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To the Graduate Council:

I am submitting herewith a dissertation written by Sarfraz Ahmad entitled "Income potential and stability of diversified Tennessee farms with emphasis on environmental horticulture plants." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Agricultural Economics.

Steven D. Mundy, Major Professor

We have read this dissertation and recommend its acceptance:

John R. Brooker, Burton C. English, Mark A. Nash

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

I am submitting herewith a dissertation written by Sarfraz Ahmad entitled "Income Potential and Stability of Diversified Tennessee Farms with Emphasis on Environmental Horticulture Plants." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Agricultural Economics.

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Accepted for the Council:

Associate Vice Chancellor
and Dean of The Graduate School

INCOME POTENTIAL AND STABILITY OF DIVERSIFIED TENNESSEE FARMS WITH EMPHASIS ON ENVIRONMENTAL HORTICULTURE PLANTS

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

SARFRAZ AHMAD

December 1994

AG-VET-MED.
Thesis
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بسم الله الرحمن الرحيم

IN THE NAME OF

ALLAH

THE MOST BENEFICENT

THE MOST MERCIFUL

DEDICATION

This dissertation is dedicated to the author's mother:

جنت بی بی

Jannet Bibi

1921-

and to the memories of author's father:

میاں عبدالحمید

Mian Abdul Hameed

1911-1952

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ABSTRACT

Generally, there is a considerable variability in year-to-year farm income for the typical farmer. Variation in farm income poses a risk in agricultural decision making. Diversification among enterprises in farm production has been practiced by producers as one measure against risk. Diversification in farm production involves adoption of a number of production activities instead of a single activity by the producer. Production diversification can potentially be successfully employed to manage price, yield and income risk if different crops, livestock, and or other alternative enterprises react differently to events. The inherent logic has applications in any situation where choice must be made with respect to a future characterized by imperfect knowledge. Variation in prices and/or yields of various enterprises are not in many cases highly positively correlated. Therefore, a combination of enterprises may result in a more stable income than one enterprise alone.

Farmers are diversifying by growing a combination of traditional commodities or enterprises such as crop-livestock mixes on their farms to enhance their incomes and/or to manage risk. However, there are other alternative enterprises available that can be considered for inclusion in farm diversification plans other than traditional commodities. These alternatives are the nontraditional agricultural commodities or enterprises that include environmental horticulture plants (EHPs), flowers, vegetables, and fruits. Other nontraditional enterprises include fish, poultry, forestry products, small animals, etc. Income potential of many of these commodities has not been fully explored by researchers and producers. However, nontraditional agricultural commodities are being grown by farmers in the southern region of the United States. Plath and Matthews compiled a list of approximately 250 such nontraditional agricultural commodities that are being raised by many producers in the southern region. One of these nontraditional commodity groups is EHPs that can be identified as alternatives enterprises for inclusion in farm diversification plans.

This study explored the potential of environmental horticulture plants for inclusion in farm diversification plans as possible alternative(s) to traditional crop-livestock enterprise(s) in Tennessee. A risk programming model, minimization of total absolute deviations (MOTAD) is used to analyze risk-return tradeoffs when EHPs are included as alternative(s) with conventional farm enterprises in the model.

The results from the analysis showed that three out of five specie of EHPs, euonymus, maple, and dogwood appear to be potential alternatives as enterprises in farm diversification plans. The optimal farm plans generated by MOTAD in which risk was considered frequently included euonymus and maple. Inclusion of EHPs with other conventional enterprises in farm plans for farms with different endowments can reduce risk. Therefore, can be managed more effectively if EHPs are combined with other conventional enterprises on farms across a variety of different resource situations.

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CHAPTER ONE

INTRODUCTION

Risk and Agricultural Production

Agricultural production is carried out in a risky environment. Risk in agriculture arises due to many events that occur continuously. Events such as competitiveness in domestic and global agricultural product markets bring unanticipated fluctuations in prices of agricultural commodities. Moreover, producers have no control over the prices of agricultural inputs. Output from farm enterprises depends on several factors dictated by natural, biological, and physical and human actions. Factors such as weather, pest and diseases, market conditions, biological processes, changing technology, government policy, farmer goals and preferences, and social interactions are some examples that must be considered in managing a farm firm. The effect of risk on the behavior of farmer as an individual and farmers as a group is important in agricultural decision making. The stochastic nature of future events must be recognized by the farmer as the decision maker.

Knight (1921) classified future events into two categories: (1) risk and (2) uncertainty. Risk can be measured by statistical techniques from a probability distribution of outcomes. Thus, risk is considered an objective measure. Two statistics used to quantify risk are variance, and standard deviation. These statistics are known as absolute measures of risk. Another measure, the coefficient of variation is a relative measure and is quite useful in comparing the riskiness of different enterprises. On the other hand, according to Knight, uncertainty is unquantifiable by any statistical technique. The notion of uncertainty is grounded in subjectivity related to mental attitude, feeling, and/or personal opinion of the decision maker. However, according to the modern definition of risk, risk and uncertainty are used interchangeably as both are based mostly on subjective feelings of the decision maker.

Sources of Business Risk

Sonka and Patrick (1984) categorized risk into five groups: (1) production and technical risks (2) market or price risks (3) technological risks (4) legal and social risks, and (5) human source risk. Production and technical risk arise due to variability in yields and weather, diseases and pestilence. Some examples of the sources in production risk are wind, fire, hailstorms, droughts, etc.. Market or price risk is inherently related to fluctuations in input and output prices. Other sources in market risk are changes in inflation and interest rate. Technological risk arises from technical change. Legal and social risks arise due to growth and expansion of the farm business. Examples of sources of legal risk are associated with private contracts and government policies and regulations. Examples of human sources of risk are sudden sickness of the farm operator and/or laborer at critical times that may lead to the loss of production and income. Other examples sources in this category of risk are changing objectives of the farmers and family aspirations. All such factors lead to risky situations that must be considered as a necessary part of management. Risk affects both the individual producer and the agricultural sector as a whole. The existence of risk and farmer responsiveness in managing risk have a great influence on formulation, conduct, and outcomes of agricultural policies. In practice, overall variability in year-to-year farm income due to the existence of risk has paved the way by inspiring and justifying technological innovations, by changing farming systems, and by improving farm management (Fleisher, 1990).

