pesticides to determine their relative toxicity. Then, it proceeds to rank them in five categories, from caution to danger/poison.

d) Nitrogen Leaching - The NLEAP model was developed by Follett, Keeney and Cruse (1990). The model is incorporated in PLANETOR to evaluate the impact of various agricultural practices and crops on the ability of the soil to retain nitrates. Using information on the amount of nutrients applied to the crop, the method of application, the potential and real losses of nitrogen, the model calculates nitrogen leaching below the root zone.

e) Phosphorus runoff - PLANETOR evaluates the potential for phosphorus runoff according to an index developed by the Natural Resources Conservation Service's Phosphorus Index Core Team. Accounting for various sources of phosphorous intake, the index predicts the phosphorous runoff potential of a particular cropping system.

2.5.2. The RUSLE Methodology

Soil erosion may result from water flows as well as wind activity. The Revised Soil Loss Equation (RUSLE) was developed by scientists of the USDA-Agricultural Research Service and it is the computerized version of the Universal Soil Loss Equation that has been the major tool for the prediction of water induced soil erosion (Yoder and Lown, 1995). The model relies on the following equation:

$$\mathbf{A = R * K * L * S * C * P}$$

This equation calculates the values of predicted annual soil loss (A), in tons per acre, as a function of various factors, namely:

- Predicted factor for measured rainfall (R)
- Factor for soil erodibility (K)
- Factor for slope length (L)
- Factor for slope steepness (S)
- Factor for cover management (C)
- Factor for support practices (P)

Most of the information required for calculating the factors for the above equation have been entered into the PLANETOR's databases. This allows for greater applicability of the model, filling gaps in site-specific empirical data with process-based calculation. In other words, it is not necessary to have specific information on every particular aspect of an activity. Instead, we may specify the processes used to accomplish that activity. The model then generates the environmental impact based on previous estimates of these processes. However, we also had to make some assumptions regarding the typical situation on the Eastern Shore. Norfolk, VA, located around 20 miles from the Eastern Shore, was chosen as the closest RUSLE site to the study area.[24] Thus, some of the RUSLE database information regarding climate and other factors were adjusted with Eastern Shore information rather than using statewide data. Bojac Fine Sandy Loam, with an average slope of 0 – 2 percent, is the predominant soil type in the area. Since most farmers use conventional tilling methods, this is reflected in the crop production information. Cover management is assumed to be either light cover or moderate rough while rill-intertill (parameter used for typical medium-textured cropland that is regularly tilled) was selected as the predominant erosion method. Soil loss from fallow land was not calculated due to incomplete information in the computer model. Appendix E includes specific information on the data requirements of the RUSLE database. The information required by the two major databases of PLANETOR, is also included in this Appendix.

The present version of the PLANETOR computer program includes information on most of the crops analyzed in this study. For two crops, kenaf and lettuce, no specific

[24] It is assumed that the climactic information for this location is representative for the study area given that the raw data is provided by the metereological station located on the Eastern Shore.

information was provided therefore the program was adjusted to include these two crops. Information on these two crops was collected from interviews with extension agents, other specialists as well as the scientific literature. In those cases when some of the data could not be procured from the above-mentioned sources, then data on crops similar in nature were used as proxy. Appendix E provides all the data used to calculate the impact of these two crops.

Several limitations of the model should also be kept in mind. Some of the factors in the main equation of the model tend to change over the year. RUSLE accounts for change in these factors by averaging it over the year then multiplying all factors. A better, and more accurate, approach would be to multiply these changing factors over the year and average the product. Nevertheless, while specific studies of Eastern Shore soil loss from water erosion could obtain more precise results from site-specific models, overall PLANETOR offers a good estimate of this environmental variable. Finally, the model offers no information on wind erosion. Given the location of the Eastern Shore, the absence of such information limits our ability to estimate the total soil erosion potential of traditional or new production alternatives.

2.5.3. The NLEAP Methodology

The Nitrate Leaching and Economic Analysis Package is a computer model developed by ARS - USDA scientists at Fort Collins, Colorado and it purports to provide an estimate of real and potential nitrate leaching. Much of the information needed for the analysis is provided in the NLEAP database accompanying the PLANETOR program. New information is required for those crops that are not included in the database. The procedure for either calculating or finding this information in the literature is presented in Appendix E. The original NLEAP model contains three possible modes of analysis depending on the data available; namely, a screening analysis, a month by month analysis and daily analysis. PLANETOR uses the second approach and estimates two specific values - nitrogen available for leaching and nitrogen leaching. Follett, Keeney and Cruse (1990) have established the mathematical relationships, incorporated in the computer model for calculating such values in a two-layer soil model.[25]

Similar to the RUSLE database, NLEAP requires some process-based, site-specific information in order to generate results. Two NLEAP sites are available for Virginia. The Albemarle county Charlottesville 1 site represents information for the eastern part of the state and that site was selected for the Eastern Shore analysis. Rainfall, wet days, and evaporation statistics (Virginia Agricultural Statistics, 1996) for this site were compared to such data for the Eastern Shore. They were found to be quite similar and therefore the selection of this site was determined to be representative for the area. However, this database could be further customized to reflect site-specific conditions. At this point, the data available fulfills the goals of this analysis. The information for this site is included in the NLEAP database and Appendix E includes its data requirements. Side slope was chosen as the most representative field position for farmland on the Eastern Shore.[26] At this time, the author was not able to collect typical data regarding the soil nitrate test for the top foot and the soil nitrate tests for 1-5 feet. This information is specific for individual farmers and may be added when calculating this factor for specific situations. In the current calculations, the

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[25] The calculation for both such values, in a two-layer soil model, is done using the following formulations:

(1) $$NAL = N_f + N_p + N_{rsd} + N_n - N_{plt} - N_{\det} - N_{oth}$$

(2) $$NL1 = (NAL1)\{1 - EXP[\frac{(-K)(WAL1)}{POR1}]\}$$

(3) $$NAL = NAL2 + NL1$$ and

(4) $$NL = (NAL)\{1 - EXP[\frac{(-K)(WAL)}{POR2}]\}$$

where NAL is nitrogen available for leaching from the root zone, N_f is the amount (lb./acre) of nitrate-N (NO_3-N) added to soil from fertilizers, N_p is the amount of NO_3N added from precipitation and irrigation water, N_{rsd} is the residual NO_3N in the soil profile, N_n is the NO_3N produced from nitrification of ammonium-N, N_{plt} is the NO_3N uptake by the crop, N_{det} is the NO_3N lost to denitrification, N_{oth} is the NO_3N lost to runoff from erosion. NAL1 and NAL2 is the amount of nitrogen available for leaching from the top and bottom layer in the root zone. K is the leaching coefficient, POR1 and POR2 is the porosity of the top foot and lower horizon in inches, WAL1 and WAL2 are the water available for leaching from the top and bottom layer, respectively, and NL is NO_3N leached from the root zone. (Follett, Keeney and Cruse, 1990, pp. 185 – 190):

[26] This is the PLANETOR default for the field lanndscape postion relative to the water flow. The default value should not be accepted only in those cases when no denitrification occurs during the entire year (summit position). Since this condition is quite rare, we have used the default value offered in the program.

model does not take into account such nitrogen sources and this may underestimate the potential for nitrogen leaching and runoff. The organic matter in the mineralizable pool is 5%, which is the default value assigned by PLANETOR. Also no typical data was collected on the amount of nitrate content of water in "ppm." As with the soil nitrate test, we substituted zero for such values and recommend that these values be modified once such data is collected.

As with RUSLE, the use of the NLEAP also poses some limitations regarding the accuracy and specificity of measurements. By using basic system processes, instead of site-specific empirical data to generate results, the model's accuracy is limited. These system processes are updated only following an event, therefore lacking the realism that dynamic models are able to simulate. No allowance is made for physical soil layering and the model is incapable of long-term simulations of cropping systems involving rotations (Follett, Keeney and Cruse, 1990). Nevertheless, this methodology constitutes a good starting point, especially considering the lack of empirical data for the alternative crops evaluated in this study.

The next chapter provides a detailed discussion of the results generated by the economic and environmental impact analysis. At present we will briefly outline the link between these two parts. The mathematical programming model will be used to evaluate the feasibility of introducing the alternative crops into the production mix of the region. Several scenarios - relating to the farm size, machinery and labor resource availability, price variability, and new crop additions - will be evaluated. Each scenario will then be evaluated with regard to its potential environmental impact. The results from both these analyses will be compared to evaluate the trade-offs, if any, between economic and environmental factors.

Chapter Three – Results and Discussion

This chapter discusses the results and implications of the economic and environmental analyses. The first section provides detailed information on the price ranges of the commodities analyzed in this study and it offers some measure of the relative variability of such prices over the last five years. The information on such prices is crucial in conducting an evaluation of the economic feasibility analysis of various alternatives.

Two representative models are constructed for Eastern Shore farmers, based on given assumptions about resource availability and crop production preferences. We analyze several scenarios to explore the impact of changes in resources, prices, or available crop alternatives. In the end, we provide two models that maximize net returns to land and management. These models are then evaluated for their environmental impact. Negative effects from soil erosion, as well as chemical leaching and runoff, are the focus of this analysis.

3.1 Market Window Analysis

Chapter Two developed the theoretical justification for the market window analysis. It briefly outlined the methods involved and identified the source of the data used for this purpose.

This section will present and discuss the results of the analysis. Specific information for individual vegetable crops is included in Appendix F. We argue that the profitability of a given crop should be evaluated in the context of its performance during the entire market window, rather than on its potential for high profit margins in selected time periods. However, while profit margins are important, it is also important to consider price variability over time. Based on both potential profit margins and past price variability, we can make a determination on the potential profitability of a commodity.

3.1.1. High, Low and Median Historical Prices

Market window analysis is often offered as a tool to target those periods when commodity prices are the highest. Managers are encouraged to take advantage of those profitable opportunities by rushing products to market when prices peak. While this method could be useful in other production sectors, it is not suited to agricultural production that depends heavily on unknowns such as weather. It also does not reflect the realities of vegetable production characterized by, among other things, a long harvesting season. Nevertheless, comparisons of historical price trends, with per unit production costs, provide the producer with a good first approximation of the profitability of a given enterprise throughout the market window.

Figures 2 and 3 illustrate this point, using historical Philadelphia Terminal Market quotes for spring plantings of romaine lettuce and snap beans. Romaine lettuce appears to be a far more attractive alternative when assessing profitability. Both the high and median prices stay well above production costs. Even the lowest price quote barely falls below the production cost line in the last two weeks of the market window. This result suggests a commodity that can provide sustainable profits throughout the market window.

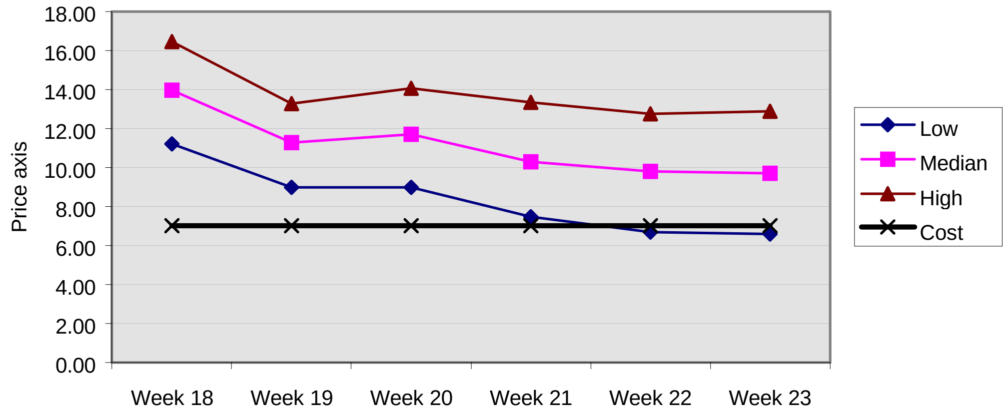

Figure 2 - Market Window Analysis for Spring Romaine Lettuce, Philadelphia Terminal Market, 1992 – 1996[27]

Spring snap beans are more problematic. Profit opportunities only appear early in the market window. Prices then fall considerably below production costs. This suggests that the production of this commodity, while profitable for a week or two, cannot offer profits during the entire market window. Producers have two alternatives. They may attempt to offer most of the product early in the season to take full advantage of the high prices offered. This may pose some problems, however, due to the prolonged harvesting of vegetable crops and difficulties in timing the harvest. The second alternative is to focus on offering stable and continuous good quality product throughout the marketing window.

The first scenario is even less appealing than it might appear from Figure 3. Brokers will have little time to get to know and establish a working relationship with the producer. They are concerned with reliable and adequate supplies of a known quality. Rushing the product to market, as early in the season as possible, does not satisfy either of these concerns. Brokers are likely to respond by offering prices below the median range for that commodity. As a result, considering the low quote line in Table 3, producers will not be able to make a profit even in the first two weeks of the market window. The second alternative assures that the producer will at least capture prices closer to the median, through better quality and continuous market presence. It does not, however, always assure profitable margins and this

[27] This analysis calculates the median, rather than the mean price, in order to avoid those cases when very high or low prices in a given range may provide a mean that is disproportionately high or low.

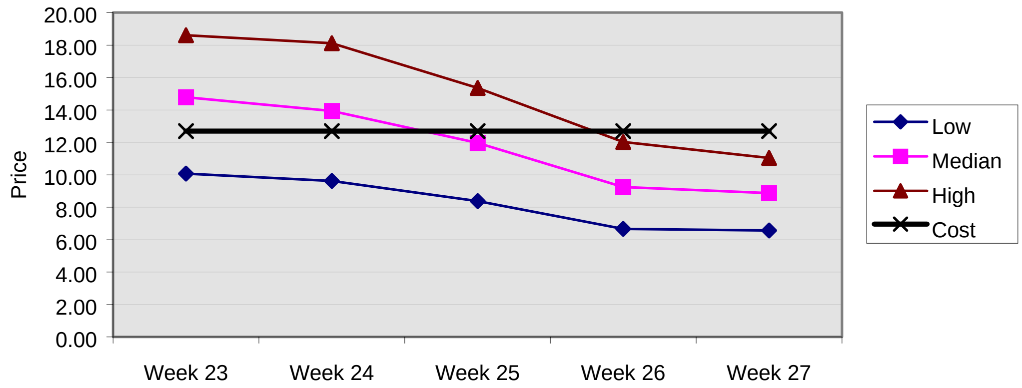

Figure 3 - Market Window Analysis for Spring Snap beans, Philadelphia Terminal Market, 1992 -1996

should send clear signals about the inability of the region to successfully match the production capabilities of its competitors.

Market window analysis does not address the issue of market depth and the potential downward effects on prices if large supplies are offered. Indeed, this is a crucial point as seasonal shipping volumes and market depth strongly affect whether or not a given commodity has the potential to become a viable alternative. Many such issues, while important and worthy of future consideration, fall outside the scope of this thesis. However, we can point to a few issues that would complete the picture offered by the market window analysis. Thus, we need to know more about the:

- volume of commodities passing through these markets, within the given market windows;
- main competitors for Eastern Shore farmers in the market windows, and the relative advantage or disadvantage that these competitors may have;
- expectations of quality for certain commodities and the ability of farmers to meet marketing requirements, such as size, color, and uniformity.[28]

[28] Lately, some of the marketing specialists working in the region have indicated that the quality of lettuce may suffer from the sand that penetrates the crop and deposits among the crop's leaves. As of this moment, it is not clear if it is possible to overcome this potential problem by adding product-cleaning facilities. Indeed, this option could increase the cost of production but it may prove beneficial given the good profit margins offered by this crop.

Currently, a comprehensive analysis of the marketing structure for current Eastern Shore products, as well as the marketing potential of the new vegetable crops discussed, is a work in progress. The completion of this phase is expected in the fall of 1998.[29] Once this information becomes available, the results presented here should be considered in the context of that study and appropriate conclusions drawn. Perhaps only a few farmers can meet the demands of growing some of the most profitable crops discussed here. However, in this section and throughout this study, we have assumed good production management and marketing. In light of the market window analysis, meeting these two requirements will assure that Eastern Shore farmers successfully compete for market share and high prices.

Table 9 summarizes the results of the market window analysis for all vegetable crops considered in this study. It contains the average low, median, and high price throughout the market window in all four markets. The averages are based on 5-year historical data, from 1992 – 1996. The average median price for spring snap beans, for instance, was highest in the Boston terminal market, quoted at $14.17 per bushel-crate and lowest in Philadelphia at $11.76. The overall average historical spring snap bean price is $12.82. Ultimately, the overall average median price is used in the mathematical programming model to perform the feasibility analysis.

Appendix F provides detailed summaries and price tables for other vegetable commodities for which historical price data was collected.[30] Four separate windows are reported for each crop depending on the terminal markets that are supplied. This provides more meaningful information on the performance of the same crop in each market by identifying those markets that may provide better profit opportunities. misleading if one does not also take into account their variability. The next section addresses this question in more detail.

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[29] Dr. Dennis Ackerman of the Old Dominion University Entrepreneurial Center is participating in this project. Projections for completion of this study are based on his personal estimates.

[30] No such information was collected for the non-vegetable crops. The price data for such crops, as well as information on high and low price levels, was procured from the production budgets compiled by farm management agents working in the region rather than primary data sources such as terminal market reports.

Table 9 - Summary of 5-year average High, Median and Low price Ranges Across Four Terminal Markets, Baltimore, Philadelphia, New York and Boston, 1992 – 1996

Commodities	Baltimore			Philadelphia			New York			Boston			Average of Median Prices in Four Markets
	Low	Median	High	Low	Median	High	Low	Median	High	Low	Median	High	
Spring Cucumbers	7.88	10.91	14.30	6.64	9.83	13.24	6.77	10.60	15.07	8.01	12.35	16.89	**10.92**
Fall Cucumbers	7.09	9.62	12.63	5.88	8.54	11.53	6.00	9.59	13.11	6.58	9.85	13.25	**9.40**
Spring SnapBeans	10.24	12.70	15.19	8.26	11.76	15.02	9.33	12.65	16.24	11.27	14.17	16.99	**12.82**
Fall Snapbeans	7.44	10.37	13.29	6.77	9.46	12.15	8.56	11.64	14.73	10.58	11.86	13.13	**10.83**
Spring Green Bell Peppers	7.75	9.22	10.83	6.23	7.84	9.65	6.57	8.03	9.65	7.54	9.09	10.81	**8.55**
Fall Green Bell Peppers	7.16	8.66	10.32	5.36	6.88	8.52	6.52	7.84	9.26	6.75	8.16	9.84	**7.89**
Cantaloupes*	10.27	10.92	11.56	9.26	10.55	11.85	9.79	11.08	12.37	10.57	11.19	11.80	**10.94**
Watermelon*	0.056	0.061	0.065	0.049	0.060	0.070	0.068	0.074	0.080	0.056	0.061	0.065	**0.066**
Spring Boston Lettuce	8.69	9.20	9.70	7.51	8.72	9.92	7.11	9.42	11.89	8.30	9.56	10.70	**9.23**
Fall Boston Lettuce	8.81	9.45	10.00	6.75	8.14	9.43	6.87	9.11	11.98	7.57	9.17	11.04	**8.97**
Spring Romaine Lettuce	10.73	12.16	13.43	8.32	11.12	13.81	9.24	12.07	15.21	10.43	12.78	14.87	**12.04**
Fall Romaine Lettuce	10.41	11.76	12.99	7.79	8.88	9.96	7.84	9.73	11.77	8.42	11.07	13.77	**10.36**
Broccoli	9.02	10.27	10.92	7.82	9.28	10.70	8.42	9.82	11.12	8.27	9.76	11.17	**9.78**

* No historical prices on these commodities were collected. The historical data used is from the study conducted by Sterrett, et al. (1996)

One word of caution is in order. The information presented in these tables reflects the historical performance of a crop in the past and it should be treated as a guide to *potential* profitability.

3.1.2. Price Variability

Historical average commodity prices are useful indices. However, they relate only part of the story about potential crop profitability and income stability over time. The first part argued that profitability is a measure of a crop's performance throughout the market window. Figures 2 and 3 illustrated this point by comparing average weekly prices to the estimated cost of production. It is now important to look at the variability of these average prices by computing their standard deviations from their mean. This calculation will illustrate the impact of big price fluctuations from year to year and, therefore, the possibility of income losses. Table 10 shows the average-price variability of spring romaine lettuce in the Baltimore Terminal Market.

The standard deviation computed in Table 10 can be interpreted in two ways. First, the greater the standard deviation, the greater the average price variability. Week 18 is a good example. All three average prices are the highest in the entire market window. While this observation would indicate high profit expectations in this part of the market window, high standard deviations of the average prices for week 18 moderate this enthusiasm. They suggest that the historical prices during this week have been quite volatile and potential profits are very uncertain.

Table 10 -Standard Deviation Coefficients for Spring Romaine Lettuce Average Prices, Baltimore Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Ave. Median	St. Dev	Ave. High	St. Dev
Week 18	13.23	5.42	14.52	6.29	15.79	7.18
Week 19	10.42	2.00	11.73	1.82	12.95	2.30
Week 20	10.90	2.40	12.91	2.36	14.54	2.84
Week 21	10.30	1.23	11.56	1.14	12.71	1.45
Week 22	9.72	1.51	10.79	1.49	11.80	1.67
Week 23	9.82	2.00	11.49	1.48	12.77	1.70
Window	11.25	3.02	12.26	3.25	13.54	3.73

The second interpretation of the standard deviation is even more revealing. Assuming that the price data exhibits a normal distribution[31], it is possible to observe the frequency with which prices have fallen under the production cost line over the last five years. This is surely not a prediction of future prices, but it does show how robust prices have been for a given commodity. The median price for week 21 has the lowest standard deviation in the Baltimore market window. Given the normality assumption discussed above, it is possible to state that spring romaine lettuce prices in the Baltimore markets for the last five years have been at $9.28 or higher 97.5 percent of the time during that week (Runyon and Haber, 1982, pp.73 – 78). Given an estimated production cost of $6.91 per sale unit, this result suggest that this crop has been quite profitable not simply from the profit margins that it offers, but more so because these margins have been quite robust throughout the past 5-years.

The same procedure can be followed for the average price of the entire market window. Thus, the standard deviation of the median price for spring romaine lettuce in the Baltimore market window is 3.25. This suggests that in the last five years the median romaine lettuce prices for this window have not fallen below $9.01 at least 84% of the time. In view of an estimated production cost of $6.91, the producer is able to judge on the profit potential of given crop. The market window analysis does little, however, to identify the combination of crops that will maximize profit, given limited available resources. This will be the objective of the mathematical programming model discussed in the next section.

In conclusion, market window analysis offers some particular insights into the marketing of vegetable crops. First, a crop is not as profitable as its highest price quote would suggest. This may be true even if it were possible to market the crop exactly when prices peaked. Channels of distribution are hard to establish and maintain. They require that the farmer have the ability to offer continuous and stable supplies of a commodity during the entire market window. This is especially true now when there is an extensive drive towards vertical cooperation and integration throughout the entire distribution chain of fresh fruit and

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[31] Pearson coefficients describe the distribution of the sample data. It is generally accepted that Pearson coefficients, negative or positive, under 0.50 indicate that the data is distributed normally. Appendix F includes such coefficients for each data sample. Not all of them have smaller than 0.50 Pearson coefficient. Nevertheless, the coefficients are small enough that, given a larger data sample (present sample of each standard deviation has around 20 observations), the population distribution approaches normality.

vegetables. In this context, growers cooperate with other growers and shippers to coordinate the marketing of their product. Often this translates into product and price pooling, mixed loads, or other arrangements that allow shippers to extend their market windows as well as offer steady supplies. Harvesting thus becomes a function of climate, grower targeting and commitments to marketing partners. Profitability, then, should be assessed for the window as a whole rather than for the portion that maximizes profit. Second, historical terminal market prices offer the opportunity to observe price variation within a given window. This provides a comparative assessment of price stability over time as well as an indication of how robust crop prices may be in the future. While historical prices can not predict the future, they do offer a frame of reference for future performance.

3.2 Economic Feasibility Analysis

The market window analysis provided some important information about the potential profitability of various commodities, given market prices and expected production costs. It cannot, however, determine the combination of activities that will maximize the farmer's profits within available resource constraints. The economic feasibility analysis addresses that specific question.

The results and their discussion will be presented in the following order:

1. Define two representative farms, Grain Farm and Vegetable Farm, reflecting the crop alternatives considered in this study, the resources available to the typical farmer and management strategies to maximize profits. Constraint assumptions are presented in Table 11.

2. Present and discuss the results from Scenario 1 for the Grain and Vegetable Farms. New crop alternatives are not considered while imposing all constraints defined in Table 11.

3. Present and discuss the results from Scenario 2 for the Grain and Vegetable Farms. Here, we proceed to include new crop alternatives and compare the results with the previous scenario. Then, we continue to analyze the resource use intensity and the impact that under utilization of resources may have on the optimal solution.

4. Present and discuss the results from Scenario 3 for both representative farms. Following the discussion of the previous point, we evaluate a no constraint scenario (except land) in order to observe resource bottlenecks and find ways of either removing or easing their impact on the profit maximizing solution and resource use.

5. Present and discuss the results from Scenario 4 for the Grain and Vegetable Farms. This scenario modifies the assumptions presented in Table 11 in view of what is learned from the previous three scenarios of both models. The solution is optimal as it finds the cropping strategy that maximizes profits and best utilizes given resources.

6. Scenario 4 of both farms is also used to perform the price sensitivity analysis. Using the information from the market window analysis, we analyze the impact of potential price increases and decreases on the optimal solution.

3.2.1. Representative Farm Models

The two representative farms shown in Table 11 outline the mathematical programming model's initial assumptions regarding two large groups of full-time farmers in the region - namely vegetable growers and grain growers.[32] On average, the amount of land available to a typical full time farmer on the Eastern Shore is about 700 acres. Vegetable growers typically have two travelling guns at their disposal. This translates into a semi-monthly irrigation constraint (one inch of water per acre on 60 acres). The main vegetable crops competing for resources are cucumbers, snap beans, potatoes and green bell peppers. The alternative agronomic crops are limited to wheat and soybeans. As the market window analysis showed such traditional vegetables offer small profit margins, their prices tend to be quite volatile, and they are consequently being replaced by wheat and soybeans. The new crops that will be considered are lettuce (Boston and Romaine varieties), cantaloupes, watermelons (seeded and seedless varieties), broccoli, and hayman sweet potatoes. Non-irrigated land is, for the most part, planted with soybeans, or winter wheat double-cropped with soybeans. Kenaf is

[32] Information provided by Mr. Fred Diem, Extension Agent at the Northampton County Cooperative Extension. As of this moment, there does not exist a systematic survey to document this information. The assumptions of this study do not dispute the accuracy of this information. The model is flexible enough, however, to accommodate with little effort new assumptions regarding land, labor or machinery resources.

the only new crop that does not require irrigation. It is assumed that the typical farmer has four to five tractors of different capacities available and four to five full time employees.

Table 11 - Main Assumptions of the Two Mathematical Programming Models for Vegetable and Non-vegetable Growing Farmers

Models	Assumptions
Grain Farm	No irrigation 700 acres of land available Four Employees: Labor at 320 hrs for semi-monthly period Machinery: Two 50 Hp Tractors - 160 hrs (semi-monthly) Two 80 Hp Tractors - 160 hrs (semi-monthly) One 110 Hp Tractor - 80 hrs (semi-monthly) Median crop prices Average crop yields 1/10 of land fallow to as good management practice
Vegetable Farm	Irrigation at 60 acre inches per semi-monthly period (based on two travelling guns available) 700 acres of land available Five Employees: Labor at 400 hrs for semi-monthly period Machinery: Two 50 Hp Tractors- 160 hrs (semi-monthly) Two 80 Hp Tractor - 160 hrs (semi-monthly) One 110 Hp Tractor- 80 hrs (semi-monthly) Median crop prices Average crop yields Crop family rotation 1/10 of land fallow to as good management practice

The full time equivalent (FTE) for both these resources is assumed to be 40 hours a week. As will discussed later, this assumption is unrealistic, especially during planting and harvesting periods, and it unduly skews the results. However, we currently retain this innitial assumption as a necessary step in developing the final model and in observing its impact on the optimal solution. There is no constraint on custom labor; therefore it is treated as another production input. For rotation purposes and as a best management practice, 1/10 of total farmland is left fallow each year.

a. Summary of Results for Scenario 1

Table 12 summarizes the results of Scenario 1 for the representative Grain Farm and Scenario 1 for the representative Vegetable Farm. These scenarios take into consideration only those crops that are currently being produced on the Eastern Shore. The results show that the solutions for both representative farms are far from optimal as land utilization is quite low in both cases. In Scenario 1 for the Grain Farm, 563 acres of crops are produced by utilizing only 396 acres of land through double-cropping, and in Scenario 1 of the Vegetable Farm 273 acres of crops are produced by utilizing only 202 acres of land. The low rate of land utilization (less than 40% of 700 acres of farmland available) indicates that the resource constraints imposed on these activities create bottlenecks that unduly restrict the amount of crops produced. Indeed, it would take only one such restriction in any of the semi-monthly periods to have a domino effect on the entire production schedule.

Table 12 – Summary of Results. Scenario 1 – Grain Farm & Scenario 1 – Veg. Farm; 700 Acres of Farmland Available. [33]

		Net Returns to Land, Management and Capital	Total crop acres produced	Optimal crop combination	Acres per crop
Grain Farm	Scenario 1			Full season soybeans	229
				Wheat*	167
		$ 12,939.80	563	DC Soybeans*	167
Veg. Farm	Scenario 1			Irish Potatoes	60
				Cucumbers	83
				Wheat*	65
		$ 31,310.40	273	DC Soybeans*	65

* Winter wheat double-cropped with soybeans in any one year

The challenge for management is to pinpoint such bottlenecks and find ways of either eliminating or minimizing them. Scenario 1 for both these representative farms, then, is a first step toward producing a farm plan that maximizes profits and the use of resources. However, before continuing to address this issue in the following sections, we need to consider whether the inclusion of new crops has any impact on net returns and/or the recommended crop mix.

[33] Detailed information, all other scenarios summarized in this chapter, is included in Appendix D

b. Scenario 2: New Vegetable Crops

No new crops enter Scenario 2 of the Grain Farm, Kenaf being the only new crop alternative, therefore the results presented below remain the same. On the other hand, the inclusion of new vegetable crops in Scenario 2 of the Vegetable Farm (Table 13) has a noticeable impact when compared to the results of Scenario 1 (Table 12). There is a substantial increase in the acres of crops produced from 273 to 527 acres. Net returns constitute the most significant change, increasing from around $31,000 to about $436,000. Lettuce and watermelons are more profitable uses of resources and, therefore, replace cucumbers and potatoes. Cultivating approximately the same acreage with lettuce and watermelons increases net returns more than sevenfold as compared to the first scenario for this representative farm (Table 12).

Table 13 - Model Results When Including New Vegetable Crops, Scenario 2 – Grain Farm & Senario 2 – Veg. Farm, 700 acres of Farmland

		Net Returns to Land, Management and Capital	Total crop acres produced	Optimal crop combination	Acres per crop
Grain Farm	**Scenario 2**			Full season soybeans	229
				Wheat*	167
		$ 12,939.80	563	DC Soybeans*	167
Veg. Farm	**Scenario 2**			Hayman Poatoes	4
				Watermelon	45
				Fall Boston Lettuce	30
				Spring Romaine Lettuce	92
				Fall Romaine Lettuce	24
				Wheat*	167
		$ 436,991.69	527	DC Soybeans*	167

*Double-crop winter wheat followed by soybeans in any one year

This result suggests that, given the production information available for the new vegetable crops, as well as the marketing assumptions previously discussion, these crops are much more competitive for the use of resources than those currently being produced in the region.

The inclusion of new vegetables does not resolve the issue of low land utilization rates. The next section analyzes land, labor and machinery use intensity in order to determine the potential bottlenecks to production in both representative farms. This third step, the first step being the discovery of low utilization rates of machinery, labor and land and the second step revealing the much higher profit potential new vegetable crops, is necessary to understand what needs to be done to obtain a truly optimal solution.

c. Labor, Land and Machinery Use Intensity

Table 14 presents semi-monthly results on land and labor use intensity for Scenario 2 for both representative farms. The results confirm the labor-intensive nature of vegetable production, compared to soybean and wheat production. The total annual labor use for the vegetable production farm is 3,567 hours, more than double of the hours used (1,492 hours) in the wheat and soybean production farm. The assumption of four to five permanent employees may be true for many full-time farmers. However, the results indicate that vegetable farming is better suited to those operations that will provide full-time employment throughout the year. The reason for this lies in the fact that some of the main field operations in vegetable production start as early as February while winter wheat production extends the growing season until late November (Table 14).

On the other hand, field operations for wheat and soybean production take place only eight months a year. The results show an under-utilization of labor during some periods and this may be caused by many factors. First, and foremost, the results reflect the fact that under the given assumptions not all the land is cultivated, which translates into lower labor use. Earlier we suggested that there is a domino effect whereby the restrictions imposed by the use of one resource also impact the entire model. As will be shown later, once these assumptions are revised to better account for resource uses (discussed in more detail in Part 3.2.2), labor use intensity is much higher throughout the year.

Table 14 - Labor and Land Use Intensity in Scenario 2 – Grain Farm & Scenario 2 – Veg. Farm, 700 acres of Farmland[34]

	Scenario 2 - Grain Farm			Scenario 2 - Veg. Farm		
Biweekly periods	Hours	FTE	Acreage	Hours	FTE	Acreage
Jan 1 - Jan 15	0.00	0.00	166.67	0.00	0.00	166.67
Jan 16 - Jan 30	0.00	0.00	166.67	0.00	0.00	166.67
Feb 1 - Feb 15	0.00	0.00	166.67	100.00	1.30	258.81
Feb 16 - Feb 30	0.00	0.00	166.67	89.82	1.10	258.81
Mar 1 - Mar 15	0.00	0.00	166.67	349.35	4.37	262.41
Mar 16 - Mar 30	0.00	0.00	166.67	1.10	0.01	262.41
Apr 1 - Apr 15	0.00	0.00	166.67	189.19	2.36	262.41
Apr 16 - Apr 30	0.00	0.00	166.67	215.47	2.69	307.12
May 1 - May 15	0.00	0.00	166.67	117.05	1.46	307.12
May 16 - May 30	114.61	1.43	395.89	387.80	4.85	307.12
Jun 1 - Jun 15	126.07	1.58	395.89	365.30	4.57	307.12
Jun 16 - Jun 30	52.36	0.65	395.89	60.48	0.76	214.97
Jul 1 - Jul 15	273.23	3.42	395.89	143.81	1.80	214.97
Jul 16 - Jul 30	167.20	2.09	395.89	119.48	1.50	214.97
Aug 1 - Aug 15	88.03	1.10	395.89	85.39	1.10	268.30
Aug 16 - Aug 30	142.20	1.78	395.89	264.27	2.10	220.00
Sep 1 - Sep 15	26.36	0.30	395.89	139.20	1.70	220.00
Sep 16 - Sep 30	99.69	1.20	395.89	188.27	2.35	220.00
Oct 1 - Oct 15	53.03	0.62	395.89	81.33	1.02	220.00
Oct 16 - Oct 30	29.69	0.37	395.89	88.00	1.10	220.00
Nov 1 - Nov 15	169.29	2.10	395.89	288.00	3.60	220.00
Nov 16 - Nov 30	60.67	0.80	166.67	84.00	1.10	220.00
Dec 1 - Dec 15	50.00	0.63	166.67	60.67	0.80	166.67
Dec 16 - Dec 30	100.00	1.25	166.67	50.00	0.63	166.67

Furthermore, the resource use tables (including labor and various types of tractors) only show the amount of resources devoted to the main field operations of these production activities. It does not take into account many of the numerous daily activities required in maintaining a 700-acre farm and each farmer resolves such resource issues in their own individual manner. Some of them may hire most of their employees only during the growing season and during the winter months they are employed somewhere else.[35] Others may keep their employees throughout the year and employ them in activities that are not directly related to production, such as machinery maintenance.

Land use intensity information from Scenario 2 of the Grain Farm (Table 14) is straightforward, where 167 acres of land are occupied for twelve months with winter wheat

[34] The acreage here refers only to the amount of land that is under crop production. The detailed information in Appendix D also counts fallow land in this column.
[35] For more information on part-time workers in the region, see Stallmann and Alwang (1992)

double cropped with soybeans. Full season soybeans occupy the rest of the 396 acres from late May to early November. Scenario 2 of Veg. Farm (Table 14) shows more variability in land use intensity, due to the short growing season of vegetable crops. The only crop growing in the first six weeks of the year is 167 acres of winter wheat (later double-cropped with soybeans). Spring Romaine Lettuce is then planted in mid February, increasing the amount of land in production to 259 acres. A small amount of seedless watermelons (4 acres) is planted in March followed by 45 acres of watermelons in April.

The maximum amount of land in production, given this profit maximizing combination, is 307 acres. Spring Romaine Lettuce is also the first crop harvested (in early June). The land is then prepared for Fall Boston and Romaine lettuce planted in early August. Specific information on the time when each crop is planted or harvested during the growing season is provided in the Chapter 2 when discussion the structure and data requirements of the mathematical programming model.

Machinery use intensity is also higher in Scenario 2 of the representative Vegetable farm. Table 15 indicates that the tractor constraint is binding at 160 hrs and 80 hrs for 50Hp and 110 Hp tractors, respectively. Indeed, it appears (there were no binding labor constraints) that machinery use restrictions are the main reason that much of the land is not cultivated. The next section removes this constraint and observes the changes both in the value of the objective function as well as in the optimal crop combination. Finally, Table 15 is quite instructive in detailing machinery excess capacity. Given the five tractor assumption stated in the beginning, Scenario 2 for the Grain Farm shows no need for 50 Hp tractors and requires only one 80 Hp and 110 Hp tractor respectively.

Table 15 - Tractor Use Intensity for Both Representative Farms, 700 Acres of Farmland,

	Scenario 2 - Grain Farm			Scenario 2 -Veg. Farm		
Biweekly Periods	50 Hp	80 Hp	110 Hp	50 Hp	80 Hp	110 Hp
Jan 1 - Jan 15	0.00	0.00	0.00	0.00	0.00	0.00
Jan 16 - Jan 30	0.00	0.00	0.00	0.00	0.00	0.00
Feb 1 - Feb 15	0.00	0.00	0.00	0.00	0.00	0.00
Feb 16 - Feb 30	0.00	0.00	0.00	152.10	0.00	0.00
Mar 1 - Mar 15	0.00	0.00	0.00	117.88	0.00	0.00
Mar 16 - Mar 30	0.00	0.00	0.00	1.08	0.00	0.00
Apr 1 - Apr 15	0.00	0.00	0.00	73.51	23.69	0.00
Apr 16 - Apr 30	0.00	0.00	0.00	110.76	8.94	0.00
May 1 - May 15	0.00	0.00	0.00	33.75	0.00	0.00
May 16 - May 30	0.00	0.00	75.64	160.00	0.00	0.00
Jun 1 - Jun 15	0.00	45.85	0.00	160.00	0.00	0.00
Jun 16 - Jun 30	0.00	45.85	0.00	1.44	0.00	0.00
Jul 1 - Jul 15	0.00	68.77	41.67	7.03	68.77	41.67
Jul 16 - Jul 30	0.00	66.85	0.00	7.03	21.00	0.00
Aug 1 - Aug 15	0.00	45.85	0.00	77.26	0.00	0.00
Aug 16 - Aug 30	0.00	21.00	0.00	160.00	21.00	0.00
Sep 1 - Sep 15	0.00	0.00	0.00	56.00	0.00	0.00
Sep 16 - Sep 30	0.00	0.00	80.00	41.92	0.00	80.00
Oct 1 - Oct 15	0.00	25.00	0.00	41.92	25.00	0.00
Oct 16 - Oct 30	0.00	33.33	0.00	48.64	33.33	0.00
Nov 1 - Nov 15	0.00	25.00	0.00	160.00	25.00	0.00
Nov 16 - Nov 30	0.00	0.00	0.00	0.00	0.00	0.00
Dec 1 - Dec 15	0.00	25.00	0.00	0.00	25.00	0.00
Dec 16 - Dec 30	0.00	0.00	0.00	0.00	0.00	0.00

Scenario 2 for the Vegetable Farm, on the other hand, requires a 110 Hp tractor in only two semi-monthly periods. Despite this apparent excess capacity in machinery resources, tractor use in both models becomes binding in several semi-monthly periods. This situation may be enough to restrict the acreage of crops that are cultivated and ultimately lower the rates of utilization of all resources. The farm manager needs to interpret this information based on his/her farm's condition and make the appropriate adjustments. In the next section we explore different ways of relaxing these constraints and the respective impact of such changes on the optimal solution.

3.2.2. Impact of Changes in Resource Availability

The previous section discussed the quantitative results from the mathematical programming models, given the best estimates of the typical resources available on farms in the region, the appropriate production technology and the inclusion of some new vegetable crops. However, the most important issue in this model identified the under-utilization of land and, consequently, lower net returns and under-utilization of machinery and labor. Indeed, closer scrutiny is in order when the profit maximizing solutions of these scenarios recommend crop mixes that do not exceed 350 acres of cultivated land at any time during the year. Part one addresses these questions. Part two builds upon this discussion and explores various scenarios in which potential variations in resources available affect the results. The last part recommends changes that need to be made to add a particular crop (Kenaf) in the production mix.

a. Scenario 3: No Resource Constraints.

The best way to analyze the problem of excess land resources is to construct scenarios for both representative farms so that there are no constraints on labor, machinery or irrigation. This approach achieves two goals. First, it validates the model by suggesting that excess land capacities result from the initial restrictions of resource availability, rather than by modeling errors. Second, it provides some quantitative information as to what it takes to operate the farm at its full potential.

Table 16 summarizes the results of both models with and without resource restrictions. The most striking result is the increase in the amount of crop acreage produced under the no-restriction scenarios. With no resource restrictions, Scenario 3 of the representative Grain Farm suggests that the best production mix consist of winter wheat double cropped with soybeans. All 630 acres are fully occupied throughout the year while 70 acres are idled every year. With no resource constraints (except land), net revenues increase about six times, from $12,939.80 to $76,588.51.

In Scenario 3 of the Vegetable Farm, the acreage of crops produced increased from 527 acres (full resource constraints) to 830 acres (no restrictions). On the one hand, the production schedule is more specialized as it no longer includes winter wheat double cropped with soybeans. However, producing 830 acres of five different vegetable crops is a very complex enterprise. The payoff from this scenario, which it should be kept in mind assumes that the farmer is only constrained by the amount of land available, is quite impressive as net returns increase from $436,991.68 to $1,184,296.35.

Table 16 - Comparison of Results for the Grain and Vegetable Farm under Full Constraint (Scenario 2) and No Contraints (Scenario 3) on Labor , Machinery , and Irrigation; 700 Acres of Farmland;.[36]

	Scenarios	Net Returns Land, Management, and Capital	Total crop acreage	Optimal crop combination	Acres per crop
Grain Farm	Scenario 2			Full season soybeans	229
				Wheat*	167
		$ 12,939.80	563	DC soybeans*	167
	Scenario 3			Wheat*	630
		$ 76,588.51	1260	DC Soybeans*	630
Veg. Farm	Scenario 2			Seedless Watermelon	4
				Watermelon	45
				Fall Boston Lettuce	30
				Spring Romaine Lett.	92
				Fall Romaine Lett.	24
				Wheat*	167
		$ 436,991.68	527	DC Soybeans*	167
	Scenario 3			Seedless Watermelon	200
				Hayman Potatoes	30
				Broccoli	200
				Irish Potatoes	200
		$ 1,184,296.35	830	Spring Romaine Lett.	200

*Double-crop winter wheat followed by soybeans in any one year

The results presented above pose an interesting question. What is happening with the excess land in the previous scenarios, given that there is little land left fallow on the Eastern Shore? Two explanations are offered. First, this situation suggests that some of the resource restriction assumptions are too conservative. More specifically, as many extension specialists will confirm, farmers will work long days during periods such as plowing, planting, and harvesting. The restriction of a 40 hr, 5-day week during these periods is not realistic. The next section suggests how to adjust the model in light of this observation and what impact these adjustments have on the final solution. However, while this explanation may be quite true for some farmers, it cannot explain the entire problem. An alternative argument, pertinent to the representative Vegetable Farm scenarios, suggests that the new crops are more demanding with regard to labor and/or machinery resources. Given the present

[36] Total crop acreage is the sum of all crop acres produced and therefore it also counts double-cropped activities. This explains how it is possible to grow 830 acres of crops , for instance, in 630 acres of land available for production (Scenario 3 of Model 2).

resource base, the farmers may not be able to cultivate the farm to its full production potential. This is not all bad, however, if the farmer is able, thanks to such high-value crops, to increase net returns while intensively cultivating only part of the farm while the rest of the land available is cultivated with traditional crops like wheat and soybeans.

Excess land, however, is only part of the question. It would be useful to find out what is necessary to take advantage of the full profit potential of these two farming operations. The answer to this question is summarized in Table 17. Even a cursory look at the demands for labor and tractor resources, under both scenarios, provides some important insights. Realizing the full profit potential of the typical wheat-soybean farm on the Eastern Shore, requires a substantial increase of labor and machinery resources. This can be addressed however by increasing their availability during crucial periods of the growing season.

Table 17 - Summary of representative Grain Farm and Vegetable Farm Annual Needs for Labor and Tractor hours; Baseline and No-constraint Scenarios; 700 Acres of Farmland.

	Grain Farm		Veg. Farm	
Resource Requirements*	Scenario 2	Scenario 3	Scenario 2	Scenario 3
Labor Requirements	1492	2545	3567	21460
50Hp Tractor Requirements	0	0	1410	7106
80Hp Tractor Requirements	402	828	252	168
110Hp Tractor Requirements	197	460	122	250

* Annual resource requirements expressed in hours of use

The same can hardly be said about the representative Vegetable Farm. In this case, the farming operation demands full specialization in vegetable production. This is accompanied by an almost sevenfold increase in two crucial resource components: labor and 50-Hp tractor hours. Such requirements remain quite high even when adjusting for extended hours during peak activities. The only viable alternative to achieve this level of production would be to increase available resources. It is doubtful, however, that the typical farmer on the Eastern Shore has either the investment capacity or, and more importantly, the expertise to embark on the full-scale production of these rather unknown crops. Therefore, it would be more realistic to envision a farm plan that represents a more feasible mix of vegetables, soybeans, and wheat. Farmers need to make adjustments to find ways of increasing net revenues through manageable changes in the resource base.

The next section addresses the issues raised above by evaluating the impact of resource variability on the objective function. The incorporation of new vegetable crops (lettuce, watermelons, broccoli, and hayman potatoes) should also provide the necessary profit margins for continued vegetable production in the region. Furthermore, this analysis validates the argument that vegetable production is still the most profitable activity on the Eastern Shore. It is then incumbent upon entrepreneurial farmers to shift their production activities toward the production of high-value vegetables. Obviously, this would not be a recipe for success for all farmers in the region. Moreover, environmental concerns need to be accounted for, as described in Section 3, before settling on a specific strategy for the future.

b. Variable Labor and Machinery resources

Scenario 3 of both representative farms provides an opportunity to evaluate how to take full advantage of the typical farm's production potential. This section will look at the feasibility of improving economic performance through small changes in resource availability. Tables 18 and 19 provide a summary of the impact that variations in labor and machinery resources have on net returns and the acreage of crops produced. The results of the analysis provide some interesting insights.

Table 18 - Impact of Changes in Resource Availability; Labor Restrictions; 700 Acres of Farmland Available[37]

	Scenarios	Net Return to Land, Management.and Capital	Acreage of crops produced	Optimal crop combination	Acres per crop
Grain Farm	Scenario 2			Full season soybeans	229
				Wheat	167
		$ 12,939.80	563	DC Soybeans	167
	320 hrs labor constraint			Wheat*	457
		$ 23,494.31	914	DC Soybeans*	457
	480 hrs labor constraints			Wheat*	630
	(season peaks)	$ 40,943.89	1,260	DC Soybeans*	630
Veg. Farm	Scenario 2			Watermelon	45
				Seedless Watermelon	4
				Fall Boston Lettuce	30
				Spring Romaine Lettuce	92
				Fall Romaine Lettuce	24
				Wheat*	167
		$ 436,991.68	527	DC Soybeans*	167
	400 hrs labor constraint			Hayman Potatoes	29
				Watermelon	27
				Broccoli	19
				Spring Romaine Lettuce	101
				Fall Romaine Lettuce	53
				Wheat*	474
		$ 509,301.11	1,175	DC Soybeans*	474
	600 hrs labor constraint			Broccoli	40
	(season peaks)			Spring Romaine Lettuce	129
				Fall Romaine Lettuce	53
				Wheat*	498
		$ 559,701.11	1,221	DC Soybeans*	498

* Winter wheat double-cropped with soybeans in any one year

First, given the resource requirements for the representative Grain and Vegetable farms (Table 11), the labor constraint has pronounced effects depending on whether it is strictly imposed during each semi-monthly window or if one accounts for longer (60 hrs) working weeks in those periods that involve intensive field operations such as plowing, planting, and harvesting.[38] Adjusting for peak periods (Grain Farm) during the growing season leads to an almost 30 percent increase of net returns as well as a 28 percent increase in the acreage of crops produced. By cultivating all 630 acres, this scenario suggests that labor use bottlenecks

[37] Based on labor available in each semi-monthly window. No machinery constraints.

[38] These periods can be identified either by looking at the resource use tables shown in Chapter 2 or by first running the model and identifying the weeks when the resource constraint becomes binding. The individual farmer, then, needs to increase the intensity of labor use in such periods based on his or her own judgement and/or management strategy. The assumption of 60 hr weeks during peak times is quite reasonable especially when considering the possibility of working on Saturdays.

can be easily resolved via a more flexible use of available labor resources. This conclusion also holds for results of the Vegetable Farm scenarios. In this case, land is used to its full potential compared to Scenario 2. Moreover, adjustments in the labor schedule have two additional effects. First, they increase the amount of vegetable acreage by about 21%, from 176 to 222 acres. Second, they change the vegetable crop mix in favor of a smaller number of crops produced on a larger scale. The results suggest that accounting for those periods when labor use is 60 hours a week translate into higher returns and better land utilization.

Despite the impact on net revenues, total acres of crops produced and the optimal crop mix, adjusting the labor constraints is irrelevant if the impact on other resources is ignored. Table 19 does precisely that by comparing the effect of adjusting the work schedules for tractors as well as evaluating the effect of having three such tractors available during the year. The representative Grain Farm model was more likely to be impacted by changes in the number of 80Hp and 110Hp tractor hours available during crucial production periods in the year.

Similar to labor use, tractors were assumed to work longer weeks (60 hrs) during the planting and harvesting season. Thus, adjustments of 80 Hp tractor hours to allow higher intensity of use in such periods would increase net revenues by almost 20% while also increasing the acreage of crops produced from 1,018 to 1,260 acres (Table 19). The same changes in the use schedule of 110 Hp tractors also increase net returns by 20% and grow the acreage of crops produced from 963 to 1,213 acres. Both scenarios suggest that adjustments in tractor use greatly influence both net returns and land use intensity. Moreover, the 50Hp tractor hours are never binding in this model. This suggests that the best tractor mix in this model would involve no 50 Hp tractors, two 80 Hp tractors, and two 110 Hp tractors.