Variability (Risk) in Farm Production

Generally, there is a considerable variability in year-to-year farm income. Variation in farm income poses great risks in farm decision making. Risk in farm production can be quantified by computing the standard deviation of some measure of net returns such as the gross margins associated with enterprises included in the farm plan. Standard deviation is the common statistics used to interpret the magnitude of risk associated with farm enterprises (Held and Zink, 1982; Patrick, 1982; Adams and Woolery, 1981; Woolery and Adams, 1980; Yahya and Adams, 1977; Heady, 1952; Anderson and Dillon, 1992; Kay, 1986; Calkin and DiPietre, 1983; and Boehlje and Eidman, 1984).

Profit maximization is considered a major goal in farm planning and management. However, profit maximization is not the only objective for a rational producer. There are other factors that affect farmer decisions and actions. For example, cash flow and risk as measured by income variability are considered important in decision making. Generally, efforts are made to combine enterprises in such a way to obtain a more stable income over a long period of time. In making farm plans, certain enterprise combinations may appear promising because of high profits when risk is ignored. However, high profits are usually associated with high year-to-year income variability (risk) that may result in heavy financial loss, thus disrupting the future viability the of farm business. Therefore, risk considerations coupled with other internal and external factors, influence farmer decision making. Year-to-year variation in crop yields and product prices is one of the important aspects of farming which must be considered by the decision maker in making future business plans.

Sources of Variability

The stochastic yield of crop, livestock, vegetable, fruit, and other farm enterprises and uncertain product and input prices are the major sources of variability or risk in farm production. During a good year, yield may be higher as compared with a bad year when yield is lower. Similarly, product prices vary considerably from year-to-year. Generally, higher yields are followed by lower prices and vice versa. Yield and price are important variables in studying farm income variability over relatively long periods. Historical data related to such variables as crop yield and product price are needed to arrive at a measure of net income such as gross margins. Cost of production based on variable input prices is subtracted from gross revenue to obtain a series of gross margins. Gross margin variability is one approach in explaining variability or risks associated with a specific farm plan.

Furthermore, the use of a time series of gross margins based in part on historical data as a proxy for projecting future farm income variability has been a popular approach in farm risk analysis (Held and Zink, 1982; Patrick, 1982; Adams and Woolery, 1981; Woolery and Adams, 1980; Yahya and Adams, 1977; Heady, 1952; Anderson and Dillon, 1992).

Decision Making under Risk

Young (1984) classified risk concepts for three classes of decision rules: (1) decision rules that require no probability information, (2) safety-first rules, and (3) maximization of expected utility (EU). Halter and Dean (1971) listed four decision rules that require no probability information: (1) minimax loss or maximin gain, (2) minimax regret, (3) Hurwicz α index, and (4) LaPlace principle of insufficient reason. Criterion (1) forwarded by Wald (1950) assumes that the decision maker looks at the worst possible outcome (maximum loss or minimum gain) and opts for that action whose worst outcome is the least harmful. Criterion (2), forwarded by Savage (1954) assumes that the decision maker minimizes maximum regret. In the Hurwicz α index approach, the decision maker considers the weighted average of the best and the worst possible outcome in considering each alternative. The LaPlace principle of insufficient reason selects the action with the highest expected outcome based on equal probabilities. The drawbacks of these decision rules are explained in detail by Halter and Dean (1971). These rules are not commonly used in modern research studies due to their theoretical weaknesses.

Safety-first rules describe that decision maker has as a first objective a strong preference for safety in selecting between action alternatives and then strives for profit as a second objective. The safety-first criterion involves lexicographic utility analysis based on a hierarchy of decision-maker goals achieved in sequential ordering. The highest priority goal is achieved at a threshold level before considering the second goal, and so on. In expected utility (EU) methods, choices are ordered according to the preferences of the decision maker. Further information is needed on action choices, a set of monetary payoffs associated with each action choice for each state of nature, and a probability density function indicating the likelihood of outcomes for an action choice for each state of nature.

Risk Attitude

In the literature much discussion is devoted to risk attitude or risk preference of the decision maker to maximize his or her utility. These textbook references are based on earlier work by Friedman and Savage (1948) and others. Boehlje and Eidman (1984), and Halter and Dean (1977) have given three categories of individuals based on risk attitude: (1) risk averse, (2) risk preferring, and (3) risk neutral. Risk averters or avoiders are more cautious individuals preferring less risky source of income or investment. They will forego some amount of expected income to reduce the probability of low income and losses. Doll and Orazem (1984) used graphs to show the shape of such behavior having a concave function. Each added dollar of wealth adds less utility such that marginal utility is positive and diminishing.

In calculus terms, the first derivative of the utility function is positive, while the second derivative is negative (Doll and Orazem, 1984). Risk preferrers or takers are more adventurous individuals who prefer more risky alternatives. Each added dollar of wealth adds more utility such that marginal utility also increases. The graphical shape of such a utility function is convex and both the first and second derivatives of the utility function are positive (Doll and Orazem, 1984). Risk neutral is the limiting case between risk averse and risk preferring where the individual opts for highest expected return irrespective of the probability associated with alternative levels of gains and losses (Boehlje and Eidman, 1984). In other words, each added dollar of wealth has the same marginal utility. The graphical shape of such a utility function is linear and the first derivative of the utility function is constant while the second derivative is zero (Doll and Orazem, 1984). Boehlje and Eidman (1984) reiterated that risk attitude does not reflect management abilities of the decision maker. However, the knowledge of risk attitudes may aid in understanding the perceptions of individuals in decision making processes.

Risk Management Strategies

Producers in the farm sector decide upon various actions, the outcome of which are not known with certainty. The outcomes for producers depend both on the actions they choose and on future events that are out of their control. Many different events are going to occur between the time the decision is made and the time the consequences are observed (Fliesher, 1975). These events lead to variability of income in farm production. Formulation and application of risk management strategies in agriculture have drawn the attention of agricultural scientists, particularly agricultural economists (Fliesher, 1975). According to Sonka and Patrick (1984), responses by farmers under risky situation are of two types: (1) actions for reducing the effects of risk on the farm business, and (2) changes in the farmer's decision process. Action taken by farmers to manage risk in farm production may be divided into three categories: (1) production response, (2) marketing response, and (3) financial organization of the farm firm (Patrick, 1992; Boehlje and Trede, 1977).

There are several production responses to manage risk or variability. These actions or strategies are generally related to a tradeoff between return and income; that is, there is reduced year-year variability (risk) with a reduced level of average income. Some important production strategies are choosing low-risk enterprises, enterprise diversification, and maintaining flexibility. In production response, enterprise selection becomes an important criterion because variability of yields and farm income differs substantially among enterprises. The risk averse farmer might opt for a more stable enterprise to reduce income variability. However, other factors such as preferences and goals of the decision maker, his or her abilities, available finances, and opportunities besides risk reduction affect enterprise selection. According to Heady (1952), profit is not the only major goal for farmers in a short-run planning period. They may be just as interested in reducing the variability and uncertainty of their incomes as in maximizing profit. Two choices are generally available to the producer: (1) large possible profit and the chance of large loss and (2) smaller but more certain profit. According to Barry (1977), diversification is a production strategy that involves selecting and combining enterprises to reduce the variability of farm income. Diversification is just one of several production approaches to attempt to reduce risk in farming.

Marketing responses are the actions taken to avoid the negative impact on the farm business of variability in commodity prices. These responses are applied to reduce variability and to transfer some or all of the risk from the producer to other parties. Farm producers usually apply a combination of both responses. The common marketing responses to manage risk are obtaining marketing information, participating in government programs, spreading sales, forward contracting, hedging, and option trading. Financial responses to manage risk primarily affect solvency or liquidity position of the farm firm. The most common financial responses to manage risk are maintaining reserves, acquiring assets, working off the farm, and leverage.

Harsh, et al. (1981) in their book, *Managing the Farm Business,* have enlisted the following strategies for managing risk in farming: insurance, diversification, flexibility, liquidity, solvency, holding reserves, contractual agreements, hedging, spatial dispersion, and government actions. Usefulness of any strategy depends on resource availability, goals held by the farmer, attitude toward risk bearing, the type of farm, and the farming environment (Harsh, et al., 1981). According to them, strategies for managing risk in farm production may have varying objectives: (1) reduce variability of income, (2) prevent net income from falling below some minimum level, and (3) increase the ability of the farm business to withstand unfavorable outcomes.

Diversification and Risk Management

Production diversification has long been practiced as a strategy in stabilizing income and managing risk in agricultural production and is widely recognized by agricultural scientists and other agricultural production professionals including farmers. Diversification in farm production involves adoption of several production activities instead of a single activity by the producer. The lack of dependency on any single commodity should typically be advantageous to the business. The effects of adversity from weather, insects, disease, and markets are minimized given that proper selection and/or combination of enterprises is made (Strickland, et al., 1991). According to Castle, et al. (1987), diversification is more effective in managing production and market risk. In reducing production risk, enterprises can be selected so that they are not equally affected by factors such as temperature and rainfall. Therefore, when the yield of one enterprise is low, the other enterprise(s) will not be reduced by the same magnitude or might even increase. Similarly, to manage market risk, diversification requires the combination of enterprises whose prices have opposite or somewhat different price cycles. Therefore, when the price of one enterprise is lower, a normal or higher price of other enterprise(s) balances out the loss (Castle, et al., 1987).

According to Castle, et al. (1987), diversification has two aspects: (1)

horizontal and (2) vertical. Horizontal diversification implies production of several commodities; whereas, vertical diversification refers to production, distribution, and/ or processing of one commodity involving many stages. Babb and Long (1987) presented a broad concept of alternative enterprises in a changing agricultural economy in the United States. They discussed major forces that led to the search for new enterprises or a combination of them in agricultural production. According to Heady (1952), variability in income can only be reduced through diversification if the prices or yields of the products included in the farm diversification plan are not highly positively correlated. For example, if the prices, yields, and incomes have correlation coefficients between two enterprises of +1.0, diversification will not reduce variability. Upton (1987) said that if products in the plan are positively related and if one product fail while other products also fail, diversification will not usually reduce risk. The relationships between different crop yields can be measured empirically by the covariance or the correlation coefficient of price, yield, or income that ranges between +1.0 and -1.0. A negative correlation value shows that price, yield, or income from crops in the farm plan are negatively related. In other words, when the yield of one crop is higher, the yield of the other crop is lower. Under such circumstances variance of total yields may be reduced by diversification. However, this outcome depends on the manner of allocation of limited resources to each enterprise (Heady, 1952; Upton, 1987).

Diversification has two dimensions in a production process: (1) the static (non-risky) situation when planning is carried out under perfect knowledge, and (2) the dynamic (risky) situation when planning is carried out under imperfect knowledge or uncertainty (Heady, 1952). In the static situation, efforts are made to study the problem of planning by considering: (a) the condition of profit maximization where the marginal rate of product substitution (MRPS) = price ratios of the products, and (b) technical relationships between inputs and outputs of each product produced in combination. In other words, product-product relationships are analyzed in terms of supplementary, complementary, and competitive relationships between two or more enterprises (products) to maximize returns to the producer.

Two products produced simultaneously have a supplementary relationship if production of one can be increased without increasing or decreasing the yield of the other. Supplementary enterprises arise through time and/or when available resources become surplus during any part of the year on a farm. For example, two crops such as corn and soybeans can use the same machinery or labor at different times of the production period. They may be considered supplementary in terms of equipment usage and farm labor (Boehlje and Eidman, 1984).

Complementarity also occurs over time. For example, when legume crops are used in a rotation with cash crops, the production of cash crops may be enhanced by the production of legume crops. Under such circumstances, legume crops serve as an "input" that leads to greater yields of cash crops (Doll and Orazem, 1984).