Similar scenarios for the representative Vegetable Farm focus on the use of 50 Hp tractor hours – the single most important piece of machinery in vegetable production. These scenarios analyze three distinct effects of changes in this resource: the effect of having three 50 Hp tractors as well as the effect of adjusting tractor use schedules in cases when either two or three such tractors are available. Following the procedure described in the previous paragraph, adjustments in tractor use schedules when two such tractors are available, increase net returns by 21 % although the acreage of the crops produced decrease slightly.

An additional tractor would add another 4.5% to net revenues in this scenario and it also increases crop acreage from 1,166 to 1,221 acres.

Table 19 - Impact of Changes in Resource Availability; Machinery Restrictions; 700 Acres of Farmland Available

	Scenarios	Net Return to Land, Management and Capital	Acreage of crops produced	Optimal crop combination	Acres per crop
Grain Farm	Scenario 2			Full season soybeans	229
				Wheat	167
		$ 12,939.80	563	DC Soybeans	167
	80 hrs constraint- One 80Hp			Full season soybeans	242
				Wheat	388
		$ 30,412.74	1,018	DC Soybeans	388
	120hrs constraint - One 80Hp			Wheat	630
	(season peaks)	$ 40,943.79	1,260	DC Soybeans	630
	80hrs constraint - One 110Hp			Full season soybeans	297
				Wheat	333
		$ 28,043.84	963	DC Soybeans	333
	Peak 120hrs FTE - One 110Hp			Full season soybeans	46
	(season peaks)			Wheat	583
		$ 38,920.24	1,213	DC Soybeans	583
Veg. Farm	Scenario 2			Watermelon	45
				Seedless Watermelon	4
				Fall Boston Lettuce	30
				Spring Romaine Lettuce	92
				Fall Romaine Lettuce	24
				Wheat*	167
		$ 436,991.68	527	DC Soybeans	167
	160hrs constraint- Two 50Hp			Watermelon	45
				Seedless Watermelon	4
				Fall Boston Lettuce	30
				Spring Romaine Lettuce	92
				Fall Romaine Lettuce	24
				Wheat*	490
		$ 444,618.01	1,173	DC Soybeans	490
	240hrs constraint- Two 50Hp			Hayman Potatoes	72
	(season peaks)			Seedless Watermelon	9
				Fall Boston Lettuce	52
				Spring Romaine Lettuce	107
				Fall Romaine Lettuce	41
				Wheat*	442
		$ 564,707.00	1,166	DC Soybeans	442
	360hrs constraint - Three 50Hp			Seedless Watermelon	12
	(season peaks)			Broccoli	23
				Fall Boston Lettuce	17
				Spring Romaine Lettuce	125
				Fall Romaine Lettuce	58
				Wheat*	493
		$ 585,202.24	1,221	DC Soybeans	493

* Winter wheat double-cropped with soybeans in any one year

c. Scenario 4: Revised Set of Resources

The results of the different resource variation scenarios point to some important adjustments that should be made to the initial assumptions of this analysis. Only at this point, after having gone through the process of discovering and addressing the restrictions imposed by resource scarcities, are we able to make such revisions. Indeed, more and more revisions are warranted as more information becomes available in the future and more site-specific data is incorporated. This revision regards the following points of each model:

Table 20 - Revised Set of Resources for each Representative Farm to Maximize Net Returns and Resource Utilization rates

Grain Farm – Scenario 4	**Veg. Farm – Scenario 4**
• 320hrs of labor available for each semi-monthly window. The working week is 40 hrs a week except for season peaks when the working week is assumed to be 60 hrs.	• 400hrs of labor available for each semi-monthly period. 40 hrs a week except for peak periods when the working week is assumed to be 60 hrs.
• No 50 Hp tractors are needed.	• Three 50 Hp tractors available
• Two 80 Hp tractors available.	• One 80 Hp tractor available
• Two 110 Hp tractors available.	• Two 110 Hp tractors.

Given these changes in assumptions (compared to assumptions presented in Table 11), the optimal solution for both representative farms will also change. Table 20 provides a comparison of the results for the representative Grain and Vegetable Farm scenarios based on the initial and revised set of resources. Net returns, after adjusting resource use schedules increased six times for the Grain Farm and more than doubled in the case of the Vegetable Farm operation. Also, total crop production acreage increased from 563 to 1,213 acres for the Grain Farm and from 527 to 1,031 acres for the Vegetable Farm.

Indeed, the effect of accounting for variable resource use schedules is quite dramatic. As stated earlier Appendix D includes detailed information on the results of both representative farms given this revised set of resources.

Table 21 - Comparison of the Results of Scenarios 2 and 4 for Each Representative Farm After Revising the Set of Resources; 700 Acres of Farmland Available.

	Scenarios	Net Return to Land, Management and Capital	Acreage of crops produced	Optimal crop combination	Acres per crop
Grain Farm	Scenario 2			Full season soybeans	229
				Wheat*	167
		$ 12,939.80	563	DC Soybeans*	167
	Scenario 4			Full season soybeans	47
				Wheat*	583
		$ 72,910.71	1,213	DC Soybeans*	583
Veg. Farm	Scenario 2			Seedless Watermelon	4
				Watermelon	45
				Fall Boston Lettuce	30
				Spring Romaine Lettuce	92
				Fall Romaine Lettuce	24
				Wheat*	167
		$ 436,991.68	527	DC Soybeans*	167
	Scenario 4			Seedless Watermelon	6
				Broccoli	27
				Fall Boston Lettuce	10
				Spring Romaine Lettuce	127
				Fall Romaine Lettuce	59
				Full season soybeans	136
				Wheat*	333
		$ 625,567.97	1,031	DC Soybeans*	333

* Winter wheat double-cropped with soybeans in any one year

3.2.3. Effects of Price Changes

The first section of this chapter discussed price variability over time. It defined the best strategy to analyze historical price data and presented some quantitative information on the price performance of several crops in the last five years. Depending on daily price quotes, the market window analysis defined a high, median and low price range for all crops. However, it fell short in evaluating competing alternatives and, given the price variability, estimating the robustness of the model's results. We now conduct a sensitivity analysis for each representative farm, using Scenario 4 at the average median price, and comparing those results to average high and low price changes. For some of the crops (wheat, soybeans, hayman potatoes, kenaf, watermelons and seedless watermelons) no historical price data was collected. In such cases, we considered a 15% increase or decrease in the price of the crop.[39]

Table 22 shows the impact of price variability on the results of each representative farm. The first and most important observation is that the models' results, in 5 out of 6 scenarios, do not change other than to increase or decrease net returns: a direct effect of the given price changes. This suggests that the profit maximizing crop mix is quite robust and it is unlikely to change when using both conservative or optimistic price estimates. There is one result that deserves special attention with regard to low price estimates in the Vegetable Farm case. Given conservative vegetable price estimates, hayman potatoes are selected as the main vegetable crop (200 acres) in the optimal farm plan. This result should be viewed with caution since it is based only on a projected 15% decrease in the price of hayman potatoes. Because the crop is new, it is necessary to conduct more research about the true price potential of this crop.

Conversely, the high and low price scenario lead to some significant changes in the bottom line of the farming operations represented in both models. The low price for Scenario 4 of the representative Grain Farm, for instance, reflects the impact of a 15% decrease in the price of the crop alternatives included in this model: soybeans, wheat and kenaf. The 15% price change for the crops included in the representative Grain Farm causes net returns to fall from $72,910.71 to $21,227.38. The potential for substantial decreases in net returns suggests that commodities such as wheat and soybeans, have small enough profit margins that even a 15% decrease in price can have large negative impacts. Alternatively, a 15% increase in the prices of all these commodities increases net returns by more than 40%. Given that wheat and soybean acreage is increasing in the region, the implication of these results is that the 15% higher price assumption (wheat $3.5 per bushel and soybeans $7 per

[39] In the absence of historical price data for these crops, we observe the effects of a 15% increase or decrease in the price of these commodities. This assumption is used in all the production budgets developed by specialists in the region when price data is not available and it is also used in this study whenever such circumstances arise. As experts of wheat and soybean commodity prices may point out, the high and low prices examined here do not reflect historical highs and lows. They are used to indicate possible fluctuations but do not attempt to capture the historical spread. As pointed out earlier, this assumption was made using production budget information and following their suggestions regarding such fluctuations.

bushel) is closer to what the farmers are getting for their product. On the other hand, these results confirm the fear of many people in the region that the soybean and wheat crop mix is highly affected by large price fluctuations and consequently, it could be unsustainable economically in the long run unless farmers diversify their crop production programs.

Table 22 - Impact of Price Variability on the Optimal Solution of both Representative Farms; 700 Acres of Farmland Available;

	Scenarios	Net Returns to Land, Management and Capital	Acreage of crops produced	Optimal crop combination	Acres per crop
Grain Farm - Scenario 4	Low Prices			Full season soybeans	47
				Wheat	583
		$ 21,227.38	1,213	DC Soybeans	583
	Median Prices			Full season soybeans	47
				Wheat	583
		$ 72,910.71	1,213	DC Soybeans	583
	High Prices			Full season soybeans	47
				Wheat	583
		$ 124,594.05	1,213	DC Soybeans	583
Veg. Farm - Scenario 4	Low Prices			Seedless Watermelon	9
				Hayman Potatoes	200
				Spring Romaine Lettuce	72
				Fall Romaine Lettuce	54
				Double cropped soybeans	294
		$ 305,454.28	924	Wheat	294
	Median Prices			Seedless Watermelon	6
				Broccoli	27
				Fall Boston Lettuce	10
				Spring Romaine Lettuce	127
				Fall Romaine Lettuce	59
				Full season soybeans	136
				Double-cropped soybeans	333
		$ 625,567.97	1,033	Wheat	333
	High Prices			Broccoli	39
				Seedless Watermelon	5
				Spring Romaine Lettuce	128
				Fall Romaine Lettuce	54
				Double-cropped soybeans	333
		$ 929,868.07	893	Wheat	333

* Winter wheat double-cropped with soybeans in any one year.

Price variation in the representative Vegetable Farm operation reflects changes in both net returns and the acreage of crops produced. It shows that vegetable production is superior to a soybean and wheat farming operation. The high profit margins offered by high value crops cushion the negative impact of low prices in other commodities. Compared to the low rate of return for the Grain Farm, a result of the 15% decrease in the price of wheat and soybeans, farmers in the representative Vegetable Farm could continue to grow these crops, acreage only fell from 333 acres to 294 acres, and still make more than $300,000. The existence of several vegetable alternatives facilitated this solution as shown by the inclusion of 200 acres of hayman potatoes while also providing a more diversified production structure.

In the end, the presentation and discussion of the results from the economic analysis leads to some important conclusions. First, the analysis confirms that vegetable production remains the most profitable agricultural activity on the Eastern Shore. However, the traditional vegetable crops of the region, such as cucumbers, snap beans and green bell peppers, failed to compete successfully with the new vegetable crops analyzed in this study. This result is not surprising, as the loss of profit margins in those crops over the years has resulted in a production shift from vegetable crops to wheat and soybeans. This suggests that farmers and agricultural specialists in the region would do well to consider the adoption of some of these new alternatives, notably lettuce, in order to boost from lagging profit margins of traditional vegetable production. This is even more significant in light of the results from the price variability. Even when farmers chose to assume conservative price estimates, they were able to cushion soybean and wheat losses with the high returns from vegetable production.

Wheat and soybean farms may have more flexibility in terms of anticipating fluctuations in the market via hedging operations. However, the overall profitability of their farms is much lower than that of vegetable farms. Indeed, many farmers may chose this option because they are familiar with the production processes and marketing requirements. Entrepreneurial farmers, however, will accept some of the increased risk in vegetable production and strive to capture higher profit potential.

Second, the results of this analysis show that vegetable production also demands a large and extensive resource base. The most profitable farm plan would achieve full specialization in vegetable production. Unfortunately, this plan is unlikely to be implemented on the Eastern Shore because it requires a sevenfold increase in the intensity of resource use. The most likely strategy would be to produce vegetables in combination with wheat and soybeans. This strategy generates high net returns and effectively utilizes well the labor and machinery resources. Third and closely related to the second point, higher resources utilization rates should be used during crucial production times. This reflects the realities of agricultural production and also removes some of the bottlenecks that are artificially created by some of initial modeling assumptions, such as 40-hour working weeks for labor and machinery. Farmers need to make their individual determination with regard to resource use schedules. This determination will eventually shape the optimal production mix offered by the model.

3.3 Environmental Impact Analysis

The analysis will now focus on the environmental impacts of Scenario 4 for each representative farm. The economic analysis offered important insights on the crop mix that maximized returns on available resources. However, before proceeding to adopt the suggestions of that analysis, it is necessary to ask one very important question: Will the new crop alternatives have such negative impacts on natural resources as to erode the short-term benefits of their adoption. The PLANETOR computer program was used to analyze the potential negative environmental effects of growing a particular crop mix. The previous chapter outlined the different models incorporated in this computer program, its capabilities, as well as some of its shortcomings. It should be re-emphasized that the results presented here are only estimates at best, based on what is scientifically known about the interaction of chemicals, crop practices, climate, and soil composition. While empirical on-site observations would greatly improve the accuracy of these results, such an undertaking was beyond the scope of this project. PLANETOR, for all practical purposes, is a simpler and more feasible approach. We proceed to evaluate six environmental factors[40] as well as analyze the effect of including of Kenaf in the optimal solution – Kenaf being one of the alternative crops which was hypothesized to have the best potential for economic and environmental improvement in the region,. After considering the results of this analysis, we continue to argue that:

[40] The previous sections showed that this scenario maximizes profits while at the same time it makes the best use of the resources available. From this point forward, we will only refer to the results of this scenario for both repesentative farm models.

- The profits from vegetable production more than offset its negative impacts on soil erosion

- Pesticide leaching and runoff from wheat and soybean production poses greater health hazards in terms of the toxicity of those chemicals with high potential to impact surface and ground water

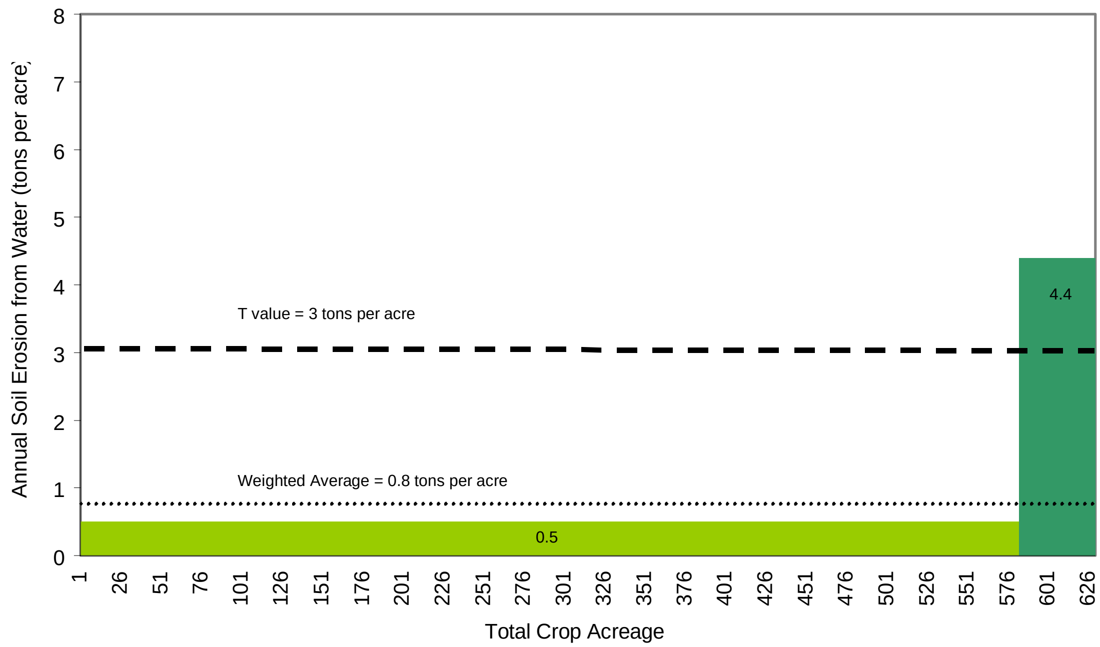
- None of the crop alternatives considered here is a magic bullet that will dramatically improve the economic and environmental record of agricultural production on the Eastern Shore. However, vegetable crops may offer the necessary profit margins to allow the adoption of more environmentally friendly alternatives.

3.3.1. Annual Soil Erosion from Water

The goal of the analysis of potential soil losses from water is to compare the computed soil loss under Scenario 4 of each representative farm with the soil loss tolerance value (T). The Natural Resource Conservation Service has determined the T values, an acceptable soil loss of 3 tons per acre, for this area. Erosion is not a problem as long as soil losses are below the T values. Figure 4 and 5[41] gives a comprehensive summary of the results of the soil erosion analysis. The annual soil erosion for a crop mix of wheat and soybeans is 0.5 tons per acre on 583 acres of wheat double-cropped soybeans and 4.4 tons per acre on the 47 acres of full season soybeans. While 4.4 tons per acre is moderate, the weighted average soil loss on the entire 630 acres is only 0.8 tons per acre. In Model 2, all vegetable crops have soil erosion levels above the T value. However, the inclusion of wheat and soybeans in the general crop mix lowers the weighted average on 630 acres to 2.63 tons per acre, below the 3.0 T-value limit. Given that the farmer will rotate this crop mix on the entire farmland, the above results suggests that soil erosion is at relatively tolerable levels.

The above results offer some interesting insights. From the environmental point of view, the results from the Grain Farm scenario (Figure 4) could be viewed as the most desirable. It offers a crop mix that utilizes the entire farmland available while at the same time having very low soil losses. Indeed, the soil erosion values for such Grain Farm seem to be

[41] Figure 4, and others presented in the rest of the section, includes only the acreage that is in crop production it does not consider land that is not currently in production (be this fallow or in a cover crop). At this point, PLANETOR developers are working to allow the program to calculate the environmental impact of circumstances in which land is not in production.

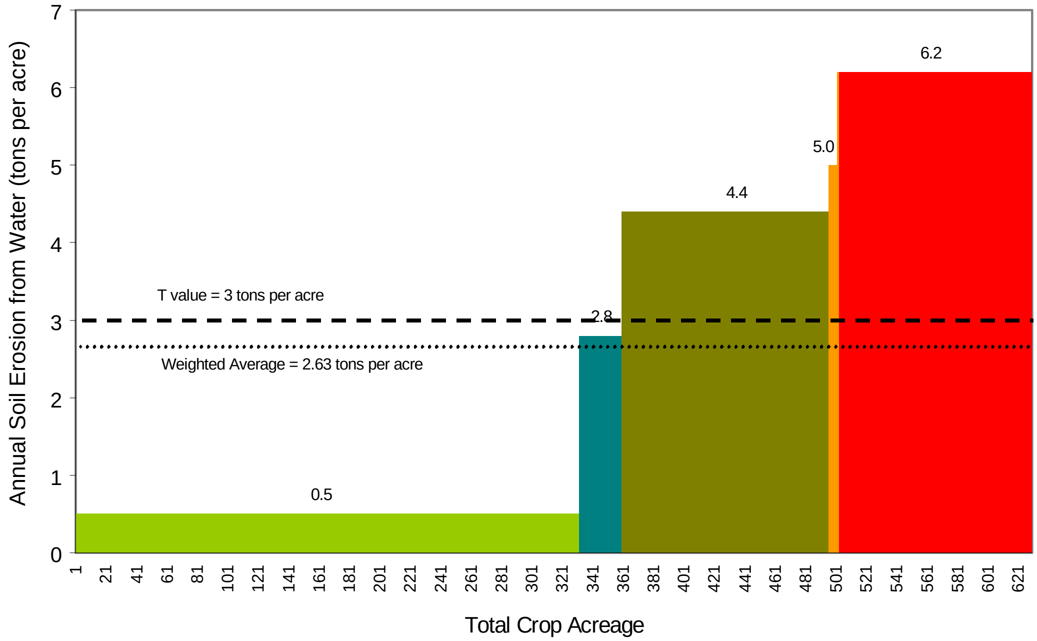


Crops	Acres	Annual Soil Erosion	Tolerable Soil Erosion	Annual Excess Erosion
Winter Wheat/DC Soybeans	583	0.5	3.0	-2.4
Full season Soybeans	47	4.4	3.0	1.4

Figure 4 - Soil Erosion Impact of Scenario 4 for a representative Grain Farm, 630 acres in Direct Crop Production

representative of the current agricultural production trends on the Eastern Shore.[42] Should we conclude that, if soil erosion is an important indicator of environmental sustainability, and that wheat and soybean farmers in the region are moving more and more in the right direction? That conclusion would be at best misleading and also incorrect. The vegetable crops that are included in the Scenario 4 of the representative Vegetable Farm may increase the potential for soil loss but the overall impact, assuming these crops are rotated appropriately, is still tolerable. Potential income, on the other hand, would increase almost eight times from about $72,000 to $625,000. The final decision must rest with the farmers

[42] Wheat production in Accomack increased from 465,438 bushels in 1987 to 1,140,115 bushels in 1992 (the last census data) while soybean production grew from 736,389 bushels to 1,513,282 bushels. Similarly, wheat and soybeans produced in Northampton county grew from 454,358 bushels and 334,606 bushels to 769,562 bushels and 777,091 bushels, respectively. (Census of Agriculture, 1992.)



Crops	Acres	Annual Soil Erosion	Tolerable Soil Erosion	Annual Excess Erosion
Wheat/DC Soybeans	333	0.5	3.0	-2.5
Broccoli	27	2.8	3.0	0.0
Full season soybeans	136	4.4	3.0	1.4
Seedless Watermelon	6	5.0	3.0	2.0
Spring Romaine Lettuce	127	6.2	3.0	3.2
*Fall Boston Lettuce (dblcrop)	10	6.2	3.0	3.2
*Fall Romaine Lettuce (dblcrop)	59	6.2	3.0	3.2

*Following spring planting of lettuce

Figure 5 - Soil Erosion Impact of Scenario 4 for a representativeVeg. Farm, 630 acres in Direct Crop Production

and other concerned citizens living in the region. However we need to ask whether the reduction in soil erosion may justify such drastic potential loses in income? Indeed, this might be too high a price to pay, given the incomplete information offered by the literature available on the subject.[43]

[43] The scientific literature accompanying the RUSLE computer model as well as the PLANETOR computer program offers no precise way of translating the amount of excess annual soil erosion into some monetary measure of the rate of depreciation of land. See RUSLE: User's guide, 1993

These results support two important conclusions. First, they show that, although larger erosion levels accompany vegetable production, the new alternatives can be successfully combined with other crops to produce a crop mix that has tolerable soil losses. Second, the soil erosion levels for vegetable production may not be high enough to justify activities that are less and less economically sustainable, such as wheat and soybeans. A combination of both could probably provide the best of both worlds.

Finally, soil erosion caused by water is only part of the overall soil erosion problem. The Eastern Shore, due to its geographic location, is also susceptible to the effects of wind erosion. Unfortunately, this factor could not be included in this analysis due to lack of data. It is expected that this information will become available soon and future work needs to address this issue.

3.3.2. Potential Chemical and Nutrient Leaching or Runoff

Modern agricultural production often depends on the use of chemicals as crop nutrients or management tools for fighting crop diseases and pests. Over the years, the rapid growth in their use has contributed to higher yields and better quality products. However, research (Kellogg, *et al.*, 1994) has shown that the potential for these chemicals to infiltrate in the ground water or be lost to surface waters via runoff is real and needs to be addressed. In this section, we will focus on the potential pesticide, nitrate and phosphorous leaching and runoff of Scenario 4 of the two representative farms developed earlier in this chapter.[44] This analysis should, nevertheless, be considered a guide to the effect of current crop practices and no attempt is made to provide quantitative information regarding the discharges of such chemicals in the regions water resources.

[44] Chapter Two describes the screening level model that PLANETOR uses to determine relative leaching and runoff potential of pesticides used in both models. Appendix E provides the detailed information included in PLANETOR databases as well as changes made to it.

a. Pesticide Leaching and Runoff

There are two ways of looking at the potential pesticide leaching and runoff from the crops grown in the representative Grain and Vegetable Farms. Table 23 presents detailed information for all pesticide applications and ranks them for potential leaching and runoff. It is difficult to discern the relative impacts of vegetable and wheat and soybean production with respect to these environmental factors by a cursory review of this table. They all use a large number of chemicals and many of them have a high potential to leave the field and enter the ground or surface waters. By focusing on the relative toxicity of the chemicals with a high potential for leaching and runoff, we get a much more revealing picture.

The main difference between the two farm models studied here is the inclusion of 200 acres of vegetable production. In the previous section, we pointed out that this production strategy had enormous economic impacts on expected net returns while at the same time maintaining soil losses at tolerable levels. Figure 6, on the other hand, compares the propensity for pesticide leaching and runoff in both models. We compare 200 acres of vegetable production for Scenario 4 of the representative Vegetable Farm to 200 acres of wheat and soybeans in Scenario 4 of the Grain Farm, everything else being equal, in order to observe the levels of pollution and polluting elements of both cropping systems. The results indicate that wheat and soybean production has the most potential to discharge chemicals that are highly toxic and which pose great health hazards. Most of the chemicals used in the cultivation of wheat and soybeans were either of moderate or high toxicity. Vegetable production, on the other hand, used mostly pesticides of low toxicity.

As indicated in Table 23, data is lacking for some pesticide applications. This suggests that the work on modeling of environmental effects from agricultural production will be an ongoing process as new chemicals are introduced. Given current information, however, this analysis helps both farmers and specialists in the region to evaluate the potential negative impact of pesticide leaching and runoff. Appendix E includes specific technical information regarding the calculation of these two factors by the PLANETOR program. This information is invaluable in guiding any future efforts to modify this analysis and find ways of reducing the negative impacts that come from chemical use.

Table 23 - Potential for Pesticide Leaching and Runoff in Scenario 4 for the representative Grain and Vegetable Farm, 630 Acres in Direct Crop Production.[45]

	Crops	Acreage	Pesticide Leaching			Pesticide Runoff			Pesticide Toxicity	
			Chemical	Index Value	Rating	Chemical	Index Value	Rating	Chemical	Rating
Scenario 4 Grain Farm	Wheat & Soybeans	630 acres	Blazer	994	H	Pounce 3.2 E.C	1000	H	Blazer	H
			2,4-D amine	981	H	Asana XL	1000	H	2, 4-D Amine	H
			Dual	971	H	Dual	998	H	Dual	M
			Bayleton	38	L	2, 4-D Amine	444	M	Asana XL	M
			Pounce 3.2 E.C	1	L	Bayleton	1	L	Bayleton	L
			Asana XL	No data		Blazer	1	L	Pounce 3.2 EC	L
Scenario 4 Vegetable Farm	Sdless Watermelon	6 acres	Prefar 4 - E	1000	H	Prefar 4 - E	1000	H	Alanap - L	M
			Bravo 720	987	H	Bravo 720	987	H	Bravo 720	M
			Alanap - L	982	H	Alanap - L	982	H	Prefar 4 - E	L
			Bravo 720	847	M	Bravo 720	847	M		
			Bravo 720	744	M	Bravo 720	744	M		
	Broccoli	27 acres	Bravo 720	992	H	Pounce 3.2EC	1000	H	Lannate LV	H
			Lannate LV	920	H	Pounce 3.2EC	1000	H	Bravo 720	M
			Treflan 5	893	H	Treflan 5	1000	H	Treflan 5	L
			Lannate LV	840	M	Bravo 720	1000	H	Pounce 3.2EC	L
			Devrinol 10-G	1	L	Lannate LV	973	H	Devrinol 10-G	L
			Pounce 3.2EC	1	L	Lannate LV	946	H		
						Devrinol 10-G	887	H		
	Fall Boston Lettuce	10 acres	Kerb 50-W	983	H	Kerb 50-W	925	H	Kerb 50-W	L
			Rovral	No Data		Rovral	No Data		Rovral	L
			Pounce 3.2 EC	No Data		Pounce 3.2 EC	23	L	Pounce 3.2 EC	L
	Spr. Romaine Lettuce	127 acres	Kerb 50-W	983	H	Pounce 3.2 EC	1000	H	Pounce 3.2 EC	L
			Rovral	500	M	Rovral	954	H	Rovral	L
			Pounce 3.2 EC	1	L	Kerb 50-W	925	H	Kerb 50-W	L
	Fall Romaine Lettuce	59 acres	Kerb 50-W	983	H	Kerb 50-W	925	H	Kerb 50-W	L
			Rovral	No Data		Rovral	No Data		Rovral	L
			Pounce 3.2 EC	No Data		Pounce 3.2 EC	23	L	Pounce 3.2 EC	L
	Soybeans (Full Season)	136 acres	Dual	996	H	Pounce 3.2 EC	1000	H	Blazer	H
			Blazer	994	H	Dual	999	H	Dual	M
			Pounce 3.2 EC	1	L	Blazer	1	L	Pounce 3.2 EC	L
	Wheat & Soybeans	333 acres	Blazer	994	H	Pounce 3.2 E.C	1000	H	Blazer	H
			2,4-D amine	981	H	Asana XL	1000	H	2, 4-D Amine	H
			Dual	971	H	Dual	998	H	Dual	M
			Bayleton	38	L	2, 4-D Amine	444	M	Asana XL	M
			Pounce 3.2 E.C	1	L	Bayleton	1	L	Bayleton	L
			Asana XL	No data		Blazer	1	L	Pounce 3.2 EC	L

In conclusion, the analysis of potential pesticide leaching and runoff shows that many of the chemicals used locally may contaminate both ground and surface waters. We conclude that wheat and soybean production is more likely to pollute toxic chemicals that are deadly to

[45] The relative leaching and runoff index has a range of 1 to 1000, where the higher the index value, the larger the potential for a problem. The index ranges, as recommended by developers of PLANETOR, for low, medium, and high potential for leaching and runoff are: Low 1 – 350 (low), Medium 350 – 850 , and- High 850 – 1000.

humans (high toxicity). Figure 6 illustrates this conclusion by showing both the level of and toxic category of chemicals used in each representative farm level. The comparison is based on the information presented in Table 23. Data for a given pesticide is a weighed sum of its applications on crop produced in each representative farm. The index that was developed reflects this approach and allows us to make a relatively good comparison of both cropping systems.

The results of this analysis should be used as a guide to improvement of current practices. It is up to the individual farmer to decide on the strategy of his or her farm. We suggest, however, that the introduction of new crops, such as lettuce and watermelons, provides both economic and environmental incentives for a more sustainable future.

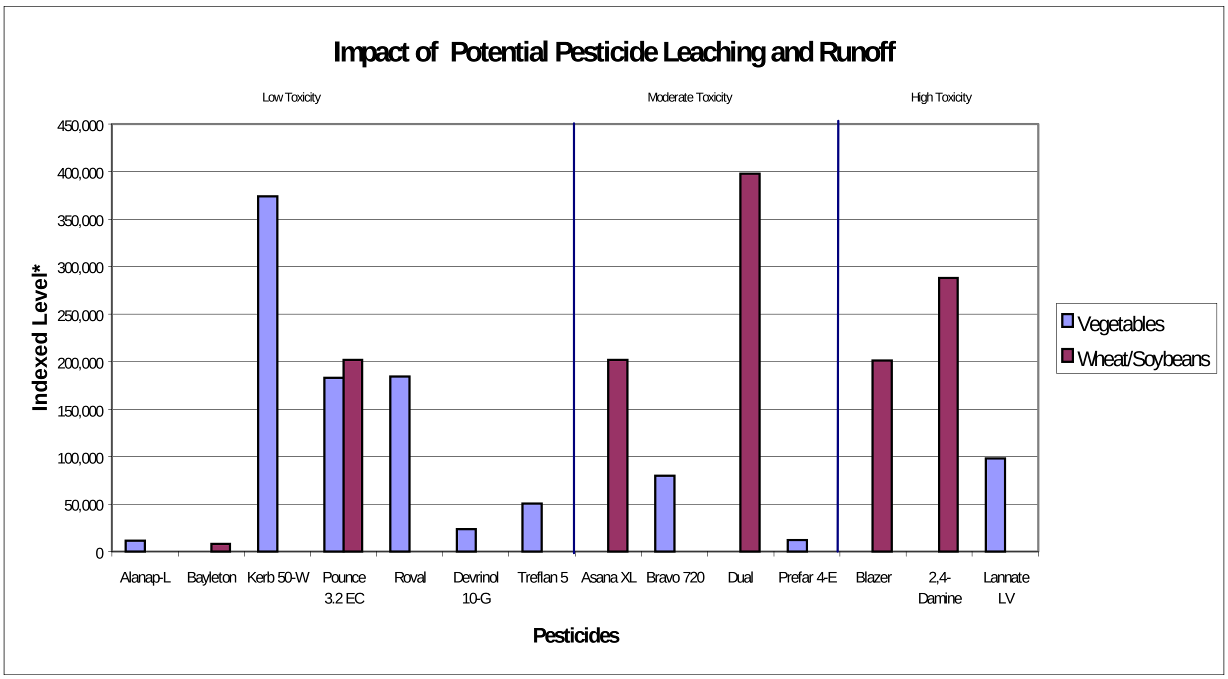


Figure 6 - Potential Leaching and Runoff Hazards from Vegetable and Wheat/Soybean Production

b. Nitrate Leaching and Phosphorus Runoff

The results of the nitrate leaching and phosphorous runoff analysis (Table 24) suggest the potentially high negative impact of vegetable production with respect to these two factors. Although the results show a medium ranking for the vegetables recommended by Scenario 4 of Model 2, caution is warranted as the NL (nitrogen leached) values are very close to the high ranking cutoff value 120 pounds per acre per year.[46] The spring romaine lettuce NL value, for instance, indicates that 115 lb/acre/year of nitrate-N was moved out of the root zone. Measures could be taken to reduce NL values such as performing periodic soil tests in order to provide better nitrogen management to the crop.

Table 24 – Pounds per Acre per Year of Nitrate Leaching and Phosphorous Runoff Potential for Scenario 4 of the respresentative Grain and Vegetable Farm.

	Crops	Acreage	Nitrate Leaching			Phosphorus Runoff
Scenario 4 Grain Farm			NAL	NL	Rating	Rating
	Wheat & Soybeans	630 acres	14 lbs	14 lbs	L	L
Scenario 4 Veg. Farm	Sdless Watermelon	6 acres	No Data on Watermelons			
	Fall Boston Lettuce	10 acres	116 lbs	112 lbs	M	M
	Spr. Romaine Lettuce	127 acres	118 lbs	115 lbs	M	M
	Fall Romaine Lettuce	59 acres	116 lbs	112 lbs	M	M
	Broccoli	27 acres	107 lbs	106 lbs	M	M
	Soybeans (Full Season)	136 acres	28 lbs	21 lbs	L	L
	Wheat & Soybeans	333 acres	14 lbs	14 lbs	L	L

If nitrogen inputs are balanced with crop needs, then consideration should be given to applying nitrogen close to the time of crop demand or time of maximum nitrogen uptake by the crop, although this could increase production costs. The results presented here are preliminary. They only reflect the impact of producing the given crops based on our assumptions regarding their cultivation.[47] Specialists in the region could easily change many of the assumptions and site specific information and test for specific practices and conditions.

[46] See the PLANETOR information in Appendix E.

[47] The last section of Chapter Two outlines these assumptions and suggests areas where more detailed information is warranted.

3.4 Analyzing the Potential Profitability and Environmental Impacts of Kenaf

Many of the vegetable crops analyzed in this study are either new to Eastern Shore farmers or represent a very small portion of vegetable production in the region. The objective of the analysis has been to evaluate the economic and environmental impacts of their cultivation with typical resource constraints and competition from traditional crops.

This section will focus on the reasons that Kenaf, a new crop alternative, was not a feasible alternative for producers in the region. We conduct this analysis for some important reasons. First of all, many new crops are often offered to producers as alternative ways for diversification, improved profits, and/or environmental protection. Often, however, little though is given to how well such crops can fit in the overall production structure of the region and it is assumed that because it is not traditional the crop must certainly be better. This may not always be the case and Kenaf production is illustrative of this fact.

In order to understand what is necessary to make Kenaf an economically feasible crop, we evaluated three important variables:

- An increase in price.
- An increase in yield.
- A decrease in the transportation costs.

The results of these changes, continuing to use Scenario 4 of each representative farm, are summarized in Tables 25 and 26. Kenaf enters in the optimal solution of both models if we could institute the following changes:

1. Kenaf enters first in the optimal solution of the representative Grain Farm (Table 25) when its price increases to $120 per ton. This represents an increase of 42 percent in the price of Kenaf from the $75 per ton assumption that is used in either farm model. For the representative Vegetable Farm, the price of Kenaf has to increase to $100 in order to grow 200 acres of the crop (Table 26). Net returns for the Grain Farm, however, increase only 13.5 percent, from $72,910 to $102,110. The inclusion of 200 acres of Kenaf in the production schedule of the Vegetable Farm is much less significant. At $100 per ton of Kenaf, net returns increase by only 1 percent.

Table 25 - Impact of Changes in the Price, Yield and Transportation Cost of Kenaf on the Profit Maximizing Solution. Scenario 4 of the Representative Grain Farm [48]

	Scenarios**	Net Returns to Land, Management and Capital	Acreage of crops produced	Optimal crop combination	Acres per crop
Scenario 4	Kenaf assumptions:			Full season soybeans	47
Grain Farm	Price - $75/ton			Wheat*	583
	Yield - 5 ton/acre	$ 72,910.71	1,213	DC Soybeans*	583
	Transportation - 150 miles				
Variable Prices	Kenaf Price at $110/ton			Kenaf	47
				Wheat*	583
		$ 86,160.00	1,213	DC Soybeans*	583
	Kenaf Price at $120/ton			Kenaf	200
				Wheat*	430
		$ 102,110.95	1,060	DC Soybeans*	430
Variable Yields	Kenaf Yield at 8 tons/acre	$ 94,109.71	1,060	Kenaf	200
				Wheat*	430
				DC Soybeans*	430
Transportation Cost	Transportation - 50 miles	$ 106,115.23	1,060	Kenaf	200
				Wheat*	430
				DC Soybeans*	430

* Winter wheat double-cropped with soybeans in any given year

** Results for changes when Kenaf enters the optimal solution

2. The yield of the Kenaf crop needs to increase from 5 tons per acre to 8 tons per acre in the first model (Table 25) and to 7 tons per acre in the second. This change increases net returns by 24 per cent for the Grain Farm and 9 per cent for the Vegetable Farm (Table 26).

3. Kenaf enters the optimal solution if the transportation distance is cut from 150 miles to 50 miles, in both models. Given that the cost of transporting a trailer load of Kenaf is calculated at $2 per loaded mile, transportation costs fall from $300 (destination assumed 150 miles away) to $100 (destination only 50 miles away). [49] This change has a more pronounced effect than the previous changes, as it results in a 33 percent increase of net

[48] Kenaf acreage was constrained at 200 acres for rotation purposes. This decision was prompted by many studies that document the crop's tendency to develop root-knot nematodes when crop rotations are not employed. See Lawrence (1989) in Goforth and Fuller (1994): 13

returns for the Grain Farm (Table 25) and a 12 per cent increase of returns for the Vegetable Farm (Table 26).

The price, yield, or transportation cost requirements to include Kenaf in the models' profit maximizing solution poses a number of problems. The most difficult to overcome is the increase of average yield from 5 tons per acre to 7 or 8 tons per acre. Agronomic research (Kurtz 1996, Hovermale 1995, 1994, 1993, Hallmark*, et al.* 1994) demonstrated that yields of 7 or 8 tons per acre are difficult to achieve. Such yields become even harder to attain considering the farmers' inexperience with its cultivation. Finally, most of the data on Kenaf yields is provided via experiments conducted at experiment stations in the Deep South. Realizing that farmers are unlikely to replicate the results achieved by controlled experiments, it is prudent to assume even lower yields. Hence, the assumption of economic feasibility based on higher yield expectations would be difficult at best.

Kenaf price and its transportation costs are analyzed separately. The rationale for this separation is the same as that discussed at great length in the market window analysis for vegetable crops. However, this separation is more significant in the case of Kenaf. First, there is no organized market for Kenaf. Economic feasibility studies (Zhang & Dicks, 1992) suggest that the most feasible way to sell Kenaf is through processor forward contract agreements. Each contract would therefore have built-in specific conditions relating to price and transportation agreements.

At the beginning of this study, some of the farmers on the Eastern Shore entered into negotiations with a Kenaf processing company. A copy of this contract is presented in Appendix G. The contract specifies that farmers will receive $75 per dry ton delivered to the processor. Furthermore, they will also receive $25 per ton towards their harvesting and storage costs. This increases the price that farmers receive to $100 per dry ton, which makes it economically feasible even when transportation costs are estimated at $2 a loaded mile (see previous page). Considering that the contract also offered to subsidize transportation costs by almost 50 percent, the agreement seemed quite attractive.

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[49] Because of its lightness (the dry product has 0% moisture), a 40,000 pound capacity trailer would be able to carry between 10,000 –15,000 pounds of Kenaf. Given yields of 5 tons per acre, the per acre transportation cost is between $210 to $300 per acre.

Table 26 - Impact of Changes in Price, Yield and Transportation Cost of Kenaf on the Profit Maximizing Solution. Scenario 4 for the RepresentativeVegetable Farm.

	Scenarios		Net Returns to Land, Management and Capital	Acreage of crops produced	Optimal crop combination	Acres per crop
Scenario 4	Kenaf assumptions:				Seedless Watermelon	6
Grain Farm	Price - $75 per ton				Broccoli	27
	Yield - 5 tons per acre				Fall Boston Lettuce	10
	Transportation - 150 miles				Spring Romaine Lettuce	127
					Fall Romaine Lettuce	59
					Full season soybeans	136
					Wheat*	333
		$	625,567.97	1033	DC Soybeans*	333
Variable Prices	Kenaf Price at $100 per ton				Kenaf	200
					Hayman Potatoes	36
					Seedless Watermelon	8
					Broccoli	17
					Fall Boston Lettuce	26
					Spring Romaine Lettuce	117
					Fall Romaine Lettuce	57
					Wheat*	269
		$	686,734.71	1000	DC Soybeans*	269
Variable Yields					Kenaf	200
					Hayman Potatoes	36
					Seedless Watermelon	8
					Broccoli	17
					Fall Boston Lettuce	26
					Spring Romaine Lettuce	117
					Fall Romaine Lettuce	57
					Wheat*	269
	Kenaf Yield at 7 tons/acre	$	684,732.00	1000	DC Soybeans*	269
Transportation Cost	Transportation at 50 Miles				Kenaf	200
					Hayman Potatoes	36
					Seedless Watermelon	8
					Broccoli	17
					Fall Boston Lettuce	26
					Spring Romaine Lettuce	117
					Fall Romaine Lettuce	57
					Wheat*	269
		$	710,734.71	1000	DC Soybeans*	269

* Winter wheat double-cropped with soybeans on every acre in any given year

The contract has not yet been implemented. The processor was unable to reimburse farmers $25 per ton in harvest costs as well as the 50% transportation subsidy. This is reflected in the present production budget for Kenaf that now assumes only a price of $75 per ton and it charges full transportation costs at $2 per loaded mile for the 150 miles that it is necessary to move the product to the processing facility.

The relationship between processors and potential Kenaf growers has deteriorated over the last year. Farmers are fearful of the dangers inherent in dealing with a single buyer and they suspect that they will be used by processors until the latter establish themselves in the market and develop more profitable partnerships with raw product supply sources closer to their plant.[50] Farmers realize that there is nothing to prevent the processing company from changing the terms of the contract or even discontinuing their activity on the Eastern Shore altogether. On the other hand, the processors are quite suspicious that the farmers are only using their company as a risk minimization tool to field test the economic feasibility of the crop. They fear that once the farmers gain some experience and expertise in growing Kenaf they will seek to built their own processing plant given the simplicity of the technology required.[51]

The feasibility analysis for Kenaf illustrates some of the problems in introducing a new crop alternative. In this section we only focused on three potential barriers to the production of Kenaf: prices, yield and transportation costs. However, other issues may pose difficulties. A case in point is as the acquisition of specific machinery for harvesting the product. The production budgets assume a lump-sum custom harvesting cost of $35 per acre. This assumption may be valid if an individual farmer could rent the machinery. Production costs would be much higher, however, if farmers had to purchase specialized equipment to harvest 200 acres especially considering the fact that it cannot be used for harvesting either wheat or soybeans.

As it has been demonstrated, it is not economically feasible to ship the product over a long distance. The Eastern Shore is at a significant disadvantage in this regard. Because of its geographic location growers face the risk of dealing with monopsonistic partners or building

[50] Information provided by discussions with specialists involved in the negotiations between Eastern Shore farmers and Kenaf processors in Delaware.

[51] This idea has been raised by some of the farmers interested in growing Kenaf on the Eastern Shore. Source of information same as above.

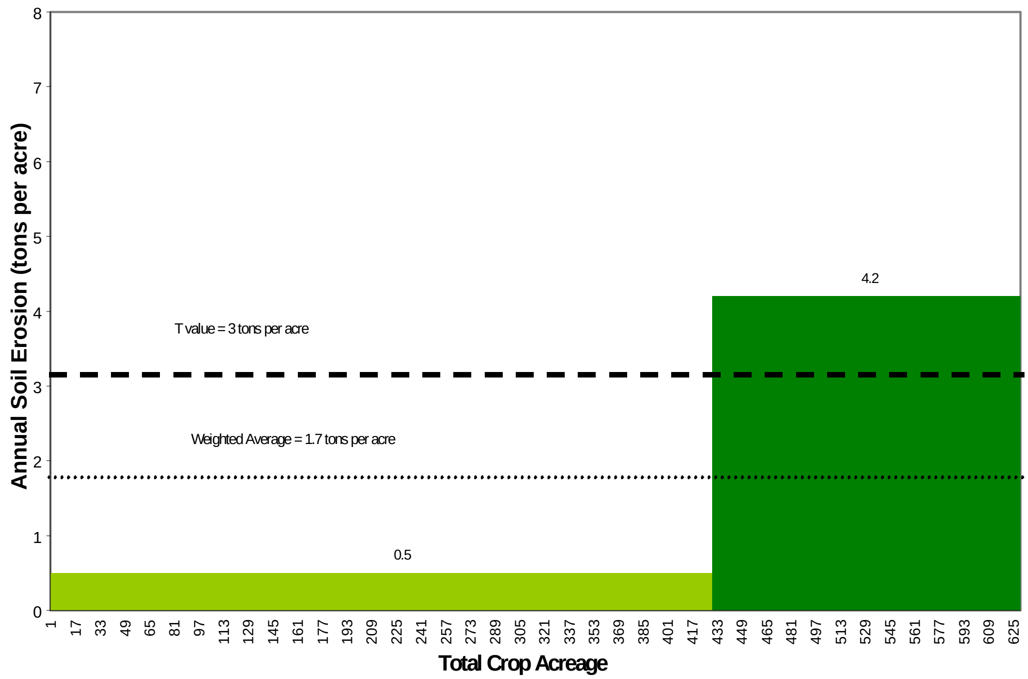
the needed infrastructure. Having a processing plant on the Eastern Shore would greatly reduce transportation costs, at or below the 50-mile constraint discussed above. The investment, however, would only shift the marketing problems from the farmers to the Kenaf processors. They would now have to deal with the few paper mills using Kenaf and it is not clear whether the processing activity offers enough value-added to the profit margins to make the entire operation economically feasible. The region, on its part, has neither the land or water resources to accommodate a paper mill. Given these barriers, Kenaf appears to have no short-term potential as a new crop that could be grown on the Eastern Shore.

Nonetheless, one final question needs to be addressed. Does Kenaf offer sufficient environmental benefits to warrant research into eliminating the barriers discussed above? Our conclusion, based on the environmental analysis discussed below, is that Kenaf offers only marginal environmental improvements, mainly because it uses fewer pesticides, over the wheat and soybean crops that it competes with. The following analysis uses the same approach as the previous section.

Figure 7 shows the effect of 200 acres of Kenaf in the optimal solution of Scenario 4 of the representative Grain Farm. Net returns under this scenario fall by almost 30 per cent, while weighted average of soil erosion in 630 acres increases from 0.8 tons per acre to 1.7 tons per acre. With such results, it is clear that Kenaf, fails to provide the economic or environmental incentives to justify its adoption in a wheat and soybean operation.

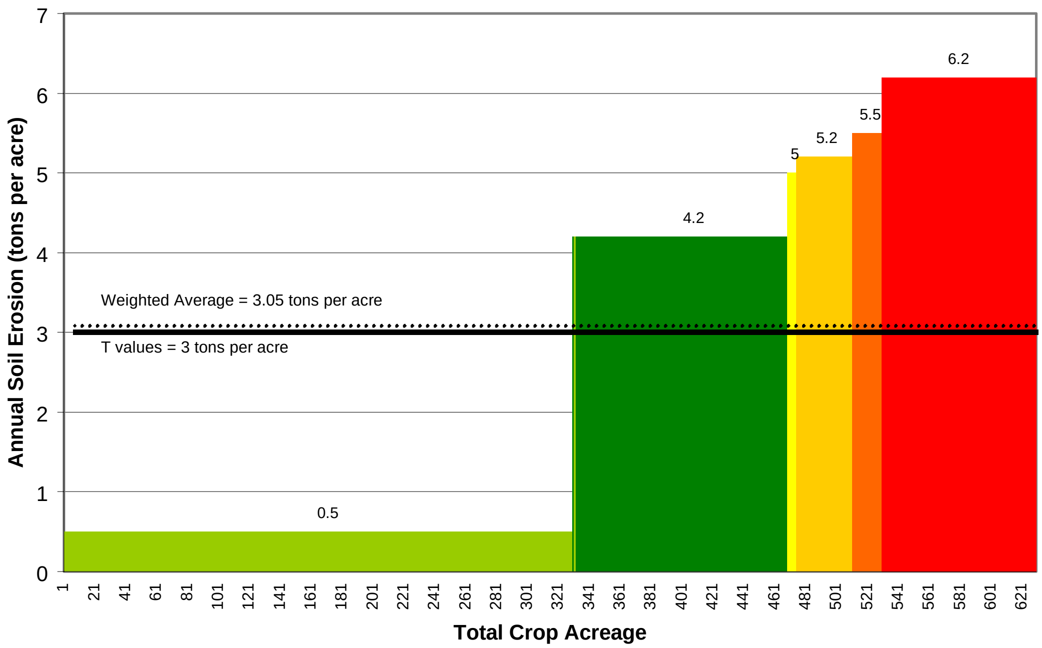
Including Kenaf in Scenario 4 of the Vegetable Farm, also, yields similar results. The weighted average of soil erosion for 630 acres is 3.05 tons per acre, higher than the results for this model (Figure 4) when Kenaf was not included. Net returns also decrease from about $625,000 to $530,000.

Kenaf could provide some relief in terms of potential pesticide leaching and runoff as compared to wheat and soybeans. Table 27 illustrates this point for both models, showing that Kenaf uses only one pesticide of moderate toxicity during the growing season compared to five pesticides used in growing the wheat and soybean crops that it replaces in either model.



Crops	Acres	Annual Soil Erosion	Tolerable Soil Erosion	Annual Excess Erosion
Kenaf	200	4.2	3.0	1.2
Wheat/DC soybeans	430	0.5	3.0	-2.5

Figure 7 - Soil Erosion Impacts of including 200 acres of Kenaf in the Optimal Solution of the Grain Farm. Net returns $16,271.12.



Crops	Acres	Annual Soil Erosion	Tolerable Soil Erosion	Annual Excess Erosion
Seedless Watermelon	8	5.0	3.0	2.0
Kenaf	200	4.2	3.0	1.2
***Broccoli**	17	5.5	3.0	2.5
Hayman Potatoes	36	5.2	3.0	2.2
Spring Romaine Lettuce	117	6.2	3.0	3.2
***Fall Boston Lettuce (dblcrop)**	26	6.2	3.0	3.2
***Fall Romaine Lettuce (dblcrop)**	57	6.2	3.0	3.2
Wheat/DC Soybeans	269	0.5	3.0	-2.5

Figure 8 - Soil Erosion Impacts of Including 200 acres of Kenaf in the Optimal Solution of the Veg. Farm. Net returns $568,893.60

Figure 9 illustrates this graphically by showing the large reduction in the amount of pesticides by cultivating Kenaf in place of wheat and soybeans and comparing it to vegetable production for the same acreage.

Table 27 - Pesticide Leaching and Runoff Potential After Including Kenaf in the Optimal Solution of Scenario 4 for both Representative Farms.

	Crops	Acreage	Pesticide Leaching			Pesticide Runoff			Pesticide Toxicit
			Chemical	Index Value	Rating	Chemical	Index Value	Rating	Chemical
Grain	**Wheat & Soybeans**	430	Blazer	994	H	Pounce 3.2 E.C	1000	H	Blazer
			2,4-D amine	981	H	Asana XL	1000	H	2, 4-D Amine
			Dual	971	H	Dual	998	H	Dual
			Bayleton	38	L	2, 4-D Amine	444	M	Asana XL
			Pounce 3.2 E.C	1	L	Bayleton	1	L	Bayleton
			Asana XL	No data		Blazer	1	L	Pounce 3.2 EC
	Kenaf	200	Command 4	941	H	Command 4	1	L	Command 4
Veg.	**Kenaf**	200 acres	Command 4	941	H	Command 4	1	L	Command 4
	Sdless Watermelon	8 acres	Prefar 4 - E	1000	H	Prefar 4 - E	1000	H	Alanap - L
			Bravo 720	987	H	Bravo 720	987	H	Bravo 720
			Alanap - L	982	H	Alanap - L	982	H	Prefar 4 - E
			Bravo 720	847	M	Bravo 720	847	M	
			Bravo 720	744	M	Bravo 720	744	M	
	Hayman Potatoes	36 acres	Monitor	1000	H	Dual	999	H	Monitor
			Dual	997	H		34	L	Dual
				No data	-	Monitor	No data	-	
			Penncozeb	No data	-	Penncozeb	No data	-	Penncozeb
			Sencor DF	No data	-	Sencor DF	No data	-	Sencor DF
	Fall Boston Lettuce	25 acres	Kerb 50-W	983	H	Kerb 50-W	925	H	Kerb 50-W
			Rovral	No Data		Rovral	No Data		Rovral
			Pounce 3.2 EC	No Data		Pounce 3.2 EC	23	L	Pounce 3.2 EC
	Spr. Romaine Lettuce	117 acres	Kerb 50-W	983	H	Pounce 3.2 EC	1000	H	Pounce 3.2 EC
			Rovral	500	M	Rovral	954	H	Rovral
			Pounce 3.2 EC	1	L	Kerb 50-W	925	H	Kerb 50-W
	Fall Romaine Lettuce	57 acres	Kerb 50-W	983	H	Kerb 50-W	925	H	Kerb 50-W
			Rovral	No Data		Rovral	No Data		Rovral
			Pounce 3.2 EC	No Data		Pounce 3.2 EC	23	L	Pounce 3.2 EC
	Wheat & Soybeans	269 acres	Blazer	994	H	Pounce 3.2 E.C	1000	H	Blazer
			2,4-D amine	981	H	Asana XL	1000	H	2, 4-D Amine
			Dual	971	H	Dual	998	H	Dual
			Bayleton	38	L	2, 4-D Amine	444	M	Asana XL
			Pounce 3.2 E.C	1	L	Bayleton	1	L	Bayleton
			Asana XL	No data		Blazer	1	L	Pounce 3.2 EC

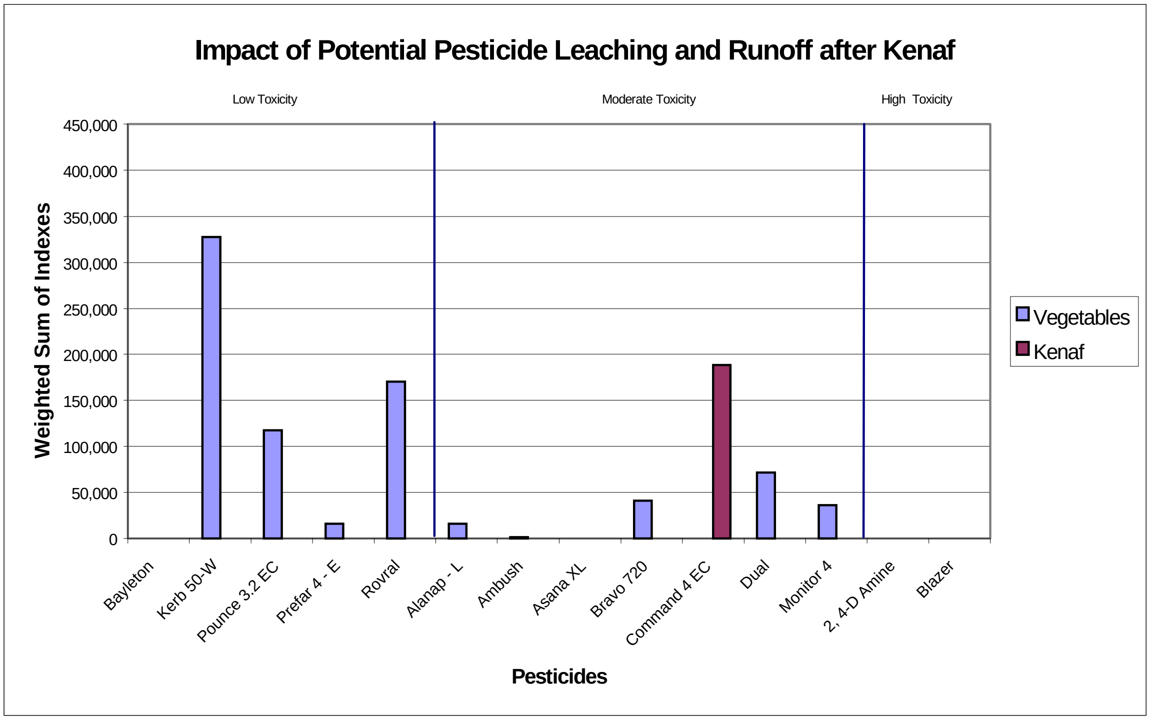


Figure 9 - Potential Pesticide Leaching and Runoff Hazards from the Production of Vegetables and Kenaf

On the other hand, as shown in Table 28, Kenaf offers little relief in terms of potential nitrate leaching. The potential for nitrate leaching is 118 pounds per acre for Kenaf

Table 28 - Nitrogen leaching and Phosphorous Runoff Potential After Including Kenaf. Scenario 4 of both Representative Farms.

	Crops	Acreage	Nitrate Leaching			Phosphorus Runoff
			NAL	NL	Rating	Rating
Scenario 4 Grain Farm	Kenaf	200 acres	129	118	M	L
	Wheat & Soybeans	430 acres	14	14	L	L
Scenario 4 Veg. Farm	Kenaf	200 acres	129	118	M	L
	Sdless Watermelon	6 acres	No Data on Watermelons			M
	Hayman Potatoes	36 acres	170	164	H	M
	Fall Boston Lettuce	10 acres	116	112	M	M
	Spr. Romaine Lettuce	127 acres	118	115	M	M
	Fall Romaine Lettuce	59 acres	116	112	M	M
	Wheat & Soybeans	333 acres	14	14	L	L

compared to 115 pounds per acre for romaine lettuce. Indeed, these results and the results for soil erosion show that Kenaf is no magic bullet that can solve the risk of environmental pollution from agricultural production on the Eastern Shore. Moreover, these results show that there are few incentives to justify research into eliminating the barriers for the production and marketing of Kenaf. This implies that a "magic bullet" crop may be in the future. In the interim, however, we believe that more attention needs to be placed onimproving the current practices for growing vegetable crops on the Eastern Shore. The next section will summarize this thesis, its conclusions and suggest some areas for future research.

Chapter Four- Summary and Conclusions

4.1 Summary of Methods and Findings

This research has provided the necessary steps for evaluating the potential economic and environmental impacts of introducing new crop production alternatives. The methods incorporate a way for farm managers or other specialists in the region to assess the potential profitability of individual crops, identify the optimal allocation of resources that maximizes net returns to land and management, and evaluate the potential environmental impacts of the proposed farm plans.

The main findings of this study can be summarized as follows:

- Market window analysis is a valuable tool in identifying the potential profitability of individual commodities. Good profit potential in a given market window is the result of two components working together: positive profit margins throughout the market window rather than in specific targeted periods and low variability of historical prices relative to the estimated production cost of the product. Some of the traditional vegetable commodities grown in the region, such as cucumbers or snap beans, failed either one or both these tests. Little surprise that farmers in the region are moving out of the production of such crops and they are increasing the production of "safer" crops such as wheat and soybeans. Some of the new crops considered in this study, such as lettuce, showed good profit potential over the entire market window and they had a good historical price record for staying above the estimated production cost line. On the other hand, marketing issues should be considered seriously before considering the production of this crop. Eliminating lettuce from the optimal solution, a scenario that is included in Appendix D, almost halves net return. However, even that scenario preferable to a simple wheat and soybean production strategy.

- Vegetable production continues to be the best way to assure the economic sustainability of agriculture in the region. The adoption of new vegetable crops, such as lettuce and watermelons, could greatly improve the economic performance of vegetable farms. Exclusive production of wheat and soybeans, on the other hand, provides only marginal returns compared to vegetable production. Although complete specialization in vegetable production is the most profitable alternative, most farmers in the region do not have the resources for such an enterprise. By allocating one third of the farmland to high value crops, they may be able to continue the production of wheat and soybeans as well as significantly increase their net returns.

- Economic profitability does not necessarily translate into environmental disasters. The analysis of potential environmental impacts of the crop alternatives studied here shows that there are no crops available to farmers that do not have any negative environmental impacts. While double-cropped wheat and soybeans did not have excessive soil erosion or nitrogen leaching, they used higher toxicity chemicals that have a high potential for entering water via leaching or runoff. Lettuce, on the other hand, had higher than recommended soil erosion values but it used low toxicity chemicals. Consequently, lettuce cultivation offers relief both in terms of higher profits as well as decreasing the amount of highly toxic chemicals that may enter the water stream.

- We do not recommend the production of Kenaf in the region. This analysis shows that the crop is not economically feasible with the current prices, yield potential, and distance from the processing facilities. It also provides for questionable economic impacts. Furthermore, the crop is new and lacks the appropriate infrastructure at all production

- and processing levels. Producers are always wary of situations in which they have to negotiate with single buyers. Kenaf production moves them precisely in that direction, while also failing to provide any noticeable environmental benefits, especially with regard to nitrogen leaching.

4.2 Limitations and Areas for Further Research

If farmers on the Eastern Shore will eventually adopt the new vegetable crops considered in this study, they need to understand both the economic and environmental impacts that will result from those decisions. To help them address these issues, this research used a variety of tools and methods: market window analysis, mathematical programming, and environmental impact computer programs. The new vegetable crops showed good profit potential as well as potentially smaller environmental impacts than the traditional wheat and soybean crop. However, we also suggest areas of research that could add to this discussion and provide decision-makers with important information. In this context, we suggest the following:

- Market window analysis is limited to those crops that are shipped to the terminal markets. No such information is available for crops such as hayman potatoes or kenaf. Consequently, this study was limited to use only estimates of the prices of these commodities based on the appropriate literature on the subject or interviews with extension specialists in the area. A more detailed marketing analysis needs to accompany the evaluation of market windows. Producers need to know the profit margins offered by a specific commodity and the specific market requirements for the product. In the first section of this chapter, we mentioned that the production of lettuce may suffer from the effects of sand and its tendency to penetrate the crop and deposit among its leaves. What can be done about such potential problems and how will this affect the price of the commodity, are questions that need to be addressed before the producers decide to enter the market.[52]

- The PLANETOR computer program contains information on most of the traditional crops. Data on new crops was sometimes lacking. Future work should focus on collecting more specific information for these crops to make the necessary adjustments in PLANETOR's databases. More importantly, we only considered those crop production practices, such as conventional tillage, that are prevalent in the region. It would be useful to know the potential effect from changing some of these practices. In addition, the values for soil erosion are incomplete. Wind erosion also needs to be taken into account and added to the overall picture of soil erosion.

- The introduction of new vegetable crops is not an easy undertaking. It requires a carefully thought and executed marketing strategy, as well as knowledge of the production process. The assumption that the farmer is both willing and able to produce the crops is the main assumption implicit in this entire study.

- We suggest that much of the future work on the economic development of the region focus on the entrepreneurial potential in the region. It is only entrepreneurial farmers that will decide to adopt commodities that promise both the risks and profits of the unknown and untested. Little is done to explore entrepreneurship among producers in the region. Consequently, little is known about ways of encouraging and assisting potential entrepreneurs. Understanding the sources and needs of potential entrepreneurs should focus the attential of public policy makers towards creating an environment that both encourages and assissts motivation and success.

- Finally, research efforts should focus on the regional effects of the adoption of new crop alternatives. Some crops could be successfully produced by a few farmers on a small scale but fail to become a viable alternative for all the farmers in the region.

[52] Appendix D provides a variation for Scenario 4 of the representative Vegetable Farm in which the lettuce crop was not considered. As can be seen, the removal of lettuce almost halves expected net retunrs. However, the operation is still far more superior than a simple wheat and soybean system.

> Furthermore, regional concerns should focus on the indirect impacts that the adoption of new alternatives have on other sectors of the economy in the region. The enterprises that stand to benefit most from a boost of the local agriculture include businesses furnishing farm inputs and machinery as well as those using locally grown produce in value-added operations.

The adoption of new vegetable crops can be a substantial part of the efforts to ensure economic and environmental sustainability. As the profit margins of traditional vegetable crops have declined, many farmers have shifted production into wheat and soybeans. This research has shown that this shift can hardly be sustained economically, given their low profitability, and environmentally, with regard to pesticide leaching and runoff. Some of the new vegetable crops studied here have shown a good potential for changing the direction of this shift. They appear to provide good economic and environmental incentives to revive vegetable production in the region and assure long term sustainability.

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Appendix A - Crop Budgets with Variable Prices and Machinery Cost Estimates

Appendix A: Table 1 – Crop Production Budget for Irish Potatoes

Irish Potatoes (with overhead irrigation)

Yield (cwt)	Historical Price Window (cwt)* $4.00	$6.00	$8.00
100	$400.00	$600.00	$800.00
150	$600.00	$900.00	$1,200.00
200	$800.00	$1,200.00	$1,600.00

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Seedpieces	Cwt	14.00	10.00	$140.00
Fertilizer:	Nitrogen	Pounds	150.00	$0.35	$52.50
	P2O5	Pounds	150.00	$0.30	$45.00
	K2O	Pounds	150.00	$0.18	$27.00
Lime		Ton	0.25	$38.00	$9.50
Spray Materials:					
Herbicides	Dual 8E	Gallons	0.25	$63.55	$15.89
	Sencor DF	Pounds	0.66	$25.75	$17.00
Insecticide	Admire, 2F	Gallons	0.10	$540.00	$54.84
	Monitor	Gallons	0.38	$14.63	$5.49
Fungicide	Penncozeb (2X)	Pounds	2.00	$11.80	$47.20
	Bravo 720 (2X)	Pounds	1.00	$13.08	$26.16
	Ridomil - MZ	Pounds	2.00	$21.50	$43.00
Irrigation:		Acre Inches	4.00	$12.00	$48.00
Machinery:					
Production	Repairs				$21.73
	Fuel, oil				$8.53
Harvest	Repairs				$28.48
	Fuel, oil				$5.20
Interest			596.83	6.00%	$35.81
Crop Supplies:	Boxes				$20.00
Miscellaneous					$35.00
Marketing:	Hauling from field	Crates	165.00	$0.07	$11.55
	Transportation Fee		0.00	$2.01	$0.00
	Packing, Handling and Sales		0.00	$3.30	$0.00
Labor Charges:	Production	Hours	7.90	$6.00	$47.40
	Harvesting	Hours	6.00	$6.00	$36.00
Irrigation	Fixed Cost		0.50	$134.83	$67.42
Land Cost:					$0.00
Machinery Cost:					
Production					$52.58
Harvesting					$63.22
Total Cost:					$964.49
Cost per Sale Unit:		Cwt	150.00		$6.43

Machinery	Freq.	Annual Hours Used Man	Machine	Cost per Hour Variable	Fixed	Cost per Acre Variable	Fixed
Plow 5B		0.40	0.33	4.24	8.85	1.40	2.92
Disk 12'	2X	0.50	0.40	4.20	4.13	1.68	1.65
Tractor,80 Hp			0.73	8.75	11.31	6.39	8.26
PotatoePlntr		1.80	0.25	19.80	83.10	4.95	20.78
Tractor,110 Hp			0.25	11.68	14.75	2.92	3.69
Cultivator, 4R	2X	0.80	0.66	3.54	4.92	2.34	3.25
Sprayer	7X	1.40	0.88	3.50	3.86	3.08	3.40
Tractor, 50Hp			0.88	5.18	6.41	4.56	5.64
Harvester		5.00	1.00	22.00	48.47	22.00	48.47
Tractor,110 Hp			1.00	11.68	14.75	11.68	14.75
Truck		3.00				3.00	3.00
Total						63.99	115.80
Production						30.31	52.58
Harvesting						33.68	63.22

* No actual termianl market data available

Appendix A: Table 2 – Crop Production Budget for Spring Cucumbers. 1 1/9 bushel carton/crates.

Spring Cucumbers (overhead irrigation)

Yield (bu)	Historical Price Window (bu) $7.32	$10.92	$14.87
125	$915.39	$1,365.55	$1,859.23
175	$1,281.54	$1,911.77	$2,602.92
225	$1,647.69	$2,457.98	$3,346.61

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Cucumber Seeds	Pounds	1.50	$46.00	$69.00
Fertilizer:	Nitrogen	Pounds	100.00	$0.30	$30.00
	P2O5	Pounds	100.00	$0.32	$32.00
	K2O	Pounds	100.00	$0.16	$16.00
	Spreading /Acre		1.00	$6.00	$6.00
Lime		Ton	0.17	$38.00	$6.46
Spray Materials:					
Herbicides	Command	Gallons	0.04	$84.80	$3.31
Insecticides	Thiodan (2X)	Gallons	0.25	$37.95	$18.98
Fungicides	Bravo 720 (4X)	Gallons	0.19	$53.15	$39.84
	Benlate 50DF (2X)	Pounds	0.50	$16.85	$16.85
Irrigation:		Acre Inches	2.00	$12.00	$24.00
Machinery					
Production	Repairs				$16.63
	Fuel				$6.84
Harvest	Repairs				$2.71
	Fuel				$1.98
Interest			335.90	5.00%	$16.80
Supplies:					$20.00
Custom Harvest Labor		Crates	210.00	1.30	$273.00
Migrant Housing Allowance					$20.00
Miscellaneous	Bees				$50.00
Marketing:	Hauling to Market	Crates	210.00	$0.07	$14.70
	Transportation Fee		175.00	$1.16	$203.00
	Packing, Handling and Sales		175.00	$2.20	$385.00
	Brokerage	20.00%	175.00	$2.18	$382.35
Labor Charges:	Production	Hours	6.80	6.00	$40.80
	Harvest	Hours	4.00	6.00	$24.00
Irrigation	Fixed Costs		0.50	134.83	$67.42
Land Cost:					$0.00
Machinery	Fixed Costs				$0.00
Production					$34.07
Harvest					$8.16
Total Cost:					$1,829.89
Cost per Sale Unit:		Bu/crates	175.00		$10.46

Machine		Annual Hours Used		Cost per Hour		Cost per Acre	
		Man	Machine	Variable	Fixed	Variable	Fixed
Plow, 5B		0.40	0.33	4.24	8.85	1.40	2.92
Disk 12'	2X	0.50	0.40	4.20	4.13	1.68	1.65
Tractor,80Hp			0.73	8.75	11.31	6.39	8.26
Planter 3R		1.00	0.50	7.20	8.81	3.60	4.41
Tractor,50Hp			0.50	5.18	6.41	2.59	3.21
Cultivate 4R	2X	0.80	0.66	3.54	4.92	2.34	3.25
Sprayer	3X	0.60	0.38	3.50	3.86	1.33	1.47
Spreader		0.50	0.20	8.00	11.02	1.60	2.20
Tractor,50Hp			0.58	5.18	6.41	3.00	3.72
Trailer		3.00	1.00	0.40	1.75	0.40	1.75
Tractor 50 Hp			1.00	5.18	6.41	5.18	6.41
Truck		3.00				3.00	3.00
Total						32.51	42.23
Production						26.93	34.07
Harvest						5.58	8.16

Appendix A: Table 3 – Crop Production Budget for Fall Cucumbers. 1 1/9 bushel carton/crates.

Fall Cucumbers (overhead irrigation)

Yield (bu)	Historical Price Window (bu) $6.38	$9.40	$12.63
75	$478.77	$705.16	$947.26
125	$797.95	$1,175.27	$1,578.77
175	$1,117.13	$1,645.38	$2,210.27

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Cucumber Seeds	Pounds	1.50	$54.75	$82.13
Fertilizer:	Nitrogen	Pounds	100.00	$0.35	$35.00
	P2O5	Pounds	100.00	$0.30	$30.00
	K2O	Pounds	100.00	$0.18	$18.00
	Spreading /Acre		1.00	$6.00	$6.00
Lime		Ton	0.17	$38.00	$6.46
Spray Materials:					
Herbicides	Command	Gallons	0.04	$84.80	$3.31
Insecticides	Thiodan (2X)	Gallons	0.25	$37.95	$18.98
Fungicides	Ridomil Bravo	Pounds	1.50	$15.70	$47.10
	Bravo 720	Gallons	0.19	$53.15	$39.84
	Benlate 50DF (2X)	Pounds	0.50	$16.85	$16.85
Irrigation:		Acre Inches	2.00	$12.00	$24.00
Machinery					
Production	Repairs				$22.33
	Fuel				$8.89
Harvest	Repairs				$2.83
	Fuel				$1.77
Interest			408.88	5.00%	$20.44
Supplies:					$20.00
Custom Harvest Labor		Crates	163.00	1.30	$211.90
Migrant Housing Allowance					$20.00
Miscellaneous	Bees				$50.00
Marketing:	Hauling to Market	Crates	163.00	$0.07	$11.41
	Transportation Fee		175.00	$1.16	$203.00
	Packing, Handling and Sales		175.00	$2.20	$385.00
	Brokerage	20.00%	175.00	$1.88	$329.08
Labor Charges:	Production	Hours	6.80	5.25	$35.70
	Harvest	Hours	4.00	5.25	$21.00
Irrigation	Fixed Cost		0.5	134.83	$67.42
Land Cost:					$0.00
Machinery Cost:					$39.21
					$6.12
Total Cost:					$1,777.63
Cost per Sale Unit:		Bu/crates	175.00		$10.16

Machine	Freq.	Annual Hours Used: Man	Machine	Cost per Hour: Variable	Fixed	Cost per Acre: Variable	Fixed
Plow, 5B		0.40	0.33	4.24	8.85	1.40	2.92
Disk 12'	2X	0.50	0.40	4.20	4.13	1.68	1.65
Tractor,80Hp			0.73	8.75	11.31	6.39	8.26
Planter 3R		1.00	0.50	7.20	8.81	3.60	4.41
Tractor,50Hp			0.50	5.18	6.41	2.59	3.21
Cultivate 4R	2X	0.80	0.66	3.54	4.92	2.34	3.25
Sprayer	7X	1.40	0.88	3.50	3.86	3.08	3.40
Spreader		0.50	0.20	8.00	11.02	1.60	2.20
Tractor,50Hp			1.08	5.18	6.41	5.59	6.92
Trailer		2.25	0.75	0.40	1.75	0.30	1.31
Tractor,50Hp			0.75	5.18	6.41	3.89	4.81
Truck		3.00				3.00	3.00
Total						35.45	45.33
Production						31.27	39.21
Harvest						4.19	6.12

Appendix A: Table 4 - Crop Production Budget for Spring Snap Beans. 30 lb bushel crates/hampers.

Spring Snapbeans (overhead irrigation)

Yield (bu)	Historical Price Window (bu) $10.50	$11.50	$12.50
75	$787.50	$862.50	$937.50
125	$1,312.50	$1,437.50	$1,562.50
175	$1,837.50	$2,012.50	$2,187.50

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Seeds	Pounds	70.00	$1.75	$122.50
Fertilizer:	Nitrogen	Pounds	80.00	$0.35	$28.00
	P2O5	Pounds	60.00	$0.30	$18.00
	K2O	Pounds	60.00	$0.18	$10.80
	Spreading/Acre		1.00	$6.00	$6.00
Lime:		Ton	0.17	$38.00	$6.46
Spray Materials:					
Herbicides	Command	Gallons	0.04	$84.80	$3.31
Insecticides	Orthene	Gallons	1.00	$11.00	$11.00
	Lannate L, (2X)	Gallons	0.25	$51.80	$25.90
Fungicides	Ridomil 2E	Gallons	0.13	$166.85	$20.86
	Ridomil PC 11G	Pounds	10.00	$2.10	$21.00
Irrigation:		Acre Inches	1.00	$12.00	$12.00
Machinery					
Production	Repairs				$21.92
	Fuel				$8.30
Harvest	Repairs				$30.63
	Fuel				$4.73
Interest:			336.04	5.00%	$16.80
Miscellaneous:					$20.00
Supplies					$20.00
Marketing:	Shipping Containers		125.00	$1.50	$187.50
	Haul to Market		125.00	$0.07	$8.75
	Transportation Fee		125.00	$1.05	$131.25
	Packing, Handling and Sales		125.00	$2.50	$312.50
	Brokerage	20.00%	125.00	$2.30	$287.50
Labor Charges:	Production		7.50	$6.00	$45.00
	Harvest		5.40	$6.00	$32.40
Irrigation			0.5	$134.83	$67.42
Land Cost:					$0.00
Machinery	Fixed Cost				$0.00
Production					$38.30
Harvest					$67.90
Total Cost:					$1,586.72
Cost per Sale Unit:		Bushels	125.00		$12.69

		Annual Hours Used		Cost per Hour		Cost per Acre	
Machine	Freq.	Man	Machine	Variable	Fixed	Variable	Fixed
Plow 5B		0.40	0.33	4.24	8.85	1.40	2.92
Disk 12'	2X	0.50	0.40	4.20	4.13	1.68	1.65
Tractor.80 Hp			0.73	8.75	11.31	6.39	8.26
Planter 3R		1.00	0.50	7.20	8.81	3.60	4.41
Tractor,50 Hp			0.50	5.18	6.41	2.59	3.21
Cultivator 4R	3X	1.10	0.99	3.54	4.92	3.50	4.87
Sprayer	5X	1.00	0.63	3.50	3.86	2.21	2.43
Spreader		0.50	0.20	8.00	11.20	1.60	2.24
Tractor,50 Hp			0.83	5.18	6.41	4.30	5.32
Harvester		4.40	2.00	12.50	27.54	25.00	55.08
Tractor 50 Hp			2.00	5.18	6.41	10.36	12.82
Truck		3				3.00	3.00
Total						65.63	106.20
Production						30.27	38.30
Harvest						35.36	67.90

Appendix A: Table 5 - Crop Production Budget for Fall Snap Beans. 30 lb bushel crates/hampers.

Fall Snapbeans (overhead irrigation)

Yield (bu)	Historical Price Window (bu) $6.75	$7.75	$8.75
75	$506.25	$581.25	$656.25
125	$843.75	$968.75	$1,093.75
175	$1,181.25	$1,356.25	$1,531.25

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Seeds	Pounds	70.00	$1.75	$122.50
Fertilizer:	Nitrogen	Pounds	80.00	$0.35	$28.00
	P2O5	Pounds	60.00	$0.30	$18.00
	K2O	Pounds	60.00	$0.18	$10.80
	Spreading/Acre		1.00	$6.00	$6.00
Lime:		Ton	0.17	$38.00	$6.46
Spray Materials:					
Herbicides	Command 4 EC	Gallons	0.04	$84.80	$3.31
Insecticides	Dimethoate	Gallons	0.12	$32.75	$4.09
	Lannate L, (2X)		0.25	$51.80	$25.90
Fungicides	Ridomil 2E	Gallons	0.06	$166.85	$10.43
	Ridomil PC 11G	Pounds	10.00	$2.10	$21.00
Irrigation:		Acre Inches	2.00	$12.00	$24.00
Machinery					
Production	Repairs				$22.71
	Fuel				$8.59
Harvest	Repairs				$30.63
	Fuel				$4.73
Interest:			331.78	5.00%	$16.59
Supplies:					$20.00
Miscellaneous:					$20.00
Marketing:	Shipping Containers		125.00	$1.50	$187.50
	Haul to Market		125.00	$0.07	$8.75
	Transportation Fee		125.00	$1.05	$131.25
	Packing, Handling and Sales		125.00	$2.50	$312.50
	Brokerage Fee	20.00%	125.00	$1.55	$193.75
Labor Charges:	Production		7.50	$5.25	$39.38
	Harvest		5.40	$5.25	$28.35
Irrigation	Fixed Costs		0.5	$134.83	$67.42
Land Cost:					$0.00
Machinery	Fixed Costs				
Production					$40.29
Harvest					$67.90
Total Cost:					$1,480.81
Cost per Sale Unit:		Bushels	125.00		$11.85

		Annual Hours Used		Cost per Hour		Cost per Acre	
Machine	Freq.	Man	Machine	Variable	Fixed	Variable	Fixed
Plow 5B		0.40	0.33	4.24	8.85	1.40	2.92
Disk 12'	2X	0.50	0.40	4.20	4.13	1.68	1.65
Tractor,80 Hp			0.73	8.75	11.31	6.39	8.26
Planter 3R		1.00	0.50	7.20	8.81	3.60	4.41
Tractor,50 Hp			0.50	5.18	6.41	2.59	3.21
Cultivator 4R	3X	1.10	0.99	3.54	4.92	3.50	4.87
Sprayer	6X	1.20	0.75	3.50	4.92	2.63	3.69
Spreader		0.50	0.20	8.00	11.02	1.60	2.20
Tractor,50 Hp			0.95	5.18	6.41	4.92	6.09
Harvester		4.40	2.00	12.50	27.54	25.00	55.08
Tractor 50 Hp			2.00	5.18	6.41	10.36	12.82
Truck		3.00				3.00	3.00
Total						66.67	108.19
Production						31.31	40.29
Harvest						35.36	67.90

Appendix A: Table 6 - Crop Production Budget for Bell Peppers Produced with Overhead Irrigation. 1 1/9 bushel carton/crates, large.

Green Bell Peppers (overhead irrigation)

Yield (box)	Historical Price Window (box)		
	$6.44	$7.88	$9.48
100	$644.00	$788.00	$948.00
300	$1,932.00	$2,364.00	$2,844.00
500	$3,220.00	$3,940.00	$4,740.00

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:		Plants (1000)	9.70	$25.00	$242.50
Fertilizer:	Nitrogen	Pounds	130.00	$0.35	$45.50
	P2O5	Pounds	50.00	$0.30	$15.00
	K2O	Pounds	130.00	$0.18	$23.40
	Spreading/Acre		1.00	$6.00	$6.00
Lime:		Ton	0.17	$35.00	$5.95
Spray Materials:					
Herbicides	Devrinol 10G	Pounds	3.00	$8.70	$26.10
Insecticides	Orthene (8X)	Pounds	1.00	$11.00	$88.00
	Lannate	Gallons	0.25	$51.80	$12.95
Fungicides	Kocide (6X)	Pounds	2.00	$2.55	$30.60
	Maneb DF (6X)	Pounds	2	2.85	$34.20
Irrigation		Acre/Inch	2	12	$24.00
Machinery					
Production	Repairs				$35.37
	Fuel				$19.49
Harvest	Repairs				$0.00
	Fuel				$0.00
Interest:			649.06	5.00%	$32.45
Supplies:					$20.00
Custom Harvest		Bins	20.00	$20.00	$400.00
Miscellaneous:					$40.00
Marketing:	Transportation Fee	Boxes	300.00	$1.05	$315.00
	Packing, Handling and Sales	Boxes	300.00	$2.50	$750.00
	Brokerage Fee	20.00%	300.00	$1.58	$472.80
Labor Charges:	Production		17.45	$6.00	$104.70
	Harvest		0.00	$6.00	$0.00
Irrigation	Fixed Costs		0.5	$134.83	$67.42
Land Cost:					$0.00
Machinery					
Production					$64.91
Harvest					$0.00
Total Cost:					$2,876.34
Cost per Sale Unit:		Boxes	300.00		$9.59

		Annual Hours Used		Cost per Hour		Cost per Acre	
Machine	Freq.	Man	Machine	Variable	Fixed	Variable	Fixed
Plow 3B		0.80	0.75	2.24	2.06	1.68	1.55
Disk 7'	3X	0.95	0.90	1.20	1.84	1.08	1.66
Tractor,50 Hp			1.65	5.18	6.41	8.55	10.58
WW Planter		10.00	4.00	1.32	1.21	5.28	4.84
Tractor,50 Hp			4.00	5.18	6.41	20.72	25.64
Sprayer	11X	2.20	1.38	3.50	3.86	4.83	5.33
Spreader		0.50	0.20	8.00	11.01	1.60	2.20
Tractor 50 Hp			1.58	5.18	6.41	8.18	10.13
Truck		3.00				3.00	3.00
Total						54.92	64.91
Production						54.92	64.91
Harvest						0.00	0.00

Appendix A: Table 7 - Crop Production Budget for Bell Peppers Produced with Drip Irrigation. 1 1/9 bushel carton/crates, large.

Green Bell Peppers (drip irrigation)

Yield (box)	Historical Price Window (box) $7.02	$8.54	$10.24
800	$5,616.00	$6,832.00	$8,192.00
1000	$7,020.00	$8,540.00	$10,240.00
1200	$8,424.00	$10,248.00	$12,288.00

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:		Plants (1000)	11.70	$50.00	$585.00
Fertilizer:	Fertilizer, 10 - 12 - 20		1400.00	$0.18	$252.00
	Spreading/Acre		1.00	$6.00	$6.00
Lime:		Ton	0.80	$38.00	$30.40
Spray Materials:					
Fumigation	Methyl Bromide	Pounds	180.00	$1.00	$180.00
Herbicides	Devrinol	Pounds	1.00	$8.70	$8.70
Insecticides	Orthene (8X)	Pounds	1.00	$11.00	$88.00
	Lannate	Gallons	0.25	$51.80	$12.95
Fungicides	Kocide (6X)	Pounds	2.00	$2.55	$30.60
	Maneb DF (6X)	Pounds	2.00	$2.85	$34.20
Irrigation			6.00	$4.00	$24.00
Plastic Mulch, tubes					$325.00
Machinery					
Production	Repairs				$49.29
	Fuel				$23.57
Harvest	Repairs				$0.00
	Fuel				$0.00
Interest:			1779.71	5.00%	$88.99
Supplies:					$20.00
Custom Harvest		Bins	75.00	$20.00	$1,500.00
Miscellaneous:	Stakes & String				$130.00
	Cleanup				$118.00
Marketing:	Transportation Fee		1000.00	$1.05	$1,050.00
	Packing, Handling and Sales		1000.00	$2.50	$2,500.00
	Brokerage Fee	20.00%	1000.00	$1.71	$1,708.00
Labor Charges:	Production		18.70	$6.00	$112.20
	Harvesting		0.00	$6.00	$0.00
	Staking		12.00	$6.00	$72.00
	Irrigation Maintenance		20.00	$6.00	$120.00
Irrigation	Fixed Cost		0.5	$309.00	$154.50
Land Cost:					$0.00
Machinery					
Production					$94.43
Harvest					$0.00
Total Cost:					$9,317.82
Cost per Sale Unit:		Boxes	1000.00		$9.32

Machine	Freq.	Annual Hours Used: Man	Machine	Cost per Hour: Variable	Fixed	Cost per Acre: Variable	Fixed
Plow, 3B		0.80	0.75	2.24	2.06	1.68	1.55
Disk 7'	2X	0.95	0.60	1.20	1.84	0.72	1.10
Rotary Tiller		1.10	1.00	6.24	8.89	6.24	8.89
Tractor,50 Hp			2.35	5.18	6.41	12.17	15.06
Plast. Combo		2.05	0.50	8.40	23.13	4.20	11.57
Tractor,110 Hp			0.50	11.68	14.75	5.84	7.38
WW Planter,1R		10.00	4.00	1.32	1.21	5.28	4.84
Tractor,50 Hp			4.00	5.18	6.41	20.72	25.64
Sprayer	12X	2.40	1.50	3.50	3.86	5.25	5.79
Tractor 50 Hp			1.50	5.18	6.41	7.77	9.62
Pick-up Truck		3.00				3.00	3.00
Total						72.87	94.43
Production						72.87	94.43
Harvest						0.00	0.00

Appendix A: Table 8 - Crop Production Budget for Western Cantaloupes. ½ cartons, 15s

Western Cantaloupes (drip irrigation)

Yield (box)	Historical Price Window (box) $10.94	$9.97	$11.89
470	$5,141.80	$4,685.90	$5,588.30
670	$7,329.80	$6,679.90	$7,966.30
870	$9,517.80	$8,673.90	$10,344.30

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:		Plants	5000.00	$0.10	$500.00
Fertilizer:	Drip 10 - 12 - 20		2000.00	$0.18	$360.00
	Spreading/Acre		1.00	$6.00	$6.00
Lime:		Ton	0.80	$38.00	$30.40
Spray Materials:					
Fumigation	Methyl Bromide	Pounds	180.00	$1.00	$180.00
Herbicides	Curbit	Gallons	0.13	$42.95	$5.37
Insecticides	Thiodan (3X)	Pounds	1.00	$6.70	$20.10
Fungicides	Bravo (6X)	Gallons	0.25	53.15	$79.73
	Bayleton (6X)	Pounds	0.25	$59.00	$88.50
Plastic Mulch, tubes					$325.00
Irrigation:		Acre Inches	5.00	$4.00	$20.00
Machinery					
Production	Repairs				$48.79
	Fuel				$22.38
Harvest	Repairs				$8.03
	Fuel				$5.91
Interest:			1731.26	5.00%	$86.56
Supplies:					$20.00
Custom Harvest Labor		Crates	737.00	$0.65	$479.05
Miscellaneous:	Bees				$45.00
	Cleanup				$46.00
Marketing:	Haul to Market	Crates	737.00	$0.07	$51.59
	Transportation Fee		670.00	$1.16	$777.20
	Packing, Handling and Sales		670.00	$3.15	$2,110.50
	Brokerage Fee	20.00%	670.00	$1.99	$1,335.98
Labor Charges:	Production		19.90	$6.00	$119.40
	Harvesting		6.00	$6.00	$36.00
	Irrigation Maintenance		10.00	$6.00	$60.00
Irrigation	Fixed Cost		0.50	$309.00	$154.50
Land Cost:					$0.00
Machinery					
Production					$108.04
Harvest					$0.00
Total Cost:					$7,130.03
Cost per Sale Unit:		Box	670.00		$10.64

Machine	Freq.	Annual Hours Used Man	Machine	Cost per Hour Variable	Fixed	Cost per Acre Variable	Fixed
Plow 3B		0.8	0.75	2.24	2.06	1.68	1.55
Disk 7'	2X	0.95	0.6	5.64	1.84	3.38	1.10
Rotary Tiller	2X	1.10	1.00	6.24	8.89	6.24	8.89
Tractor,50 Hp			2.35	5.18	6.41	12.17	15.06
Plast. Combo		2.05	0.50	7.20	20.50	3.60	10.25
Tractor,110 Hp			0.50	11.68	14.75	5.84	7.38
WW Planter		10.00	4.00	1.32	1.21	5.28	4.84
Tractor, 50 Hp			4.00	5.18	6.41	20.72	25.64
Sprayer	8	2.4	1.00	3.2	3.52	3.20	3.52
Tractor, 50 Hp			1.00	5.18	6.41	5.18	6.41
Trailer		5.00	2.50	0.4	1.75	1.00	4.38
Tractor 50 Hp			2.50	5.18	6.41	12.95	16.03
Truck		3.00				3.00	3.00
Total						84.25	108.04
Production						84.25	108.04
Harvest						0.00	0.00

Appendix A: Table 9 - Crop Production Budget for Boston Head Lettuce. 20 lb. Carton/crates, 24s.

Boston Head Lettuce (overhead irrigation)

Yield (crt)	Historical Price Window (crt)* $7.90	$9.22	$10.55
300	$2,370.00	$2,766.00	$3,165.00
500	$3,950.00	$4,610.00	$5,275.00
700	$5,530.00	$6,454.00	$7,385.00

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Seeds	Pounds	0.50	$160.00	$80.00
Fertilizer:	Nitrogen	Pounds	95.00	$0.35	$33.25
	P2O5	Pounds	70.00	$0.30	$21.00
	K2O	Pounds	70.00	$0.18	$12.60
	Spreading/Acre		1.00	$6.00	$6.00
Lime:		Ton	0.17	$38.00	$6.46
Spray Materials:					
Herbicides	Kerb	Pounds	2.00	$24.35	$48.70
Insecticides	Pounce (2X)	Gallons	0.05	$172.95	$16.19
Fungicides	Rovral 50W (2X)	Pounds	1.50	$22.85	$68.55
Irrigation:		Acre Inches	2.00	$12.00	$24.00
Machinery					
Production	Repairs				$22.46
	Fuel				$13.27
Harvest	Repairs				$9.64
	Fuel				$7.10
Interest:			392.48	5.00%	$19.62
Supplies:					$20.00
Crates		Crates	500.00	$1.30	$650.00
Custom Thinning					$10.00
Custom Harvest Labor		Crates	500.00	$0.90	$450.00
Miscellaneous:					$40.00
Marketing:	Haul to Market		500.00	$0.04	$20.00
	Transportation Fee		500.00	$1.05	$525.00
	Packing, Handling and Sales		500.00	$1.00	$500.00
	Brokerage Fee	20.00%	500.00	$1.84	$922.00
Labor Charges:	Production		9.72	$6.00	$58.32
	Harvest		7.00	$6.00	$42.00
Irrigation	Fixed Costs		0.50	134.83	$67.42
Land Cost:					$0.00
Machinery					
Production					$42.88
Harvest					$24.48
Total Cost:					$3,760.94
Cost per Sale Unit:		Crates	500.00		$7.52

		Annual Hours Used		Cost per Hour		Cost per Acre	
Machine	Freq.	Man	Machine	Variable	Fixed	Variable	Fixed
Plow 3B		0.80	0.75	2.24	2.06	1.68	1.55
Disk 7'	4X	1.32	1.20	1.20	1.84	1.44	2.21
Tractor,50Hp			1.95	5.18	6.41	10.10	12.50
Planter 2R		2.00	0.75	2.40	2.94	1.80	2.21
Tractor,50Hp			0.75	5.18	6.41	3.89	4.81
Cultivator 2R	2X	1.50	1.32	0.84	0.58	1.11	0.77
Sprayer		0.60	0.38	3.50	3.86	1.33	1.47
Spreader		0.50	0.20	8.00	11.01	1.60	2.20
Tractor,50Hp			1.90	5.18	6.41	9.84	12.18
Trailer		6.00	3.00	0.40	1.75	1.20	5.25
Tractor 50 Hp			3.00	5.18	6.41	15.54	19.23
Truck		3.00				3.00	3.00
Total						52.53	67.36
Production						35.79	42.88
Harvest						16.74	24.48

* Spring Planting Price Information

Appendix A: Table 10 - Crop Production Budget for Romaine Head Lettuce. 20 lb. Carton/crates, 24s.

Romaine Head Lettuce (overhead irrigation)

Yield (crt)	Historical Price Window (crt)*		
	$9.67	$12.03	$14.32
500	$4,835.00	$6,015.00	$7,160.00
700	$6,769.00	$8,421.00	$10,024.00
900	$8,703.00	$10,827.00	$12,888.00

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Seeds	Pounds	0.50	$160.00	$80.00
Fertilizer:	Nitrogen	Pounds	95.00	$0.35	$33.25
	P2O5	Pounds	70.00	$0.30	$21.00
	K2O	Pounds	70.00	$0.18	$12.60
			1.00	$6.00	$6.00
Lime:		Ton	0.17	$38.00	$6.46
Herbicides	Kerb	Pounds	2.00	$24.35	$48.70
Insecticides	Pounce (2X)	Gallons	0.05	$172.95	$16.19
Fungicides	Rovral 50W (2X)	Pounds	1.50	$22.85	$68.55
Irrigation:		Acre Inches	2.00	$12.00	$24.00
Machinery					
Production	Repairs				$22.46
	Fuel				$13.27
Harvest	Repairs				$9.64
	Fuel				$7.10
Interest:			402.48	5.00%	$20.12
Crop Supplies:					$20.00
Crates		Crates	700.00	$1.45	$1,015.00
Custom Thinning					$10.00
Custom Harvest Labor		Crates	700.00	$0.90	$630.00
Miscellaneous:					$40.00
Marketing:	Haul to Market		700.00	$0.04	$28.00
	Transportation Fee		700.00	$1.05	$735.00
	Packing, Handling and Sales		700.00	$1.00	$700.00
	Brokerage Fee	20.00%	700.00	$2.41	$1,684.20
Labor Charges:	Production		9.72	$6.00	$58.32
	Harvest		7.00	$6.00	$42.00
Land Cost:					$0.00
Irrigation	Fixed Costs		0.50	134.83	$67.42
Machinery					
Production					$42.88
Harvest					$24.48
Total Cost:					$5,486.64
Cost per Sale Unit:		Crates	700.00		$7.84

		Annual Hours Used		Cost per Hour		Cost per Acre	
Machine	Freq.	Man	Machine	Variable	Fixed	Variable	Fixed
Plow 3B		0.80	0.75	2.24	2.06	1.68	1.55
Disk 7'	4X	1.32	1.20	1.20	1.84	1.44	2.21
Tractor 50 Hp			1.95	5.18	6.41	10.10	12.50
Planter 2R		2.00	0.75	2.40	2.94	1.80	2.21
Tractor 50 Hp			0.75	5.18	6.41	3.89	4.81
Cultivator 2R	2X	1.50	1.32	0.84	0.58	1.11	0.77
Sprayer		0.60	0.38	3.50	3.86	1.33	1.47
Spreader		0.50	0.20	8.00	11.01	1.60	2.20
Tractor 50 Hp			1.90	5.18	6.41	9.84	12.18
Trailer		6.00	3.00	0.40	1.75	1.20	5.25
Tractor 50 Hp			3.00	5.18	6.41	15.54	19.23
Pick-up Truck		3.00				3.00	3.00
Total						52.53	67.36
Production						35.79	42.88
Harvest						16.74	24.48

* Spring Planting Price Information

Appendix A: Table 11 - Crop Production Budget for Watermelons.

Watermelons (overhead irrigation)

Yield (cwt)	Price Window (cwt)* $6.00	$7.00	$8.00
100	$600.00	$700.00	$800.00
300	$1,800.00	$2,100.00	$2,400.00
500	$3,000.00	$3,500.00	$4,000.00

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Seeds, $/1000		2.50	$14.90	$37.25
Fertilizer:	Nitrogen	Pounds	200.00	$0.35	$70.00
	P2O5	Pounds	100.00	$0.30	$30.00
	K2O	Pounds	150.00	$0.18	$27.00
	Spreading/Acre		1.00	$6.00	$6.00
Lime:		Ton	0.50	$38.00	$19.00
Spray Materials:					
Herbicides	Curbit	Gallons	0.25	$42.95	$10.74
	Poast	Gallons	0.12	$105.95	$13.23
	Crop Oil				$2.96
Insecticides	Sevin XLR	Gallons	0.25	$28.00	$7.00
	Asana	Gallons	0.09	$140.25	$13.14
Fungicides	Bravo 720 (2X)	Gallons	0.19	53.15	$19.92
	Ridomil-Bravo (2X)	Pound	1.50	$15.70	$47.10
	Topsin M (2X)	Pounds	0.40	$16.60	$13.28
Irrigation:		Acre Inches	3.00	$12.00	$36.00
Machinery					
Production	Repairs				$20.39
	Fuel				$10.48
Harvest	Repairs				$0.00
	Fuel				$0.00
Interest:			413.49	5.00%	$20.67
Supplies:					$20.00
Custom Harvest Labor			30000.00	$0.02	$450.00
Miscellaneous:	Bees				$30.00
Thinning Labor			2.00	5.00	$10.00
Marketing:	Transportation Fee		300.00	$2.20	$660.00
	Packing, Handling and Sales		300.00	$1.00	$300.00
	Brokerage Fee	20.00%	300.00	$1.40	$420.00
Labor Charges:	Production		6.80	$6.00	$40.80
	Harvest		0.00	$6.00	$0.00
Irrigation	Fixed Cost		0.5	$134.83	$67.42
Land Cost:					$0.00
Machinery					
Production					$38.02
Harvest					$0.00
Total Cost:					$2,440.40
Cost per Sale Unit:		Cwt	300.00		$8.13

		Annual Hours Used		Cost per Hour		Cost per Acre	
Machine	Freq.	Man	Machine	Variable	Fixed	Variable	Fixed
Plow 5B		0.40	0.33	4.24	8.85	1.40	2.92
Disk 12'	2X	0.50	0.40	4.20	4.13	1.68	1.65
Tractor, 80 Hp			0.73	8.75	11.31	6.39	8.26
Planter 2R		1.00	0.75	2.40	2.94	1.80	2.21
Tractor, 50 Hp			0.75	5.18	6.41	3.89	4.81
Cultivator 4R	2X	0.70	0.66	3.54	4.92	2.34	3.25
Sprayer	6X	1.20	0.75	3.50	3.86	2.63	2.90
Tractor 50 Hp			1.41	5.18	6.41	7.30	9.04
Truck		3.00				3.00	3.00
Total						30.42	38.02
Production						30.42	38.02
Harvest						0.00	0.00

* No terminal market data available

Appendix A: Table 12 - Crop Production Budget for Broccoli. 21 lb. carton/crates.