The relationship between enterprises is competitive when an increase in the output of one leads to a decrease in the output of the other. Enterprises included in the farm plan compete for the same resources during the same period. For example, crop and livestock enterprises compete for labor and machinery during at least some periods of the year (Boehlje and Eidman, 1984).

In the dynamic or risky aspect of diversification, on the other hand, the producer is unable to predict price and yield outcomes. Thus, efforts are made to select a combination of enterprises which leads to stable year-to-year income. Furthermore, the probability that the farm business becomes bankrupt is minimized. Short-run production enterprises are chosen which prevent bankruptcy with the opportunity to maximize income in the future (Heady, 1952).

According to Heady (1952), there are two different approaches for applying diversification in managing the farm business. The first approach is to increase total resources to produce the additional enterprise(s). The objective here is to reduce income variability over the entire career of the farmer. An example may be the use of more capital by the farmer. The second approach is to hold the amount of total resources constant (because they are limited) and to transfer some resources to the additional enterprise(s). The objective here is to reduce income variance with limited resources. This is more applicable because most farmers have limited resources.

Agricultural diversification is a complex process. Schuh and Barghouti (1988) described different dimensions of diversification. At the farm level, diversification can be an effective way to manage risk related to unpredictable weather or fluctuations in market prices.

Aggregate Production of Major Crop Enterprises in Tennessee

The relative importance of farm enterprises can be studied by observing the amount and proportion of resources devoted to and production and/or market value of the enterprises in a farm plan during a particular period. The direction of change in resource use and/or production value can be viewed by comparing two or more different periods. A negative (positive) change in resource use and/or product value suggests a reduction (increase) in the resource use and/or value and vice versa for that enterprise. Such changes show or at least imply shifting of production from one enterprise to another.

Similarly, changes in aggregate production patterns can be observed for a geographical area such as the state of Tennessee. In total, crop production levels in Tennessee have changed over time. Results in Appendix Table 1 indicate change in acreage and production value for 12 major farm enterprises. These include field crops, vegetables, and fruits in Tennessee for two different periods. The period, 1983-87, was taken as a base period and the change in acreage and production value were calculated for the period, 1988-92. Comparisons between the two periods show that crop acreage of soybeans, tobacco, wheat, corn, sorghum, and alfalfa hay declined for the period 1988-92. A large decline of 74.1 percent was observed for sorghum followed by alfalfa hay (27.58 percent) and soybeans (26.73 percent). The acreage under corn also declined sharply by 19.07 percent for the period. In terms of gross production value, soybeans, corn, sorghum, and snapbeans declined in value.

Corn experienced the highest value decline of 15.73 percent followed by sorghum (12.94 percent) and all other hay (11 percent). On the other hand, acreage for cotton, peaches, apples, and all other hay increased. The acreage for cotton increased by 64.88 percent followed by peaches (22.72 percent), apples (14.47 percent), and all other hay (12.52 percent). Similarly, gross value for cotton, peaches, apples, and all other hay increased by 57.14 percent, 48.44 percent, 11.34 percent, and 30.21 percent, respectively.

The changes in crop acreages and values may be attributed to a number of factors. These factors are government policy and programs, demand and supply relationships including foreign competition, relative gross margin of a particular crop compared to other crops and off-farm employment opportunities. The acreage changes also suggest that producers as a whole are making choices among enterprises that offer greater potential.

Environmental Horticulture Plants

A focus of this study is on evaluating the economic potential under risks of environmental horticulture plants (EHPs) as farm enterprises. Relatively little research in the field of farm management and production economics has focused on this area. However, researchers have explored the importance of EHPs in U.S. agriculture and the economy. Johnson and Johnson (1993) grouped six categories of EHPs. These categories are nursery plants, unfinished plant materials, sods (turfgrass), bulbs, flower and vegetable seed, and cut Christmas trees. These plants, according to the Johnson and Johnson definition, include trees, shrubs, ground covers, vines, and fruit and nut plants. This study focuses on small-to medium-size trees and ornamental shrubs that are common and can successfully be grown in the field on Tennessee farms. The plants are generally sold or marketed as bare-root or balled and burlapped (B & B) to consumers.

Presently, EHPs are relatively uncommon enterprises among Tennessee farmers. However, in some parts of Tennessee these plants are being grown as farm enterprises. There were 22,160 acres of land under nursery production on farms in Tennessee (Agriculture Census, 1987). According to Johnson and Johnson (1993), Tennessee was the leading state based on acreage under nursery plants in the South. Of the total acreage devoted to nursery plants in the South, 23 percent was in Tennessee, followed by Florida at 19 percent and Texas at 10 percent. EHPs are playing a dominant role in the U.S. and Tennessee economies. In 1991, U.S. grower cash receipts from floriculture and EHPs accounted for 11 percent of all farm crop cash receipts and the industry was ranked sixth among all farm enterprise groups. The other five top ranking enterprises in the U.S. were beef cattle, dairy, corn, hogs, and soybeans. For floriculture and EHPs, grower cash receipts were about one-fourth greater than the combined cash receipts for tobacco, sugar crops, peanuts, grain sorghum, and food grains in the U.S. in 1991 (Johnson and Johnson, 1993).

EHPs cultivation was dominant in Middle Tennessee as compared to East or West Tennessee in 1987 (Tennessee Agriculture, 1993). According to these statistics, the market value of nursery products was $108 million in Tennessee. About 78 percent of the market value was contributed by farm production in Middle Tennessee. More than 50 percent of the value originated from Warren County alone. East and West Tennessee accounted for 11 percent each in the market value of nursery products. Shelby County and Knox County were the leading production areas in 1987 for the western and eastern part of the state, respectively (Tennessee Agriculture, 1993).

Economic Potential for EHPs

Farmers are diversifying by growing a combination of traditional commodities or enterprises such as crop-livestock mixes on their farms to stabilize and enhance their incomes. There are other alternatives available that have not been fully explored and can be considered for inclusion in the farm diversification plan other than traditional commodities. These alternatives are the nontraditional agricultural commodities or enterprises that include EHPs, flowers, roses, vegetables, and fruits. Other nontraditional enterprises include fish, poultry, and small animals. Although income potential of many of these commodities has not been fully explored by researchers and producers, nontraditional agricultural commodities are being grown by farmers in the southern region of the United States. As mentioned above, one of these nontraditional commodity groups is EHPs that can be identified as possible alternative enterprises for inclusion in a farm diversification plan.

Cox, et al. (1994) said that employment in landscape services increased during the past 20 years as compared to declining employment in the agricultural production sector. The U.S. Department of Labor (1990) and Economic Research Service (1991) of the USDA predicted that the increasing trend in employment by the landscape services sector and the declining trend in agriculture will continue in the future years. Purcell, et al. (1993) showed that income variability (risk) could be managed in agriculture by diversification in landscape plant production and marketing. Johnson (1993) forecasted some future aspects of the floriculture and EHPs industries. He predicted that grower cash receipts will increase about 5-6 percent to $10.4 billion in 1994. According to his estimates, grower receipts will continue to rise at a moderate rate throughout the 1990's. Using a conservative growth rate of 4-6 percent per year, Johnson (1993) projected producer receipts to be $13-14 billion by the year 2000. The industry is expected to be ranking the fifth highest commodity group based on grower cash receipts by 1995 and the third or fourth highest by the turn of the century (Johnson, 1993).

According to Hall, et al. (1991), the United States nursery industry was a rapidly growing industry in 1990. Financial stress in traditional farm businesses that prevailed during the 1980s attracted attention to nursery products as alternatives to traditional farm enterprises. According to Hall, et al. (1991), farmers were diversifying by producing and marketing ornamental landscape plants in significant quantities especially in the southern region. Johnson (1993), while discussing Agriculture Outlook for 1994, observed that "grower's cash receipts for floriculture and environmental horticulture plants are outpacing all other major segments of U.S. agriculture. Producer receipts rose from $6.0 billion in 1986 to $9.0 billion in 1992, an increase of $500 million per year or 7.1 percent annually." He observed that wholesale and retail markets grew at a faster rate than grower receipts. Economic levels in landscaping, interior plantscaping, and related service sectors were high due to strong consumer and commercial demand.

Plath and Matthews (1990) compiled a list of approximately 250 such nontraditional agricultural commodities that are being raised by different producers in different states in the southern region. Assessment of the income potential of EHPs as alternative enterprises in agricultural businesses is no small task for the manager or the researcher. This research study is an attempt to explore the potential of EHPs as alternatives with traditional farm enterprise(s) in Tennessee.

Statement of the Research Problem

Generally, there is considerable variability in the year-to-year farm income primarily due to variation in yields and prices of inputs and outputs. Variation in farm income poses a great risk in agricultural decision making. Diversification among enterprises in farm production has been practiced by producers as one measure against risk. Diversification in farm production involves several production activities instead of a single activity. Farmers are diversifying by growing a combination of traditional commodities or enterprises such as crop-livestock mixes on their farms to enhance their incomes and/or manage the risk. There are other alternatives available that can be considered for inclusion in the farm diversification plan other than traditional commodities. As mentioned earlier, these alternatives are the nontraditional agricultural commodities or enterprises that include EHPs (greenhouse and nursery plants), flowers, vegetables, fruits, fish, poultry, forestry products, small animals, etc. Of these particular nontraditional commodity groups several EHPs may be identified as possible alternative enterprises for inclusion in farm diversification plans.

This study explored the potential of EHPs for inclusion in farm diversification plans as alternative(s) to traditional crop-livestock enterprise(s) in Tennessee. A risk programming model, minimization of total absolute deviations (MOTAD) was used to analyze risk-return tradeoffs when EHPs were included as alternative(s) with conventional farm enterprises in the model.

Objectives of the Study

The study objectives were as follows:

1) To study and compare the level and variation in farm income (risk) of selected crop, livestock, fruit, vegetable, and EHPs enterprises in Tennessee.

2) To examine the feasibility of farm plan diversification under risk by evaluating changes in income levels and variability when selected EHPs are allowed as alternatives with and/or as substitutes for conventional farm enterprises.

Research Justification

The information obtained through research of this type is needed by farmers and change agents who advise farmers in Tennessee. Results from this study might be useful to farmers in other states, particularly those in the same climatic zone where geographic and climatic conditions are comparable to Tennessee. These states, according to USDA classification (USDA Plant Hardiness Zones--Appendix Figure 1), are Maryland, New Jersey, Delaware, Virginia, West Virginia, North and South Carolina, Georgia, Alabama, Mississippi, Arkansas, Oklahoma, Texas, part of New Mexico, Arizona, California, Oregon, and Washington. The study should be useful to farmers in making production decisions by assessing tradeoffs between farm income and risk.

The major aim of this research study is to provide empirical and analytical analysis for judging the performance of EHPs as farm enterprises on diversified Tennessee farms. It is not complete in its coverage or exhaustive in its analysis. Nevertheless, this research will help initiate and guide further research on this important topic.

CHAPTER TWO

OVERVIEW OF ENVIRONMENTAL HORTICULTURE INDUSTRIES IN THE UNITED STATES AND TENNESSEE

Importance of Environmental Horticulture in the Farm Sector

Producers in the farm sector face income variability or risk in production. Generally, producers are risk averse. They would like to increase farm income and decrease income variability. This has lead to investigation of new and diversified sources of income by farmers. According to Johnson (1993), the potential of growing trees and plants on farm lands has not been fully investigated.

Furuta (1976) reported that THE value of ornamentals was $135.8 million in California in 1974. Hilton (1978) reported that the total value of landscape contracting services in Canada in 1976 was about $41 million. Johnson (1993) reported that total value of U.S. exports of EHPs and products increased from approximately $105 million in 1989 to $210 million in 1992. This showed about a 100-percent increase in exports of EHPs and by-products in five years.