Broccoli (overhead irrigation)

Yield (box)	Historical Price Window (box) $8.38	$9.78	$10.97
250	$2,095.00	$2,445.00	$2,742.50
350	$2,933.00	$3,423.00	$3,839.50
450	$3,771.00	$4,401.00	$4,936.50

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Seeds	Pounds	1.00	$160.00	$160.00
Fertilizer:	Nitrogen	Pounds	145.00	$0.35	$50.75
	P2O5	Pounds	100.00	$0.30	$30.00
	K2O	Pounds	145.00	$0.18	$26.10
	Spreading/Acre		1.00	$6.00	$6.00
Lime:		Ton	0.17	$38.00	$6.46
Spray Materials:					
Herbicides	Devrinol	Pounds	3.00	$8.70	$26.10
	Treflan 5	Gallon	0.13	$30.95	$3.87
Insecticides	Pounce (3X)	Gallon	0.05	$172.95	$24.32
	Lannate (2X)	Gallons	0.25	$51.80	$25.90
	Dipel (3X)	Pounds	0.50	$12.50	$18.75
Fungicides	Bravo 720	Gallons	0.19	$53.15	$9.97
Irrigation:		Acre Inches	3.00	$12.00	$36.00
Machinery					
Productiom	Repairs				$22.42
	Fuel				$12.51
Harvest	Repairs				$27.30
	Fuel				$18.92
Interest:			499.14	5.00%	$24.96
Supplies					$20.00
Boxes		Boxes	350.00	$1.00	$350.00
Custom Harvest Labor		Boxes	350.00	$1.00	$350.00
Miscellaneous					$40.00
Marketing:	Haul to Market	Boxes	350.00	$0.07	$24.50
	Cooling	Boxes	350.00	$0.85	$297.50
	Transportation Fee	Boxes	350.00	$1.16	$406.00
	Packing, Handling and Sales	Boxes	350.00	$1.00	$350.00
	Brokerage Fee	20.00%	350.00	$1.96	$684.60
Labor Charges:	Production		19.52	$6.00	$117.12
	Harvest		13.00	$6.00	$78.00
Irrigation	Fixed Costs		0.50	134.83	$67.42
Land Cost:					$0.00
Machinery	Fixed Costs				
Production					$42.06
Harvest					$72.28
Total Cost:					$3,429.80
Cost per Sale Unit:		Boxes	350.00		$9.80

		Annual Hours Used		Cost per Hour		Cost per Acre	
Machine	Freq.	Man	Machine	Variable	Fixed	Variable	Fixed
Plow 3B		0.80	0.75	2.24	2.06	1.68	1.55
Disk 7'	4X	1.32	1.20	1.20	1.84	1.44	2.21
Tractor 50 Hp			1.95	5.18	6.41	10.10	12.50
Planter 2R		2.00	0.75	2.40	2.94	1.80	2.21
Tractor 50 Hp			0.75	5.18	6.41	3.89	4.81
Cultivator 2R		10.70	0.66	0.84	0.58	0.55	0.38
Sprayer	6X	1.20	0.75	3.50	3.86	2.63	2.90
Spreader		0.50	0.20	8.00	11.01	1.60	2.20
Tractor 50 Hp			1.61	5.18	6.41	8.34	10.32
Trailer		12.00	12.00	0.40	1.75	4.80	21.00
Tractor 50 Hp			8.00	5.18	6.41	41.44	51.28
Truck		3.00				3.00	3.00
Total						81.27	114.34
Production						35.03	42.06
Harvest						46.24	72.28

Appendix A: Table 13 - Crop Production Budget for Kenaf.

Kenaf

Yield (ton)	Price Window (ton) $65.00	$75.00	$85.00
3.00	$195.00	$225.00	$255.00
5.00	$325.00	$375.00	$425.00
7.00	$455.00	$525.00	$595.00

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Seeds	Pounds	14.00	$3.00	$42.00
Fertilizer:	Nitrogen	Pounds	100.00	$0.31	$31.00
Spreading, Pro-rated			1.00	$6.00	$6.00
Lime		Ton	0.33	$38.00	$12.54
Spray Materials:					
Herbicides	Command	Gallons	0.04	$84.80	$3.31
Insecticides					$0.00
Fungicides					$0.00
Irrigation:					$0.00
Machinery					
Production	Repairs				$12.29
	Fuel				$7.87
Harvest	Repairs				$0.00
	Fuel				$0.00
Interest:			120.01	8.00%	$9.60
Crop Supplies:			0.00	$0.00	$0.00
Custom rate Harvest					$35.00
Miscellaneous:					$5.00
Marketing*:	Transportation	Loaded mile	150.00	$2.00	$300.00
					$0.00
Labor Charges:	Production	Hours	3.00	$6.00	$18.00
	Harvest		0.00	$5.25	$0.00
Land Cost:					$0.00
Fixed Costs:					
Machinery Cost:					
Production					$23.49
Harvest					$0.00
Land (one crop per year)					$0.00
Irrigation (one crop per year)					$0.00
Total Cost:					$506.09
Cost per Sale Unit:		Ton	5.00		$101.22

		Annual Hours Used		Cost per Hour		Cost per Acre	
Machine	Freq	Man	Machine	Variable	Fixed	Variable	Fixed
Plow 5B		0.40	0.33	4.24	8.55	1.40	2.82
Disk 17'	2X	0.30	0.30	12.00	8.87	3.60	2.66
Tractor 150 Hp			0.63	14.35	12.34	9.04	7.77
Drill		0.40	0.20	7.08	23.54	1.42	4.71
Sprayer		0.20	0.15	3.50	1.03	0.53	0.15
Tractor 80 Hp			0.35	8.83	8.19	3.09	2.87
Truck		0.70				2.50	2.50
Total						21.57	23.49
Production						21.57	23.49
Harvest						0.00	0.00

Appendix A: Table 14 - Crop Production Budget for Seedless Watermelons.

Seedless Watermelons (overhead irrigation)

Yield (crt)	Price Window (cwt) $7.00	$9.00	$11.00
400	$2,800.00	$3,600.00	$4,400.00
500	$3,500.00	$4,500.00	$5,500.00
600	$4,200.00	$5,400.00	$6,600.00

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Plants	1000	2.50	$14.90	$37.25
Fertilizer:	Nitrogen	Pounds	90.00	$0.35	$31.50
	P2O5	Pounds	100.00	$0.30	$30.00
	K2O	Pounds	100.00	$0.18	$18.00
Lime:		Ton	0.17	$38.00	$6.33
Herbicides	Prefar	Pounds	5.00	$38.87	$194.35
	Alanup	Pounds	2.00	$45.35	$90.70
	Adios	Pounds	1.25	$13.67	$17.09
Fungicides	Bravo 720	Gal	0.38	$53.15	$19.93
Irrigation:			2.00	$12.00	$24.00
Machinery					
Production	Repairs				$14.74
	Fuel				$10.39
Harvest	Repairs				$0.00
	Fuel				$0.00
Interest:			534.28	5.00%	$26.71
Crop Supplies:	Miscellaneous				$20.00
Custom Harvest Labor*		Hours	120.00	$5.25	$630.00
Miscellaneous:	Bees				$40.00
Marketing*:	Transportation Cost		500.00	$2.20	$1,100.00
	Packing, Handling and Sales		500.00	$1.00	$500.00
	Brokerage Fee	20.00%	500.00	$0.00	$0.00
Labor Charges:	Production	Hours	36.35	$6.00	$218.10
	Harvest		115.74	$6.00	$694.44
Irrigation	Fixed Costs		0.50	309.00	$154.50
Land Cost:					$0.00
Machinery	Fixed Costs				
Production					$79.65
Harvest					$115.03
Total Cost:					$4,072.72
Cost per Sale Unit:		Cwt	500.00		$8.15

Machine	Freq	Annual Hours Used Man	Machine	Cost per Hour Variable	Fixed	Cost per Acre Variable	Fixed
Plow 3B		0.80	0.75	2.24	2.06	1.68	1.55
Disk 7'	3X	0.45	0.90	1.20	3.90	1.08	3.51
Tractor,50 Hp			1.65	5.18	6.41	8.55	10.58
Tube-Mulch		1.00	0.50	8.40	23.13	4.20	11.57
WW Planter 1R		10.00	4.00	1.32	1.21	5.28	4.84
Tractor 50 Hp			4.50	5.18	6.41	23.31	28.85
Pruning		5.00					
Sprayer	8X	1.60	1.00	3.50	3.86	3.50	3.86
Spreader		0.50	0.20	8.00	11.10	1.60	2.22
Tractor 50 Hp			1.20	5.18	6.41	6.22	7.69
Trailer		29.57	5.91	0.40	1.75	2.36	10.34
Tractor 50 Hp			2.96	5.18	6.41	15.33	18.97
Hauling		23.81				92.86	85.71
Truck		5.00				5.00	5.00
Total						126.87	133.80
Production						60.41	79.65
Harvest						110.56	115.03

Appendix A: Table 15 - Crop Production Budget for Doubble-cropped Soybeans.

Double-cropped Soybeans

Yield (bu)	Price Window (bu) $5.50	$6.00	$6.50
20	$110.00	$120.00	$130.00
30	$165.00	$180.00	$195.00
40	$220.00	$240.00	$260.00

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Seed	Pounds	60.00	0.25	$15.00
Fertilizer:	Nitrogen	Pounds	0.00	$0.35	$0.00
	P2O5, Pro-rated	Pounds	30.00	$0.30	$9.00
	K2O, Pro-rated	Pounds	45.00	$0.18	$8.10
Spreading	Per acre/Pro-rated		0.50	$6.00	$3.00
Lime		Ton	0.20	$38.00	$7.60
Spray Materials:					
Herbicides	Dual 8E	Gallons	0.19	$63.90	$11.98
	Blazer	Pint	0.25	$99.20	$24.80
Insecticide	Pounce 3.2 EC	Liquid ounce	0.05	$182.25	$8.57
Machinery:					
Production	Repairs				$10.20
	Fuel, oil				$5.60
Harvest	Repairs				$5.38
	Fuel, oil				$3.96
Crop Insurance					$7.00
Miscellaneous					$2.00
Interest			112.85	6.00%	$6.77
Labor Charges:	Production	Hours	2.35	$6.00	$14.10
Land Cost:					$0.00
Machinery Cost:					
Production					$11.85
Harvesting					$18.42
Total Cost:					$173.33
Cost per Sale Unit:		Cwt	30.00		$5.78

		Annual Hours Used		Cost per Hour		Cost per Acre	
Machinery	Freq.	Man	Machine	Variable	Fixed	Variable	Fixed
Planter, 4R		1.00	0.25	7.20	4.41	1.80	1.10
Tractor,80 Hp			0.25	8.75	11.31	2.19	2.83
Cultivator, 4R	2X	0.80	0.33	3.54	1.62	1.17	0.53
Sprayer	7X	1.40	0.88	3.50	3.86	3.06	3.38
Tractor, 80Hp			1.21	5.18	6.41	6.24	7.72
Combine		5.00	1.00	9.43	9.21	9.43	9.21
Tractor,80 Hp			1.00	8.75	11.31	9.43	9.21
Truck		0.75				0.75	0.75
Total						28.91	30.27
Production						10.05	11.85
Harvesting						18.86	18.42

Appendix A: Table 16 - Crop Production Budget for Full Season Soybeans

Full Season Soybeans

Yield (bu)	Price Window (bu) $5.50	$6.00	$6.50
25	$137.50	$150.00	$162.50
35	$192.50	$210.00	$227.50
45	$247.50	$270.00	$292.50

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Seed	Pounds	60.00	0.25	$15.00
Fertilizer:	Nitrogen	Pounds	0.00	$0.35	$0.00
	P2O5, Pro-rated	Pounds	30.00	$0.30	$9.00
	K2O, Pro-rated	Pounds	45.00	$0.18	$8.10
Spreading	Per acre/Pro-rated		0.50	$6.00	$3.00
Lime		Ton	0.20	$28.00	$5.60
Spray Materials:					
Herbicides	Dual 8E	Gallons	0.19	$63.90	$11.98
	Blazer	Pint	0.25	$99.20	$24.80
Insecticide	Pounce 3.2 EC	Liquid ounce	0.05	$182.25	$8.57
Machinery:					
Production	Repairs				$10.20
	Fuel, oil				$5.60
Harvest	Repairs				$5.38
	Fuel, oil				$3.96
Crop Insurance					$7.00
Miscellaneous					$2.00
Interest			110.85	6.00%	$6.65
Labor Charges:	Production	Hours	2.35	$6.00	$14.10
Land Cost:					$0.00
Machinery Cost:					
Production					$18.12
Harvesting					$9.21
Total Cost:					$168.26
Cost per Sale Unit:		Cwt	35.00		$4.81

		Annual Hours Used		Cost per Hour		Cost per Acre	
Machinery	Freq.	Man	Machine	Variable	Fixed	Variable	Fixed
17 Disk		0.20	0.15	12.00	8.87	1.80	1.33
17 Fld Cult		0.18	0.18	4.12	2.54	0.74	0.46
12' Drill		0.35	0.20	7.08	15.70	1.42	3.14
Sprayer	7X	0.60	0.60	3.50	0.47	2.10	0.28
Combine		5.00	1.00	9.43	9.21	9.43	9.21
Tractor,80 Hp			1.13	8.75	11.31	10.66	10.41
Truck		0.70				2.50	2.50
Total						24.69	22.40
Production						19.21	18.12
Harvesting						9.43	9.21

Appendix A: Table 17 - Crop Production Budget for Wheat

Wheat

Yield (bu)	Price Window (bu) $2.50	$3.00	$3.50
60	$150.00	$180.00	$210.00
80	$200.00	$240.00	$280.00
100	$250.00	$300.00	$350.00

Variable Costs		Units	Quantity	Price	Cost
Seeding Costs:	Seed	Pounds	135.00	0.26	$35.10
Fertilizer:	Nitrogen	Pounds	100.00	$0.31	$31.00
	P2O5, Pro-rated	Pounds	45.00	$0.30	$13.50
	K2O, Pro-rated	Pounds	50.00	$0.14	$7.00
Spreading	Per acre/Pro-rated		0.50	$6.00	$3.00
Lime		Ton	0.30	$28.00	$8.40
Spray Materials:					
Herbicides	2-4-D	Gallons	0.09	$55.74	$5.24
Insecticide					$1.85
Fungicide	Bayleton (6X)	Pounds	0.08	$59.00	$26.90
Machinery:					
Production	Repairs				$13.54
	Fuel, oil				$8.48
Harvest	Repairs				$5.66
	Fuel, oil				$5.24
Crop Insurance					$0.00
Miscellaneous					$2.00
Interest			156.01	5.00%	$7.80
Labor Charges:	Production	Hours	2.90	$6.00	$17.40
Land Cost:					$0.00
Machinery Cost:					
Production					$20.32
Harvesting					$11.87
Total Cost:					$224.30
Cost per Sale Unit:		Bu	70.00		$3.20

Machinery	Freq.	Annual Hours Used Man	Machine	Cost per Hour Variable	Fixed	Cost per Acre Variable	Fixed
5b Plow		0.40	0.33	4.24	8.55	1.40	2.82
17 Disk	2X	0.30	0.30	12.00	8.87	3.60	2.66
Drill		0.40	0.20	7.08	23.54	1.42	4.71
Sprayer	2X	0.40	0.30	3.50	1.03	1.05	0.31
Combine		0.30	0.25	32.41	70.04	8.10	17.51
80 Hp Tractor			0.50	8.83	8.19	4.42	4.10
110 Hp Tractor			0.63	14.35	12.34	9.04	7.77
Truck		0.70				2.50	2.50
Total						25.11	32.19
Production						11.65	20.32
Harvesting						13.46	11.87

Appendix B - Farm Record Forms for Each Stage of the Growing and Harvesting Season

Enterprise: __________________ Acres of land prepared: ______________________

Task: **Spring Soil Preparation**

		Mo/Day	Unit	Cost/unit*	Quantity	Comments
Machinery	50 Hp Tractor		Hp		hrs.	
(Please specify)	80 Hp Tractor		Hp		hrs.	
	110 Hp Tractor		Hp		hrs.	
	Plow		Hours		hrs.	
	Tiller		Hours		hrs.	
	Harrow		Hours		hrs.	
	Disk		Hours		hrs.	
	Hoe		Hours		hrs.	
Labor	Own		Hours		hrs	
	Family		Hours		hrs	
	Hired		Hours		hrs	
	Piecework		Hours		hrs	
Fuel			Gallons		gal	
Nutrients:	N		Pounds		lbs	
	P		Pounds		lbs	
	K		Pounds		lbs	
	Manure		Tonne		tn	
Spray material:	Insecticides					
(Please specify)	Fungicides					
	Herbicides:					
Irrigation	Energy					
	Water		Inches		in	
Organic practices:						
(Please specify)						

Enterprise: __________________ Acres of land planted: ________________________

Task: **Planting or Transplanting**

		Mo/ Day	Unit	Cost/unit*	Quantity	Comments
Machinery:	50 Hp Tractor		Hp		hrs	
(Please specify)	80 Hp Tractor		Hp		hrs	
	110 Hp Tractor		Hp		hrs	
	Cutter		Hours		hrs	
	Transplanter		Hours		hrs	
	Planter		Hours		hrs	
	Seeder		Hours		hrs	
Seeds			Pounds			
Seedlings			Plants			
Labor	Own		Hours		hrs	
	Family		Hours		hrs	
	Hired		Hours		hrs	
	Piecework		Hours		hrs	
Fuel			Gallons		gal	
Nutrients:	N		Pounds		lbs	
	P		Pounds		lbs	
	K		Pounds		lbs	
Lime			Tons		tns	
Spray materials:	Insecticide:					
(specify)	Fungicide:					
	Herbicide:					
Irrigation	Energy					
(specify)	Water		Inches		in	
Supplies	Plastic Mulch					
	Organic Mulch					
Organic Practices						
(specify)						

Enterprise: __________________ Acres of land planted: ______________________

Task: **Growing Season**

		Mo/Day	Unit	Cost/unit*	Quantity	Comments
Machinery:	50 Hp Tractor		Hp		hrs	
(Please specify)	80 Hp Tractor		Hp		hrs	
	110 Hp Tractor		Hp		hrs	
	Hyboy Sprayer		Hours		hrs	
	Cultivator		Hours		hrs	
Labor	Own		Hours		hrs	
	Family		Hours		hrs	
	Hired		Hours		hrs	
	Piecemeal		Hours		hrs	
Fuel			Gallons		gal	
Irrigation:	Energy					
	Water					
Fertigator:	N		Gallons		gal	
	P		Gallons		gal	
	K		Gallons		gal	
Nutrients:	Nitrogen		Pounds		lbs	
	Phosphorus		Pounds		lbs	
	Potash		Pounds		lbs	
	Manure		Tonne		tn	
Spray mtr:	Insecticide:					
(Please specify)	Fungicide:					
	Herbicide:					
Organic Practices						
(Please specify)						

Enterprise: __________________ Acres of land harvested: ______________________

Task: **Harvesting**

		Mo/Day	Unit	Cost/unit*	Quantity	Comments
Machinery	50 Hp Tractor		Hp		hrs	
(Please specify)	80 Hp Tractor		Hp		hrs	
	110 Hp Tractor		Hp		hrs	
	Belt Conveyor		Hours		hrs	
	Wagons		Hours		hrs	
	Pick-up Truck		Hours		hrs	
Labor	Own		Hours		hrs	
	Family		Hours		hrs	
	Hired		Hours		hrs	
	Piecemeal		Hours		hrs	
Fuel			Gallons		gal	
Spray materials:			Gallons		gal	
(please specify)						
Supplies	Boxes					
	Crates					
	Bushel Baskets					
Organic Practices						
(Please specify)						

Enterprise	/acre	Total
Acres		
Yield		
Price $/unit		
Sales		
Broker %	________	________
Gross Output		

Enterprise: __________________ Acres of land harvested: ____________________

Task: **Post-harvest Activities**

		Mo/Day	Unit	Price/unit*	Quantity	Comments
Machinery:	Belt Conveyor				hrs	
(Please specify)	Washers				hrs	
	Air Dryers				hrs	
	Sponge Rollers				hrs	
	Sorters				hrs	
	Bush Hog				hrs	
Labor	Own		Hours		hrs	
	Family		Hours		hrs	
	Hired		Hours		hrs	
	Piecemeal		Hours		hrs	
Fuel			Gallons		gal	
Supplies	Boxes					
	Bags					
	Cartons					
	Crates					
	Bulk Bins					
Marketing:	Hauling					
	Grading					
	Sizing					
	Packing					
	Cooling					
Disposal of Plastic Mulch						
Storage						
Organic Practices						
(Please specify)						

Enterprise: ________________ Acres of land harvested: ____________________

Task: **Fall Soil Preparation**

		Mo/Day	Unit	Cost/unit*	Quantity	Comments
Machinery:	50 Hp Tractor		Hp			
(Please specify)	80 Hp Tractor		Hp			
	110 Hp Tractor		Hp		hrs	
	Plow		Hours		hrs	
	Tiller		Hours		hrs	
	Harrow		Hours		hrs	
	Disk		Hours		hrs	
	Hoe		Hours		hrs	
	Fallowing Tools		Hours		hrs	
Seeding:	Cover (specify)		Bushels		bu	
	Other					
Seeding equip:						
(Please specify)						
Fuel			Gallons		gal	
Labor	Own		Hours		hrs	
	Family		Hours		hrs	
	Hired		Hours		hrs	
	Piecemeal		Hours		hrs	
Fertilizer:	N		Pounds		lbs	
	P		Pounds		lbs	
	K		Pounds		lbs	
Spray materials:	Insecticides:					
	Fungicides					
	Herbicides:					
Irrigation	Energy					
	Water					
Organic Practices						
(specify)						

Appendix C - Description of Variables of the Linear Programming Model

DEFINITIONS OF LINEAR PROGRAMMING ACTIVITIES (Variable Names)

Production Activities

PKNAF	Produce Kenaf for Sale
PSWMEL	Produce Seedless Watermelons for Sale
PHPOT	Produce Hayman Sweet Potatoes for Sale
PWMEL	Produce Watermelons for Sale
PBROC	Produce Broccoli for Sale
PPOT	Produce Potatoes for Sale
PSCUKE	Produce Spring Cucumbers for Sale
PFCUKE	Produce Fall Cucumbers for Sale
PSSNAP	Produce Spring Snap Beans for Sale
PFSNAP	Produce Fall Snap Beans for Sale
POPEP	Produce Overhead IrrigationBell Peppers for Sale
PDPEP	Produce Drip IrrigationBell Peppers for Sale
PCANT	Produce Cantaloupes for Sale
PSBLET	Produce Spring Boston Lettuce for Sale
PFBLET	Produce Fall Boston Lettuce for Sale
PSRLET	Produce Spring Romaine Lettuce for Sale
PFRLET	Produce Fall Romaine Lettuce for Sale
PDCSOY	Produce Double-crop Soybeans for Sale
PFSSOY	Produce Full-season Soybeans for Sale
PWHEAT	Produce Wheat for Sale
FLLOW	Fallow Land

Total Acreage

TACG	Total Acreage, Accounting Activity

Total Crop Acreage

TKNAFA	Total Kenaf Acreage, Accounting Activity
TSWMLA	Total Seedless Watermelon Acreage, Accounting Activity
THPOTA	Total Hayman Sweet Potatoe Acreage, Accounting Activity
TWMELA	Total Watermelon Acreage, Accounting Activity
TBROCA	Total Broccoli Acreage, Accounting Activity
TPOTA	Total Potatoe Acreage, Accounting Activity
TSCUKA	Total Spring Cucumber Acreage, Accounting Activity
TFCUKA	Total Fall Cucmber Acreage, Accounting Activity
TSSNPA	Total Spring Snap Beans Acreage, Accounting Activity
TFSNPA	Total Fall Snap Beans Acreage, Accounting Activity
TOPEPA	Total Overhead Irrigation Bell Pepper Acreage, Accounting Activity
TDPEPA	Total Drip-Irrigation Bell Pepper Acreage, Accounting Activity
TCANTA	Total Cantaloupe Acreage, Accounting Activity
TSBLTA	Total Spring Boston Lettuce Acreage, Accounting Activity
TFBLTA	Total Fall Boston Lettuce Acreage, Accounting Activity

TSRLTA	Total Spring Romaine Lettuce Acreage, Accounting Activity
TFRLTA	Total Fall Romaine Lettuce Acreage, Accounting Activity
TDSOYA	Total Double-crop Soybean Acreage, Accounting Activity
TFSOYA	Total Full-season Soybean Acreage, Accounting Activity
TWHETA	Total Wheat Acreage, Accounting Activity

Total Crop Sales

TKNAFS	Total Kenaf Sales, Accounting Activity
TSWMLS	Total Seedless Watermelon Sales, Accounting Activity
THPOTS	Total Hayman Sweet Potatoe Sales, Accounting Activity
TWMELS	Total Watermelon Sales, Accounting Activity
TBROCS	Total Broccoli Sales, Accounting Activity
TPOTS	Total Potatoe Sales, Accounting Activity
TSCUKS	Total Spring Cucumber Sales, Accounting Activity
TFCUKS	Total Fall Cucumber Sales, Accounting Activity
TSSBS	Total Spring Snap Beans Sales, Accounting Activity
TFSBS	Total Fall Snap Beans Sales, Accounting Activity
TOPEPS	Total Overhead IrrigationBell Pepper Sales, Accounting Activity
TDPEPS	Total Drip-IrrigationBell Pepper Sales, Accounting Activity
TCANTS	Total Cantaloupe Sales, Accounting Activity
TSBLTS	Total Spring Boston Lettuce Sales, Accounting Activity
TFBLTS	Total Fall Boston Lettuce Sales, Accounting Activity
TSRLTS	Total Spring Romaine Lettuce Sales, Accounting Activity
TFRLTS	Total Fall Romaine Lettuce Sales, Accounting Activity
TDSOYS	Total Double-crop Soybean Sales, Accounting Activity
TFSOYS	Total Full-season Soybean Sales, Accounting Activity
TWHETS	Total Wheat Sales, Accounting Activity

Total Irrigation Hours Used Annually

TOVIR	Total Overhead Irrigation Hours, Accounting Activity
TDRIR	Total Drip Irrigation Hours, Accounting Activity

Total Machine Hours Used Annually

SPLWTH	Total 3B Plow Hours Used, Accounting Activity
LPLWTH	Total 5B Plow Hours Used, Accounting Activity
SDSTH	Total 7 inch Disc Hours Used, Accounting Activity
MDSTH	Total 12 inch Disc Hours Used, Accounting Activity
LDSTH	Total 17 inch Disc Hours Used, Accounting Activity
POTPTH	Total Potatoe Planter Hours Used, Accounting Activity
SPLTH	Total 2 row Planter Hours Used, Accounting Activity
MPLTH	Total 3 row Planter Hours Used, Accounting Activity
LPLTH	Total 4 Row Planter Hours Used, Accounting Activity
WPLTH	Total Waterwheel Planter Hours Used, Accounting Activity
SCULTH	Total 2 row Cultivator Hours Used, Accounting Activity

LCULTH	Total 4 row Cultivator Hours Used, Accouting Activity
SRYTH	Total Sprayer Hours Used, Accounting Activity
SPRDTH	Total Spreader Hours Used, Accounting Activity
PLSTH	Total Plastic Combo Hours, Accounting Activity
POTHTH	Total Potatoe Harvester Hours Used, Accounting Activity
SBHTH	Total Snap Bean Harvester Hours Used, Accounting Activity
TRAITH	Total Trailer Hours Used, Accounting Activity
RTILTH	Total Pickup Truck Hours Used, Accounting Activity
COMBTH	Total Rotating Tiller Hours Used, Accounting Activity
CPLWTH	Total Driller Hours Used, Accounting Activity
STRCTH	Total Combine Hours Used, Accounting Activity
MTRCTH	Total Chisel Plow Hours Used, Accounting Activity
LTRCTH	Total 50 Hp Tractor Hours Used, Accounting Activity
TH80TR	Total 80 Hp Tractor Hours Used, Accounting Activity
TH110TR	Total 110 Hp Tractor Hours Used, Accounting Activity

Farm Supply Purchases

SDKNAF	Plants - Kenaf
SDSWML	Plants - Seedless Watermelon
SDHPOT	Plants - Hayman Sweet Potatoes
SDWML	Seeds - Broccoli
SDBROC	Seeds - Watermelon
SDPOT	Seeds - Potatoes
SDSCUK	Seeds - Spring Cucumbers
SDFCUK	Seeds - Fall Cucumbers
SDSSB	Seeds - Spring Snap Beans
SDFSB	Seeds - Fall Snap Beans
SDOPEP	Seeds - Bell Peppers (overhead)
SDDPEP	Seeds - Bell Peppers (drip)
SDCANT	Seeds - Cantaloupes
SDSBLT	Plants - Spring Boston Lettuce
SDFBLT	Plants - Fall Boston Lettuce
SDSRLT	Plants - Spring Romaine Lettuce
SDFRLT	Plants - Fall Romaine Lettuce
SDDSY	Seeds - Soybeans (FS)
SDFSY	Seeds - Soybeans (DC)
SDWHET	Seeds - Wheat
N	Fertilizer - N
P	Fertilizer - P
K	Fertilizer - K
DRIP	Fertigator
LIME	Lime
SPRED	Spreading
DUAL	Chemical - Dual 8E
SENC	Chemical - Sencor DF
COMD	Chemical - Command
DEVR	Chemical - Devrinol
TREF	Chemical - Treflan

KERB	Chemical - Kerb
CURB	Chemical - Curbit
POAST	Chemical - Poast
CRPOIL	Chemical - Cropoil
BLAZER	Chemical - Blazer
24D	Chemical - 2-4-D Amine
ALNUP	Chemical - Alanup
ADIOS	Chemical - Adios
PRFAR	Chemical - Prefar
POUNCE	Chemical - Pounce
ADMIR	Chemical - Admire
MONITR	Chemical - Monitor
THIDAN	Chemical - Thiodan 3EC
DIMETH	Chemical - Dimethoate
LANATE	Chemical - Lanate
OTHEN	Chemical - Orthene 75S
DIPL	Chemical - Dipel
SEVIN	Chemical - Sevin 4F
MOCAB	Chemical - Mocab
ASANA	Chemical - Asana XL
BRAVO	Chemical - Bravo
BRAVOR	Chemical - Ridomil Bravo
BNLATE	Chemical - Benlate
RIDMIL	Chemical - Ridomil
RDPC11	Chemical - Ridomil PC11
ROVRAL	Chemical - Rovral
BLETON	Chemical - Bayleton
TOPSIN	Chemical - Topsin M 4.5F
BROMID	Chemical - Bromide
COOL	Other Inputs - Cooling
CLNUP	Other Inputs - Cleanup
PSIC	Other Inputs - Plastic
MISC	Other Inputs - Miscellaneous
PMREP	Other Inputs - Production Machinery (Repairs)
PMFL	Other Inputs - Production Machinery (Fuel and Oil)
SPLIES	Other Inputs - Supplies
CUSTOM	Other Inputs - Custom Labor
HMREP	Other Inputs - Harvest Machinery (Repairs)
HMFL	Other Inputs - Harvest Machinery (Fuel and Oil)
HOUS	Other Inputs - Migrant Housing
INTER	Other Inputs - Interest
INSUR	Other Inputs - Insurance

Cost of Irrigation

IKNAF	Irrigationfor Kenaf
IWMEL	Irrigationfor Watermelons
ISWMEL	Irrigationfor Seedless Watermelons

IBROC	Irrigationfor Broccoli
IHPOT	Irrigationfor Hayman Sweet Potatoes
IPOT	Irrigationfor Potatoes
ISCUKE	Irrigationfor Spring Cucumbers
IFCUKE	Irrigationfor Fall Cucumers
ISSNAP	Irrigationfor Spring Snap Beans
IFSNAP	Irrigationfor Fall Snap Beans
IOPEP	Irrigationfor Bell Peppers (Overhead)
IDPEP	Irrigationfor Bell Peppers (Drip)
ICANT	Irrigationfor Cantaloupes
ISBLET	Irrigationfor Spring Boston Lettuce
IFBLET	Irrigationfor Fall Boston Lettuce
ISRLET	Irrigationfor Spring Romaine Lettuce
IFRLET	Irrigationfor Fall Romaine Lettuce
IWMEL	Irrigationfor Watermelon
IBROC	Irrigationfor Broccoli
IDCSOY	Irrigationfor Double-cropped Soybeans
IFSSOY	Irrigationfor Full-season Soybeans

Labor Use

LBOR1	Labor Use for Jan 1 - Jan 15
LBOR2	Labor Use for Jan 16 - Jan 30
LBOR3	Labor Use for Feb 1 - Feb 15
LBOR4	Labor Use for Feb 16 - Feb 28
LBOR5	Labor Use for Mar 1 - Mar 15
LBOR6	Labor Use for Mar 16 - Mar 30
LBOR7	Labor Use for Apr 1 - Apr 15
LBOR8	Labor Use for Apr 16 - Apr 30
LBOR9	Labor Use for May 1 - May 15
LBOR10	Labor Use for May 16 - May 30
LBOR11	Labor Use for Jun 1 - Jun 15
LBOR12	Labor Use for Jun 16 - Jun 30
LBOR13	Labor Use for Jul 1 - Jul 15
LBOR14	Labor Use for Jul 16 - Jul 30
LBOR15	Labor Use for Aug 1 - Aug 15
LBOR16	Labor Use for Aug 16 - Aug 30
LBOR17	Labor Use for Sep 1 - Sep 15
LBOR18	Labor Use for Sep 16 - Sep 30
LBOR19	Labor Use for Oct 1 - Oct 15
LBOR20	Labor Use for Oct 16 - Oct 30
LBOR21	Labor Use for Nov 1 - Nov 15
LBOR22	Labor Use for Nov 16 - Nov 30
LBOR23	Labor Use for Dec 1 - Dec 15
LBOR24	Labor Use for Dec 16 - Dec 30

Land Use

LND1	Land Use for Jan 1 - Jan 15
LND2	Land Use for Jan 16 - Jan 30
LND3	Land Use for Feb 1 - Feb 15
LND4	Land Use for Feb 16 - Feb 28
LND5	Land Use for Mar 1 - Mar 15
LND6	Land Use for Mar 16 - Mar 30
LND7	Land Use for Apr 1 - Apr 15
LND8	Land Use for Apr 16 - Apr 30
LND9	Land Use for May 1 - May 15
LND10	Land Use for May 16 - May 30
LND11	Land Use for Jun 1 - Jun 15
LND12	Land Use for Jun 16 - Jun 30
LND13	Land Use for Jul 1 - Jul 15
LND14	Land Use for Jul 16 - Jul 30
LND15	Land Use for Aug 1 - Aug 15
LND16	Land Use for Aug 16 - Aug 30
LND17	Land Use for Sep 1 - Sep 15
LND18	Land Use for Sep 16 - Sep 30
LND19	Land Use for Oct 1 - Oct 15
LND20	Land Use for Oct 16 - Oct 30
LND21	Land Use for Nov 1 - Nov 15
LND22	Land Use for Nov 16 - Nov 30
LND23	Land Use for Dec 1 - Dec 15
LND24	Land Use for Dec 16 - Dec 30

Land Rent Cost

LANDCST	Land Rent

Machine Use

50TR1	50 Hp Tractor Use for Jan 1 - Jan 15
50TR2	50 Hp Tractor Use for Jan 16 - Jan 30
50TR3	50 Hp Tractor Use for Feb 1 - Feb 15
50TR4	50 Hp Tractor Use for Feb 16 - Feb 28
50TR5	50 Hp Tractor Use for Mar 1 - Mar 15
50TR6	50 Hp Tractor Use for Mar 16 - Mar 30
50TR7	50 Hp Tractor Use for Apr 1 - Apr 15
50TR8	50 Hp Tractor Use for Apr 16 - Apr 30
50TR9	50 Hp Tractor Use for May 1 - May 15
50TR10	50 Hp Tractor Use for May 16 - May 30
50TR11	50 Hp Tractor Use for Jun 1 - Jun 15
50TR12	50 Hp Tractor Use for Jun 16 - Jun 30
50TR13	50 Hp Tractor Use for Jul 1 - Jul 15
50TR14	50 Hp Tractor Use for Jul 16 - Jul 30
50TR15	50 Hp Tractor Use for Aug 1 - Aug 15

50TR16	50 Hp Tractor Use for Aug 16 - Aug 30
50TR17	50 Hp Tractor Use for Sep 1 - Sep 15
50TR18	50 Hp Tractor Use for Sep 16 - Sep 30
50TR19	50 Hp Tractor Use for Oct 1 - Oct 15
50TR20	50 Hp Tractor Use for Oct 16 - Oct 30
50TR21	50 Hp Tractor Use for Nov 1 - Nov 15
50TR22	50 Hp Tractor Use for Nov 16 - Nov 30
50TR23	50 Hp Tractor Use for Dec 1 - Dec 15
50TR24	50 Hp Tractor Use for Dec 16 - Dec 30
80TR1	80 Hp Tractor Use for Jan 1 - Jan 15
80TR2	80 Hp Tractor Use for Jan 16 - Jan 30
80TR3	80 Hp Tractor Use for Feb 1 - Feb 15
80TR4	80 Hp Tractor Use for Feb 16 - Feb 28
80TR5	80 Hp Tractor Use for Mar 1 - Mar 15
80TR6	80 Hp Tractor Use for Mar 16 - Mar 30
80TR7	80 Hp Tractor Use for Apr 1 - Apr 15
80TR8	80 Hp Tractor Use for Apr 16 - Apr 30
80TR9	80 Hp Tractor Use for May 1 - May 15
80TR10	80 Hp Tractor Use for May 16 - May 30
80TR11	80 Hp Tractor Use for Jun 1 - Jun 15
80TR12	80 Hp Tractor Use for Jun 16 - Jun 30
80TR13	80 Hp Tractor Use for Jul 1 - Jul 15
80TR14	80 Hp Tractor Use for Jul 16 - Jul 30
80TR15	80 Hp Tractor Use for Aug 1 - Aug 15
80TR16	80 Hp Tractor Use for Aug 16 - Aug 30
80TR17	80 Hp Tractor Use for Sep 1 - Sep 15
80TR18	80 Hp Tractor Use for Sep 16 - Sep 30
80TR19	80 Hp Tractor Use for Oct 1 - Oct 15
80TR20	80 Hp Tractor Use for Oct 16 - Oct 30
80TR21	80 Hp Tractor Use for Nov 1 - Nov 15
80TR22	80 Hp Tractor Use for Nov 16 - Nov 30
80TR23	80 Hp Tractor Use for Dec 1 - Dec 15
80TR24	80 Hp Tractor Use for Dec 16 - Dec 30
110TR1	110 Hp Tractor Use for Jan 1 - Jan 15
110TR2	110 Hp Tractor Use for Jan 16 - Jan 30
110TR3	110 Hp Tractor Use for Feb 1 - Feb 15
110TR4	110 Hp Tractor Use for Feb 16 - Feb 28
110TR5	110 Hp Tractor Use for Mar 1 - Mar 15
110TR6	110 Hp Tractor Use for Mar 16 - Mar 30
110TR7	110 Hp Tractor Use for Apr 1 - Apr 15
110TR8	110 Hp Tractor Use for Apr 16 - Apr 30
110TR9	110 Hp Tractor Use for May 1 - May 15
110TR10	110 Hp Tractor Use for May 16 - May 30
110TR11	110 Hp Tractor Use for Jun 1 - Jun 15
110TR12	110 Hp Tractor Use for Jun 16 - Jun 30
110TR13	110 Hp Tractor Use for Jul 1 - Jul 15
110TR14	110 Hp Tractor Use for Jul 16 - Jul 30
110TR15	110 Hp Tractor Use for Aug 1 - Aug 15
110TR16	110 Hp Tractor Use for Aug 16 - Aug 30
110TR17	110 Hp Tractor Use for Sep 1 - Sep 15

110TR18	110 Hp Tractor Use for Sep 16 - Sep 30
110TR19	110 Hp Tractor Use for Oct 1 - Oct 15
110TR20	110 Hp Tractor Use for Oct 16 - Oct 30
110TR21	110 Hp Tractor Use for Nov 1 - Nov 15
110TR22	110 Hp Tractor Use for Nov 16 - Nov 30
110TR23	110 Hp Tractor Use for Dec 1 - Dec 15
110TR24	110 Hp Tractor Use for Dec 16 - Dec 30
3BPLOW	3B Plow Use
5BPLOW	5B Plow Use
CPLOW	Chisel Plow Use
7DISC	7 inch Disc Use
12DISC	12 inch Disc Use
17DISC	17 inch Disc Use
POTPL	Potatoe Planter Use
2RPLT	2 row Planter Use
3RPLT	3 row Planter Use
4RPLT	4 row Planter Use
WWPLT	Waterwheel Planter Use
2RCULT	2 row Cultivator Use
4RCULT	4 row Cultivator Use
SPRAY	Sprayer Use
SPREAD	Fertilizer Spreader Use
PLASTIC	Plastic Setter Use
POTHV	Potatoe Harvester Use
SBHV1	Snap Bean Harvester Use
TRAILER	Trailer Use
PTRUCK	Pick-up Truck
RTILL	Rotary Tiller Use
DRILL	Driller Use
COMB	Combine Use

Marketing Costs

MKNAF	Marketing Costs, Kenaf
MWMEL	Marketing Costs, Watermelons
MSWMEL	Marketing Costs, Seedless Watermelons
MBROC	Marketing Costs, Broccoli
MHPOT	Marketing Costs, Hayman Sweet Potatoes
MPOT	Marketing Costs, Potatoes
MSCUKE	Marketing Costs, Spring Cucumbers
MFCUKE	Marketing Costs, Fall Cucumbers
MSSNAP	Marketing Costs, Spring Snap Beans
MFSNAP	Marketing Costs, Fall Snap Beans
MOPEP	Marketing Costs, Bell Peppers (Overhead irrigation)
MDPEP	Marketing Costs, Bell Peppers (Drip irrigation)
MMEL	Marketing Costs, Cantaloupes
MSBLET	Marketing Costs, Spring Boston Lettuce
MFBLET	Marketing Costs, Fall Boston Lettuce
MSRLET	Marketing Costs, Spring Romaine Lettuce
MFRLET	Marketing Costs, Fall Romaine Lettuce

MDCSOY	Marketing Costs, Double-cropped Soybeans
MFSSOY	Marketing Costs, Full - season Soybean

Market Sales

SKNAF	Kenaf Sales
SWMEL	Watermelon Sales
SSWMEL	Seedless Watermelon Sales
SBROC	Broccoli Sales
SHPOT	Hayman Sweet Potatoe Sales
SPOT	Potatoe Sales
SSCUKE	Spring Cucumber Sales
SFCUKE	Fall Cucumber Sales
SSSNAP	Spring Snap Bean Sales
SFSNAP	Fall Snap Bean Sales
SOPEP	Bell Peppers (Overhead irrigation) Sales
SDPEP	Bell Peppers (Drip irrigation) Sales
SCANT	Cantaloupes Sales
SSBLET	Spring Boston Lettuce Sales
SFBLET	Fall Boston Lettuce Sales
SSRLET	Spring Romaine Lettuce Sales
SFRLLET	Fall Romaine Lettuce Sales
SDCSOY	Double-cropped Soybean Sales
SFSSOY	Full - season Soybean Sales

Definitions of Linear Programming Constraints

Labor Use Transfers

LABOR1	Labor Use for Jan 1 - Jan 15
LABOR2	Labor Use for Jan 16 - Jan 30
LABOR3	Labor Use for Feb 1 - Feb 15
LABOR4	Labor Use for Feb 16 - Feb 28
LABOR5	Labor Use for Mar 1 - Mar 15
LABOR6	Labor Use for Mar 16 - Mar 30
LABOR7	Labor Use for Apr 1 - Apr 15
LABOR8	Labor Use for Apr 16 - Apr 30
LABOR9	Labor Use for May 1 - May 15
LABOR10	Labor Use for May 16 - May 30
LABOR11	Labor Use for Jun 1 - Jun 15
LABOR12	Labor Use for Jun 16 - Jun 30
LABOR13	Labor Use for Jul 1 - Jul 15
LABOR14	Labor Use for Jul 16 - Jul 30
LABOR15	Labor Use for Aug 1 - Aug 15
LABOR16	Labor Use for Aug 16 - Aug 30
LABOR17	Labor Use for Sep 1 - Sep 15
LABOR18	Labor Use for Sep 16 - Sep 30
LABOR19	Labor Use for Oct 1 - Oct 15
LABOR20	Labor Use for Oct 16 - Oct 30
LABOR21	Labor Use for Nov 1 - Nov 15
LABOR22	Labor Use for Nov 16 - Nov 30
LABOR23	Labor Use for Dec 1 - Dec 15
LABOR24	Labor Use for Dec 16 - Dec 30

Land Use (When the Land is Being Used)

ACRES1	Land Use for Jan 1 - Jan 15
ACRES2	Land Use for Jan 16 - Jan 30
ACRES3	Land Use for Feb 1 - Feb 15
ACRES4	Land Use for Feb 16 - Feb 28
ACRES5	Land Use for Mar 1 - Mar 15
ACRES6	Land Use for Mar 16 - Mar 30
ACRES7	Land Use for Apr 1 - Apr 15
ACRES8	Land Use for Apr 16 - Apr 30
ACRES9	Land Use for May 1 - May 15
ACRES10	Land Use for May 16 - May 30
ACRES11	Land Use for Jun 1 - Jun 15
ACRES12	Land Use for Jun 16 - Jun 30
ACRES13	Land Use for Jul 1 - Jul 15
ACRES14	Land Use for Jul 16 - Jul 30
ACRES15	Land Use for Aug 1 - Aug 15
ACRES16	Land Use for Aug 16 - Aug 30
ACRES17	Land Use for Sep 1 - Sep 15
ACRES18	Land Use for Sep 16 - Sep 30

ACRES19	Land Use for Oct 1 - Oct 15
ACRES20	Land Use for Oct 16 - Oct 30
ACRES21	Land Use for Nov 1 - Nov 15
ACRES22	Land Use for Nov 16 - Nov 30
ACRES23	Land Use for Dec 1 - Dec 15
ACRES24	Land Use for Dec 16 - Dec 30

Land Use (Transfer Rows for Accounting Purposes)

Land1	Land Use for Jan 1 - Jan 15
Land2	Land Use for Jan 16 - Jan 30
Land3	Land Use for Feb 1 - Feb 15
Land4	Land Use for Feb 16 - Feb 28
Land5	Land Use for Mar 1 - Mar 15
Land6	Land Use for Mar 16 - Mar 30
Land7	Land Use for Apr 1 - Apr 15
Land8	Land Use for Apr 16 - Apr 30
Land9	Land Use for May 1 - May 15
Land10	Land Use for May 16 - May 30
Land11	Land Use for Jun 1 - Jun 15
Land12	Land Use for Jun 16 - Jun 30
Land13	Land Use for Jul 1 - Jul 15
Land14	Land Use for Jul 16 - Jul 30
Land15	Land Use for Aug 1 - Aug 15
Land16	Land Use for Aug 16 - Aug 30
Land17	Land Use for Sep 1 - Sep 15
Land18	Land Use for Sep 16 - Sep 30
Land19	Land Use for Oct 1 - Oct 15
Land20	Land Use for Oct 16 - Oct 30
Land21	Land Use for Nov 1 - Nov 15
Land22	Land Use for Nov 16 - Nov 30
Land23	Land Use for Dec 1 - Dec 15
Land24	Land Use for Dec 16 - Dec 30

Machine Use Transfer Rows

50TRC1	50 Hp Tractor Use for Jan 1 - Jan 15
50TRC2	50 Hp Tractor Use for Jan 16 - Jan 30
50TRC3	50 Hp Tractor Use for Feb 1 - Feb 15
50TRC4	50 Hp Tractor Use for Feb 16 - Feb 28
50TRC5	50 Hp Tractor Use for Mar 1 - Mar 15
50TRC6	50 Hp Tractor Use for Mar 16 - Mar 30
50TRC7	50 Hp Tractor Use for Apr 1 - Apr 15
50TRC8	50 Hp Tractor Use for Apr 16 - Apr 30
50TRC9	50 Hp Tractor Use for May 1 - May 15
50TRC10	50 Hp Tractor Use for May 16 - May 30
50TRC11	50 Hp Tractor Use for Jun 1 - Jun 15

50TRC12	50 Hp Tractor Use for Jun 16 - Jun 30
50TRC13	50 Hp Tractor Use for Jul 1 - Jul 15
50TRC14	50 Hp Tractor Use for Jul 16 - Jul 30
50TRC15	50 Hp Tractor Use for Aug 1 - Aug 15
50TRC16	50 Hp Tractor Use for Aug 16 - Aug 30
50TRC17	50 Hp Tractor Use for Sep 1 - Sep 15
50TRC18	50 Hp Tractor Use for Sep 16 - Sep 30
50TRC19	50 Hp Tractor Use for Oct 1 - Oct 15
50TRC20	50 Hp Tractor Use for Oct 16 - Oct 30
50TRC21	50 Hp Tractor Use for Nov 1 - Nov 15
50TRC22	50 Hp Tractor Use for Nov 16 - Nov 30
50TRC23	50 Hp Tractor Use for Dec 1 - Dec 15
50TRC24	50 Hp Tractor Use for Dec 16 - Dec 30
80TRC1	80 Hp Tractor Use for Jan 1 - Jan 15
80TRC2	80 Hp Tractor Use for Jan 16 - Jan 30
80TRC3	80 Hp Tractor Use for Feb 1 - Feb 15
80TRC4	80 Hp Tractor Use for Feb 16 - Feb 28
80TRC5	80 Hp Tractor Use for Mar 1 - Mar 15
80TRC6	80 Hp Tractor Use for Mar 16 - Mar 30
80TRC7	80 Hp Tractor Use for Apr 1 - Apr 15
80TRC8	80 Hp Tractor Use for Apr 16 - Apr 30
80TRC9	80 Hp Tractor Use for May 1 - May 15
80TRC10	80 Hp Tractor Use for May 16 - May 30
80TRC11	80 Hp Tractor Use for Jun 1 - Jun 15
80TRC12	80 Hp Tractor Use for Jun 16 - Jun 30
80TRC13	80 Hp Tractor Use for Jul 1 - Jul 15
80TRC14	80 Hp Tractor Use for Jul 16 - Jul 30
80TRC15	80 Hp Tractor Use for Aug 1 - Aug 15
80TRC16	80 Hp Tractor Use for Aug 16 - Aug 30
80TRC17	80 Hp Tractor Use for Sep 1 - Sep 15
80TRC18	80 Hp Tractor Use for Sep 16 - Sep 30
80TRC19	80 Hp Tractor Use for Oct 1 - Oct 15
80TRC20	80 Hp Tractor Use for Oct 16 - Oct 30
80TRC21	80 Hp Tractor Use for Nov 1 - Nov 15
80TRC22	80 Hp Tractor Use for Nov 16 - Nov 30
80TRC23	80 Hp Tractor Use for Dec 1 - Dec 15
80TRC24	80 Hp Tractor Use for Dec 16 - Dec 30
110TRC1	110 Hp Tractor Use for Jan 1 - Jan 15
110TRC2	110 Hp Tractor Use for Jan 16 - Jan 30
110TRC3	110 Hp Tractor Use for Feb 1 - Feb 15
110TRC4	110 Hp Tractor Use for Feb 16 - Feb 28
110TRC5	110 Hp Tractor Use for Mar 1 - Mar 15
110TRC6	110 Hp Tractor Use for Mar 16 - Mar 30
110TRC7	110 Hp Tractor Use for Apr 1 - Apr 15
110TRC8	110 Hp Tractor Use for Apr 16 - Apr 30
110TRC9	110 Hp Tractor Use for May 1 - May 15
110TRC10	110 Hp Tractor Use for May 16 - May 30
110TRC11	110 Hp Tractor Use for Jun 1 - Jun 15
110TRC12	110 Hp Tractor Use for Jun 16 - Jun 30
110TRC13	110 Hp Tractor Use for Jul 1 - Jul 15