The U.S. nursery industry experienced considerable growth during the 1980s. Appendix Figures 2 and 3 show the nursery/greenhouse grower cash receipts in the United States and Tennessee, respectively. The growth in the industry is evident from both graphs.

Brooker and Turner (1990) estimated that the greenhouse/nursery industry experienced an annual growth rate of 10 percent per annum since 1982. In 1988, it accounted for 9.6 percent of all farm crop cash receipts in the United States. They further reported that greenhouse/nursery cash receipts were $9.6 billion for the United States in 1988. This was 182 percent increase over the 1980 cash receipts of $3.4 billion. Brooker and Turner (1990) reported that nursery crops accounted for 63 percent of the greenhouse/nursery industry's total cash receipts during 1988. They conducted a study of grower cash receipts for landscape plants in 23 states of the U.S. in 1983 and 1989. The states covered were Alabama, Arizona, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Kentucky, Louisiana, Maine, Michigan, Mississippi, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, and Tennessee. They found that grower cash receipts increased within a range of 15.6 to 363.3 percent in the different states between 1983 and 1989. During the period, there was an increase of 15.6 percent for Arkansas and 363.3 percent for Arizona, respectively, in grower cash receipts. Other states showing significant increases in grower cash receipts during the study period were: South Carolina (350 percent), Oklahoma (348 percent), Delaware (146.2 percent), Kentucky (142 percent), Louisiana (122.3 percent), Maine (117.3 percent), and Connecticut (89.5 percent). However, grower cash receipts declined in Florida (-30 percent), California (-7.9 percent), Pennsylvania (-7.4 percent), and New York (-1.1 percent) during the period. However, California and Florida were the leading states during 1989 by contributing $937 million and $455 million, respectively, in grower cash receipts. During the period 1983 and 1989, there was no change in grower cash receipts in Tennessee. However, receipts were $145 million in 1989 and ranked eighth in grower cash receipts among the 23 states included in the study. The study showed that overall nursery crop cash receipts in the U.S. were $4.93 billion in 1989 which was a 14.4 percent increase over 1983.

Hall, et al. (1991) reported that the combined wholesale value of ornamental landscape plants or EHPs in 10 southern states was $1.3 billion in 1987. This value was 36 percent of the $3.7 billion total wholesale revenue of ornamental landscape plants in the United States in 1987. In 1991 the greenhouse and nursery industry contributed $8.5 billion to farm crop cash receipts in the U.S. (Strickland, et al., 1991). The greenhouse and nursery industry ranked sixth among all the crops produced in the United States in 1991 and ranked seventh in 1990 (Strickland, et al., 1991). According to Strickland et al. (1991), in Alaska and Rhode Island, greenhouse and nursery were the leading farm crops in 1991 and accounted for 57 percent and 55 percent of the state total farm receipts, respectively. In California, Oregon, and Florida, the industry accounted for 11 percent, 15 percent, and 16 percent of the state total farm receipts respectively, in 1991. In Tennessee, the industry accounted for 6.5 percent of the state total farm receipts in 1991 (Strickland, et al., 1991).

Carson (1992) compared production values of major field crops such as tobacco, soybeans, and cotton with estimated expenditures for turf maintenance in Tennessee in 1991. He estimated the value of expenditure for turfgrass maintenance in 1991 at $360.4 million. According to Carson (1992), the farm production value of tobacco that was the leading cash crop in Tennessee, was $222.8 million in 1991.

The value of the turfgrass industry to the economy of the state was impressive. The 1991 farm production value of cotton and soybeans in Tennessee was $198.3 million and $181.1 million, respectively. These comparisons with major agricultural crops produced in Tennessee showed that the turfgrass industry is very important.

Johnson (1993) said that the U.S. ornamental industry (floriculture and environmental horticulture) experienced continuous expansion in all states. EHPs as farm enterprises outpaced all other commodity sectors in U.S. agriculture in grower cash receipts. He reported that since 1976, grower cash receipts in the EHPs industry (including floriculture) increased more than fourfold. It stood at $8.7 billion in 1991 as compared to $2 billion in 1976. However, the growth rate was slowed in 1991 as compared with 1990 rates of growth. The decline in the growth rate was attributed to recession, several farms growing ornamental plants, increased farm expenses, and lower sales. Johnson (1993) estimated net farm income for floriculture and environmental horticulture farms during 1990. He reported that average net farm income for the ornamental industry producer grew 10 percent annually. It increased from $40,011 in 1987 to $53,589 in 1990. However, it declined to $22,125 in 1991, but improved in 1992 to $24,418. Johnson (1993), observed a 43-percent increase in the number of floriculture and environmental horticulture farms in 1991 over 1987. There were 34,151 farms in 1987. These grew to 48,916 in 1991. There were 22,116 floriculture and environmental horticulture farms in the southern region of the U.S. in 1990. This region generated a gross value of $3.26 billion (37 percent) of EHPs in the United States in 1990. This one region accounts for more farm cash receipts than U.S. tobacco grower cash receipts (Johnson, 1993).

According to Johnson (1993), in the South, Tennessee ranked third in the number of farms and value of nursery crop sales during 1987. In Tennessee, there were 663 floriculture and environmental horticulture farms with nursery crop sales of $63 million. Florida had 1964 farms, followed by North Carolina with 923 farms. The total sale value of nursery crops was the highest in Florida (about $227 million) followed by Texas (about $76 million) in the southern region, in 1987. In Tennessee, grower cash receipts from greenhouse/nursery crops increased from $132 million in 1980 to $164 million in 1988 (Tennessee Agriculture, 1993, and Appendix Figure 3). Farm cash receipts for nursery and greenhouse crops were ranked fourth after tobacco, soybeans, and cotton in Tennessee in 1991. Cash receipts for nursery and greenhouse crops ranked above corn, hay, wheat, tomatoes, sorghum, and snapbeans during the same period (Tennessee Agriculture, 1993, and Appendix Figure 4). However, nursery and greenhouse crops ranked seventh when livestock enterprises were included. Beef cow/calf, dairy, and broiler enterprises were first, second, and sixth, respectively, in Tennessee, in 1991, based on farm cash receipts (Tennessee Agriculture, 1993, and Appendix Figure 5).

Stanton, et al., studied the importance of differences in net value-added for various types of farms. Types of farms were ranked by the percentage contribution that value-added made to the gross farm income in 1989 in the U.S. In all, there were 24,300 greenhouse and nursery farms in the United States in 1989. Net value-added to the gross farm income by greenhouse and nursery farms was 62 percent during 1989 and these farms ranked third among all other types in the country. Vegetable farms and cash grain farms ranked first and second by contributing 63.7 percent and 63.1 percent, respectively. Other farms, such as sugar, tobacco, corn, rice, cotton, fruit, other field crops, wheat, soybeans, peanuts, hay and forage, beef cow/calf, poultry, dairy, other livestock, hogs, sheep, and fed cattle ranked lower than greenhouse and nursery farms during the same period.

In a recent study, the Economic Research Service of the USDA reported that 85 percent of greenhouse/nursery growers are commercial farms (over $250,000 in sales). On these farms, 95 percent of the agricultural production was of greenhouse/ nursery crops. These statistics suggest that EHPs are significantly contributing to the growth of U.S. agriculture.

Demand for Environmental Horticulture Plants

Understanding the demand situation for a product or set of products is considered an important factor in beginning and managing a business. To initiate new enterprises such as environmental horticulture plants (EPHs), sufficient effective demand for EHPs should exist. A farm firm that produces EHPs would not be established unless sufficient effective demand for EHPs exists or can be created. In other words, demand is essential for the creation, survival, and profitability of the business (Salvatore, 1989).

According to Furuta (1976),..."wide scale uses of plants in ones' environment is characteristic of a maturing society. In the U.S. and other countries of the world, societies have matured to the point where plants are considered essential in the environment. In the future, plants will be used in increasing numbers."

Results from recent research studies on ornamental and EHPs businesses suggest future economic potential for the industry. Specifically, studies conducted by Johnson (1993), Made (1993), Cox (1994), and Hubbard, et al. (1989) showed continuous expansion of ornamental landscape crops and businesses due to projected increased demand for the next ten years. Johnson (1993) reported that grower cash receipts, in the U.S. for EPHs rose from $3.765 billion in 1986 to $5.818 billion in 1993 and are expected to rise to $6.312 billion in 1994 (Appendix Figure 2). This increase in grower cash receipts from EHPs was almost 68 percent within eight years. According to Johnson's estimates, per capita consumer expenditures for EPHs were approximately $90 and $93 for 1992 and 1993, respectively, in the U.S. Per capita expenditures were projected to increase to $100 for the year 1994 (Appendix Figure 6). Total expenditures for EPHs was $24.1 billion in 1993, and is projected to rise to $26.1 billion in 1994. Out of the total expenditures, 50 percent was made for shade/flowering trees and evergreens. The remaining 50 percent of the total expenditures were made on turfgrass, fruit/nut plants, bulbs, and other ornamental species.

Johnson (1993) performed financial trends and presented an economic outlook for the U.S. greenhouse, turfgrass, and nursery industries. According to his projections, grower cash receipts for the industry will increase by 5-6 percent to $9.7 billion and $10.4 billion during 1993 and 1994, respectively. Eventually, using a moderate growth rate of 4-6 percent for the industry, grower cash receipts will rise to $13-14 billion by the end of the decade (Appendix Figure 7). Johnson (1993) said that by the year 2000, the industry will be ranked third or fourth as a farm commodity group in grower cash receipts.

Cox, et al. (1994) studied the importance of the landscape service industry (which is a part of the ornamental horticulture industry) as a source of employment compared with agricultural production. They reported that employment in landscape services in the U.S. has grown significantly over the last 20 years. In contrast, during this period employment in agricultural production declined. The number of workers in the U.S. landscape services increased from 78,439 to 197,795 (growth of 152 percent) between 1977 and 1986. During the same period, the number of landscape firms increased from 18,111 to 34,268 (growth of 89 percent). Overall, landscape services in the U.S. have experienced an increase in all states except Hawaii during the period. The growth of the industry increased in all states but Ohio and Vermont. Cox, et al. (1994) observed that landscape services were a crucial segment of U.S. agriculture. As the economy of agriculture grows, the size of landscape services sector is expected to expand. There is a great potential for job opportunities in the sector, as efforts are directed to improve scenic areas for visitors. More services for design, installation, and maintenance will be required. In other words, expansion in landscape services can be visualized as an indicator for the increase in the demand for EPHs and their by-products.

Hubbard, et al. (1989) studied the economic profile of the commercial landscape industry in Georgia in 1987. They concluded that the landscape business will increase in the state. Overall, 94 percent of the firms in Atlanta area and 81 percent in the rest of the state expected an increase in dollar revenue in the future. An increase of 88 percent in sales volume was predicted by the industry. They observed that the landscape business was also a major user of EHPs and consequently supported the other components of the ornamental horticulture industry. The bulk of plant material obtained by landscape firms was from growers of ornamental plants.

According to Made (1993), the growth in the U.S. floriculture and environmental horticulture commodities outpaced all other agricultural commodities at the national level. He observed that during 1976 and 1991, this sector increased by more than 400 percent in sales volume. According to Made, floriculture and environmental horticulture commodities have become a major contributor to the growth and development of U.S. agriculture.

Marketing of Environmental Horticulture Plants

Marketing is considered a key factor in the production-consumption systems in any economy. An efficient marketing system ensures effective exchange of goods and services between the suppliers and consumers. In economic theory, production is creation of utility or the process of producing useful goods and services. The productive processes are further divided into form utility, place utility, time utility, and possession utility (Kohls, 1988). The role of marketing becomes essential when the products produced at one place are consumed at another place. The movement of the product from one place to another where it is needed or demanded is called "place utility." In advanced economies, marketing is highly organized and complex.

Marketing has been defined in different ways by different writers. A simple definition has been offered by Kohls (1988). According to this definition, "marketing is the performance of business activities. These activities direct the flow of goods and services from the producer to the consumer to reach the consumer at the time, place, and in the form he wants at a price he is willing to pay."