110TRC14	110 Hp Tractor Use for Jul 16 - Jul 30
110TRC15	110 Hp Tractor Use for Aug 1 - Aug 15
110TRC16	110 Hp Tractor Use for Aug 16 - Aug 30
110TRC17	110 Hp Tractor Use for Sep 1 - Sep 15
110TRC18	110 Hp Tractor Use for Sep 16 - Sep 30
110TRC19	110 Hp Tractor Use for Oct 1 - Oct 15
110TRC20	110 Hp Tractor Use for Oct 16 - Oct 30
110TRC21	110 Hp Tractor Use for Nov 1 - Nov 15
110TRC22	110 Hp Tractor Use for Nov 16 - Nov 30
110TRC23	110 Hp Tractor Use for Dec 1 - Dec 15
110TRC24	110 Hp Tractor Use for Dec 16 - Dec 30
3PLOW	3B Plow Use
5PLOW	5B Plow Use
CHPLOW	Chisel Plow Use
7INDISC	7 inch Disc Use
12INDISC	12 inch Disc Use
17INDISC	17 inch Disc Use
POTPLANT	Potatoe Planter Use
2RPLANT	2 row Planter Use
3RPLANT	3 row Planter Use
4RPLANT	4 row Planter Use
WWPLANT	Waterwheel Planter Use
2RWCULT	2 row Cultivator Use
4RWCULT	4 row Cultivator Use
SPRAYER	Sprayer Use
SPREADER	Fertilizer Spreader Use
PLASTC	Plastic Setter Use
POTHARV	Potatoe Harvester Use
SBHARV	Snap Bean Harvester Use
TRAIL	Trailer Use
PUTRUCK	Pick-up Truck
ROTILL	Rotary Tiller Use
DRILLER	Driller Use
COMBINE	Combine Use

Irrigation Costs Transfer Rows

IKENAF	Irrigation for Kenaf
IWMELON	Irrigation for Watermelons
ISWMELON	Irrigation for Seedless Watermelons
IBROCLI	Irrigation for Broccoli
IHYPOT	Irrigation for Hayman Sweet Potatoes
IPOTAT	Irrigation for Potatoes
ISPCUKE	Irrigation for Spring Cucumbers
IFACUKE	Irrigation for Fall Cucumers
ISPSNAP	Irrigation for Spring Snap Beans
IFASNAP	Irrigation for Fall Snap Beans
IOVPEP	Irrigation for Bell Peppers (overhead)
IDRPEP	Irrigation for Bell Peppers (drip)

ICANTL	Irrigation for Melons
ISPBLET	Irrigation for Spring Boston Lettuce
IFABLET	Irrigation for Fall Boston Lettuce
ISPRLET	Irrigation for Spring Romaine Lettuce
IFARLET	Irrigation for Fall Romaine Lettuce
IDCSOYB	Irrigation for Double-cropped Soybeans
IFSSOYB	Irrigation for Full-season Soybeans

Input Costs Transfer Rows

SDKENAF	Plants - Kenaf
SDWMELN	Seeds - Watermelon
SDSWMELN	Plants - Seedless Watermelon
SDBROCL	Seeds - Broccoli
SDHPOTAT	Plants - Hayman Sweet Potatoes
SDPOTAT	Seeds - Potatoes
SDSPCUKE	Seeds - Spring Cucumbers
SDFACUKE	Seeds - Fall Cucumbers
SDSPSNAP	Seeds - Spring Snap Beans
SDFASNAP	Seeds - Fall Snap Beans
SDOVPEP	Seeds - Bell Peppers
SDCANTL	Seeds - Cantaloupes
SDSPBLET	Plants - Spring Boston Lettuce
SDFABLET	Plants - Fall Boston Lettuce
SDSPRLET	Plants - Spring Romaine Lettuce
SDFARLET	Plants - Fall Romaine Lettuce
SDSOYB	Seeds - Soybeans
N	Fertilizer - N
P	Fertilizer - P
K	Fertilizer - K
DRIP	Fertigator
LIME	Lime
SPREAD	Spreading
DUAL8E	Chemical - Dual 8E
SENCOR	Chemical - Sencor DF
COMDAND	Chemical - Command
DEVRINOL	Chemical - Devrinol
TREFLAN	Chemical - Treflan
KERB	Chemical - Kerb
CURBIT	Chemical - Curbit
POASTT	Chemical - Poast
CROPOIL	Chemical - Cropoil
BLZER	Chemical - Blazer
2-4-DA	Chemical - 2-4-D Amine
ALANUP	Chemical - Alanup
ADIOS	Chemical - Adios
PREFAR	Chemical - Prefar
POUNCE	Chemical - Pounce
ADMIRE	Chemical - Admire

MONITOR	Chemical - Monitor
THIODAN	Chemical - Thiodan 3EC
DIMETHO	Chemical - Dimethoate
LANATE	Chemical - Lanate
ORTHENE	Chemical - Orthene 75S
DIPEL	Chemical - Dipel
SEVIN	Chemical - Sevin 4F
MOCAB	Chemical - Mocab
ASANA	Chemical - Asana XL
BRAVO	Chemical - Bravo
RIDMBRV	Chemical - Ridomil Bravo
BENLATE	Chemical - Benlate
RIDOML	Chemical - Ridomil
RIDPC11	Chemical - Ridomil PC11
ROVRAL	Chemical - Rovral
BAYLETON	Chemical - Bayleton
TOPSIN	Chemical - Topsin M 4.5F
BROMIDE	Chemical - Bromide
COOLIN	Other Inputs - Cooling
CLEANUP	Other Inputs - Cleanup
PSTIC	Other Inputs - Plastic Mulch
PSTICDP	Other Inputs - Plastic Mulch Disposal
OIRR	Other Inputs - Overhead Irrigation
DIRR	Other Inputs - Drip Irrigation
MISCEL	Other Inputs - Miscellaneous
PRODMREP	Other Inputs - Production Machinery (Repair)
PRODMFL	Other Inputs - Production Machinery (Fuel and Oil)
SUPLIES	Other Inputs - Supplies
CONTAIN	Other Inputs - Containers per Specific Crop
CUSTO	Other Inputs - Custom Labor?
HARVMREP	Other Inputs - Harvest Machinery (Repair)
HARVMFL	Other Inputs - Harvest Machinery (Fuel and Oil)
HAULIN	Other Inputs - Hauling
THININ	Other Inputs - Thinning

Total Acreage Accounting Constraint

TACRES	Accounting Constraint, Total Acreage

Crop Acreage Accounting Constraint

TKENAFA	Accounting Constraint, Total Kenaf Acreage
TWAMELA	Accounting Constraint, Total Watermelon Acreage
TSWAMELA	Accounting Constraint, Total Seedless Watermelon Acreage
TBROCLA	Accounting Constraint, Total Broccoli Acreage
THPOTATA	Accounting Constraint, Total Hayman Sweet Potatoe Acreage
TPOTATA	Accounting Constraint, Total Potatoe Acreage
TSPCUKEA	Accounting Constraint, Total Spring Cucumber Acreage
TFACUKEA	Accounting Constraint, Total Fall Cucmber Acreage

TSPSNAPA	Accounting Constraint, Total Spring Snap Beans Acreage
TFASNAPA	Accounting Constraint, Total Fall Snap Beans Acreage
TOVPEPA	Accounting Constraint, Total overhead irrigation Bell Pepper Acreage
TDRPEPA	Accounting Constraint, Total drip-irrigation Bell Pepper Acreage
TCANTLA	Accounting Constraint, Total Cantaloupe Acreage
TSPBLETA	Accounting Constraint, Total Spring Boston Lettuce Acreage
TFABLETA	Accounting Constraint, Total Fall Boston Lettuce Acreage
TSPRLETA	Accounting Constraint, Total Spring Romaine Lettuce Acreage
TFARLETA	Accounting Constraint, Total Fall Romaine Lettuce Acreage
TDCSOYBA	Accounting Constraint, Total Double-crop Soybean Acreage
TFSSOYBA	Accounting Constraint, Total Full-season Soybean Acreage

Crop Sales Accounting Constraint

TKENAFS	Accounting Constraint, Total Kenaf Sales
PWAMELS	Accounting Constraint, Total Watermelon Sales
PSWAMELS	Accounting Constraint, Total Seedless Watermelon Sales
PBROCLS	Accounting Constraint, Total Broccoli Sales
THPOTATS	Accounting Constraint, Total Hayman Sweet Potatoe Sales
TPOTATS	Accounting Constraint, Total Potatoe Sales
TSPCUKES	Accounting Constraint, Total Spring Cucumber Sales
TFACUKES	Accounting Constraint, Total Fall Cucumber Sales
TSPSNAPS	Accounting Constraint, Total Spring Snap Beans Sales
TFASNAPS	Accounting Constraint, Total Fall Snap Beans Sales
TOVPEPS	Accounting Constraint, Total Overhead irrigation Bell Pepper Sales
TDRPEPS	Accounting Constraint, Total Drip-irrigation Bell Pepper Sales
TCANTLS	Accounting Constraint, Total Cantaloupe Sales
TSPBLETS	Accounting Constraint, Total Spring Boston Lettuce Sales
TFABLETS	Accounting Constraint, Total Fall Boston Lettuce Sales
TSPRLETS	Accounting Constraint, Total Spring Romaine Lettuce Sales
TFARLETS	Accounting Constraint, Total Fall Romaine Lettuce Sales
TDCSOYBS	Accounting Constraint, Total Double-crop Soybean Acreage
TFSSOYBS	Accounting Constraint, Total Full-season Soybean Acreage

Machine Hours Used Accounting Constraint

3PLOWH	Accounting Constraint, 3B Plow Hours Used
5PLOWH	Accounting Constraint, 5B Plow Hours Used
CHPLOWH	Accounting Constraint, Chisel Plow Hours Used
7DISCH	Accounting Constraint, 7 inch Disc Hours Used
12DISCH	Accounting Constraint, 12 inch Disc Hours Used
17DISCH	Accounting Constraint, 17 inch Disc Hours Used
PPLANTH	Accounting Constraint, Potatoe Planter Hours Used
2PLANTH	Accounting Constraint, 2 row Planter Hours Used
3PLANTH	Accounting Constraint, 3 row Planter Hours Used
4PLANTH	Accounting Constraint, 4 row Planter Hours Used
WWPLANTH	Accounting Constraint, Waterwheel Planter Hours Used
2WCULTH	Accounting Constraint, 2 row Cultivator Hours Used
4WCULTH	Accounting Constraint, 4 row Cultivator Hours Used

SPRAYH	Accounting Constraint, Sprayer Hours Used
SPREADH	Accounting Constraint, Fertilizer Spreader Hours Used
PLASTCH	Accounting Constraint, Plastic Setter Hours Used
PHARVH	Accounting Constraint, Potatoe Harvester Hours Used
SBHARVH	Accounting Constraint, Snap Bean Harvester Hours Used
TRAILH	Accounting Constraint, Trailer Hours Used
PTRUCKH	Accounting Constraint, Pick-up Truck
ROTILLH	Accounting Constraint, Rotary Tiller Hours Used
DRILLH	Accounting Constraint, Driller Hours Used
COMBINEH	Accounting Constraint, Combine Hours Used

Marketing Constraint

MKENAF	Marketing Constraint, Kenaf
MWAMEL	Marketing Constraint, Watermelons
MSWAMEL	Marketing Constraint, Seedless Watermelons
MBROCL	Marketing Constraint, Broccoli
MHPOTAT	Marketing Constraint, Hayman Sweet Potatoes
MPOTAT	Marketing Constraint, Potatoes
MSPCUKE	Marketing Constraint, Spring Cucumbers
MFACUKE	Marketing Constraint, Fall Cucumbers
MSPSNAP	Marketing Constraint, Spring Snap Beans
MFASNAP	Marketing Constraint, Fall Snap Beans
MOVPEP	Marketing Constraint, Bell Peppers (overhead irrigation)
MDRPEP	Marketing Constraint, Bell Peppers (drip irrigation)
MCANTL	Marketing Constraint, Cantaloupes
MSPBLET	Marketing Constraint, Spring Boston Lettuce
MFABLET	Marketing Constraint, Fall Boston Lettuce
MSPRLET	Marketing Constraint, Spring Romaine Lettuce
MFARLET	Marketing Constraint, Fall Romaine Lettuce
MDCSOYB	Marketing Constraint, Double-cropped Soybeans
MFSSOYB	Marketing Constraint, Full - season Soybean

Constraint on the Total Amount of Land Available

PRODLAND Total Amount of Land Available for Production

Land Use Transfer

LANDRNT Land Cost Transfer

Fallow Land Constraint

FALLOW Fallow Land Constraint

Rotation Constraint

LROT	Leguminosae or Pulse Family Rotation
RROT	Convolvulaceae or Root Family Rotation
GROT	Gramineae or Grass Family Rotation
CROT	Compositae or Composite Family Rotation
GUROT	Curcurbitaceae or Gourd Family Rotation
MROT	Cruciferae or Mustard Family Rotation
SROT	Solanaceae or Nightshade Family Rotation

Appendix D - Results of the Economic Feasibility Analysis: Scenarios

Appendix D: Table 1 - Financial Summary for Scenario 1 - Grain Farm.

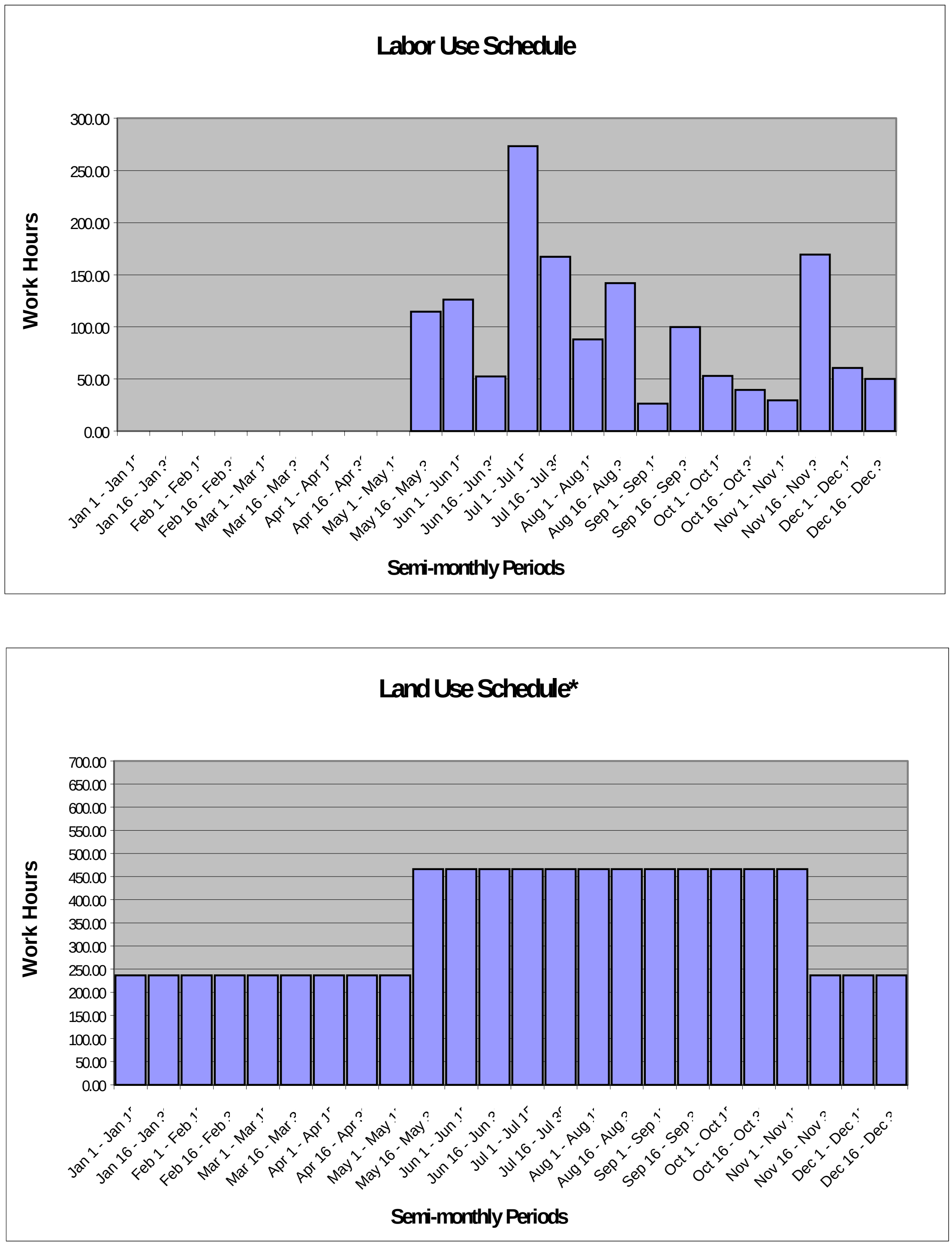
Financial Summary

Revenues

Fresh Vegetable Sales	Acres	Sale Units	Dollars Per Sale Unit		Sales
Kenaf	0.00	0.00	70.00	$	-
Seedless Watermelon	0.00	0.00	9.00	$	-
Hayman Potatoes	0.00	0.00	13.00	$	-
Watermelon	0.00	0.00	9.56	$	-
Broccoli	0.00	0.00	10.58	$	-
Irish Potatoes	0.00	0.00	10.87	$	-
Spring Cucumbers	0.00	0.00	13.29	$	-
Fall Cucumbers	0.00	0.00	10.07	$	-
Spring Snapbeans	0.00	0.00	16.26	$	-
Fall Snapbeans	0.00	0.00	10.94	$	-
Green Bell Peppers (over)	0.00	0.00	9.38	$	-
Green Bell Peppers (drip)	0.00	0.00	9.52	$	-
Cantaloupes	0.00	0.00	10.93	$	-
Spring Boston Lettuce	0.00	0.00	8.30	$	-
Fall Boston Lettuce	0.00	0.00	8.57	$	-
Spring Romaine Lettuce	0.00	0.00	10.36	$	-
Fall Romaine Lettuce	0.00	0.00	10.50	$	-
Double-cropped soybeans	166.67	7500.00	6.00	$	45,000.00
Full season soybeans	229.23	10315.19	6.00	$	61,891.12
Wheat	166.67	13333.33	3.00	$	40,000.00
Total	562.56			**$**	**146,891.12**

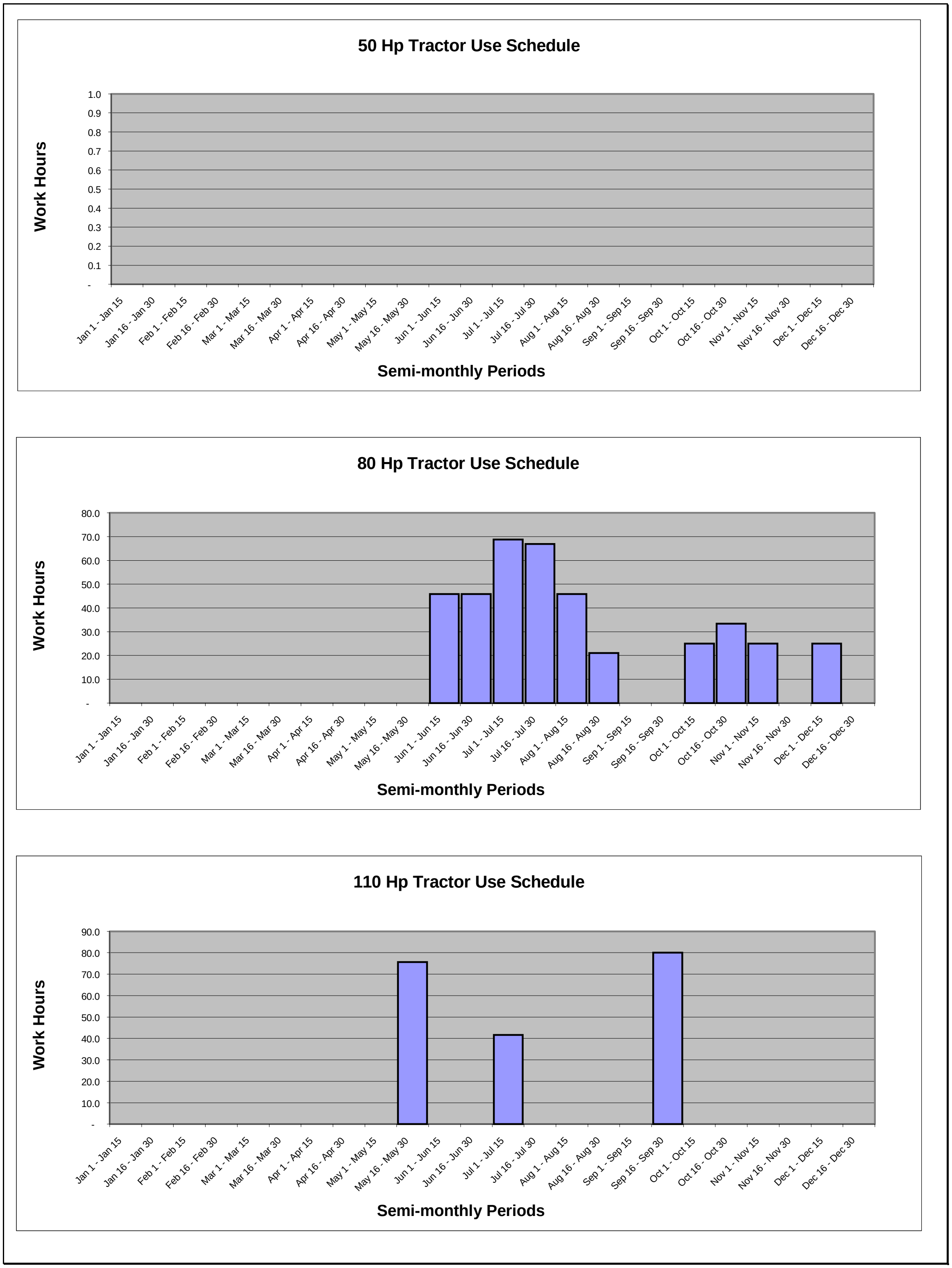
Total Revenue	**$**	**146,891.12**
Expenses		
Farm Input Purchases	$	87,871.32
Production Labor Costs	$	8,952.78
Total Irrigation Costs	$	-
Transportation Costs*	$	-
Packaging, Handling & Sales*	$	-
Brokerage Fee*	$	-
Overhead Labor**	$	37,127.22
Farm Equipment	$	-
Total Expenses	**$**	**133,951.32**
Net Returns to Land, Management and Capital	**$**	**12,939.80**

* Costs deducted from the terminal market price to calculate the farm-gate price
** Calculated after deducting production labor costs.



* Includes 70 acres of land not in direct production

Appendix D: Figure 1 – Land and Labor Use for Scenario 1 – Grain Farm



Appendix D: Figure 2 – Tractor Use for Scenario 1 of – Grain Farm

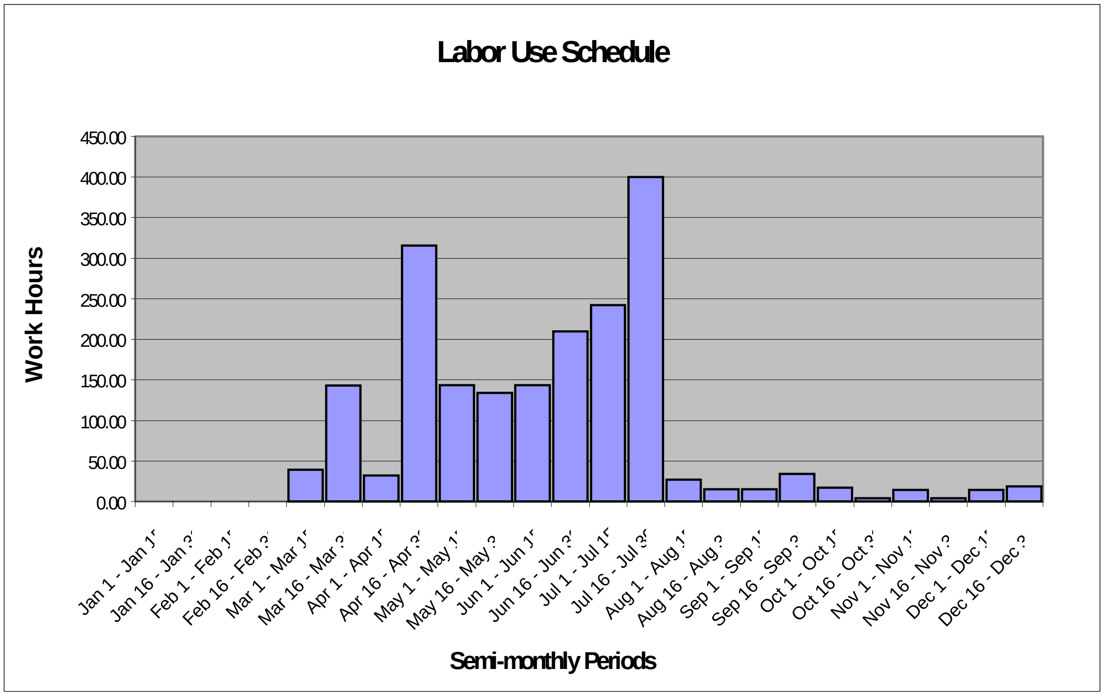
Appendix D: Table 2 - Financial Summary for Scenario 1 – Vegetable Farm

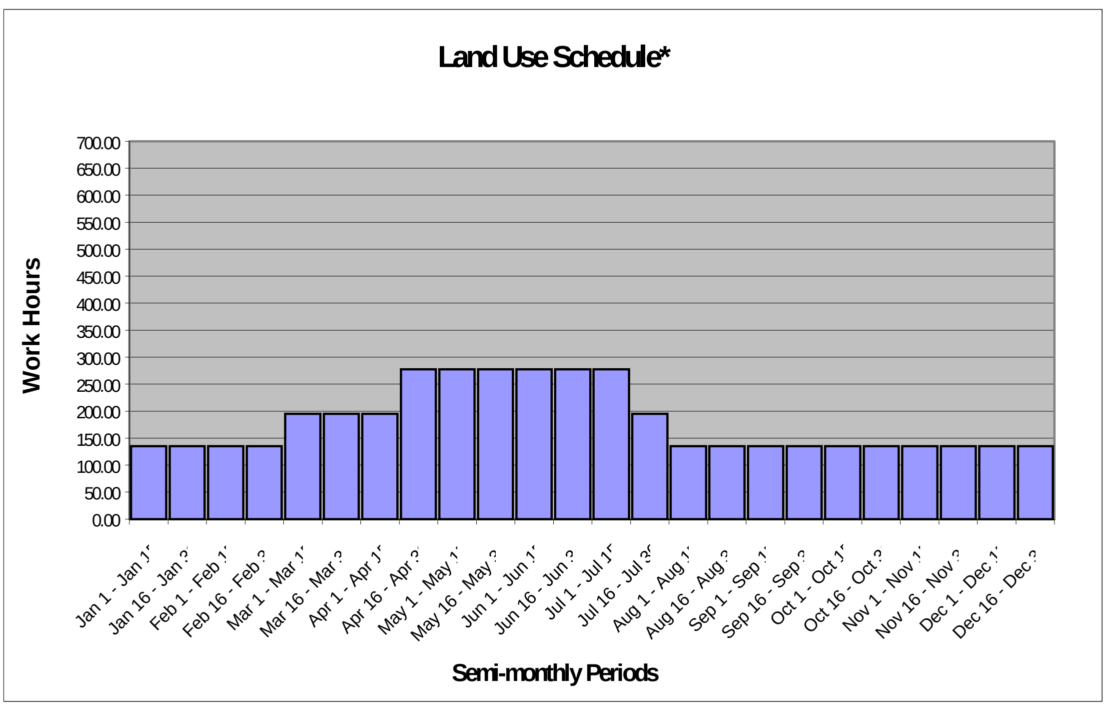
Financial Summary

Revenues

Fresh Vegetable Sales	Acres	Sale Units	Dollars Per Sale Unit		Sales
Kenaf	0.00	0.00	70.00	$	-
Seedless Watermelon	0.00	0.00	9.00	$	-
Hayman Potatoes	0.00	0.00	13.00	$	-
Watermelon	0.00	0.00	9.56	$	-
Broccoli	0.00	0.00	9.78	$	-
Irish Potatoes	60.00	9000.00	10.87	$	97,830.00
Spring Cucumbers	82.51	14438.94	10.92	$	157,673.27
Fall Cucumbers	0.00	0.00	9.40	$	-
Spring Snapbeans	0.00	0.00	12.82	$	-
Fall Snapbeans	0.00	0.00	10.83	$	-
Green Bell Peppers (over)	0.00	0.00	9.38	$	-
Green Bell Peppers (drip)	0.00	0.00	9.52	$	-
Cantaloupes	0.00	0.00	10.93	$	-
Spring Boston Lettuce	0.00	0.00	9.23	$	-
Fall Boston Lettuce	0.00	0.00	8.97	$	-
Spring Romaine Lettuce	0.00	0.00	12.04	$	-
Fall Romaine Lettuce	0.00	0.00	10.36	$	-
Double-cropped soybeans	65.15	2280.13	6.00	$	13,680.78
Full season soybeans	0.00	0.00	6.00	$	-
Wheat	65.15	5211.73	3.00	$	15,635.18
Total	272.80			**$**	**284,819.23**
Total Revenue				**$**	**284,819.23**
Expenses					
Farm Input Purchases				$	111,057.07
Production Labor Costs				$	11,800.09
Total Irrigation Costs				$	4,860.00
Transportation Costs*				$	16,749.17
Packaging, Handling & Sales*				$	31,765.68
Brokerage Fee*				$	31,476.90
Overhead Labor**				$	45,799.91
Farm Equipment				$	-
Total Expenses				**$**	**253,508.82**
Net Returns to Land, Management and Capital				**$**	**31,310.40**

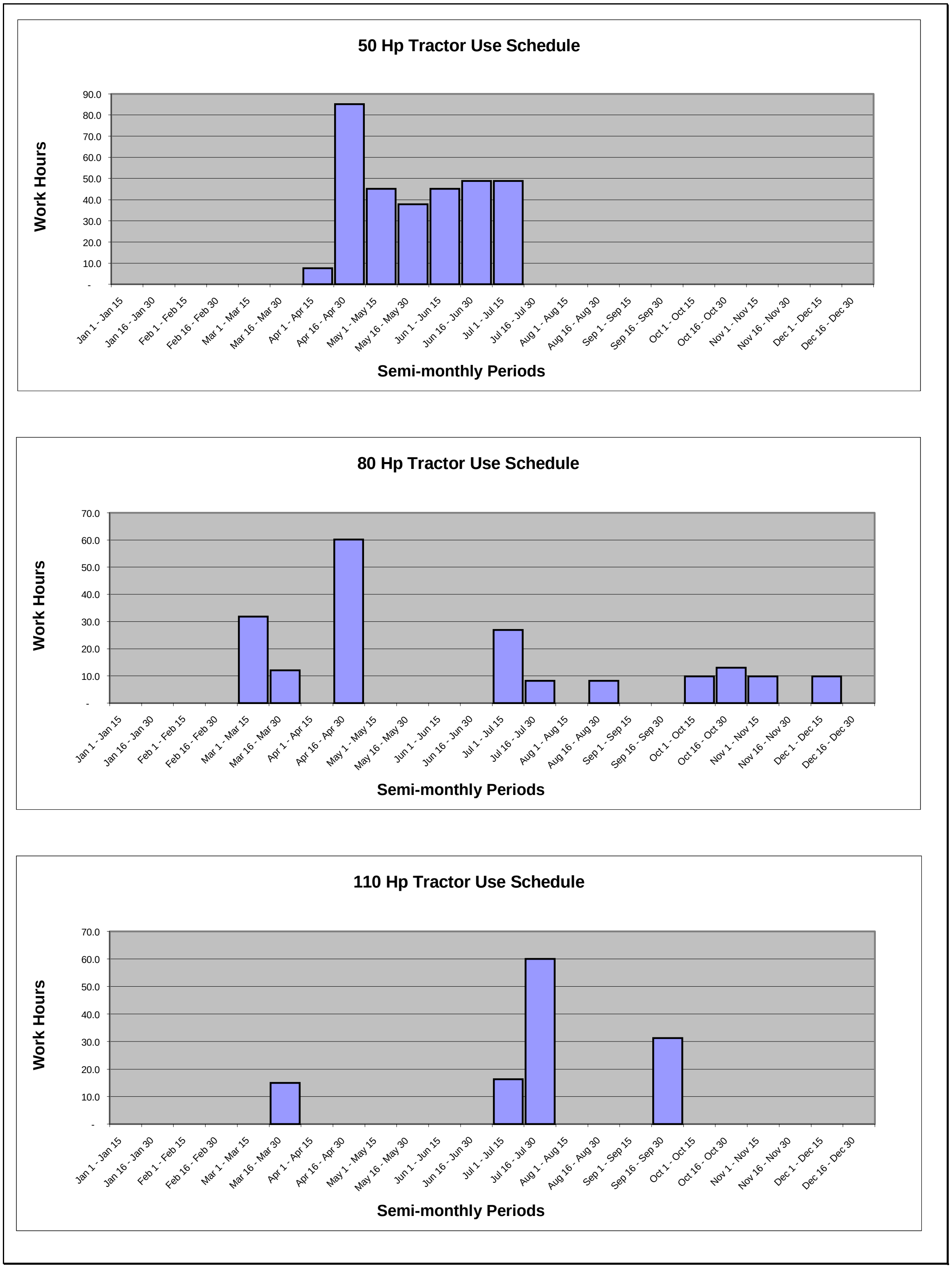
* Costs deducted from the terminal market prices to calculate farm-gate price
** Calculated after deducting variable labor costs.





* Includes 70 acres of land not in direct production

Appendix D: Figure 3 - Land and Labor Use for Scenario 1 – Vegetable Farm



Appendix D: Figure 4 – Tractor Use for Scenario 1 – Vegetable Farm

Appendix D: Table 3 - Financial Summary for Scenario 2 – Grain Farm

Financial Summary

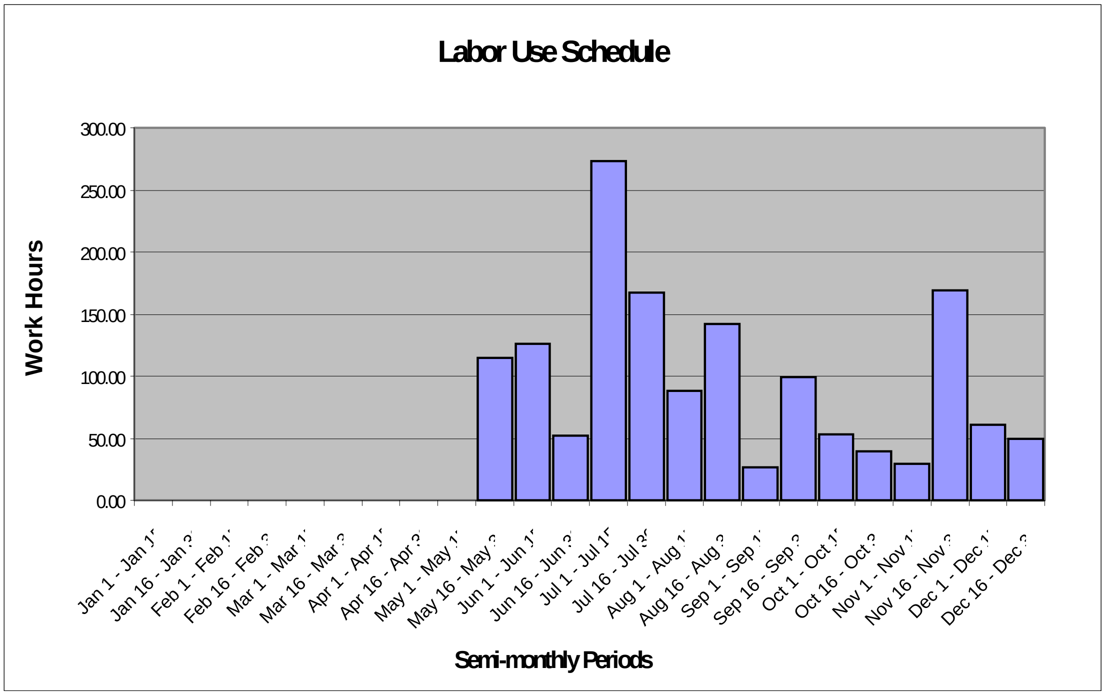
Revenues

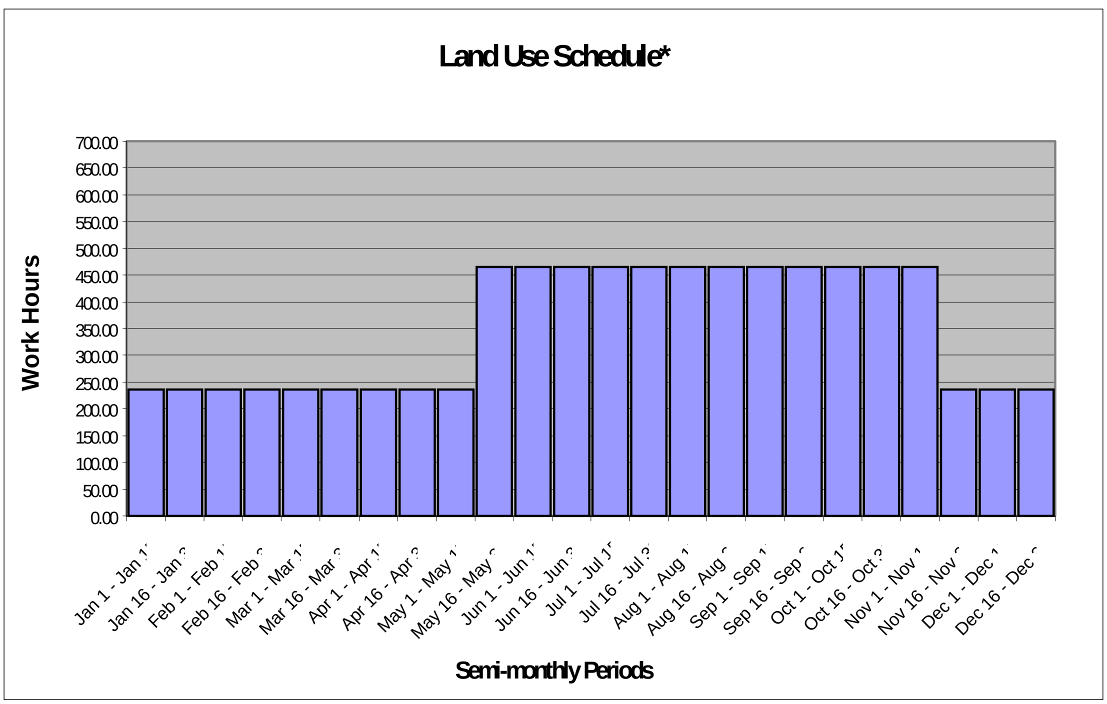
Fresh Vegetable Sales	Acres	Sale Units	Dollars Per Sale Unit		Sales
Kenaf	0.00	0.00	70.00	$	-
Seedless Watermelon	0.00	0.00	9.00	$	-
Hayman Potatoes	0.00	0.00	13.00	$	-
Watermelon	0.00	0.00	9.56	$	-
Broccoli	0.00	0.00	10.58	$	-
Irish Potatoes	0.00	0.00	10.87	$	-
Spring Cucumbers	0.00	0.00	13.29	$	-
Fall Cucumbers	0.00	0.00	10.07	$	-
Spring Snapbeans	0.00	0.00	16.26	$	-
Fall Snapbeans	0.00	0.00	10.94	$	-
Green Bell Peppers (over)	0.00	0.00	9.38	$	-
Green Bell Peppers (drip)	0.00	0.00	9.52	$	-
Cantaloupes	0.00	0.00	10.93	$	-
Spring Boston Lettuce	0.00	0.00	8.30	$	-
Fall Boston Lettuce	0.00	0.00	8.57	$	-
Spring Romaine Lettuce	0.00	0.00	10.36	$	-
Fall Romaine Lettuce	0.00	0.00	10.50	$	-
Double-cropped soybeans	166.67	7500.00	6.00	$	45,000.00
Full season soybeans	229.23	10315.19	6.00	$	61,891.12
Wheat	166.67	13333.33	3.00	$	40,000.00
Total	562.56			**$**	**146,891.12**

Total Revenue	**$**	**146,891.12**
Expenses		
Farm Input Purchases	$	87,871.32
Production Labor Costs	$	8,952.78
Total Irrigation Costs	$	-
Transportation Costs*	$	-
Packaging, Handling & Sales*	$	-
Brokerage Fee*	$	-
Overhead Labor**	$	37,127.22
Farm Equipment	$	-
Total Expenses	**$**	**133,951.32**
Net Returns to Land, Management and Capital	**$**	**12,939.80**

* Costs deducted from the terminal market price to calculate the farm-gate price

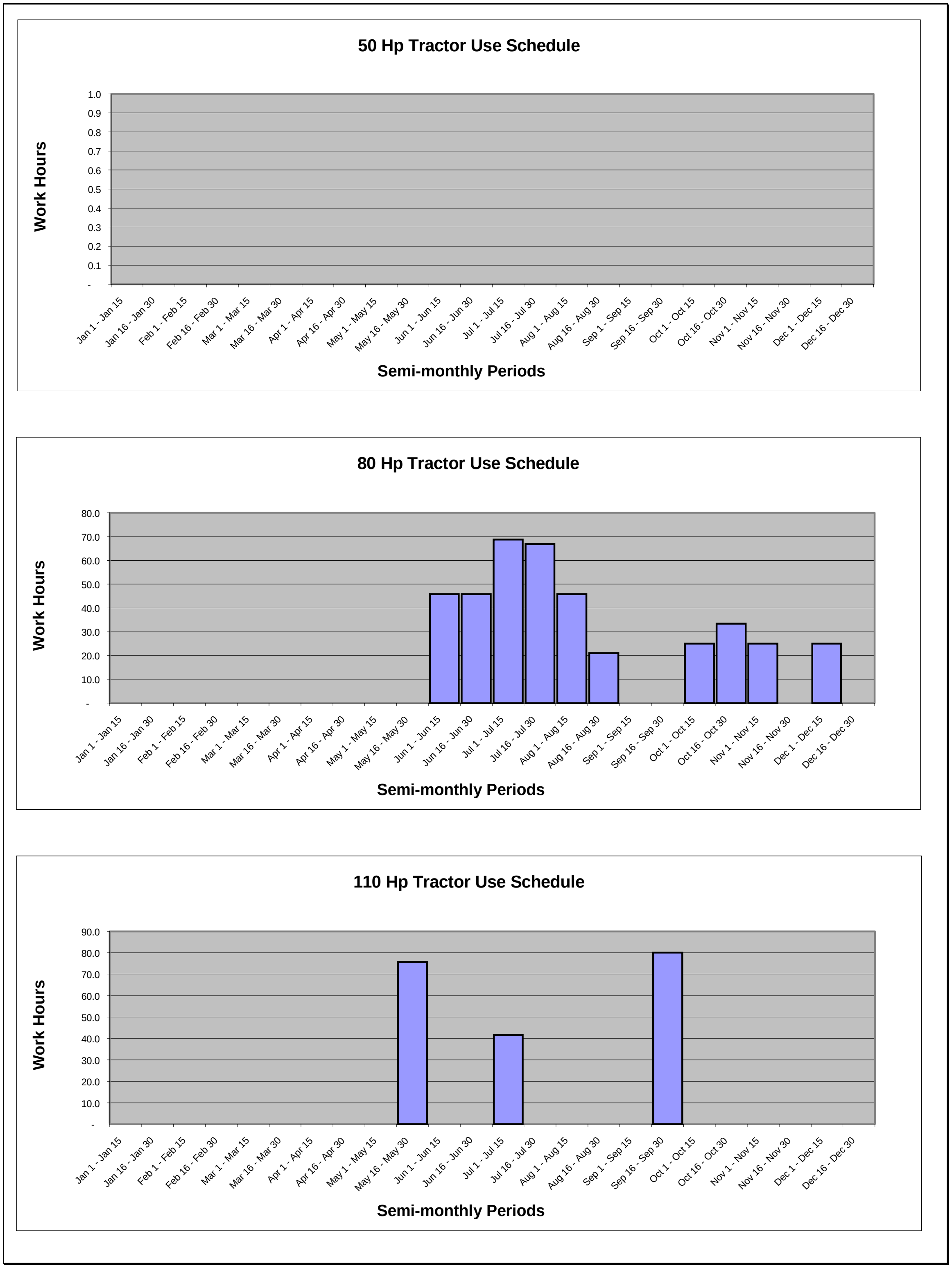
** Calculated after deducting the variable labor costs.





* Includes 70 acres of land not in direct production

Appendix D: Figure 5 – Land and Labor Use for Scenario 2 – Grain Farm.



Appendix D: Figure 6 – Tractor Use for Scenario 2 – Grain Farm.

Appendix D: Table 4 – Financial Summary for Scenario 2 – Vegetable Farm.

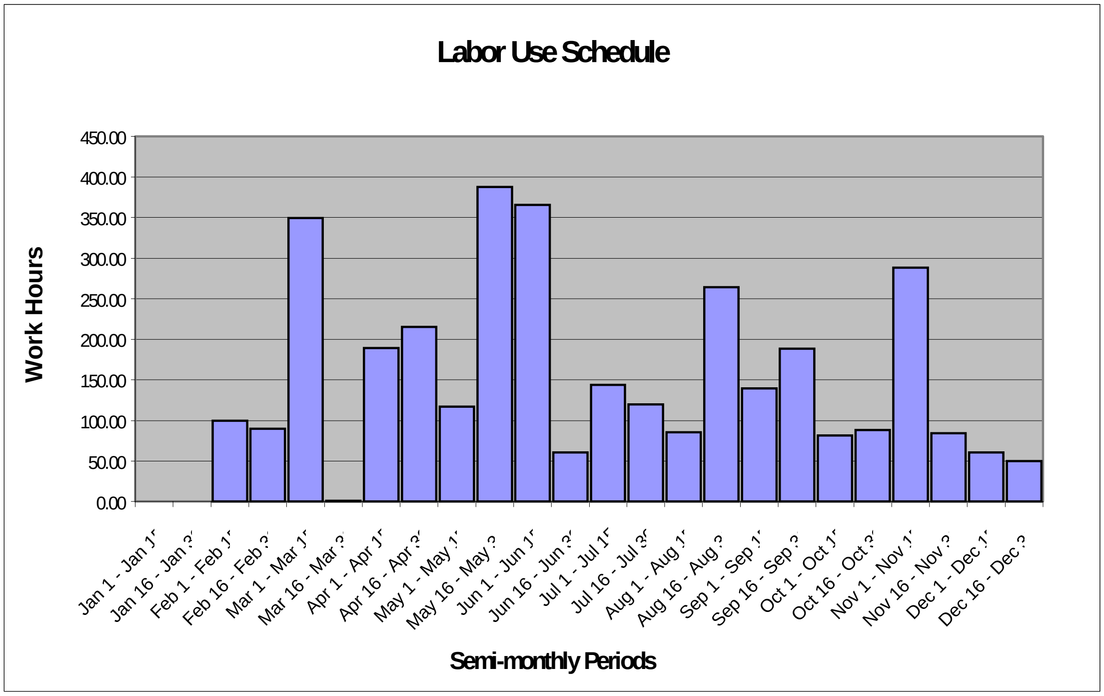
Financial Summary

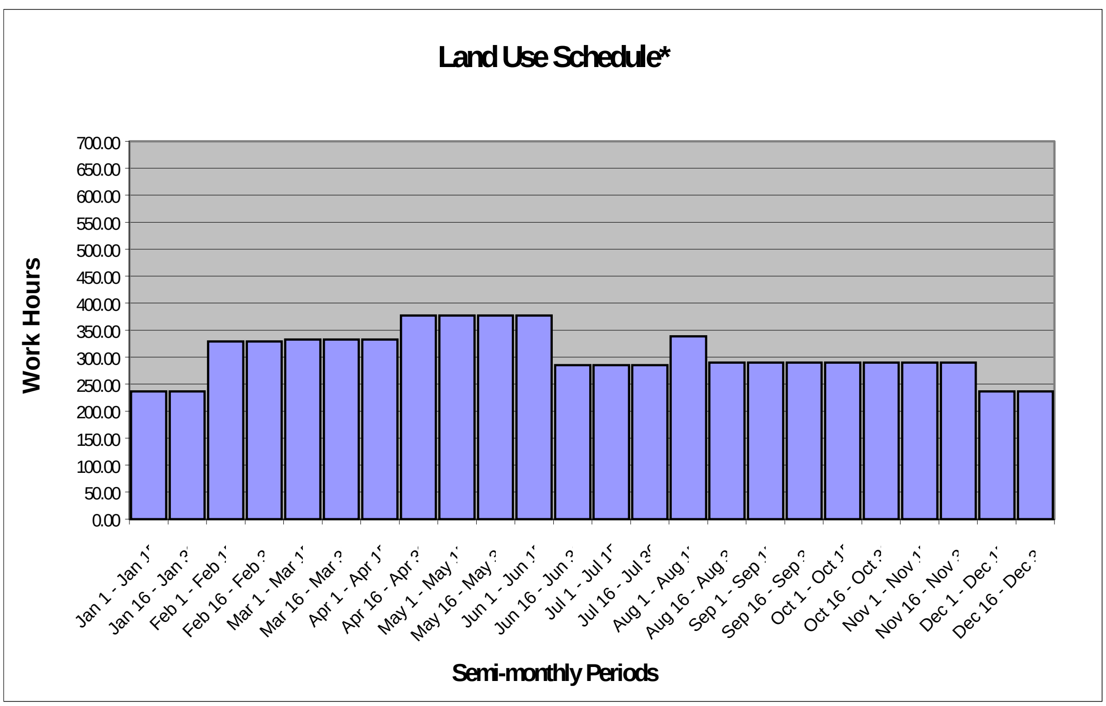
Revenues

Fresh Vegetable Sales	Acres	Sale Units	Dollars Per Sale Unit		Sales
Kenaf	0.00	0.00	70.00	$	-
Seedless Watermelon	3.60	1799.03	9.00	$	16,191.23
Hayman Potatoes	0.00	0.00	13.00	$	-
Watermelon	44.70	13410.91	9.56	$	128,208.34
Broccoli	0.00	0.00	9.78	$	-
Irish Potatoes	0.00	0.00	10.87	$	-
Spring Cucumbers	0.00	0.00	10.92	$	-
Fall Cucumbers	0.00	0.00	9.40	$	-
Spring Snapbeans	0.00	0.00	12.82	$	-
Fall Snapbeans	0.00	0.00	10.83	$	-
Green Bell Peppers (over)	0.00	0.00	9.38	$	-
Green Bell Peppers (drip)	0.00	0.00	9.52	$	-
Cantaloupes	0.00	0.00	10.93	$	-
Spring Boston Lettuce	0.00	0.00	9.23	$	-
Fall Boston Lettuce	29.63	14814.81	8.97	$	132,888.89
Spring Romaine Lettuce	92.15	64503.08	12.04	$	776,617.12
Fall Romaine Lettuce	23.70	16592.59	10.36	$	171,899.26
Double-cropped soybeans	166.67	5833.33	6.00	$	35,000.00
Full season soybeans	0.00	0.00	6.00	$	-
Wheat	166.67	13333.33	3.00	$	40,000.00
Total	527.12			**$**	**1,300,804.84**

Total Revenue	**$**	**1,300,804.84**
Expenses		
Farm Input Purchases	$	417,119.86
Production Labor Costs	$	21,404.50
Total Irrigation Costs	$	5,343.58
Transportation Costs*	$	104,663.87
Packaging, Handling & Sales*	$	111,120.43
Brokerage Fee*	$	165,565.40
Overhead Labor Costs**	$	38,595.50
Farm Equipment	$	-
Total Expenses	**$**	**863,813.15**
Net Return to Land, Management and Capital	**$**	**436,991.69**

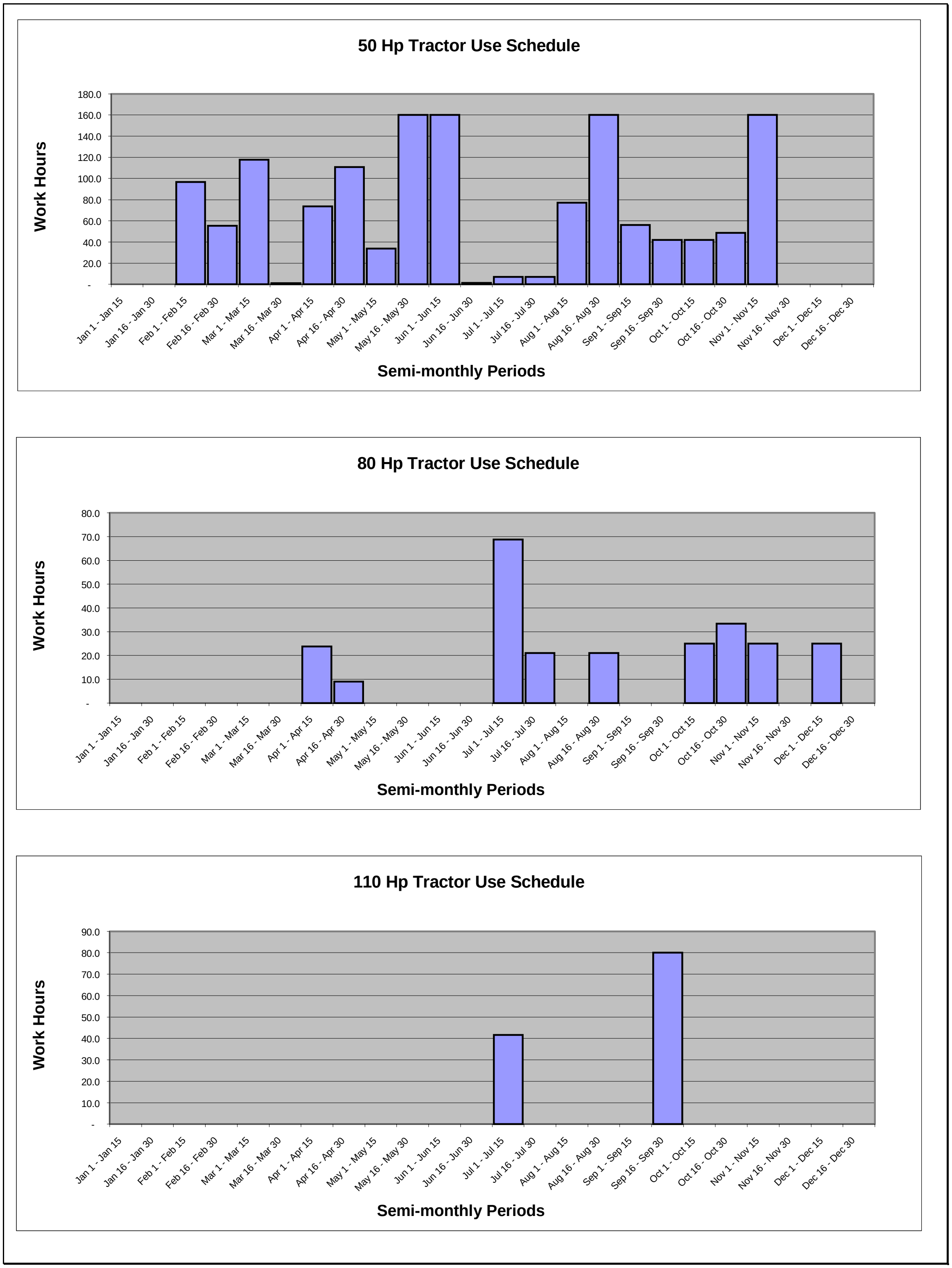
* Costs deducted from the terminal market price to calculate the farm-gate price
** Calculated after deducting variable labor costs.





* Includes 70 acres of land not in direct production

Appendix D: Figure 7 – Land and Labor Use for Scenario 2 – Vegetable Farm.



Appendix D: Figure 8 – Tractor Use for Scenario 2 – Vegetable Farm.

Appendix D: Table 5 - Financial Summary for Scenario 3 – Grain Farm

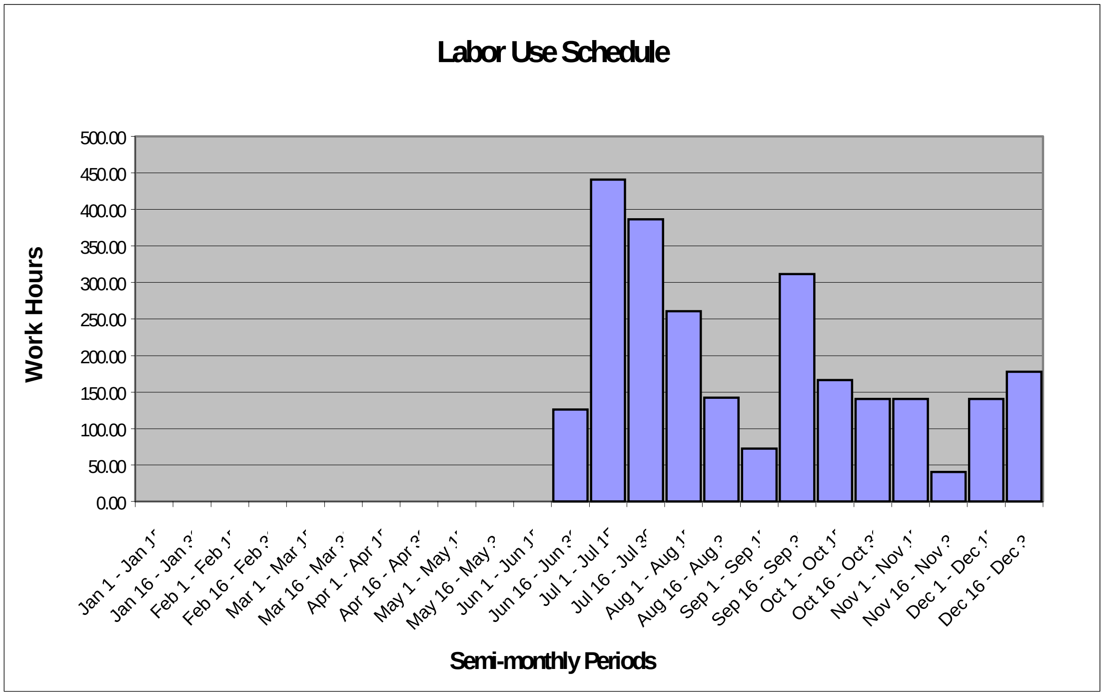
Financial Summary

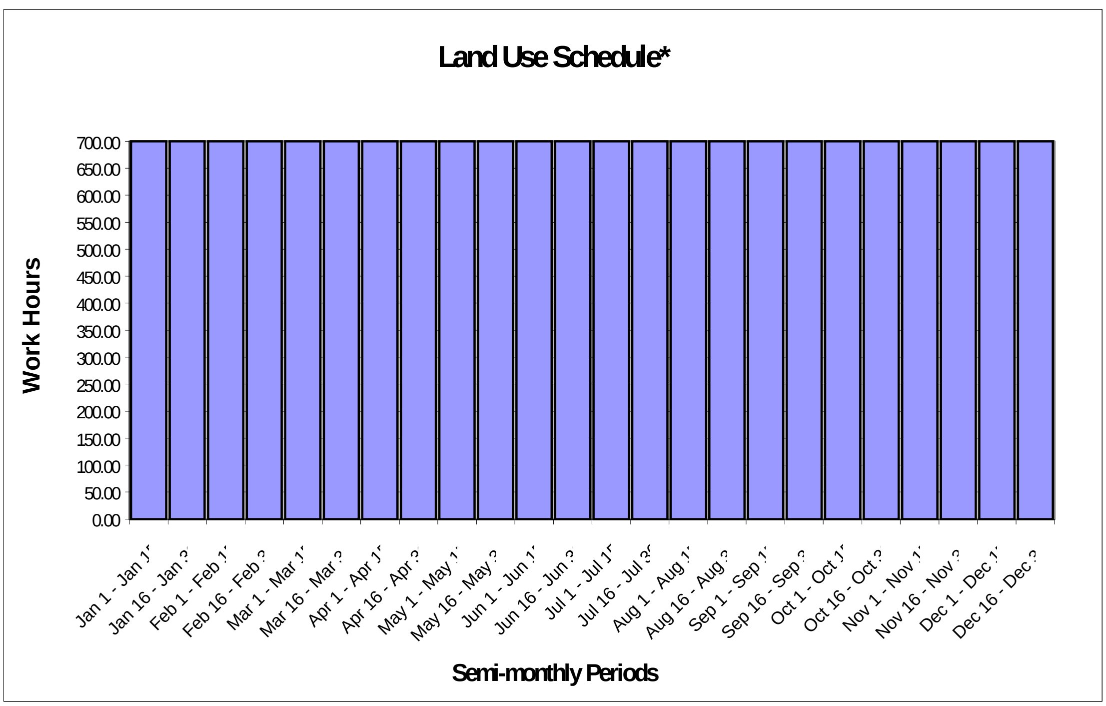
Revenues

Fresh Vegetable Sales	Acres	Sale Units	Dollars Per Sale Unit		Sales
Kenaf	0.00	0.00	70.00	$	-
Seedless Watermelon	0.00	0.00	9.00	$	-
Hayman Potatoes	0.00	0.00	13.00	$	-
Watermelon	0.00	0.00	9.56	$	-
Broccoli	0.00	0.00	10.58	$	-
Irish Potatoes	0.00	0.00	10.87	$	-
Spring Cucumbers	0.00	0.00	13.29	$	-
Fall Cucumbers	0.00	0.00	10.07	$	-
Spring Snapbeans	0.00	0.00	16.26	$	-
Fall Snapbeans	0.00	0.00	10.94	$	-
Green Bell Peppers (over)	0.00	0.00	9.38	$	-
Green Bell Peppers (drip)	0.00	0.00	9.52	$	-
Cantaloupes	0.00	0.00	10.93	$	-
Spring Boston Lettuce	0.00	0.00	8.30	$	-
Fall Boston Lettuce	0.00	0.00	8.57	$	-
Spring Romaine Lettuce	0.00	0.00	10.36	$	-
Fall Romaine Lettuce	0.00	0.00	10.50	$	-
Double-cropped soybeans	630.00	28350.00	6.00	$	170,100.00
Full season soybeans	0.00	0.00	6.00	$	-
Wheat	630.00	50400.00	3.00	$	151,200.00
Total	1260.00			**$**	**321,300.00**

Total Revenue	**$**	**321,300.00**
Expenses		
Farm Input Purchases	$	198,631.49
Production Labor Costs	$	15,271.20
Total Irrigation Costs	$	-
Transportation Costs*	$	-
Packaging, Handling & Sales*	$	-
Brokerage Fee*	$	-
Overhead Labor Costs**	$	30,808.80
Farm Equipment	$	-
Total Expenses	**$**	**244,711.49**
Net Returns to Land, Management and Capital	**$**	**76,588.51**

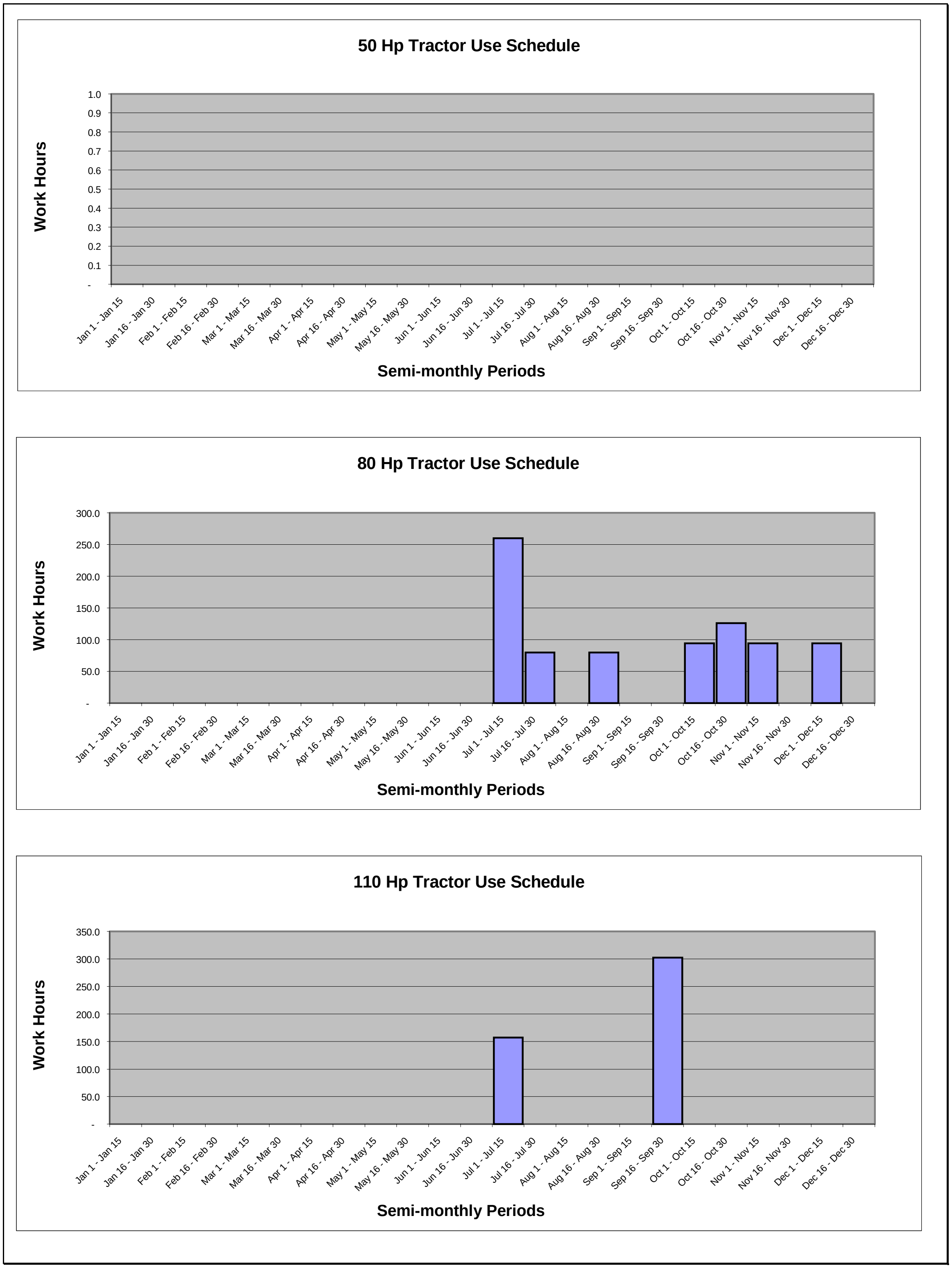
* Costs deducted from the terminal market price to calculate the farm-gate price
** Calculated after deducting variable labor costs.





* Includes 70 acres of land not in direct production

Appendix D: Figure 9 – Land and Labor Use for Scenario 3 – Grain Farm



Appendix D: Figure 10 – Tractor Use for Scenario 3 – Grain Farm

Appendix D: Table 6 - Financial Summary for Scenario 3 – Vegetable Farm.

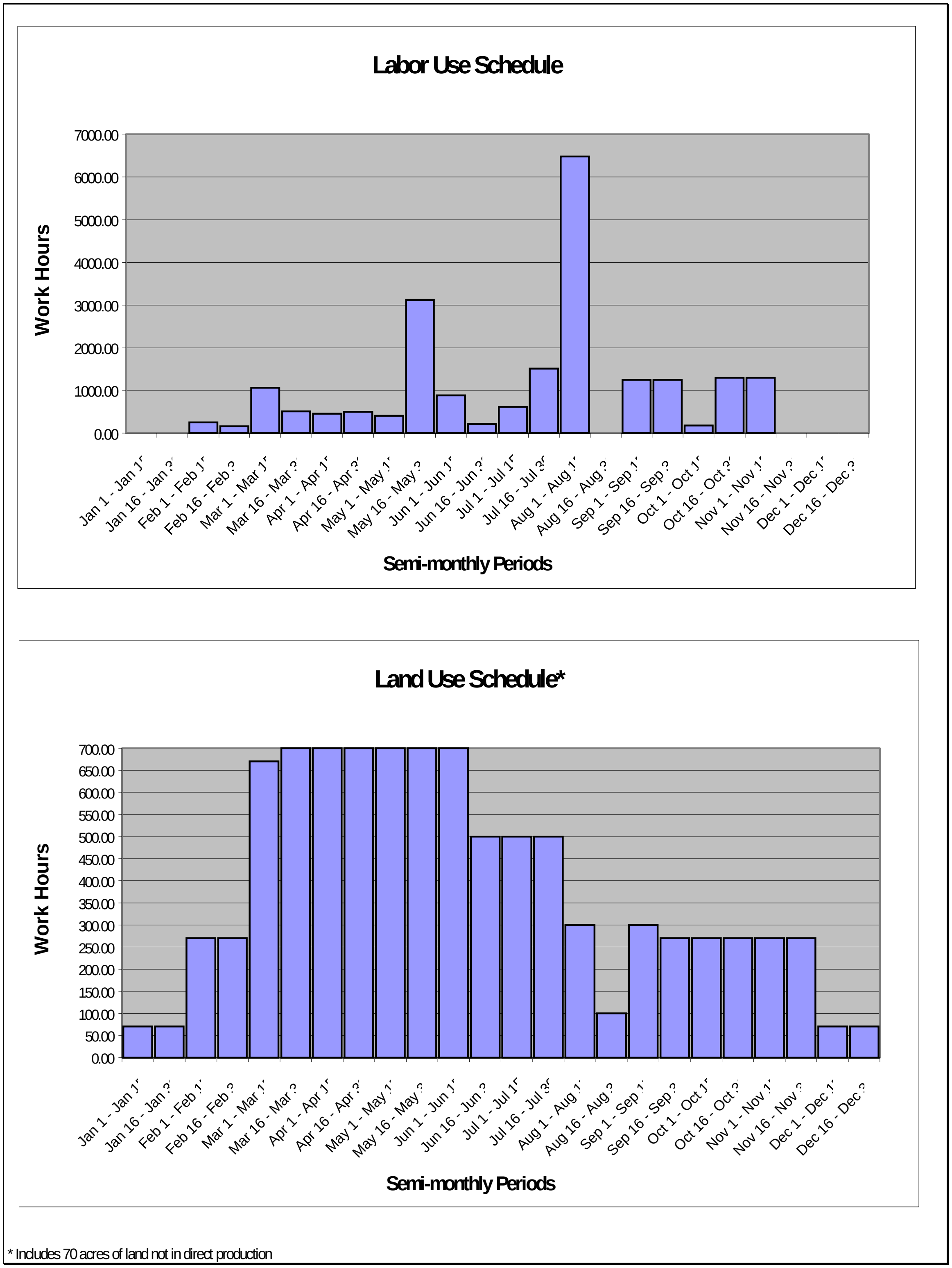
Financial Summary

Revenues

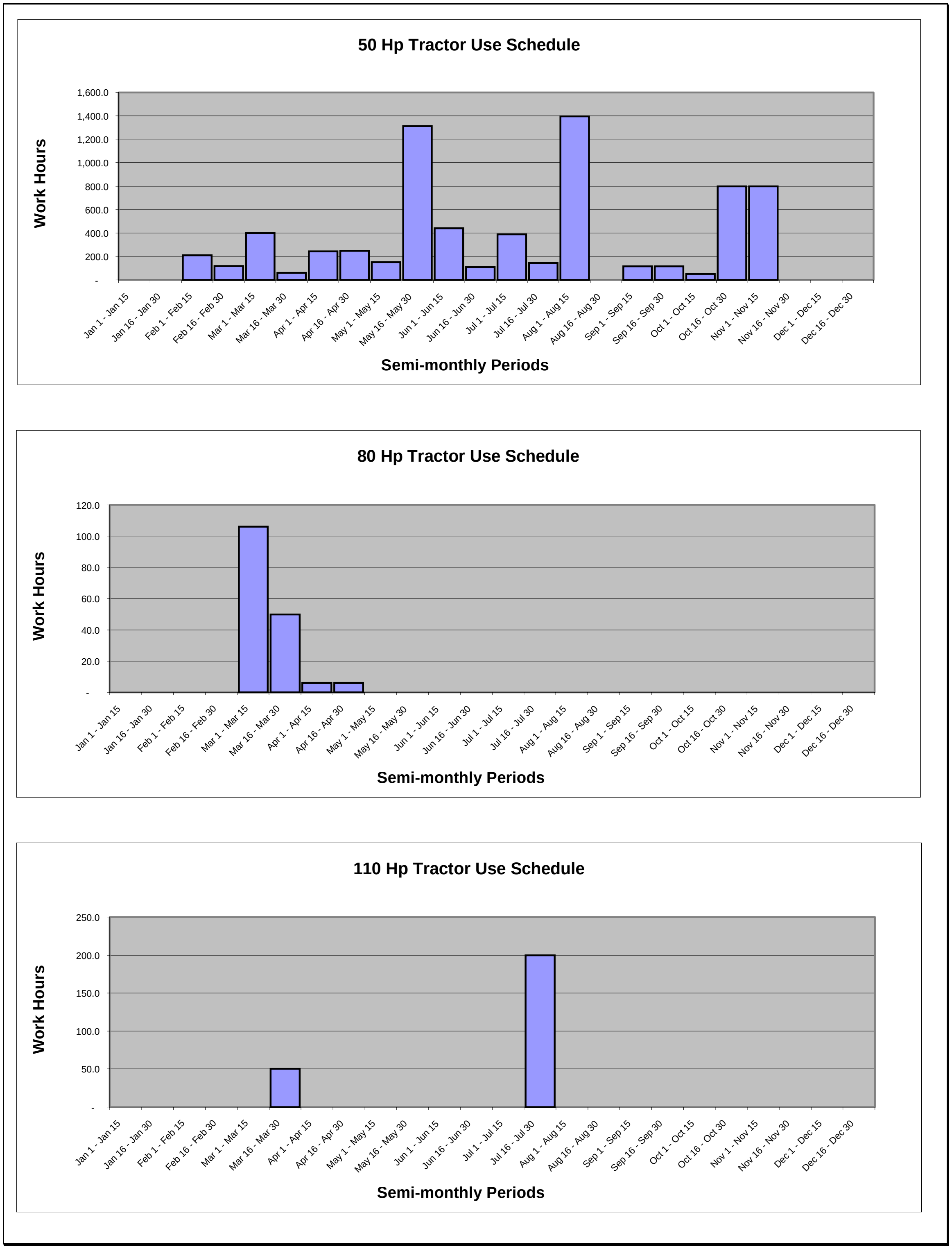
Fresh Vegetable Sales	Acres	Sale Units	Dollars Per Sale Unit		Sales
Kenaf	0.00	0.00	70.00	$	-
Seedless Watermelon	200.00	100000.00	9.00	$	900,000.00
Hayman Potatoes	30.00	4500.00	13.00	$	58,500.00
Watermelon	0.00	0.00	9.56	$	-
Broccoli	200.00	70000.00	10.58	$	740,600.00
Irish Potatoes	200.00	30000.00	10.87	$	326,100.00
Spring Cucumbers	0.00	0.00	13.29	$	-
Fall Cucumbers	0.00	0.00	10.07	$	-
Spring Snapbeans	0.00	0.00	16.26	$	-
Fall Snapbeans	0.00	0.00	10.94	$	-
Green Bell Peppers (over)	0.00	0.00	9.38	$	-
Green Bell Peppers (drip)	0.00	0.00	9.52	$	-
Cantaloupes	0.00	0.00	10.93	$	-
Spring Boston Lettuce	0.00	0.00	8.30	$	-
Fall Boston Lettuce	0.00	0.00	8.57	$	-
Spring Romaine Lettuce	200.00	140000.00	10.36	$	1,450,400.00
Fall Romaine Lettuce	0.00	0.00	10.50	$	-
Double-cropped soybeans	0.00	0.00	6.00	$	-
Full season soybeans	0.00	0.00	6.00	$	-
Wheat	0.00	0.00	3.00	$	-
Total	830.00			**$**	**3,475,600.00**

Total Revenue	**$**	**3,475,600.00**
Expenses		
Farm Input Purchases	$	1,052,186.51
Production Labor Costs	$	128,760.60
Total Irrigation Costs	$	26,406.78
Transportation Costs*	$	448,200.00
Packaging, Handling & Sales*	$	313,750.00
Brokerage Fee*	$	322,000.00
Overhead Labor Costs**	$	-
Farm Equipment	$	-
Total Expenses	**$**	**2,291,303.89**
Net Returns to Land, Management and Capital	**$**	**1,184,296.11**

* Costs deducted from terminal market prices to calculate the farm-gate price
** Calculated after deducting variable labor costs.



Appendix D: Figure 11 – Land and Labor Use for Scenario 3 – Vegetable Farm.



Appendix D: Figure 12 – Tractor Use for Scenario 3 – Vegetable Farm.

Appendix D: Table 7 - Financial Summary for Scenario 4 – Grain Farm.

Financial Summary

Revenues

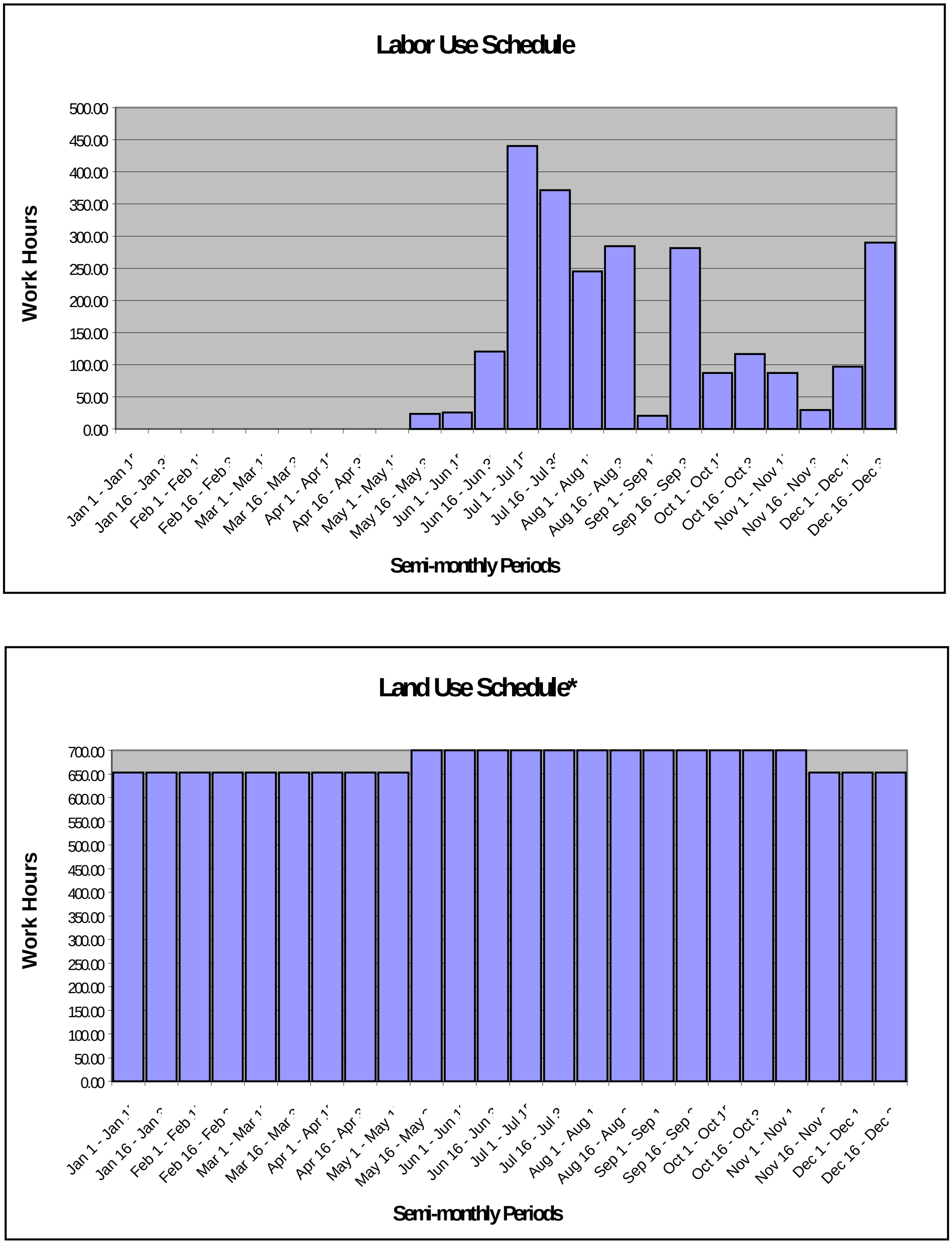
Fresh Vegetable Sales	Acres	Sale Units	Dollars Per Sale Unit	Sales
Kenaf	0.00	0.00	70.00	$ -
Seedless Watermelon	0.00	0.00	9.00	$ -
Hayman Potatoes	0.00	0.00	13.00	$ -
Watermelon	0.00	0.00	9.56	$ -
Broccoli	0.00	0.00	9.78	$ -
Irish Potatoes	0.00	0.00	10.87	$ -
Spring Cucumbers	0.00	0.00	10.92	$ -
Fall Cucumbers	0.00	0.00	9.40	$ -
Spring Snapbeans	0.00	0.00	12.82	$ -
Fall Snapbeans	0.00	0.00	10.83	$ -
Green Bell Peppers (over)	0.00	0.00	9.38	$ -
Green Bell Peppers (drip)	0.00	0.00	9.52	$ -
Cantaloupes	0.00	0.00	10.93	$ -
Spring Boston Lettuce	0.00	0.00	9.23	$ -
Fall Boston Lettuce	0.00	0.00	8.97	$ -
Spring Romaine Lettuce	0.00	0.00	12.04	$ -
Fall Romaine Lettuce	0.00	0.00	10.36	$ -
Double-cropped soybeans	583.33	26250.00	6.00	$ 157,500.00
Full season soybeans	46.67	2100.00	6.00	$ 12,600.00
Wheat	583.33	46666.67	3.00	$ 140,000.00
Total	1213.33			**$ 310,100.00**

Total Revenue	**$ 310,100.00**

Expenses

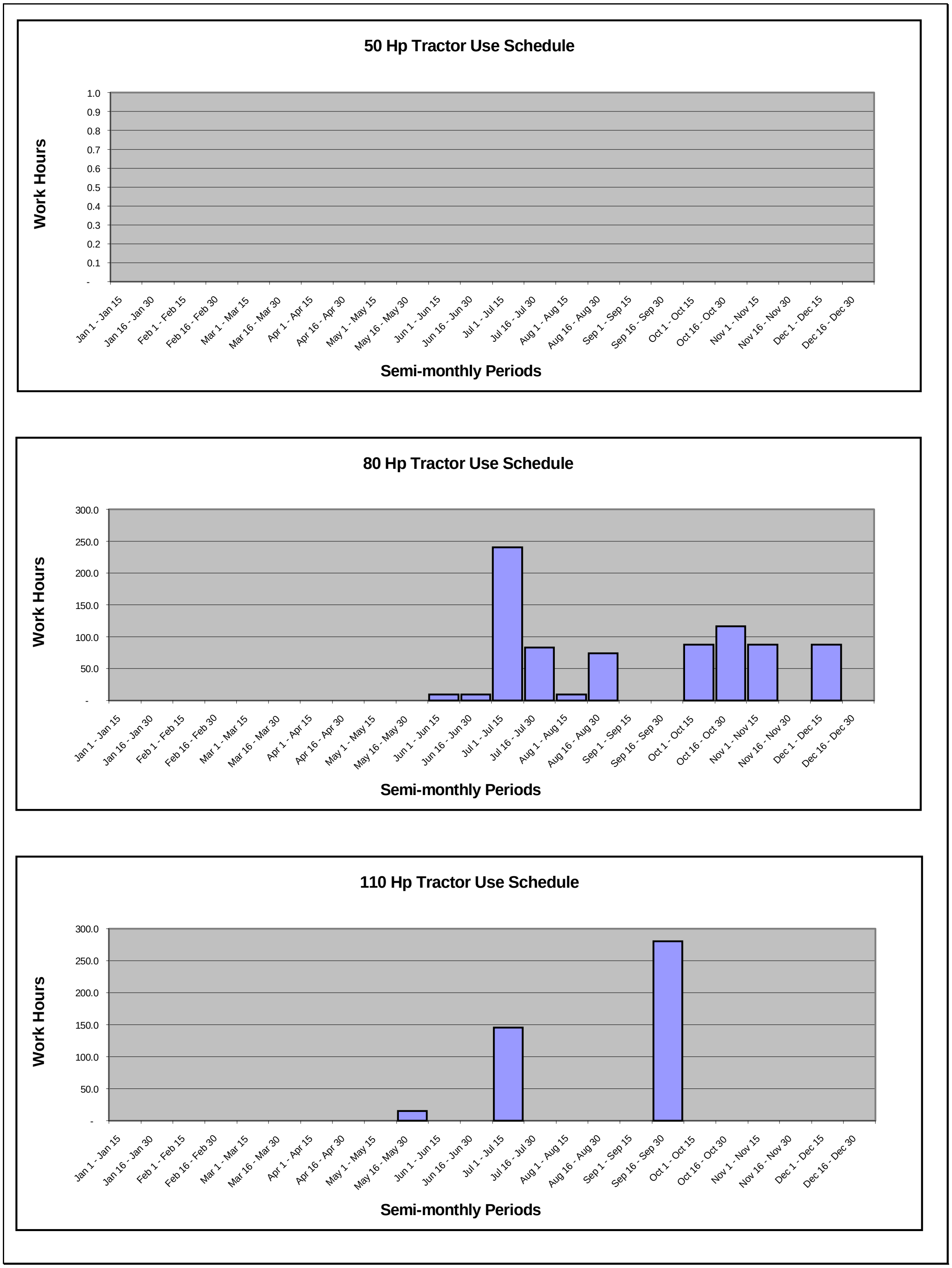
Farm Input Purchases	$ 191,109.29
Production Labor Costs	$ 15,140.16
Total Irrigation Costs	$ -
Transportation Costs*	$ -
Packaging, Handling & Sales*	$ -
Brokerage Fee*	$ -
Overhead Labor Costs**	$ 30,939.84
Farm Equipment	$ -
Total Expenses	**$ 237,189.29**
Net Returns to Land, Management and Capital	**$ 72,910.71**

* Costs deducted from the terminal market price to calculate the farm gate prices
** Calculated after deducting variable costs



* Includes 70 acres of land not in direct production

Appendix D: Figure 13 – Land and Labor Use for Scenario 4 – Grain Farm.



Appendix D: Figure 14 – Tractor Use for Scenario 4 – Grain Farm.

Appendix D: Table 8 - Financial Summary of Scenario 4 – Vegetable Farm

Financial Summary

Revenues

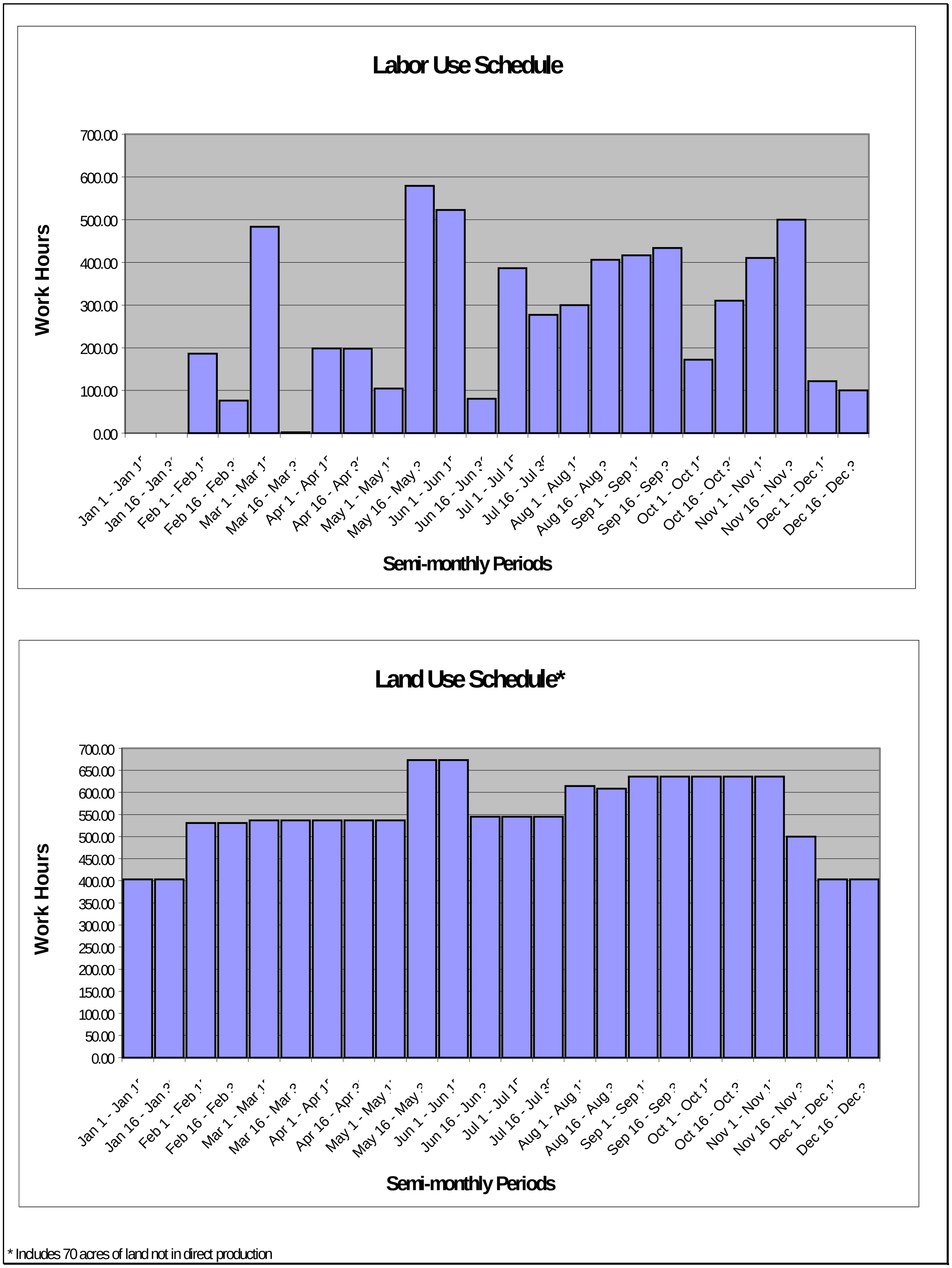
Fresh Vegetable Sales	Acres	Sale Units	Dollars Per Sale Unit		Sales
Kenaf	0.00	0.00	70.00	$	-
Seedless Watermelon	5.87	2934.55	9.00	$	26,410.96
Hayman Potatoes	0.00	0.00	13.00	$	-
Watermelon	0.00	0.00	9.56	$	-
Broccoli	27.26	9542.69	9.78	$	93,327.54
Irish Potatoes	0.00	0.00	10.87	$	-
Spring Cucumbers	0.00	0.00	10.92	$	-
Fall Cucumbers	0.00	0.00	9.40	$	-
Spring Snapbeans	0.00	0.00	12.82	$	-
Fall Snapbeans	0.00	0.00	10.83	$	-
Green Bell Peppers (over)	0.00	0.00	9.38	$	-
Green Bell Peppers (drip)	0.00	0.00	9.52	$	-
Cantaloupes	0.00	0.00	10.93	$	-
Spring Boston Lettuce	0.00	0.00	9.23	$	-
Fall Boston Lettuce	10.24	5121.31	8.97	$	45,938.17
Spring Romaine Lettuce	127.49	89246.48	12.04	$	1,074,527.61
Fall Romaine Lettuce	58.98	41283.02	10.36	$	427,692.05
Double-cropped soybeans	333.33	11666.67	6.00	$	70,000.00
Full season soybeans	136.04	4761.32	6.00	$	28,567.93
Wheat	333.33	26666.67	3.00	$	80,000.00
Total	1032.55			**$**	**1,846,464.26**

Total Revenue	**$**	**1,846,464.26**

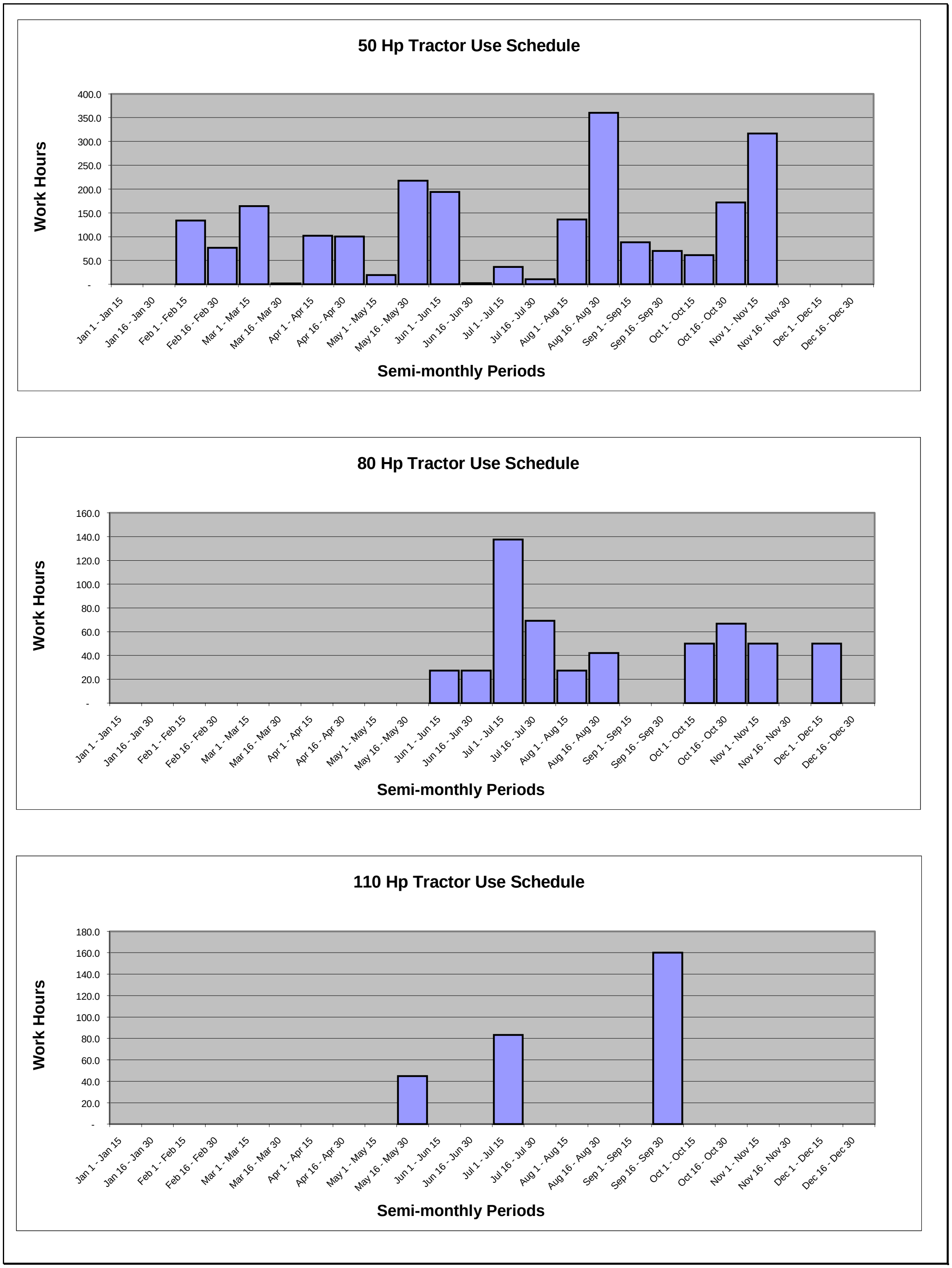
Expenses

Farm Input Purchases	$	626,656.19
Production Labor Costs	$	37,592.86
Total Irrigation Costs	$	6,056.69
Transportation Costs*	$	159,958.89
Packaging, Handling & Sales*	$	148,128.05
Brokerage Fee*	$	228,096.47
Overhead Labor Costs**	$	14,407.14
Farm Equipment	$	-
Total Expenses	**$**	**1,220,896.29**
Net Returns to Land, Management and Capital	**$**	**625,567.97**

* Costs deducted from the terminal market prices to determine farm-gate prices
** Calculated after deducting variable costs



Appendix D: Figure 15 – Land and Labor Use for Scenario 4 – Vegetable Farm



Appendix D: Figure 16 – Tractor Use for Scenario 4 – Vegetable Farm

Appendix D: Table 9 – Financial Summary for Scenario 4 – Vegetable Farm. No Lettuce Crop Considered

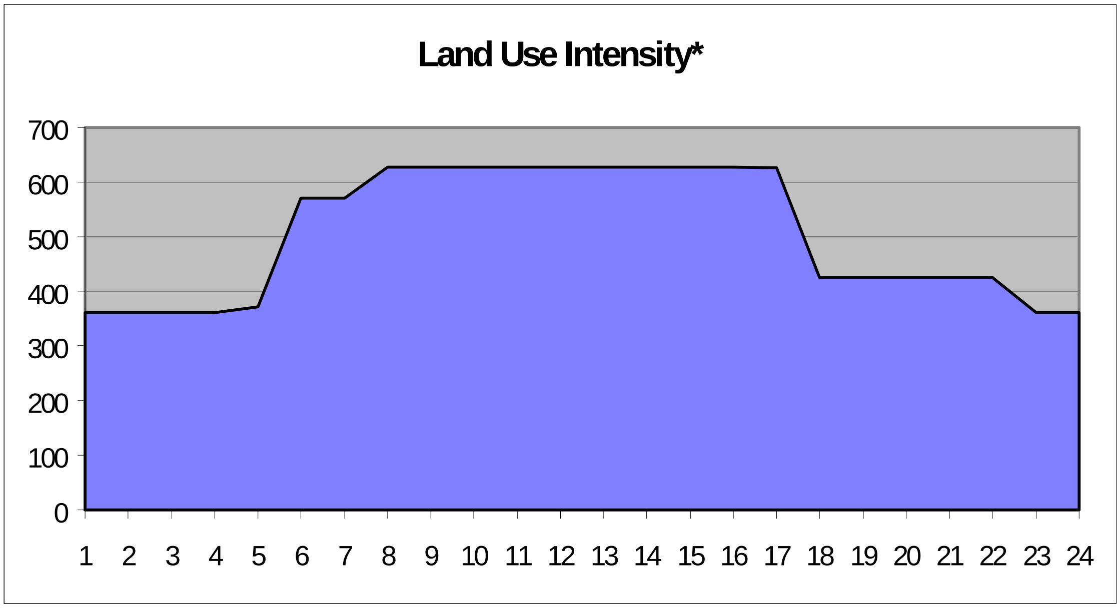
Financial Summary

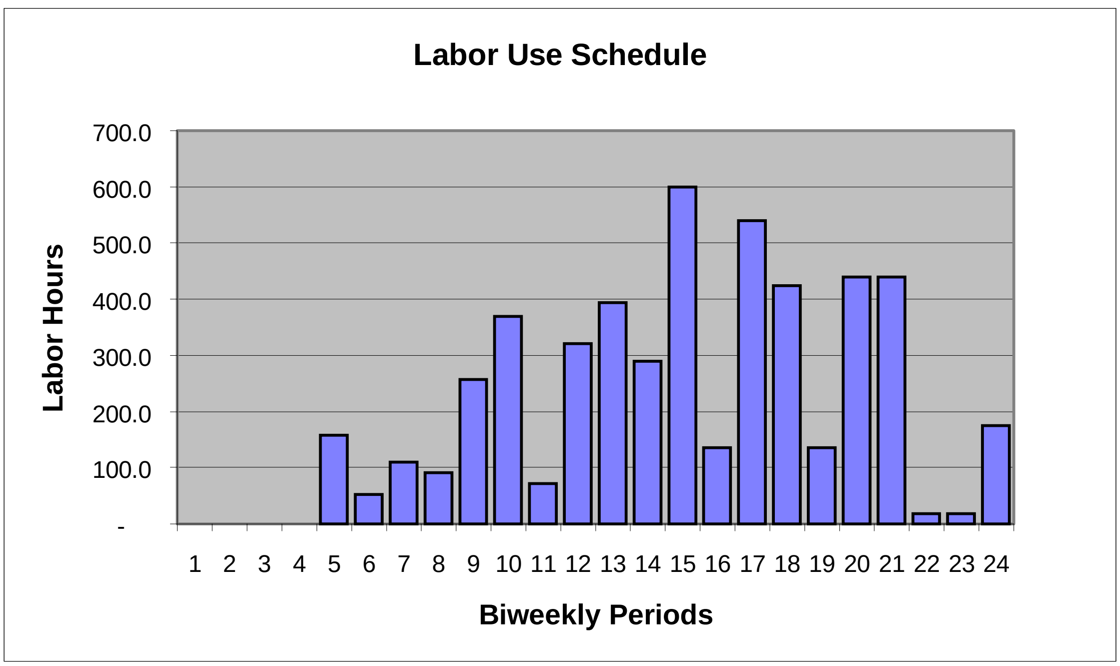
Revenues

Fresh Vegetable Sales	Acres	Sale Units	Dollars Per Sale Unit		Sales
Kenaf	0.00	-	70.00	$	-
Seedless Watermelon	10.02	5,009	9	$	45,079.46
Hayman Potatoes	200.00	30,000	13	$	390,000.00
Watermelon	55.99	16,797	9.56	$	160,580.99
Broccoli	64.80	22,678	10.58	$	239,936.96
Irish Potatoes	0.00	-	10.87	$	-
Spring Cucumbers	0.00	-	13.29	$	-
Fall Cucumbers	0.00	-	10.07	$	-
Spring Snapbeans	0.00	-	16.26	$	-
Fall Snapbeans	0.00	-	10.94	$	-
Green Bell Peppers (over)	0.00	-	9.38	$	-
Green Bell Peppers (drip)	0.00	-	9.52	$	-
Cantaloupes	0.00	-	10.93	$	-
Spring Boston Lettuce	0.00	-	8.30	$	-
Fall Boston Lettuce	0.00	-	8.57	$	-
Spring Romaine Lettuce	0.00	-	10.36	$	-
Fall Romaine Lettuce	0.00	-	10.50	$	-
Double-cropped soybeans	290.84	10,179	6	$	61,076.10
Full season soybeans	0.00	-	6	$	-
Wheat	290.84	23,267	3	$	69,801.26
Total	912.48			**$**	**966,474.78**

Total Revenue	**$**	**966,474.78**
Expenses		
Farm Input Purchases	$	421,640.58
Variable Labor Costs	$	30,215.04
Total Irrigation Costs	$	6,946.65
Transportation Costs*	$	37,326.31
Packaging, Handling & Sales*	$	69,484.36
Brokerage Fee*	$	55,265.74
Overhead Labor**	$	27,384.96
Farm Equipment	$	-
Total Expenses	**$**	**648,263.64**
Net Returns to Land, Labor and Capital	**$**	**318,211.14**

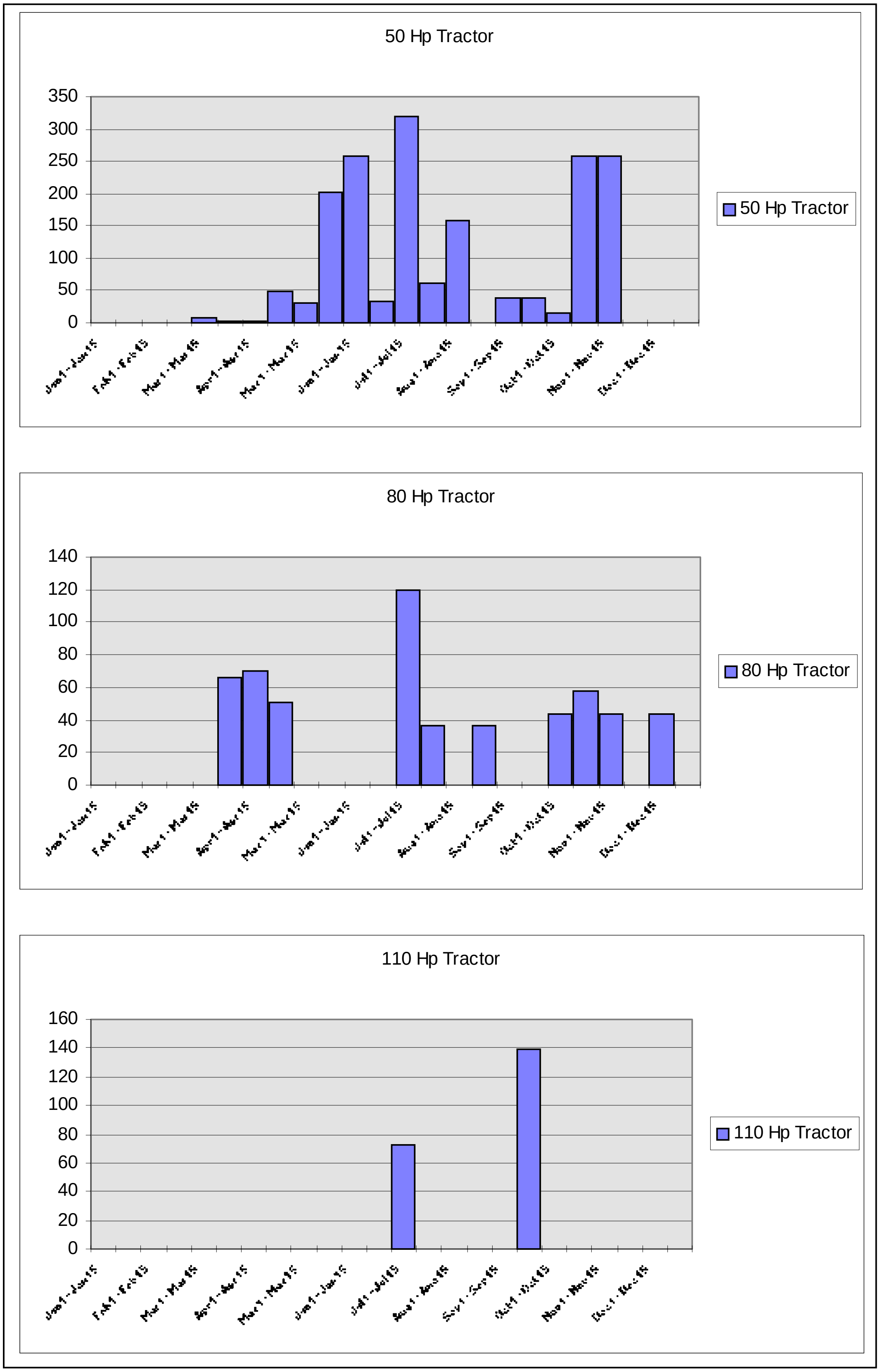
* Costs deducted from the terminal market price to calculate the farm-gate price
** Calculated after deducting the variable labor costs.





* Includes 70 acres not in direct production.

Appendix D: Figure 17 – Land and Labor Use for Scenario 4 – Vegetable Farm. No Lettuce Crop Considered



Appendix D: Figure 18 – Tractor Use for Scenario 4 – Vegetable Farm. No Lettuce Crop Considered.

Appendix E - PLANETOR Database Requirements and Technical Information

PLANETOR Computer Program

RUSLE and NLEAP Database Information

An overview of the database information required by the PLANETOR Computer Program. References and topical illustrations.

Most of the crops analyzed in this study were included in the PLANETOR database. For specific technical information on each of them contact the Center for Farm Financial Management at the Department of Applied Economics, University of Minnesota, 1994 Buford Avenue, St.Paul, MN 55108, 612-625-1964 or 1-800-234-1111. The database did not provide any information on two crops investigated in this study, lettuce and kenaf. Technical information on these two crops was determined in consultation with extension specialists in the region and the literature. In those cases when neither of these sources could provide the required information, then data on similar crops, cabbage for lettuce and corn for kenaf, were used as proxy. As work on the cultivation of these crops in the region progresses, more specific information will be supplanted to these databases. Extension specialists in the region who may want to use this program should look at the information included in these databases and modify it, to the best of their knowledge, with more specific data. The explanations included in this appendix should assist them in understanding what is required and how to either acquire or estimate the data. Data on lettuce and kenaf is provided as illustration in each case. Data on other crops is provided in those cases when such data is hard to estimate and specialists may use them as proxies.

Crop Database Information

Overview of the crop characteristics and technical coefficients required by PLANETOR.

NLEAP Data Requirements

Unit weight. This is the weight in pounds of the units in which crop yield is measured. These units could be bushel/crate/ton.

Crop Name	Unit	Unit Weight in pounds
Kenaf	Ton	2000
Lettuce	Cwt.	100

Moisture content of the harvested portion. Water content of the crop at harvest time, expressed as a simple ratio of %H_20/100.

Before proceeding with this discussion, it is necessary to define the procedure with which such information can be procured. There are three available options:

- Take measurements in field. This is always the most preferable option but it is not always the easiest as it requires both time and technology that may not be available.
- Get local estimation procedures from Extension, University, SCS sources.
- Use published information for estimates.

Crop Name	Moisture Content of Harvested Portion
Kenaf	.15
Lettuce	.93

C:N ratios of the harvested and unharvested portion. This is the ratio between the amount of carbon and the amount of nitrogen in the crop, expressed %C / %N

The amounts of percentages are on a dry weight basis. As a rule of thumb when we don't have actual data on plant materials, follow this procedure:

> *C: N = (TOTAL_DRY_MATTER * .40) / %N*
> *90.5 * .40 / 2.45* *(data for alfalfa)*
> *C: N = 14.8*

This information is available for most traditional crops. The simple procedure shown above should be followed until we have more data on the new crops.

Crop Name	C:N Ratio of Harvested Portion	C:N Ratio of Unharvested Portion
Kenaf	25.8	38.6
Lettuce	14.3	14.3

Growing Season (Initial/Development/Reproduction and Maturation stages. The reproduction and maturation stages are also called mid-season and late season stages. In order to estimate the crop transpiration coefficients, it is necessary to determine the portion of the growing season in each of these stages. This is done as shown below and for most crops the procedure is provided by Doorenbos & Pruitt (1979):

> *#Days in initial stage/ #days in crop development/#days in mid-season/#days in late season*
> *Portions (.xx/.xx/.xx/.xx = 1.00)*
> *e.g. (cotton spring planting,):*
> *30 days/50 days/60 days/55 days (195 day growing season) - .15/ .26/ .31/ .28*

The data used for kenaf and lettuce is:

Crop Name	Growing Season Initial Stage	Growing Season Reproduction Stage	Growing Season Maturation Stage
Kenaf	0.16	0.28	0.32
Lettuce	0.25	0.41	0.29

Crop coefficients for each growing stage. These coefficients refer to daily transpiration changes for a particular crop growth stage. The procedure for determining these coefficients is as follows:

> *BEG_VALUE = number between 0 and 1*
> *END_VALUE = number between 0 and 1*
> *Change in Transpiration = (BEG_VALUE - END_VALUE/#DAYS_IN_STAGE)*

Crop transpiration changes vary by stages. In the initial stage, transpiration changes are negligible. Hence the beginning and ending values for this stage are zero or close to it.

Crop Name	Crop Coeff. Initial Stage	Crop Coeff. Reproduction Stage	Crop Coeff. Maturation Stage
Kenaf	0.3	1.1	0.6
Lettuce	0.3	1.1	0.6

Total N uptake. It is measured in lb./acre, especially for new crops. It is one of the hardest parameters to measure and there is a dearth of information in the literature on non-traditional crops. The best strategy would be to inquire with individual reasearchers and/or use data available for crops similar in nature.

Crop Name	Total N Uptake
Kenaf	1.2
Lettuce	11

Legume crop. Fairly straightforward and requires only a yes/no answer. Neither kenaf or lettuce are legume crops

Winter growing season days. The number of the growing season days which falls in the winter months. This is quite important for Kenaf which is harvested sometime between December and March. The number of days for Kenaf was estimated to be 50 days

Inactive Temperature. It is expressed in F and it refers to the temperature under which the crop is inactive.

Root biomass ratio. It refers to the proportion of above ground biomass that equals below ground root biomass. This number has to be between 1.00 and 0.00. Root biomass is expressed in lb/acre.

Crop Name	Root Biomass Ratio
Kenaf	0.15
Lettuce	0.2

Maximum root depth – Maximum rooting depth for crop to the nearest foot. For kenaf it was estimated 5 feet while for lettuce it was 2 feet

Row crop – Requires a yes/no answer. Both kenaf and lettuce are row crops.

Non-harvested yield – Estimate of the non-harvested yield of forage (perennial) crops after the last cutting as a proportion of the total harvested yield in the year. Expects a number between 1.00 and 0.00. For both kenaf and lettuce this value was 0.00

Maximum yield – Maximum yield for crops in harvest units. For kenaf this value was 7.00 while for lettuce it was 200.

RUSLE data information

Surface residue decomposition. This is a parameter value that reflects how readily each crop decomposes and it is used to compute the loss of residue by decomposition. Such values are published for a number of crops. Agriculture Handbook XXX provides decomposition coefficient values for the following crops:

Crop	Coefficient
Alfalfa	.020
Bromegrass	.017
Corn	.016
Cotton	.015
Oats	.017
Peanuts	.015
Rye	.017
Sorghum	.016
Soybeans	.016
Sunflowers	.016
Tobacco	.015
Wheat	.008

The value used for Kenaf was 0.16, same as corn, while the value used for lettuce was 0.02, same as cabbage.

Yield/Residue Ratio. This is a conversion factor of yield to residue on a mass basis. Data for some crops is presented in the table below. In the RUSLE methodology, crop residue is created after certain operations, such as a harvest.. This amount of residue created after a harvest is computed on the basis of the yield/residue conversion factors entered in the database.

Crop Name	Residue/Yield Ratio
Alfalfa	.15
Bromegrass	.15
Corn	1.0
Cotton	1.0
Oats	2.0
Peanuts	1.3
Rye	1.5
Sorghum	1.0
Soybeans	1.5
Sunflowers	1.5
Tobacco	1.8
Wheat	1.3

The coefficient used for kenaf was .15 while for lettuce the coefficient value used was 0.173

Relation of residue cover to residue mass. It is the weight of the crop residue at 30%, 60% and 90% surface cover and it is used to calculate the percent cover from the mass of residue. These values exist for a number of crops and they are expressed in lb./acre. For new crops it is necessary to talk to individual researchers.

Crop Name	30%	60%	90%
Alfalfa	640	1650	4100
Bromegrass	640	1650	4100
Corn	950	2400	6050
Cotton	1620	4150	---
Oats	330	850	2150
Peanuts	1200	3050	---
Rye	640	1650	4100
Sorghum	1050	2700	6750
Soybeans	600	1600	---
Sunflowers	1500	3800	---
Tobacco	1050	2700	---
Wheat	600	1500	3850

The coefficient values for kenaf and lettuce are as follows:

Crop Name	Residue Wgt. With 30% Cover	Residue Wgt. With 60% Cover	Residue Wgt. With 90% Cover
Kenaf	950	2400	6050
Lettuce	500	1500	3500

Fragile residue. It refers to the consistency of the residue left by crop. Requires a yes/no answer. It is no for all crops considered in the model. The answer is no for both kenaf and lettuce.

Row spacing – Distance between rows in inches. For both crops the distance was assumed to be 30 inches

Plant population - The amount of live plants per acre. This number varies depending on location and yields.

Root mass - The amount of root mass (lbs./acre) in the upper 4 inches of soil for every two weeks after planting. It is expressed in pounds per acre. These values were developed by NRCS and for kenaf and lettuce the coefficients for corn and cabbage, respectively, were used but also modified to reflect the length of the growing season for these two crops.

Canopy cover - The percentage of land surface which is covered by canopy measured in biweekly intervals starting from planting day. Values for corn and cabbage were used, modified to reflect the length of growing season.

Canopy droplet fall height - It is the distance water would fall from the crop canopy to the soil surface and it is expressed in feet, measured in biweekly intervals. Values for corn and cabbage were used, modified only to reflect length of growing season.

Appendix F - Market Window Analysis Results Including Standard Deviations and Pearson Coefficients

In the section dealing with the market window analysis (Sec. 3.1) we illustrated the implications that price variability may have on determining the relative profitability of a specific commodity. Indeed, it is very important to know with what frequency prices have fallen below a certain point over the last five years. While this information is not indicative of future trends, it allows us to determine whether prices are prone to high or low volatility. Our discussion specified that it would also be important to know whether the data analyzed approached a normal distribution. If this hypothesis was correct, then we could infer more precisely the frequency with which prices have dipped below a certain point. This appendix provides information on the price level in each market for which historical data was collected; standard deviations for each week and market window, as well as the values of the Pearson coefficients. Using the information on standard deviations, Runyon and Haber (1982, pp.73 – 78) suggest the following empirical rule for interpreting variability through standard deviation values:

- Prices have been – 1 standard deviation approximately 84% of the time. For example, if (data for spring romaine lettuce, median price window, Baltimore market) median price is $12.26 and standard deviation is 3.25, then prices have been above $9.01 (Price – 1 St. Dev) 97% of the time
- Prices have been – 2 standard deviations approximately 97% of the time. Using the above example, prices have not been under the $5.76 level 97% of the time.
- Prices have been – 3 standard deviations approximately 99% of the time.

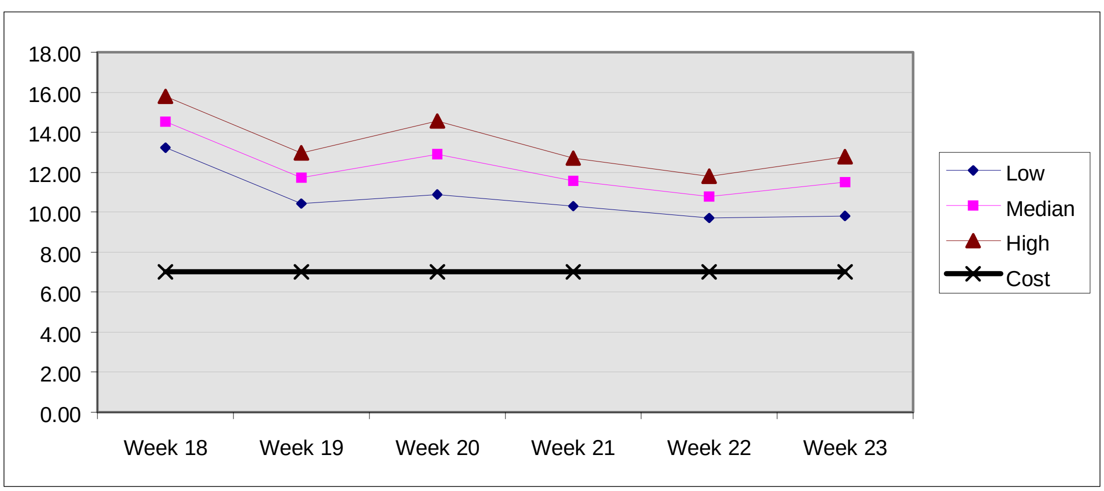
Note should be made of the fact that the above relies on the assumption that the distribution of prices relatively normal. To see if this assumption holds, we need to look at the value of the Pearson coefficients. In the above case, the Pearson coefficient is .69, slightly above the .50 value required for a normal distribution. However, given that the data sample is small, we suggest that the coefficient would approach the required parameters with a larger data sample. However, in those cases when the Pearson coefficient is larger, that indicates that the distribution is not normal and therefore we cannot make the same assumptions as above. In those cases, the standard deviations only show, by way of their nominal value, how volatile prices have been.

Appendix F: Table 1 - Spring Romaine Lettuce. Baltimore Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 18	13.71	5.42	0.9491
Week 19	11.09	2.00	0.1361
Week 20	11.67	2.40	-0.4083
Week 21	10.52	1.23	1.2780
Week 22	9.97	1.51	-0.0522
Week 23	10.33	2.00	1.2364
Window	11.25	3.02	1.2435

	Ave. Median	St. Dev	Pearson coeff.
Week 18	14.80	6.29	1.8116
Week 19	11.91	1.82	1.4957
Week 20	12.98	2.36	-0.6644
Week 21	11.54	1.14	0.0944
Week 22	10.57	1.49	0.1328
Week 23	11.50	1.48	-1.0165
Window	12.26	3.25	0.6988

	Ave. High	St. Dev	Pearson coeff.
Week 18	16.10	7.18	1.7113
Week 19	13.23	2.30	0.9475
Week 20	14.63	2.84	-0.3902
Week 21	12.69	1.45	1.4254
Week 22	11.53	1.67	-0.8506
Week 23	12.75	1.70	-1.3255
Window	13.54	3.73	1.2386

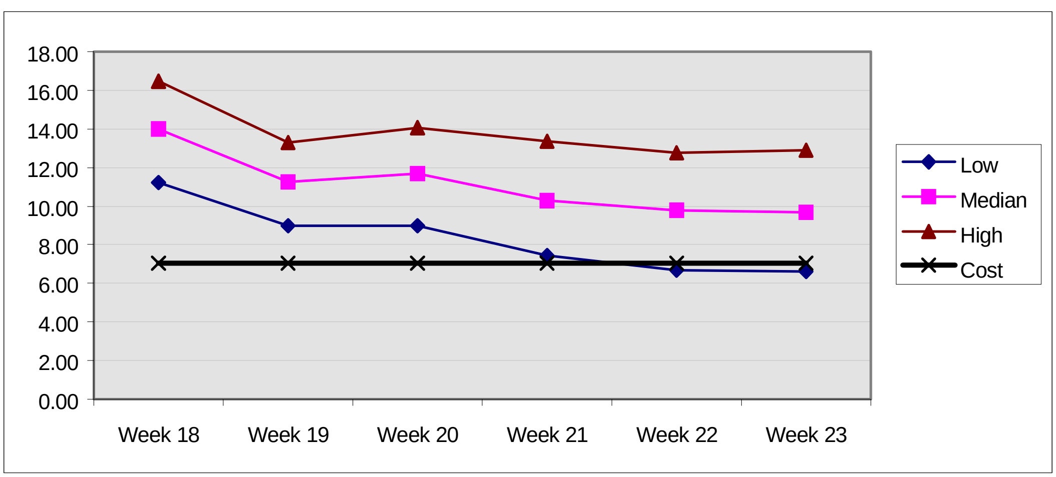


Appendix F: Table 2 – Spring Romaine Lettuce. Philadelphia Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 18	10.98	4.66	0.6296
Week 19	9.00	1.50	0.0000
Week 20	9.12	2.78	1.2080
Week 21	7.27	1.75	-0.8165
Week 22	6.14	1.82	1.4623
Week 23	6.60	1.41	1.2781
Window	8.28	3.11	0.2700

	Ave. Median	St. Dev	Pearson coeff.
Week 18	13.66	5.59	0.8051
Week 19	11.22	1.75	0.3385
Week 20	11.79	2.91	1.3230
Week 21	10.14	1.63	0.7179
Week 22	9.33	1.61	1.1998
Week 23	9.70	1.52	0.2275
Window	11.04	3.21	0.5063

	Ave. High	St. Dev	Pearson coeff.
Week 18	15.79	6.55	1.6337
Week 19	12.95	2.28	0.4610
Week 20	14.54	2.47	1.0869
Week 21	12.71	1.67	-0.7850
Week 22	11.80	1.13	2.1842
Week 23	12.77	1.46	2.3657
Window	13.67	3.36	0.5938

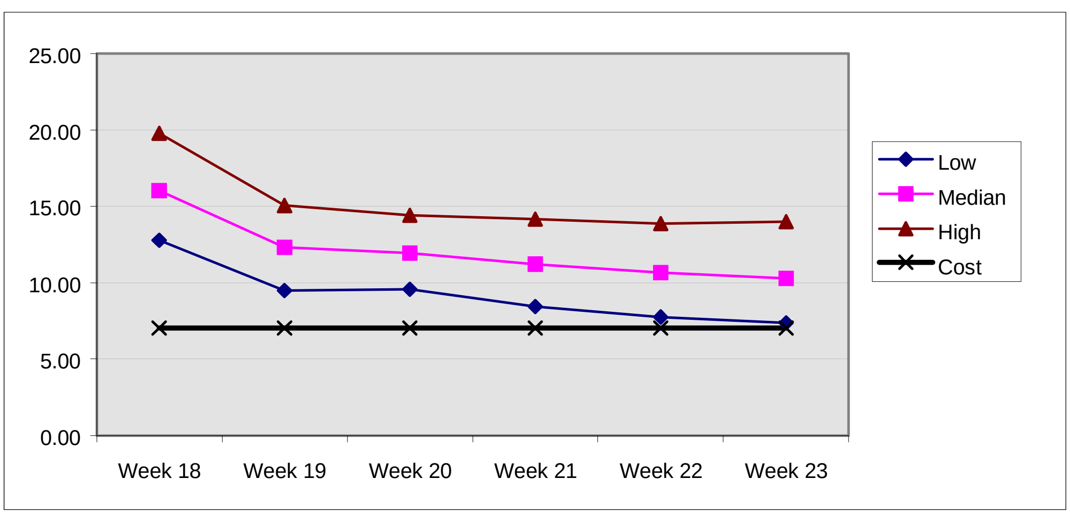


Appendix F: Table 3 - Spring Romaine Lettuce. New York Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 18	13.10	6.59	1.4097
Week 19	9.50	1.45	-1.0318
Week 20	9.59	2.15	0.8235
Week 21	8.52	2.54	1.7983
Week 22	7.65	1.53	0.2939
Week 23	7.41	1.97	0.6237
Window	9.30	3.66	0.6539

	Ave. Median	St. Dev	Pearson coeff.
Week 18	16.43	7.68	1.7303
Week 19	12.26	1.71	0.8955
Week 20	11.93	2.11	-0.0969
Week 21	11.24	2.53	0.8742
Week 22	10.54	1.53	-0.4176
Week 23	10.34	1.71	0.1591
Window	12.12	4.05	0.4609

	Ave. High	St. Dev	Pearson coeff.
Week 18	19.60	9.63	1.4335
Week 19	14.96	2.44	-1.2831
Week 20	14.36	1.84	0.5929
Week 21	14.14	2.33	0.1839
Week 22	13.75	1.83	-0.4094
Week 23	14.00	1.41	0.0000
Window	15.09	4.59	0.7147

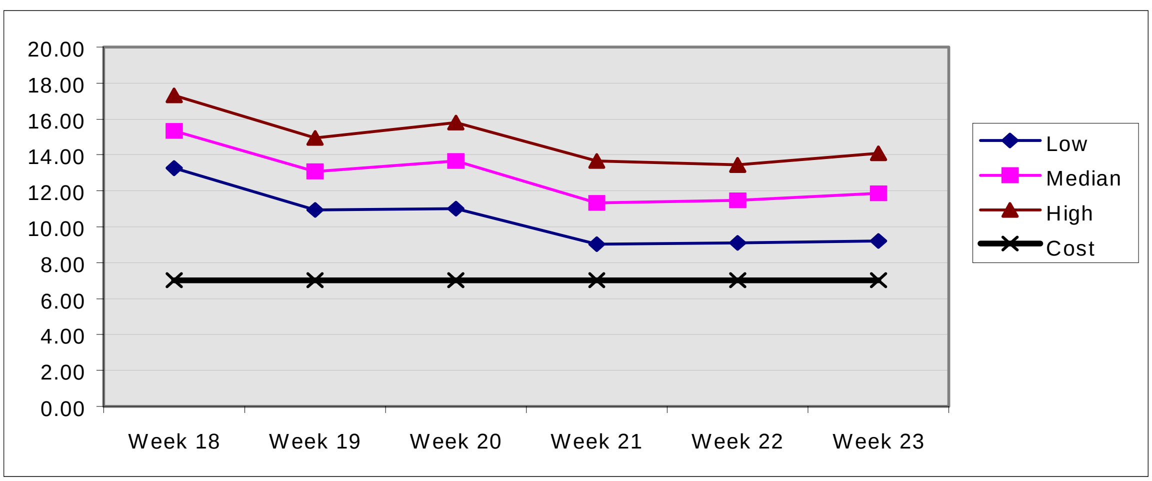


Appendix F: Table 4 - Spring Romaine Lettuce. Boston Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 18	12.91	5.56	1.5689
Week 19	11.00	1.86	-0.8048
Week 20	10.93	2.22	1.2619
Week 21	9.04	1.39	0.0939
Week 22	8.92	1.43	-0.1660
Week 23	9.25	1.59	0.4723
Window	10.34	3.07	0.3352

	Ave. Median	St. Dev	Pearson coeff.
Week 18	14.98	5.89	1.7698
Week 19	13.16	1.85	2.6958
Week 20	13.57	2.64	1.2087
Week 21	11.36	1.45	-0.2928
Week 22	11.39	1.12	-0.2822
Week 23	11.94	1.42	-0.1320
Window	12.74	3.15	0.7061

	Ave. High	St. Dev	Pearson coeff.
Week 18	16.91	6.35	1.8457
Week 19	15.05	2.11	0.0709
Week 20	15.74	3.37	0.6579
Week 21	13.70	1.33	-0.6869
Week 22	13.32	1.06	0.8964
Week 23	14.17	1.46	0.3414
Window	14.83	3.39	0.7374

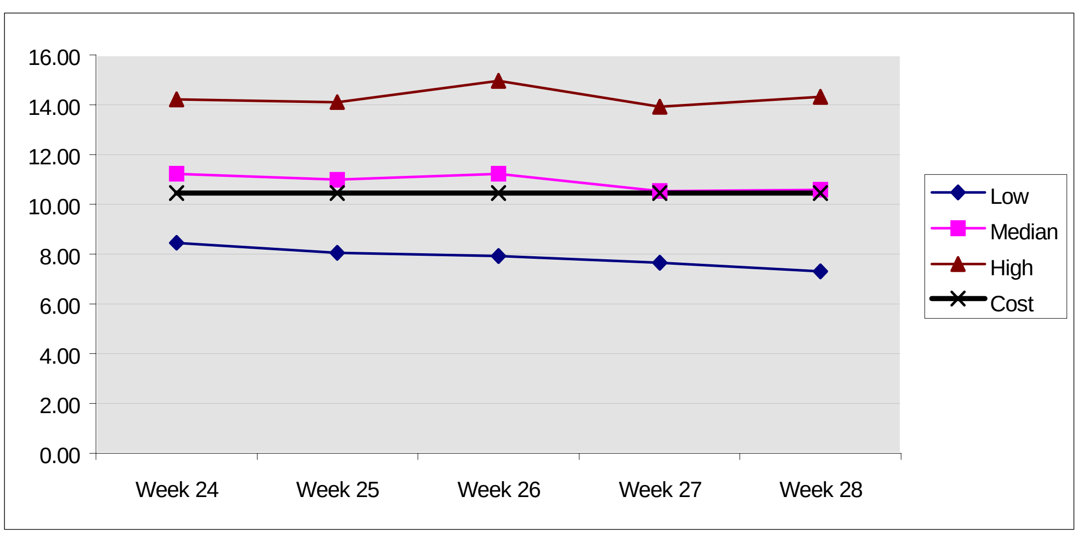


Appendix F: Table 5 - Spring Cucumbers. Baltimore Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 24	9.29	2.51	0.6473
Week 25	9.10	3.47	0.9502
Week 26	9.43	3.54	1.2160
Week 27	8.61	2.89	1.6723
Week 28	8.98	3.57	1.6628
Window	9.09	3.18	1.0311

	Ave. Median	St. Dev	Pearson coeff.
Week 24	11.22	1.57	1.1336
Week 25	11.00	2.62	0.5732
Week 26	11.11	1.70	1.0740
Week 27	10.61	3.10	0.8370
Week 28	10.70	2.86	0.2123
Window	10.94	2.40	0.5493

	Ave. High	St. Dev	Pearson coeff.
Week 18	14.23	2.23	-0.0280
Week 19	14.10	3.42	0.9644
Week 20	14.76	2.88	-0.2491
Week 21	14.02	4.10	0.7476
Week 22	14.43	3.04	0.4226
Window	14.30	3.14	0.2907

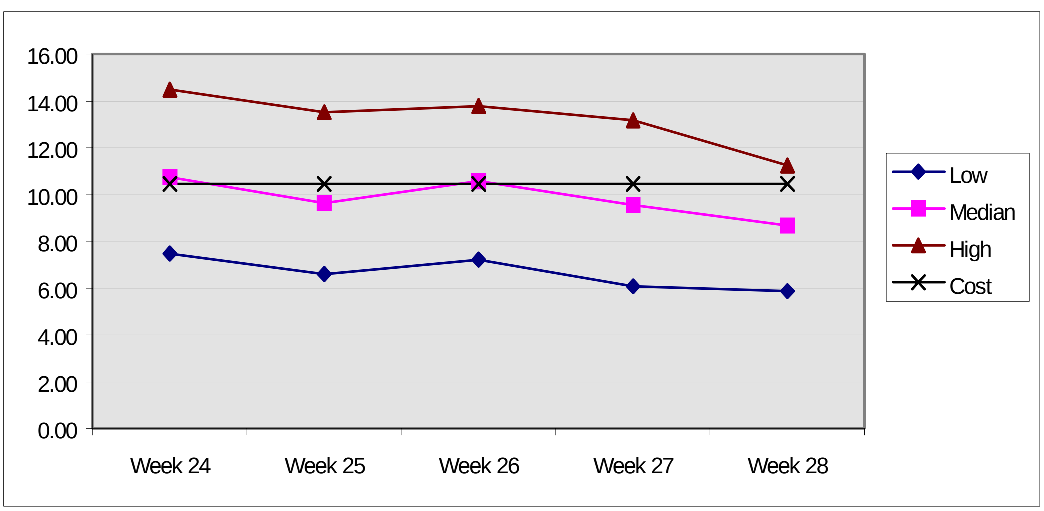


Appendix F: Table 6 - Spring Cucumbers. Philadelphia Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 24	7.42	1.59	-0.6279
Week 25	6.61	1.92	0.9489
Week 26	7.18	1.47	0.3715
Week 27	6.11	1.10	0.2870
Week 28	5.87	0.92	-0.4255
Window	6.66	1.55	1.2700

	Ave. Median	St. Dev	Pearson coeff.
Week 24	10.67	2.21	-0.4515
Week 25	9.70	2.84	-0.3211
Week 26	10.61	2.11	-0.5494
Week 27	9.58	2.10	0.8258
Week 28	8.70	1.39	-0.6579
Window	9.86	2.27	1.1363

	Ave. High	St. Dev	Pearson coeff.
Week 18	14.33	2.33	0.4284
Week 19	13.61	4.30	1.1214
Week 20	13.95	2.94	-0.0465
Week 21	13.11	3.11	-0.8639
Week 22	11.26	2.12	-1.0483
Window	13.26	3.19	1.1861

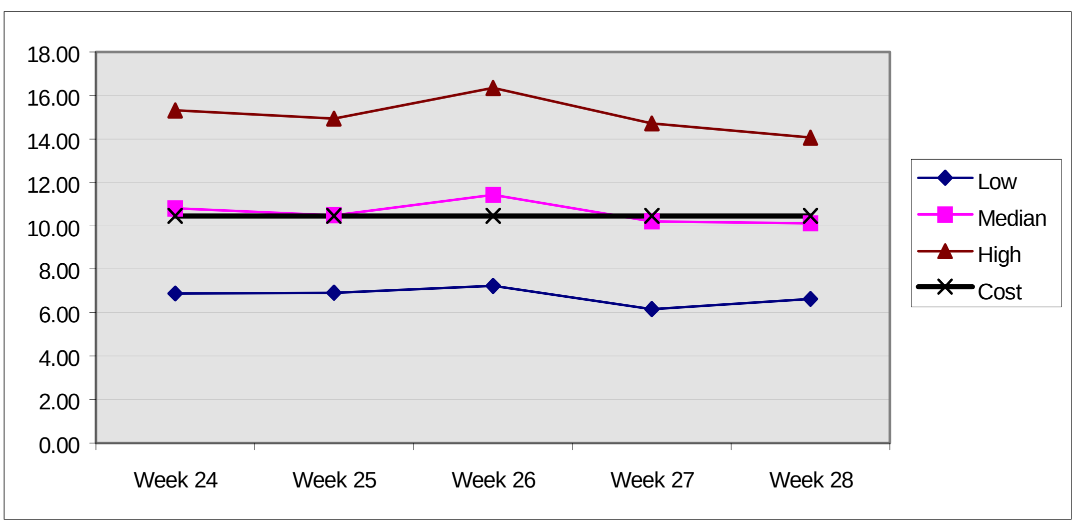


Appendix F: Table 7 - Spring Cucumbers. New York Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 24	6.91	1.60	0.7666
Week 25	7.04	2.93	1.0682
Week 26	7.24	2.07	0.3448
Week 27	6.14	1.62	0.2643
Week 28	6.65	1.64	-0.6360
Window	6.80	2.04	-0.2935

	Ave. Median	St. Dev	Pearson coeff.
Week 24	10.82	2.29	1.0711
Week 25	10.59	3.93	0.4484
Week 26	11.33	2.30	0.4340
Week 27	10.12	2.86	-0.9231
Week 28	10.11	1.92	0.9518
Window	10.59	2.75	0.6400

	Ave. High	St. Dev	Pearson coeff.
Week 18	15.27	3.22	0.2537
Week 19	15.09	5.18	0.6298
Week 20	16.19	2.84	-0.8553
Week 21	14.62	4.44	0.4179
Week 22	14.00	2.83	2.1213
Window	15.02	3.83	0.4060

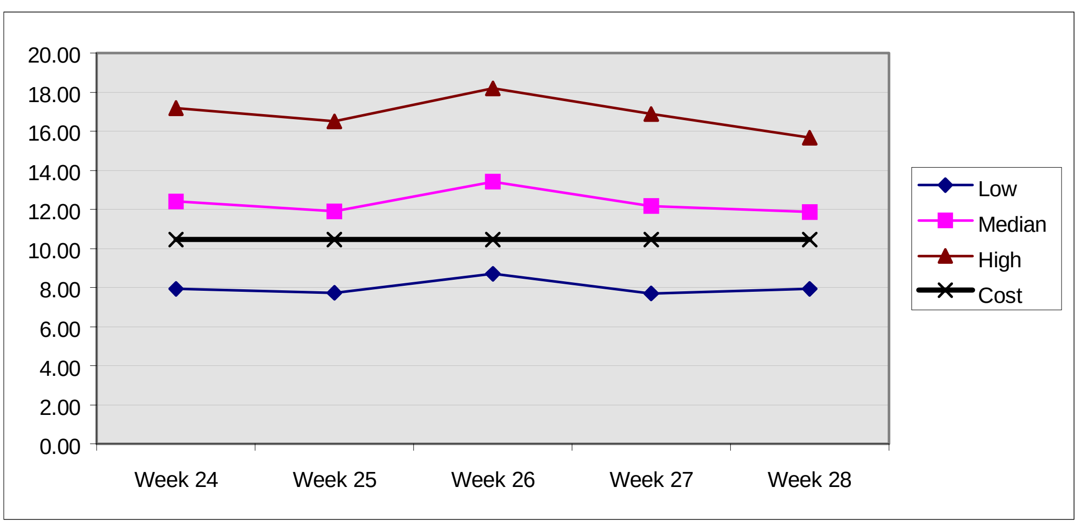


Appendix F: Table 8 - Spring Cucumbers. Boston Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 24	8.09	2.17	0.1201
Week 25	7.71	2.18	0.9763
Week 26	8.52	2.49	0.6297
Week 27	7.68	1.46	-0.6537
Week 28	7.96	1.52	-0.0857
Window	7.99	1.99	-0.0198

	Ave. Median	St. Dev	Pearson coeff.
Week 24	12.63	3.14	-0.3533
Week 25	11.94	2.92	-1.0929
Week 26	13.14	2.87	-0.3800
Week 27	12.14	2.45	0.1673
Week 28	11.84	2.02	0.5013
Window	12.33	2.71	0.3624

	Ave. High	St. Dev	Pearson coeff.
Week 18	17.48	4.50	0.9852
Week 19	16.54	4.86	1.2595
Week 20	17.82	4.27	-0.1277
Week 21	16.86	3.52	-0.1161
Week 22	15.65	2.69	-0.3879
Window	16.86	4.05	0.6360

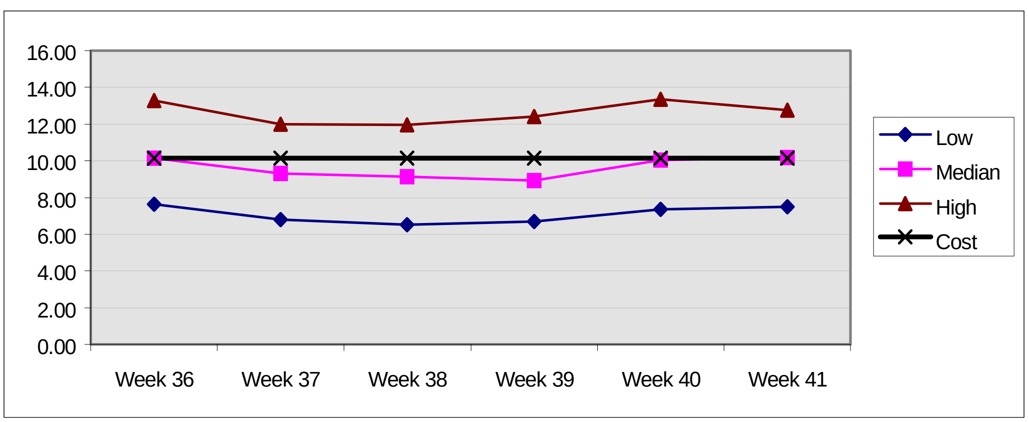


Appendix F: Table 9 - Fall Cucumbers. Baltimore Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 36	7.61	2.96	0.6187
Week 37	6.89	1.86	1.4341
Week 38	6.48	0.92	0.7419
Week 39	6.62	1.50	-0.7623
Week 40	7.52	2.93	1.0465
Week 41	7.88	3.34	1.4579
Window	7.13	2.35	0.8050

	Ave. Median	St. Dev	Pearson coeff.
Week 36	9.87	1.07	-1.0832
Week 37	8.65	0.40	-1.2362
Week 38	9.42	1.11	1.7941
Week 39	8.76	0.80	-0.2013
Week 40	12.88	3.57	0.3172
Week 41	13.90	4.22	0.1092
Window	10.69	3.15	1.4394

	Ave. High	St. Dev	Pearson coeff.
Week 36	13.28	4.19	0.7351
Week 37	12.06	1.91	0.0873
Week 38	11.82	1.81	1.3564
Week 39	12.26	2.69	0.8509
Week 40	13.54	5.33	0.8670
Week 41	13.45	5.57	1.5902
Window	12.72	3.79	0.6086

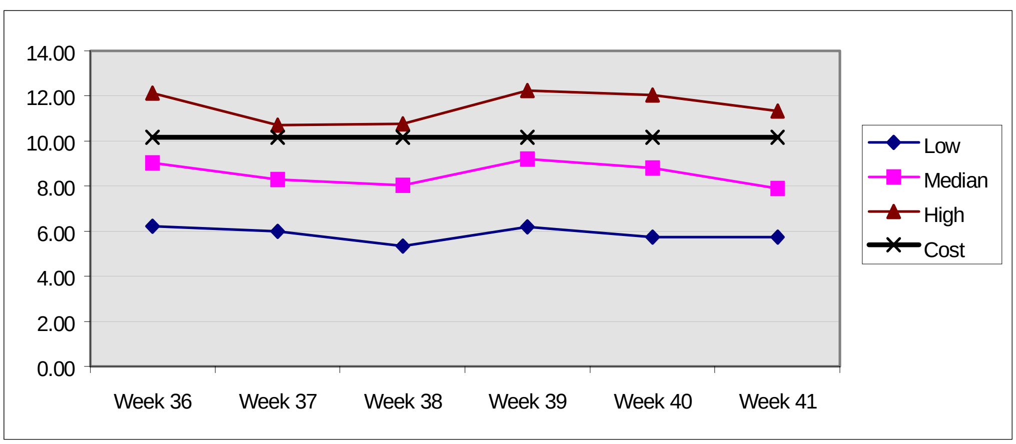


Appendix F: Table 10 - Fall Cucumbers. Philadelphia Terminal Market, 1996 - 1992

	Ave. Low	St. Dev	Pearson coeff.
Week 36	6.18	2.09	0.2645
Week 37	5.98	0.77	-0.0975
Week 38	5.25	0.85	0.8816
Week 39	5.95	1.59	-0.0859
Week 40	5.87	2.69	0.9716
Week 41	5.86	2.04	1.2649
Window	5.85	1.81	1.4069

	Ave. Median	St. Dev	Pearson coeff.
Week 36	8.99	2.69	-0.0147
Week 37	8.25	1.03	-0.7265
Week 38	7.95	1.47	0.9196
Week 39	8.70	2.64	0.5175
Week 40	8.99	4.10	1.0885
Week 41	8.08	2.38	1.0513
Window	8.51	2.61	0.5884

	Ave. High	St. Dev	Pearson coeff.
Week 36	12.05	3.76	0.0420
Week 37	10.65	1.66	1.1725
Week 38	10.70	2.25	0.9333
Week 39	11.67	3.81	-0.2623
Week 40	12.30	5.98	1.1559
Week 41	11.37	3.83	1.0711
Window	11.48	3.85	1.1494

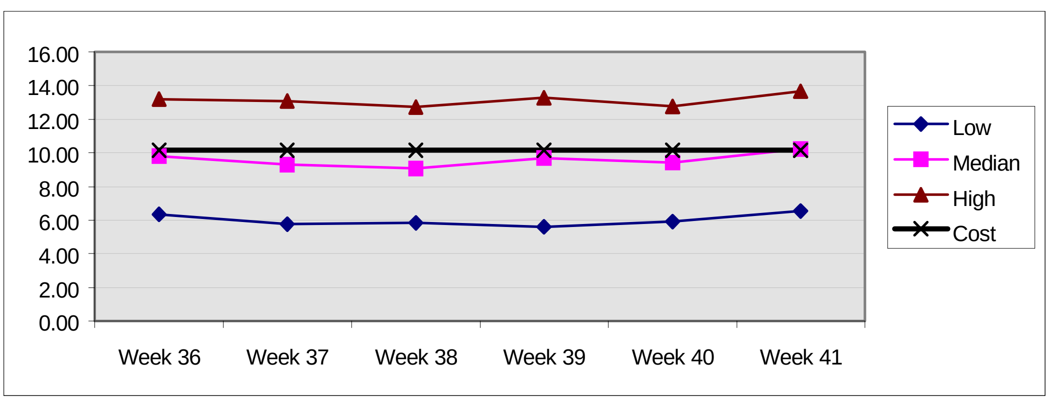


Appendix F: Table 11 - Fall Cucumbers. New York Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 36	6.16	1.61	0.2946
Week 37	5.79	1.03	2.2957
Week 38	5.64	1.47	1.3028
Week 39	5.68	1.81	1.1303
Week 40	5.96	1.99	1.4457
Week 41	6.58	3.11	1.5208
Window	5.95	1.92	1.4865

	Ave. Median	St. Dev	Pearson coeff.
Week 36	9.42	2.72	0.4636
Week 37	9.32	1.03	0.9196
Week 38	8.85	1.52	0.6930
Week 39	9.55	2.77	0.5911
Week 40	9.50	3.61	1.2460
Week 41	10.26	3.87	1.3665
Window	9.47	2.77	1.0496

	Ave. High	St. Dev	Pearson coeff.
Week 36	12.68	3.48	0.5897
Week 37	13.05	1.27	2.4902
Week 38	12.41	2.40	0.5106
Week 39	13.05	3.81	0.8230
Week 40	12.88	4.97	1.7346
Week 41	13.68	5.18	0.9763
Window	12.94	3.75	0.7554

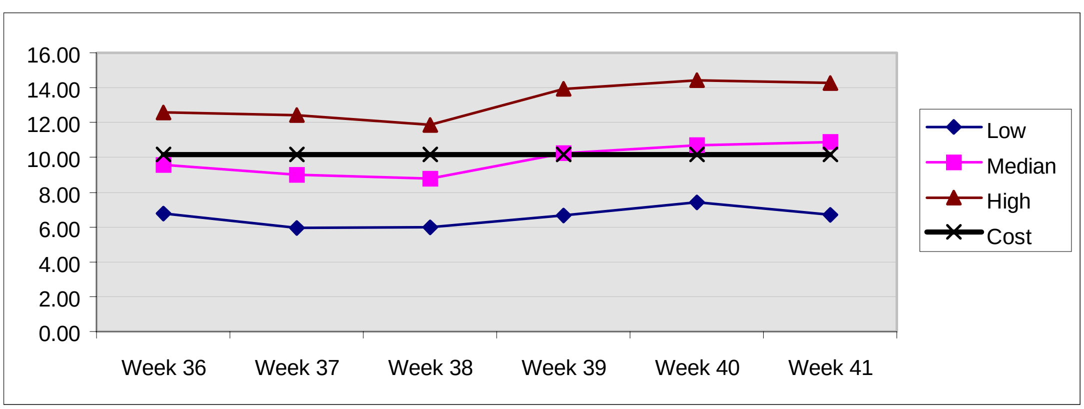


Appendix F: Table 12 - Fall Cucumbers. Boston Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 36	6.47	1.78	0.8004
Week 37	6.00	0.97	0.0000
Week 38	5.86	1.52	-0.2689
Week 39	6.48	1.59	0.9014
Week 40	7.50	4.30	1.3942
Week 41	7.00	3.34	0.8994
Window	6.56	2.58	0.6514

	Ave. Median	St. Dev	Pearson coeff.
Week 36	9.13	2.71	0.6999
Week 37	9.06	1.08	0.8715
Week 38	8.60	2.05	0.1500
Week 39	9.90	2.56	1.0566
Week 40	10.76	4.87	1.0846
Week 41	11.00	4.16	1.6218
Window	9.75	3.26	1.1483

	Ave. High	St. Dev	Pearson coeff.
Week 36	12.11	3.25	0.0973
Week 37	12.50	1.15	1.3077
Week 38	11.59	2.46	-0.4984
Week 39	13.48	3.54	-0.4421
Week 40	14.46	5.85	1.2616
Week 41	14.39	4.89	1.4660
Window	13.10	3.96	0.8350

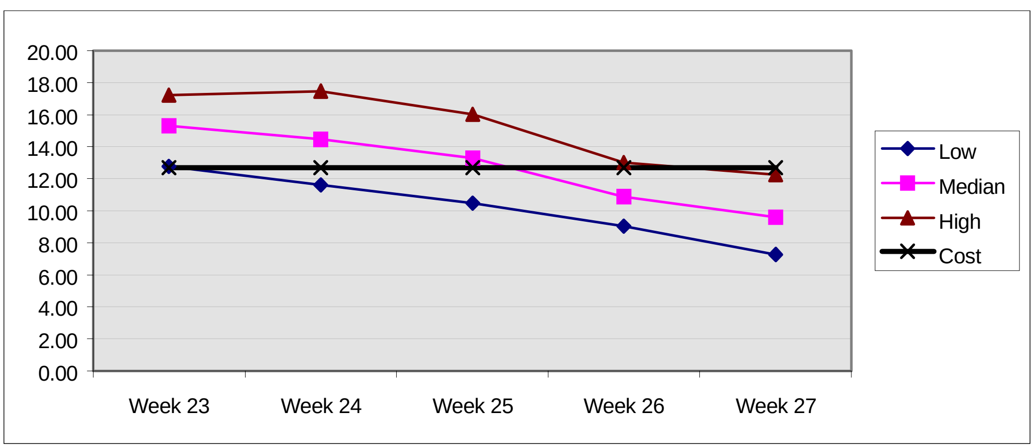


Appendix F: Table 13 - Spring Snap Beans. Baltimore Terminal Market, 1996 - 1992

	Ave. Low	St. Dev	Pearson coeff.
Week 23	13.06	3.37	-0.8410
Week 24	11.73	3.65	0.1868
Week 25	10.35	2.63	1.5439
Week 26	9.22	4.60	1.4455
Week 27	7.32	2.46	0.3885
Window	9.79	3.96	0.5984

	Ave. Median	St. Dev	Pearson coeff.
Week 23	15.71	2.90	-0.2991
Week 24	14.49	3.55	-0.4322
Week 25	13.08	3.11	2.0080
Week 26	10.99	3.88	1.1527
Week 27	9.57	2.09	0.0977
Window	12.45	3.90	0.7277

	Ave. High	St. Dev	Pearson coeff.
Week 23	17.74	3.10	-0.2545
Week 24	17.52	4.24	-0.6928
Week 25	16.04	4.42	1.3852
Week 26	13.06	3.71	0.8584
Week 27	12.11	2.78	0.6629
Window	15.11	4.40	0.7600

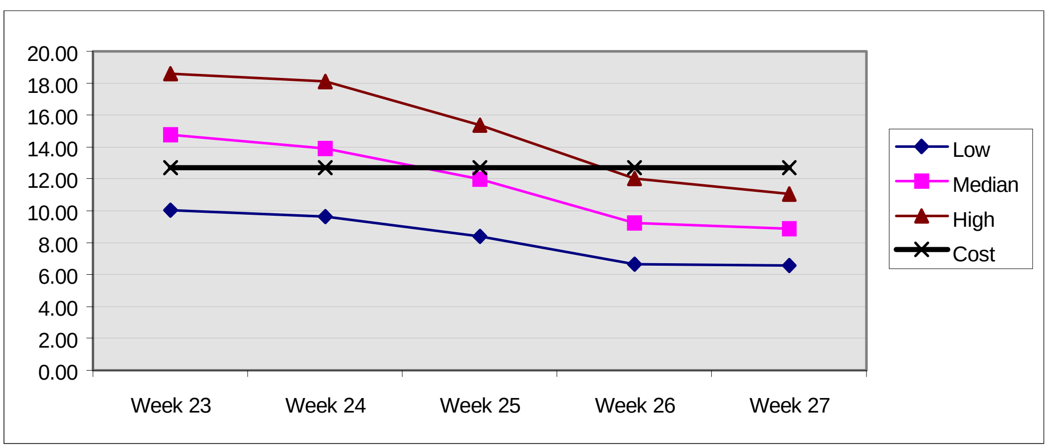


Appendix F: Table 14 - Spring Snap Beans. Philadelphia Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 23	9.94	3.51	0.8082
Week 24	9.52	3.80	0.4119
Week 25	8.26	3.18	1.1896
Week 26	6.86	2.96	0.8739
Week 27	6.35	2.37	1.0768
Window	8.01	3.44	0.8800

	Ave. Median	St. Dev	Pearson coeff.
Week 23	14.76	3.51	-0.2027
Week 24	14.06	4.03	0.0466
Week 25	11.91	4.07	1.7777
Week 26	9.48	3.23	1.6037
Week 27	8.83	3.26	0.7667
Window	11.69	4.26	0.8341

	Ave. High	St. Dev	Pearson coeff.
Week 23	18.53	3.92	-1.1275
Week 24	17.83	4.92	0.8126
Week 25	15.35	4.85	0.8339
Week 26	12.27	3.57	1.0681
Week 27	11.00	3.56	0.8418
Window	14.91	5.05	0.5376

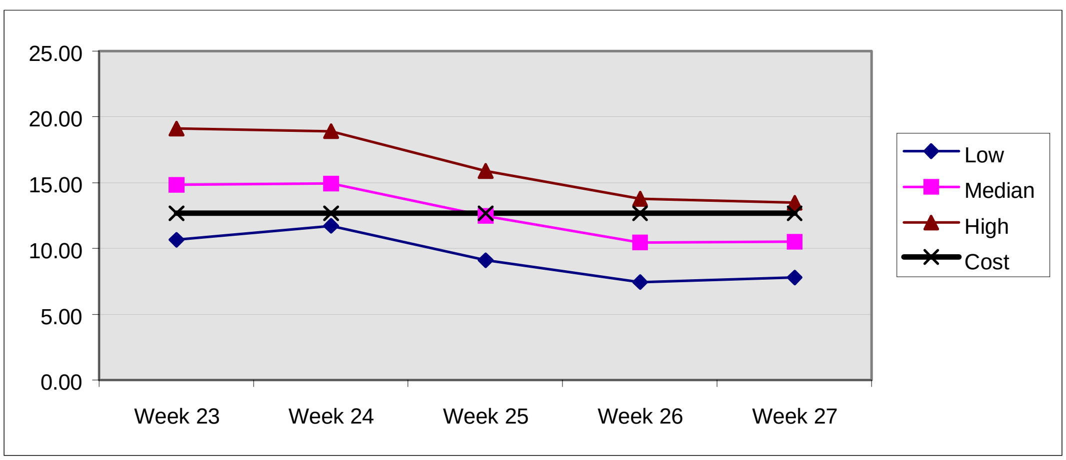


Appendix F: Table 15 - Spring Snap Beans. New York Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 23	10.73	2.75	0.7945
Week 24	11.32	3.84	1.0266
Week 25	8.74	3.19	0.6942
Week 26	7.57	2.46	0.6965
Week 27	7.57	3.63	1.2941
Window	8.83	3.55	0.7034

	Ave. Median	St. Dev	Pearson coeff.
Week 23	14.91	3.05	-0.0854
Week 24	14.98	4.49	0.6522
Week 25	11.91	3.63	-0.0718
Week 26	10.62	2.74	0.6771
Week 27	10.28	4.12	0.9340
Window	12.32	4.16	0.9511

	Ave. High	St. Dev	Pearson coeff.
Week 23	19.17	4.05	-0.6115
Week 24	18.95	5.21	-0.6032
Week 25	15.27	4.24	0.1928
Week 26	13.95	3.34	1.7543
Week 27	13.22	5.01	0.7292
Window	15.87	5.02	0.5182

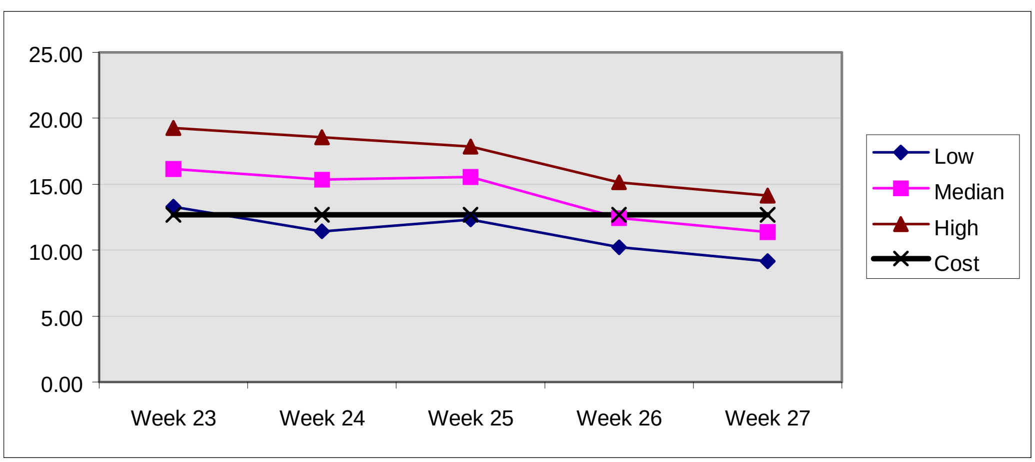


Appendix F: Table 16 - Spring Snap Beans. Boston Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 23	12.85	3.88	1.4291
Week 24	11.75	3.49	1.5032
Week 25	12.28	4.42	0.8679
Week 26	10.10	2.84	1.1552
Week 27	9.16	2.97	1.1705
Window	10.59	3.96	0.4474

	Ave. Median	St. Dev	Pearson coeff.
Week 23	16.17	4.27	-1.2835
Week 24	15.82	4.78	1.4558
Week 25	15.67	5.00	0.3997
Week 26	12.43	3.04	0.6719
Week 27	11.39	3.41	1.2286
Window	13.90	4.63	0.9039

	Ave. High	St. Dev	Pearson coeff.
Week 23	19.35	4.77	-0.4099
Week 24	19.14	5.78	0.8487
Week 25	17.95	5.16	-0.0277
Week 26	15.09	3.99	0.4446
Week 27	14.18	4.21	1.5551
Window	16.83	5.23	1.0484

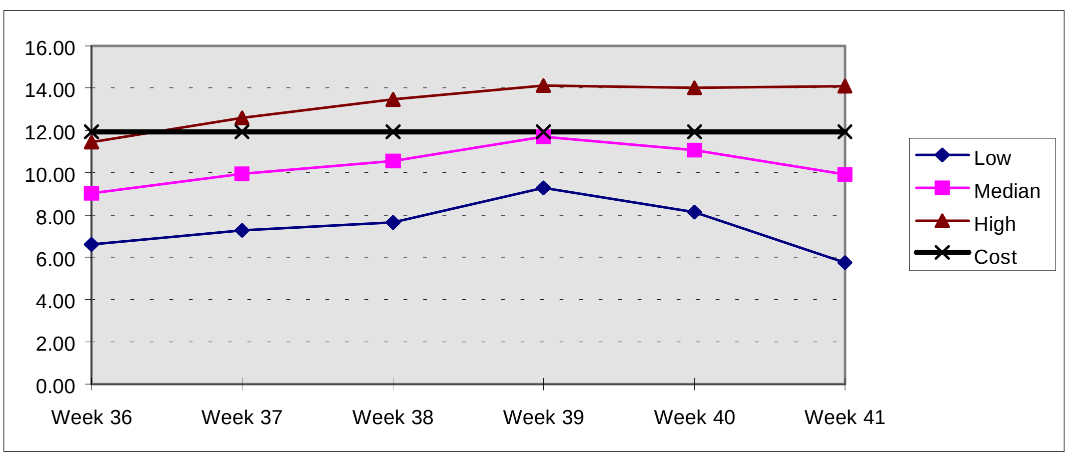


Appendix F: Table 17 - Fall Snap Beans. Baltimore Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 36	6.50	1.64	0.9156
Week 37	7.95	2.57	-0.0614
Week 38	9.04	4.07	1.5052
Week 39	9.00	3.02	-0.4961
Week 40	8.41	3.25	0.8401
Week 41	10.71	3.95	-0.2234
Window	8.57	3.36	0.5080

	Ave. Median	St. Dev	Pearson coeff.
Week 36	8.68	1.99	1.7726
Week 37	10.74	3.04	3.1910
Week 38	11.80	4.49	1.2058
Week 39	11.89	3.64	-0.2993
Week 40	12.04	3.63	0.4495
Week 41	14.21	4.28	0.1475
Window	11.57	3.90	0.4360

	Ave. High	St. Dev	Pearson coeff.
Week 36	11.41	3.06	1.3827
Week 37	13.03	3.16	0.9757
Week 38	13.64	2.96	1.1499
Week 39	13.86	1.92	-0.2128
Week 40	13.81	3.22	-0.1747
Week 41	14.09	3.77	1.2674
Window	13.40	3.12	0.8619

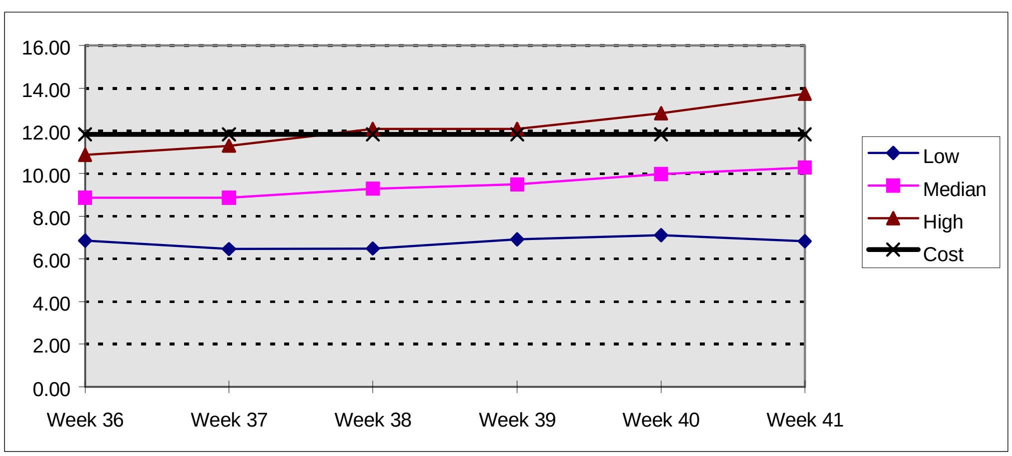


Appendix F: Table 18 - Fall Snap Beans. Philadelphia Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 36	6.80	2.48	0.9663
Week 37	6.45	1.79	0.7537
Week 38	6.26	1.52	0.5188
Week 39	6.74	1.91	-0.4133
Week 40	7.22	2.65	1.3808
Week 41	6.63	1.77	1.0702
Window	6.70	2.06	1.0172

	Ave. Median	St. Dev	Pearson coeff.
Week 36	8.78	2.30	0.3592
Week 37	8.63	2.63	0.1426
Week 38	8.84	1.86	0.5507
Week 39	9.33	2.53	-0.2075
Week 40	9.87	2.80	0.3958
Week 41	9.92	2.17	1.2706
Window	9.24	2.43	0.2963

	Ave. High	St. Dev	Pearson coeff.
Week 36	10.70	2.20	0.9533
Week 37	11.30	3.06	1.2735
Week 38	11.89	2.79	-0.1133
Week 39	11.65	3.10	-0.3387
Week 40	12.96	3.50	0.8207
Week 41	13.32	2.91	1.3579
Window	11.98	3.05	-0.0163

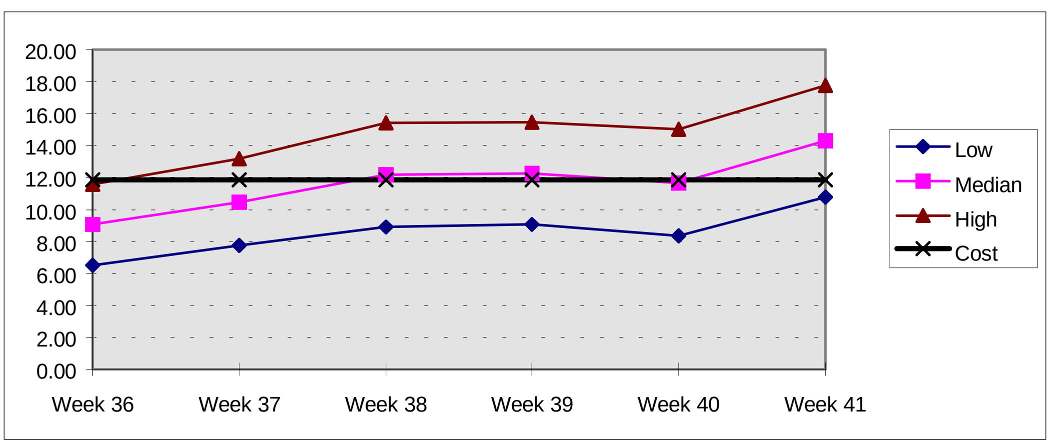


Appendix F: Table 19 - Fall Snap Beans. New York Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 36	6.50	1.64	0.9156
Week 37	7.95	2.57	-0.0614
Week 38	9.04	4.07	1.5052
Week 39	9.00	3.02	-0.4961
Week 40	8.41	3.25	0.8401
Week 41	10.71	3.95	-0.2234
Window	8.57	3.36	0.5080

	Ave. Median	St. Dev	Pearson coeff.
Week 36	8.68	1.99	1.7726
Week 37	10.74	3.04	3.1910
Week 38	11.80	4.49	1.2058
Week 39	11.89	3.64	-0.2993
Week 40	12.04	3.63	0.4495
Week 41	14.21	4.28	0.1475
Window	11.57	3.90	0.4360

	Ave. High	St. Dev	Pearson coeff.
Week 36	11.45	2.31	1.2364
Week 37	13.58	3.56	1.3291
Week 38	15.52	5.53	1.3691
Week 39	15.23	4.52	-0.5124
Week 40	15.30	3.53	-0.5904
Week 41	17.53	4.90	-0.2898
Window	14.79	4.52	0.5267

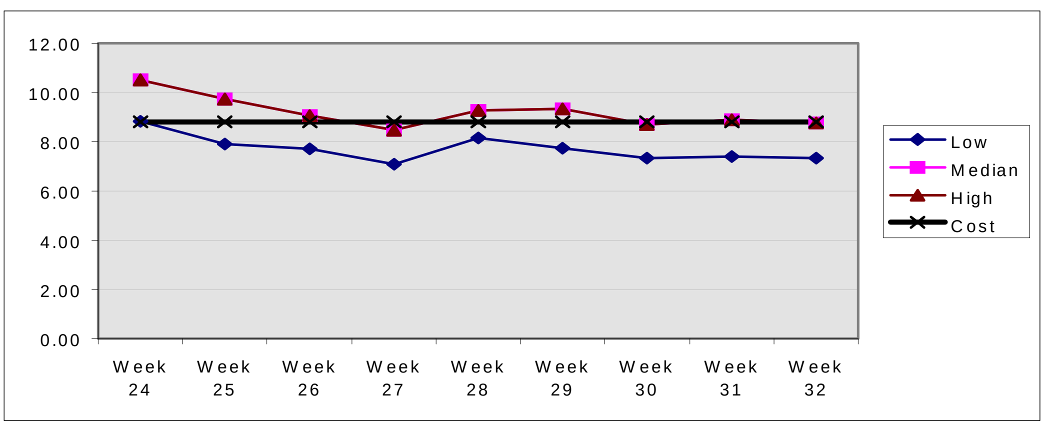


Appendix F: Table 20 - Spring Bell Peppers. Baltimore Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 24	8.83	1.65	1.5031
Week 25	7.90	2.10	0.5653
Week 26	7.72	1.63	-0.5203
Week 27	7.09	1.54	-0.8035
Week 28	8.15	1.48	0.2960
Week 29	7.73	1.38	-0.5974
Week 30	7.34	1.81	0.5668
Week 31	7.39	1.73	1.5430
Week 32	7.34	1.12	-1.7643
Window	7.75	1.68	-0.4539

	Ave. Median	St. Dev	Pearson coeff.
Week 24	10.50	1.59	0.9444
Week 25	9.73	2.63	0.9750
Week 26	9.05	1.81	-0.3242
Week 27	8.47	1.30	-0.0751
Week 28	9.26	1.77	0.4414
Week 29	9.34	1.23	-0.3969
Week 30	8.70	1.86	0.7198
Week 31	8.89	1.68	1.1529
Week 32	8.76	1.04	-1.4056
Window	9.22	1.80	0.3584

	Ave. High	St. Dev	Pearson coeff.
Week 24	10.50	1.59	0.9444
Week 25	9.73	2.63	0.9750
Week 26	9.05	1.81	-0.3242
Week 27	8.47	1.30	-0.0751
Week 28	9.26	1.77	0.4414
Week 29	9.34	1.23	-0.3969
Week 30	8.70	1.86	0.7198
Week 31	8.89	1.68	1.1529
Week 32	8.76	1.04	-1.4056
Window	10.83	2.21	1.1306

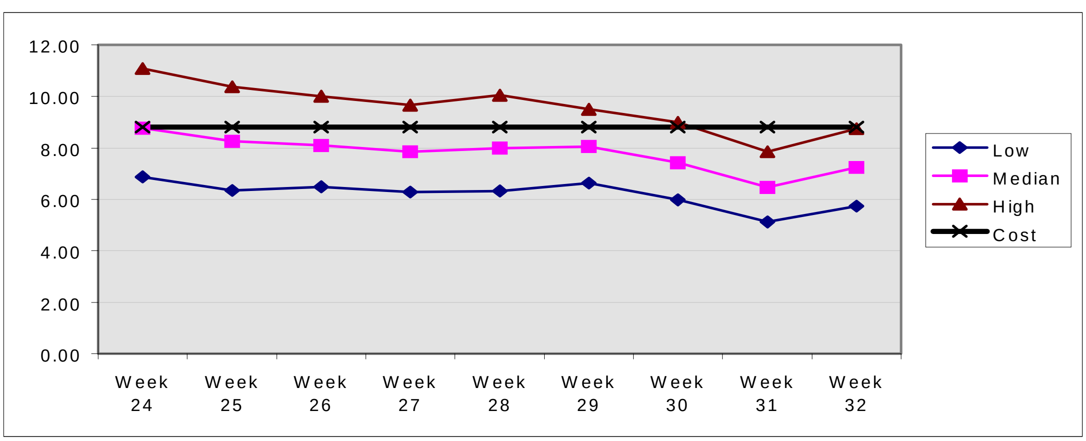


Appendix F: Table 21 - Spring Bell Peppers. Philadelphia Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 24	6.87	1.73	-0.2257
Week 25	6.35	1.32	0.8033
Week 26	6.48	1.92	0.7466
Week 27	6.28	1.18	0.7071
Week 28	6.32	1.31	0.7263
Week 29	6.64	1.90	1.0062
Week 30	5.98	1.49	-0.0503
Week 31	5.13	0.70	0.5607
Week 32	5.74	0.86	-0.9225
Window	6.23	1.51	0.4547

	Ave. Median	St. Dev	Pearson coeff.
Week 24	8.76	1.64	-0.4365
Week 25	8.26	2.07	1.1041
Week 26	8.09	1.85	0.1410
Week 27	7.85	1.12	0.2600
Week 28	8.00	1.46	1.0276
Week 29	8.05	2.02	0.8106
Week 30	7.43	1.60	0.7949
Week 31	6.46	0.41	-0.2885
Week 32	7.25	0.88	-0.8542
Window	7.84	1.66	0.6073

	Ave. High	St. Dev	Pearson coeff.
Week 24	11.09	1.68	0.1556
Week 25	10.38	2.81	0.4003
Week 26	10.00	2.20	0.0000
Week 27	9.67	1.19	-0.8416
Week 28	10.05	1.65	0.0828
Week 29	9.50	2.17	0.6908
Week 30	9.00	1.89	1.5858
Week 31	7.84	0.37	-1.2644
Week 32	8.74	1.05	-0.7549
Window	9.65	2.02	-0.5231

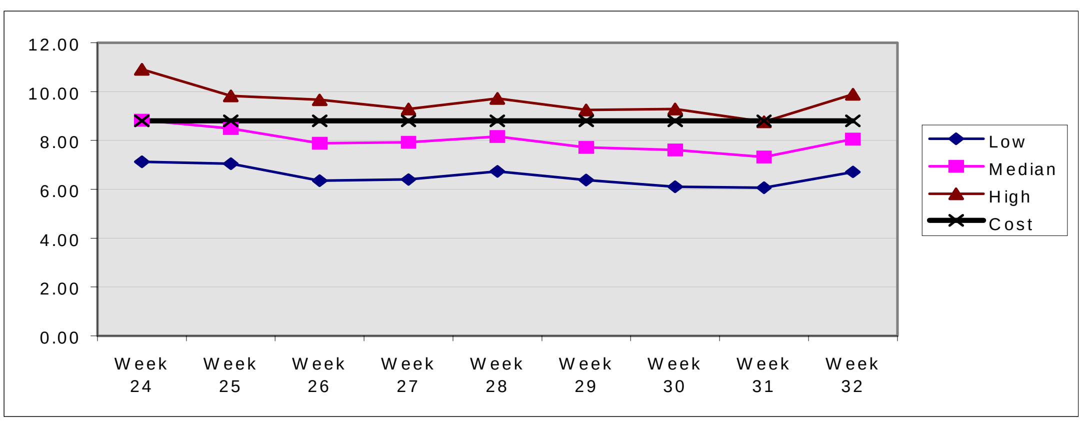


Appendix F: Table 22 - Spring Bell Peppers. New York Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 24	7.14	0.89	0.4603
Week 25	7.04	2.90	1.0796
Week 26	6.36	1.76	0.6196
Week 27	6.40	1.27	0.9425
Week 28	6.73	1.35	-0.6053
Week 29	6.38	1.50	-1.2388
Week 30	6.11	1.57	0.2126
Week 31	6.06	0.83	0.2134
Week 32	6.71	0.85	-1.0394
Window	6.57	1.61	-0.7991

	Ave. Median	St. Dev	Pearson coeff.
Week 24	8.82	1.16	0.1763
Week 25	8.48	3.53	1.2572
Week 26	7.89	1.96	0.5903
Week 27	7.93	1.99	1.4004
Week 28	8.16	1.42	0.3367
Week 29	7.71	1.38	0.4646
Week 30	7.61	1.41	-0.2956
Week 31	7.32	0.83	1.1721
Week 32	8.06	1.01	0.1741
Window	8.03	1.87	0.0438

	Ave. High	St. Dev	Pearson coeff.
Week 24	10.91	1.93	1.4168
Week 25	9.83	4.11	1.3335
Week 26	9.66	2.58	0.1847
Week 27	9.29	1.98	1.9496
Week 28	9.73	1.72	-0.4748
Week 29	9.24	1.45	0.4940
Week 30	9.28	1.49	-1.4567
Week 31	8.76	1.35	1.7023
Week 32	9.88	1.54	-0.2297
Window	9.65	2.27	-0.4665

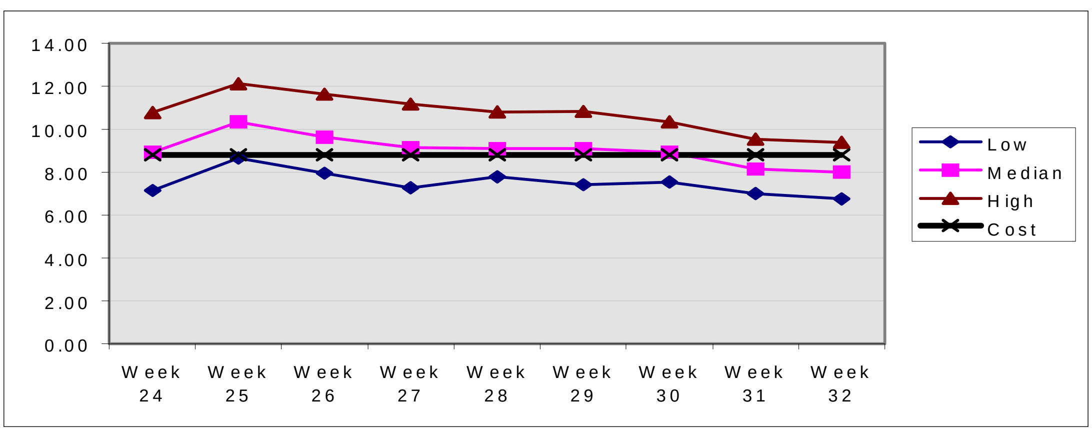


Appendix F: Table 23 - Spring Bell Peppers. Boston Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 24	7.14	1.33	-0.2513
Week 25	8.67	2.87	0.6969
Week 26	7.95	2.27	-0.0695
Week 27	7.26	1.09	-2.0211
Week 28	7.79	1.27	-0.4962
Week 29	7.41	1.00	-1.7583
Week 30	7.53	1.93	0.8220
Week 31	7.00	0.58	0.0000
Week 32	6.77	0.73	-0.9607
Window	7.54	1.71	0.9478

	Ave. Median	St. Dev	Pearson coeff.
Week 24	8.93	1.78	-0.1169
Week 25	10.35	3.50	1.1544
Week 26	9.63	2.41	-0.4578
Week 27	9.15	1.66	0.2664
Week 28	9.09	1.40	0.1970
Week 29	9.10	1.21	0.2555
Week 30	8.93	2.25	1.2374
Week 31	8.15	0.55	-1.8721
Week 32	8.00	0.63	0.0000
Window	9.09	2.03	0.8732

	Ave. High	St. Dev	Pearson coeff.
Week 24	10.78	2.24	-0.2979
Week 25	12.11	4.06	1.1914
Week 26	11.63	2.87	-0.3849
Week 27	11.18	2.35	0.2251
Week 28	10.82	1.79	-0.3089
Week 29	10.82	1.63	1.5164
Week 30	10.35	2.64	1.5349
Week 31	9.54	0.97	-1.4312
Week 32	9.40	0.63	1.8974
Window	10.81	2.47	0.9787

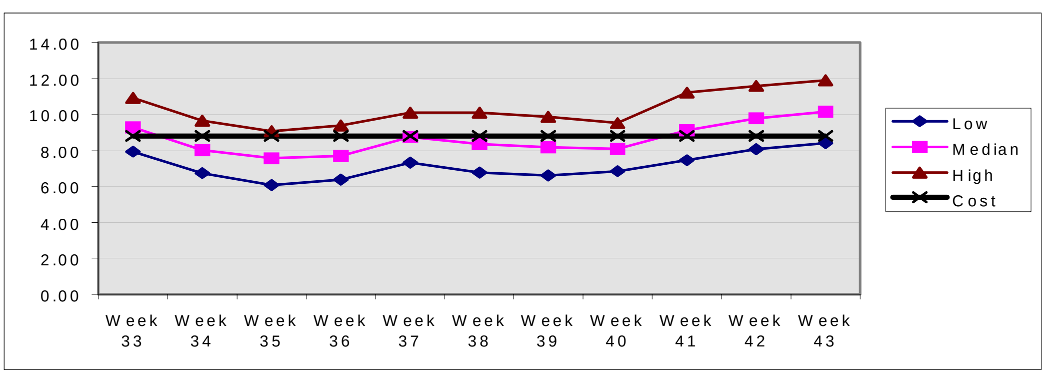


Appendix F: Table 24 - Fall Bell Peppers. Baltimore Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 33	7.95	0.92	-0.1636
Week 34	6.75	1.37	1.6468
Week 35	6.10	1.54	2.1491
Week 36	6.38	1.18	0.9724
Week 37	7.33	1.33	0.1882
Week 38	6.77	0.86	-0.7971
Week 39	6.62	0.85	-1.3444
Week 40	6.86	0.98	-0.4266
Week 41	7.47	1.21	-0.0691
Week 42	8.08	2.08	0.1152
Week 43	8.42	1.49	-0.1673
Window	7.16	1.47	0.3349

	Ave. Median	St. Dev	Pearson coeff.
Week 33	9.30	0.84	-0.7135
Week 34	8.02	1.10	0.7213
Week 35	7.58	1.30	1.3264
Week 36	7.69	1.25	1.6566
Week 37	8.75	1.71	0.6593
Week 38	8.38	0.82	-0.4557
Week 39	8.18	0.87	-0.2453
Week 40	8.11	0.92	-0.4543
Week 41	9.13	0.91	0.4109
Week 42	9.79	1.82	-0.3507
Week 43	10.16	1.24	0.0835
Window	8.66	1.44	0.0682

	Ave. High	St. Dev	Pearson coeff.
Week 33	10.93	1.33	-0.1499
Week 34	9.66	1.27	-0.8092
Week 35	9.08	1.24	0.7873
Week 36	9.38	1.75	-0.2011
Week 37	10.11	2.32	0.7890
Week 38	10.11	1.14	0.2981
Week 39	9.87	1.20	0.9202
Week 40	9.52	1.25	0.0482
Week 41	11.22	1.25	-0.6661
Week 42	11.60	1.95	-0.6152
Week 43	11.92	1.20	-0.2077
Window	10.32	1.72	0.5598

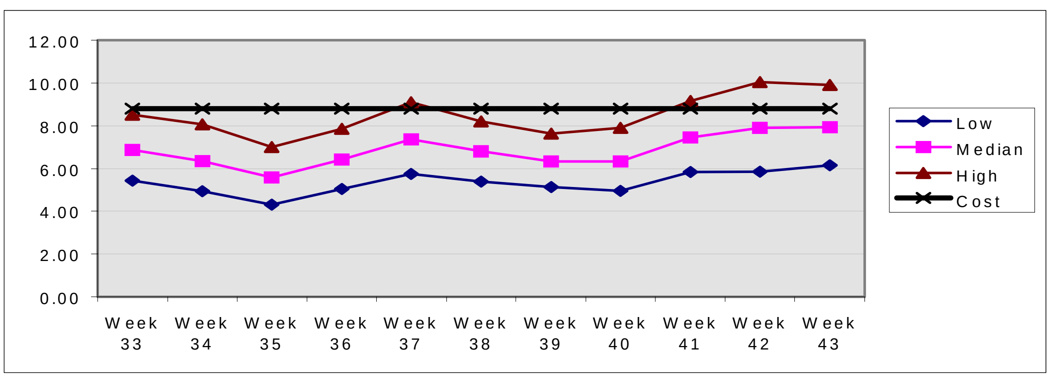


Appendix F: Table 25 - Fall Bell Peppers. Philadelphia Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 33	5.42	0.84	1.4801
Week 34	4.94	0.61	-0.2896
Week 35	4.31	0.67	1.3737
Week 36	5.05	1.24	0.1205
Week 37	5.74	1.21	0.5900
Week 38	5.38	0.86	1.3218
Week 39	5.14	0.76	0.5391
Week 40	4.95	0.86	-0.1652
Week 41	5.83	1.10	-0.4553
Week 42	5.86	1.00	-0.4179
Week 43	6.15	1.16	0.3928
Window	5.36	1.07	0.9978

	Ave. Median	St. Dev	Pearson coeff.
Week 33	6.86	0.87	1.2435
Week 34	6.35	0.74	-0.5963
Week 35	5.58	0.43	0.5831
Week 36	6.43	1.51	0.8450
Week 37	7.37	1.73	1.5058
Week 38	6.80	0.76	-0.7937
Week 39	6.33	0.61	0.3916
Week 40	6.33	0.77	-0.6512
Week 41	7.46	1.21	0.5151
Week 42	7.91	0.91	1.3631
Week 43	7.92	1.41	-0.7094
Window	6.88	1.28	0.8850

	Ave. High	St. Dev	Pearson coeff.
Week 33	8.50	1.04	1.4379
Week 34	8.06	1.03	0.1715
Week 35	7.00	0.77	0.0000
Week 36	7.85	1.73	1.4716
Week 37	9.10	2.33	0.7674
Week 38	8.19	0.99	0.5752
Week 39	7.64	0.66	-1.6580
Week 40	7.90	1.14	-0.2515
Week 41	9.17	1.65	0.3023
Week 42	10.05	1.10	0.1365
Week 43	9.92	1.79	-0.1400
Window	8.52	1.65	0.9408

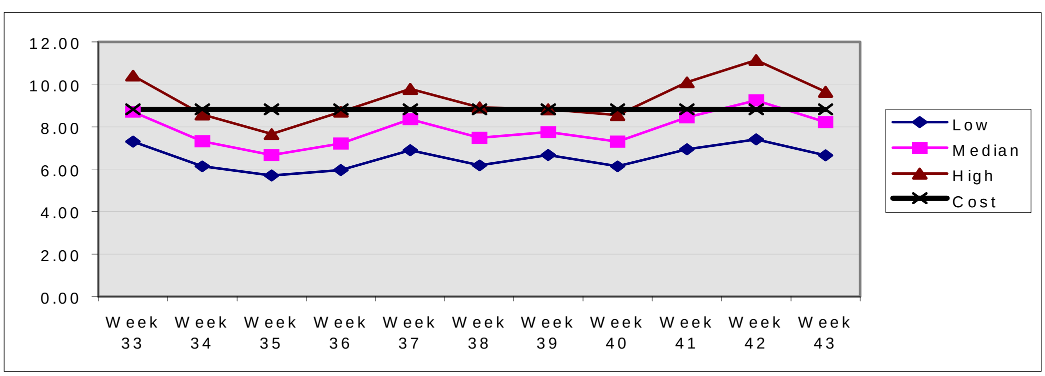


Appendix F: Table 26 – Fall Bell Peppers. New York Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 33	7.29	1.26	0.6985
Week 34	6.13	0.66	0.5950
Week 35	5.70	0.73	-1.2283
Week 36	5.95	1.50	1.9058
Week 37	6.89	1.66	-0.1899
Week 38	6.17	1.34	0.3903
Week 39	6.68	0.84	-1.1381
Week 40	6.13	1.19	0.3149
Week 41	6.95	0.97	-0.1627
Week 42	7.42	1.26	1.0015
Week 43	6.65	1.15	-0.9055
Window	6.52	1.27	1.2189

	Ave. Median	St. Dev	Pearson coeff.
Week 33	8.71	1.44	1.4739
Week 34	7.32	0.87	1.0897
Week 35	6.68	0.69	0.7570
Week 36	7.21	1.86	1.1513
Week 37	8.34	2.05	0.5010
Week 38	7.47	1.48	0.9489
Week 39	7.75	0.86	0.8765
Week 40	7.29	1.26	0.6950
Week 41	8.45	1.21	-0.1303
Week 42	9.24	1.35	-0.5859
Week 43	8.22	1.06	-0.7967
Window	7.84	1.49	0.6919

	Ave. High	St. Dev	Pearson coeff.
Week 33	10.41	1.62	0.7614
Week 34	8.58	1.30	1.3314
Week 35	7.65	0.81	-1.2919
Week 36	8.71	2.95	1.7422
Week 37	9.79	2.64	-0.2395
Week 38	8.91	1.78	1.5375
Week 39	8.82	1.26	1.9500
Week 40	8.54	1.59	1.0237
Week 41	10.11	1.63	0.1938
Week 42	11.16	1.80	-1.4010
Week 43	9.65	1.23	-0.8492
Window	9.26	1.98	0.3882

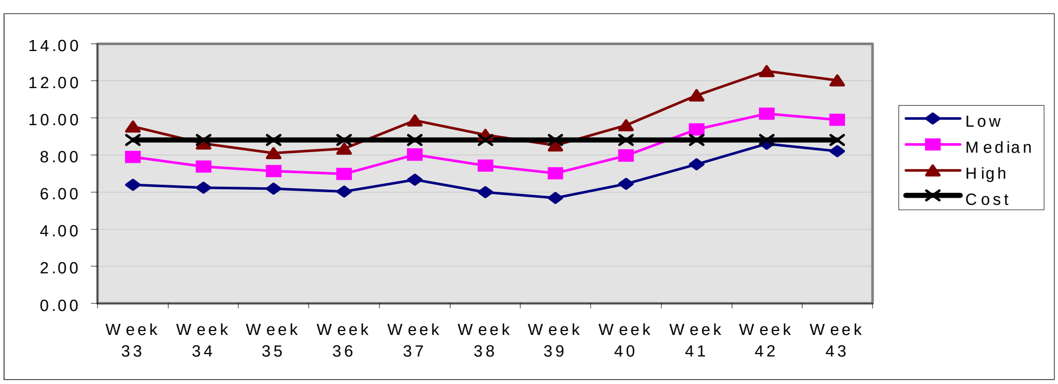


Appendix F: Table 27 - Fall Bell Peppers. Boston Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 33	6.38	0.65	1.7739
Week 34	6.23	0.63	1.0938
Week 35	6.19	0.38	1.5025
Week 36	6.03	1.04	0.0959
Week 37	6.69	1.25	0.4500
Week 38	6.00	0.94	0.0000
Week 39	5.69	0.67	-1.3737
Week 40	6.45	0.60	-0.2480
Week 41	7.50	1.02	0.0000
Week 42	8.59	1.12	1.5738
Week 43	8.21	1.23	0.5142
Window	6.75	1.30	-0.5806

	Ave. Median	St. Dev	Pearson coeff.
Week 33	7.88	1.00	1.1502
Week 34	7.38	0.55	2.1134
Week 35	7.15	0.44	1.0503
Week 36	7.00	1.05	0.0000
Week 37	8.03	1.40	0.6044
Week 38	7.43	1.21	1.0765
Week 39	7.01	0.86	0.0485
Week 40	7.96	0.45	-0.2521
Week 41	9.38	1.38	0.8138
Week 42	10.24	1.06	0.6644
Week 43	9.89	1.13	1.0439
Window	8.16	1.51	0.3263

	Ave. High	St. Dev	Pearson coeff.
Week 33	9.54	1.66	0.9707
Week 34	8.62	0.96	1.9215
Week 35	8.12	0.71	0.4864
Week 36	8.33	2.29	0.4369
Week 37	9.88	2.90	0.9066
Week 38	9.08	2.27	1.4230
Week 39	8.53	1.33	-0.4999
Week 40	9.60	0.82	-1.4620
Week 41	11.21	2.26	0.9485
Week 42	12.53	1.37	1.1554
Week 43	12.03	1.77	0.0447
Window	9.84	2.28	1.1000

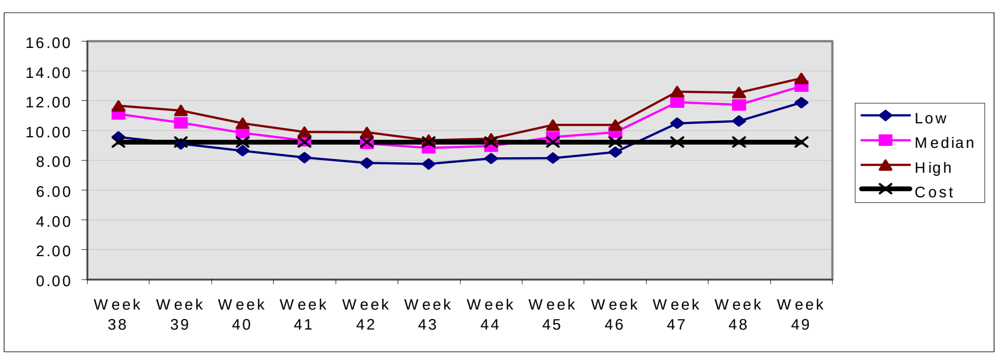


Appendix F: Table 28 - Broccoli. Baltimore Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 38	9.58	2.98	0.5790
Week 39	9.11	2.41	1.3891
Week 40	8.65	1.78	1.0858
Week 41	8.19	1.20	0.4852
Week 42	7.83	1.89	0.5168
Week 43	7.75	1.95	1.1536
Week 44	8.12	1.17	0.3087
Week 45	8.17	1.51	1.3236
Week 46	8.55	2.65	0.6255
Week 47	10.50	4.47	0.3358
Week 48	10.65	7.56	1.0508
Week 49	11.87	8.93	1.3003
Window	9.07	4.09	0.7852

	Ave. Median	St. Dev	Pearson coeff.
Week 38	11.11	2.64	1.5475
Week 39	10.53	2.16	1.7795
Week 40	9.85	1.89	1.3460
Week 41	9.33	0.94	0.6654
Week 42	9.14	1.69	0.9104
Week 43	8.83	1.86	1.1353
Week 44	8.95	1.06	0.5670
Week 45	9.58	1.38	1.8060
Week 46	9.88	2.24	1.5167
Week 47	11.91	4.47	0.7807
Week 48	11.74	7.62	1.0764
Week 49	12.99	9.00	1.4127
Window	10.30	4.06	0.9638

	Ave. High	St. Dev	Pearson coeff.
Week 38	11.68	2.61	1.3521
Week 39	11.34	2.48	1.9280
Week 40	10.48	1.95	0.7381
Week 41	9.92	1.14	1.0957
Week 42	9.88	1.53	0.7356
Week 43	9.35	1.82	1.4052
Week 44	9.44	1.11	-0.1619
Week 45	10.38	1.24	-0.2877
Week 46	10.37	2.28	1.1405
Week 47	12.63	4.28	0.4418
Week 48	12.56	7.65	1.3956
Week 49	13.50	9.04	1.4929
Window	10.94	4.07	1.0600

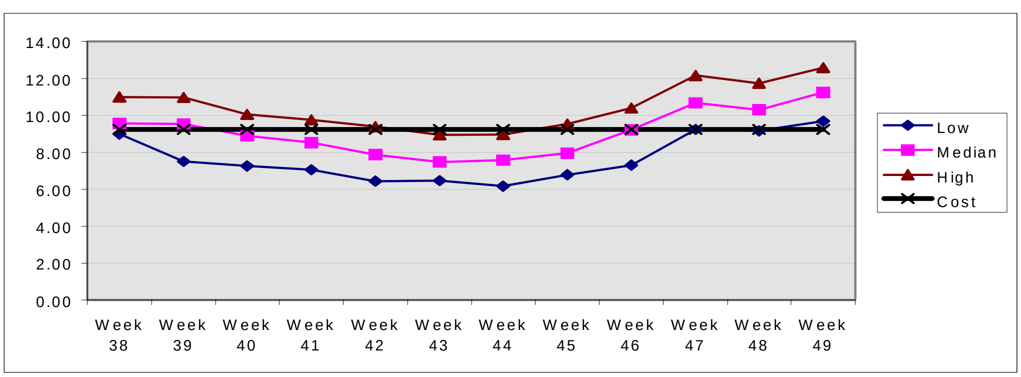


Appendix F: Table 29 - Broccoli. Philadelphia Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 38	9.00	1.62	0.0000
Week 39	7.52	2.12	0.7363
Week 40	7.26	1.64	0.4761
Week 41	7.06	1.20	0.1474
Week 42	6.45	0.80	1.6864
Week 43	6.48	0.70	-2.2352
Week 44	6.17	1.02	0.5125
Week 45	6.80	1.26	0.7036
Week 46	7.32	1.54	0.6158
Week 47	9.25	4.00	1.3118
Week 48	9.17	6.17	1.2968
Week 49	9.70	7.03	1.3647
Window	7.62	3.17	0.5869

	Ave. Median	St. Dev	Pearson coeff.
Week 38	9.56	2.00	0.4636
Week 39	9.55	2.14	1.4634
Week 40	8.89	1.78	0.2377
Week 41	8.51	1.03	0.0385
Week 42	7.88	0.98	1.1702
Week 43	7.49	0.84	-0.0356
Week 44	7.59	1.15	0.2364
Week 45	7.96	1.22	1.1437
Week 46	9.23	2.06	1.0543
Week 47	10.68	4.09	0.8677
Week 48	10.30	6.45	1.0701
Week 49	11.25	8.17	1.3772
Window	9.02	3.50	0.8791

	Ave. High	St. Dev	Pearson coeff.
Week 38	11.00	2.40	0.6242
Week 39	10.98	2.34	1.2515
Week 40	10.07	2.01	0.0972
Week 41	9.76	1.18	-0.6007
Week 42	9.38	1.47	0.7799
Week 43	8.94	1.27	1.0400
Week 44	8.98	1.34	-0.0509
Week 45	9.55	1.59	1.0344
Week 46	10.40	2.40	0.4992
Week 47	12.16	4.39	0.1087
Week 48	11.73	7.18	1.1427
Week 49	12.60	8.67	1.4175
Window	10.41	3.79	1.1177

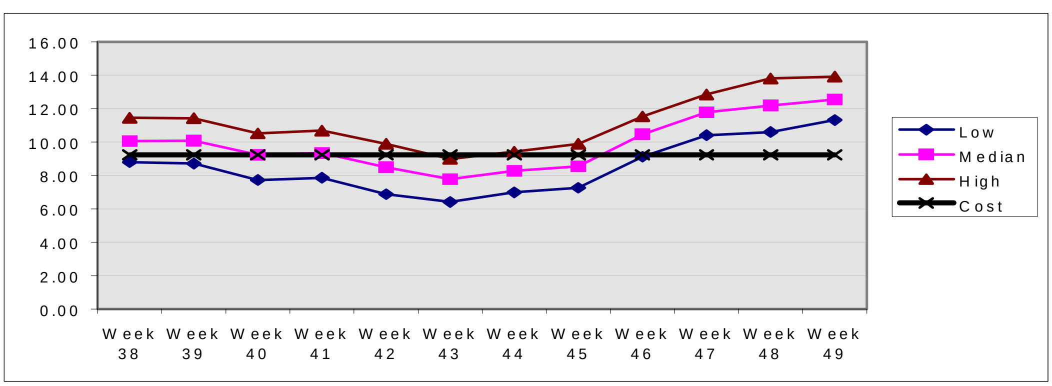


Appendix F: Table 30 - Broccoli. New York Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 38	8.78	2.92	0.8033
Week 39	8.71	2.31	0.9295
Week 40	7.73	1.69	0.4074
Week 41	7.88	1.28	0.8816
Week 42	6.88	1.07	-0.3490
Week 43	6.41	1.03	-1.7101
Week 44	6.98	1.47	0.9740
Week 45	7.25	1.27	1.1791
Week 46	9.12	2.20	0.1601
Week 47	10.40	4.61	0.9144
Week 48	10.60	6.05	1.2903
Week 49	11.33	8.91	1.4573
Window	8.45	3.94	1.1007

	Ave. Median	St. Dev	Pearson coeff.
Week 38	10.04	3.09	1.2539
Week 39	10.07	2.58	1.2434
Week 40	9.24	1.79	0.8192
Week 41	9.34	1.29	0.7828
Week 42	8.49	1.15	-0.0326
Week 43	7.77	1.00	-0.6850
Week 44	8.28	1.47	0.5753
Week 45	8.54	1.40	1.0340
Week 46	10.47	2.30	0.6139
Week 47	11.79	4.64	0.5084
Week 48	12.20	6.90	1.1741
Week 49	12.54	9.01	1.3466
Window	9.83	4.07	0.9813

	Ave. High	St. Dev	Pearson coeff.
Week 38	11.46	3.35	1.3055
Week 39	11.43	2.71	1.5800
Week 40	10.51	2.00	0.7671
Week 41	10.68	1.44	0.8827
Week 42	9.90	1.41	-0.2127
Week 43	9.00	1.15	0.0000
Week 44	9.43	1.60	0.8128
Week 45	9.90	1.47	0.8189
Week 46	11.53	2.12	0.7475
Week 47	12.86	5.13	0.5014
Week 48	13.80	7.84	1.0715
Week 49	13.91	10.00	1.4746
Window	11.13	4.46	0.7601

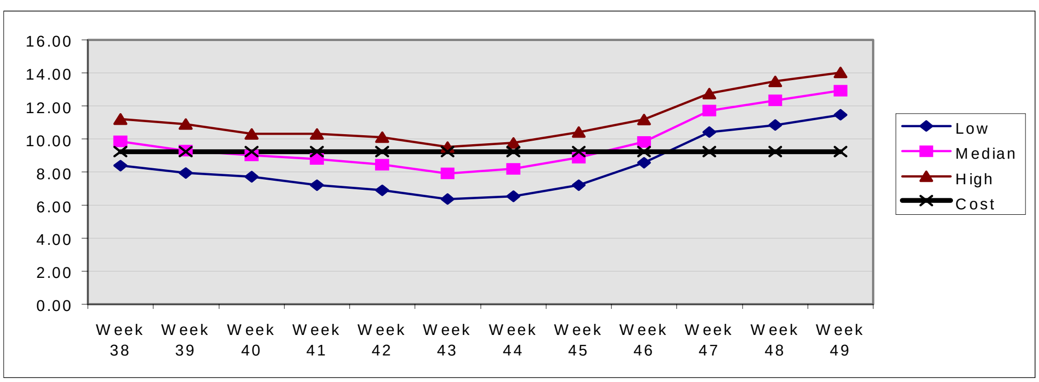


Appendix F: Table 31 - Broccoli. Boston Terminal Market, 1992 - 1996

	Ave. Low	St. Dev	Pearson coeff.
Week 38	8.38	1.47	-0.2423
Week 39	7.93	1.71	1.6359
Week 40	7.72	1.38	1.0206
Week 41	7.21	1.09	0.5664
Week 42	6.90	0.82	-0.3655
Week 43	6.36	1.22	-0.3362
Week 44	6.54	1.27	0.0948
Week 45	7.21	1.03	0.6231
Week 46	8.56	1.30	-1.0200
Week 47	10.41	4.51	0.6071
Week 48	10.86	7.98	1.0746
Week 49	11.48	9.35	1.5967
Window	8.31	4.27	0.9212

	Ave. Median	St. Dev	Pearson coeff.
Week 38	9.86	1.57	1.1569
Week 39	9.28	1.87	1.2587
Week 40	9.01	1.59	0.9622
Week 41	8.79	1.08	0.8172
Week 42	8.44	1.11	0.5087
Week 43	7.92	1.33	0.3843
Week 44	8.20	1.11	0.5282
Week 45	8.89	0.96	0.4256
Week 46	9.84	1.58	-1.2538
Week 47	11.73	4.59	0.3128
Week 48	12.33	8.39	1.1027
Week 49	12.92	9.67	1.5283
Window	9.78	4.39	0.8734

	Ave. High	St. Dev	Pearson coeff.
Week 38	11.21	1.95	1.8714
Week 39	10.89	2.06	1.2972
Week 40	10.32	1.90	0.5058
Week 41	10.32	1.12	0.8688
Week 42	10.10	1.59	1.5993
Week 43	9.52	1.57	0.9991
Week 44	9.78	1.34	0.6273
Week 45	10.42	1.27	0.9856
Week 46	11.18	1.73	0.3057
Week 47	12.76	4.64	0.4923
Week 48	13.50	8.36	1.2566
Week 49	14.02	9.77	1.3879
Window	11.18	4.41	0.8004



Appendix G - Kenaf Contract Agreement

[redacted]

KENAF PRODUCTION AGREEMENT

FOR EASTERN SHORE VIRGINIA

In signing this agreement I understand and agree to the following:

* I will plant kenaf on my land at my expense for seed, fertilization, chemicals, and field operations according to University of Delaware recommendations.

* Seed cost for this year's crop will cost approximately $3 per pound, and will require approximately 8 lbs/acre.

* As weather permits, I will harvest the crop and store it in modules at the edge of the field where it was grown.

* Harvest will occur between December 1, 1996 and May 31, 1997. I agree to allow kenaf modules to be stored at the edge of my field until hauled to [redacted], DE to be processed by [redacted].

* Payment for the crop will be as follows: Price will be $75 per ton delivered adjusted to 0% moisture. An additional $25 per ton will be paid for harvest and storage. [redacted]. also agrees to pay one half the transportation to [redacted], DE, their portion not to exceed $1 per loaded mile, or a maximum of $25 per ton, which ever is less.

Under these conditions I will plant ____________ acres.

Name: ______________________
Address: ____________________
____

Phone: __________________

[redacted]

VITA

Altin A. Kalo, son of Agim and Nekie Kalo, was born in Tirana, Albania on October 2, 1971. He was raised and educated in Tirana, Albania. He received a Bachelor of Arts Degree in English Language and Literature from the University of Tirana in 1993. He received a Bachelor of Arts Degree in Liberal Arts, with a major in Political Science, from Kenyon College in 1995. His graduate studies leading to a Master of Science in Agricultural and Applied Economics were completed in December, 1997.