The production aspects of EHPs are largely different from traditional agricultural commodities. Similarly, the marketing and distribution of EHPs also differ from other agricultural commodities. Furuta (1976) discussed that central markets, centralized auctions, and other common agricultural organizations are nonexistent for the ornamentals industry in the U.S. The marketing and distribution of EHPs include assembling the plants and shipping them to retailers, contractors, or other users. The plants are moved in various ways from the producer to ultimate landscape uses. According to Furuta (1976), two common marketing channels for EHPs are:

1) producer - contractor - landscape use

2) producer - retailer - consumer - landscape use

The movement of ornamental plants from one place to the other, however, does not always follow the channels noted above due to lack of organizations and central markets. There are different alternative marketing outlets available for marketing ornamental landscape plants. The producer of EHPs may consider any among these outlets suitable to his/her conditions. These outlets include the following: wholesalers, mail orders suppliers, retail groceries stores, discount department stores, trade shows, hardware suppliers with garden centers, landscape contractors, farmer's markets, direct sales to consumers at the farm by the choose-and-dig method, market cooperatives consisting of by groups of farmers in the respective producing areas, brokerage firms, contracts, yard sales, highway departments, home deliveries, local governments, roadside stands, and 'flea' markets. The marketing of EHPs can also be promoted through telephone contacts, advertising on radio and television, and price lists and descriptions through trade newspapers.

These outlets are available usually throughout the season and/or year. However, marketing efficiency will depend on several factors. Some important factors are: (1) the demand for EHPs in the producing and neighboring regions, (2) improved transportation facilities, (3) distance to the market outlet, (4) availability of labor and capital (for digging plants, packaging, loading, and unloading), (5) availability of proper machinery, and (6) the nature of the product produced (production system).

Furuta (1976), categorized ornamental nursery plant production systems in three categories[1]: (a) bare root, (b) ball and burlapped (B & B), and (c) container

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[1]This study dealt with field grown plants. Therefore, (a) and (b) need to be described briefly. In system (a), soil is removed from the root system of the plant. The plant material is marketed when it is in the dormant stage after proper packaging or balled with peat. The important plant groups under this system include deciduous plants, herbaceous plants, and perennials. In system (b), soil remains around the plant that is wrapped with burlap or other material. The plant material is marketed either by placing in baskets or in containers when it is in the dormant stage. The important plant groups

grown.

According to the technical committee, SM-33, (Southern Cooperative Series, 1969), the marketing of woody landscape plants became more commercial during the 1960s. Traditionally, most nursery operations were considered small-sized, family-owned firms that served the demand of local residents and localized markets including commercial users. However, there occurred a change that led to commercial nursery operations. These changes resulted in part from changes in size economies as they relate to production costs, improved production techniques, and transportation facilities. The committee observed that there were contributory factors that led to expansion in the demand for woody landscape plants. Some factors were: (1) the increased amount of residential landscaping that resulted from increasing population, new housing, and higher disposable income, (2) increased plant requirements for landscaping commercial and public buildings, and (3) expanded needs of ornamental plants to carry out highway and community beautification. The committee observed that in the marketing of woody landscape plants, 72 percent of the sales were made locally or to outlets within 25 miles of the production place in the Southern region in 1969. An additional 21 percent of all sales were to southern cities more than 25 miles from the point of production. The major cities in the Southern region were Atlanta, Washington, D.C., Dallas-Fort Worth, Houston, Tampa, and Miami. The remaining 7 percent of the sales were

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under this system include evergreens and some deciduous plants. Depending on the nature of plant material to be produced, the producer can adopt either of the production systems or both of them. However, basic production techniques are required to produce EHPs in either of the two systems.

made to states outside the Southern region. The states were New York, Maryland, and Pennsylvania.

Badenhop, et al. (1973) in their study (Southern Cooperative Series, Bul.180) in eight southern states (Alabama, Arkansas, Florida, Georgia, Kentucky, Mississippi, Tennessee, and Virginia) found that independent nurseries, chain stores, retail florists, mail-order houses, and other outlets were the major sources of plant materials and supplies. Independent nurseries were the principal sources for trees and shrubs purchased by the homeowners. Sixty percent of the purchases of trees and 52 percent of the purchases of shrubs were from this source. According to the study, chain stores and independent nurseries were equally important as market outlets.

Raleigh and Smith (1965) studied the situation and scope of marketing of nursery products in Chester and Delaware Counties in Pennsylvania; Salem County, New Jersey; and New Castle, Kent, and Sussex Counties in Delaware in 1965. They surveyed 40 full-time and 31 part-time nursery operators and found that over slightly half of the full-time operators confined their business to retailing and most of the nurserymen believed that there was no marketing problem for their products. The 50 percent of the full-time nurserymen based prices of their products (landscape plants) on the prices quoted in wholesale or retail catalogs published by larger sellers. Another one-fourth used cost of production data in finding their prices by adding a reasonable markup to the cost to obtain a positive return on investment. Another one-quarter of the firms had more than a 100-percent markup in their prices. These firms were catering to high-income residents. Raleigh and Smith (1965) observed that most nurseries had a variety of plant material and that the losses varied between zero and 15 percent with a medium loss of 3 percent. Retailing business was mainly confined to metropolitan areas while wholesaling was common in rural areas. Results from the study showed that major outlets for landscape plants were landscaping, forms of advertising, garden centers, sale yards, brokerage firms, mail order houses and contracting. Among these outlets, landscaping, garden centers, and sale yards were the most common outlets used by full-time operators to market landscape plants.

Another study conducted by Raleigh and Smith (1965) was related to demand of ornamentals by consumers. The survey was based on personal interviews with 258 homeowners in the Wilmington-Newark region in 1965. They found that increasing the value of the home and improving the general appearance of the lot were two main factors behind the demand of landscape plants in the area. The owners of high-valued lots appeared to spend more money for nursery products. Among the surveyed homeowners, maple and dogwood were favorite trees and azalea, yew, and lilac were favorite shrubs to be added in the landscape plan. The local nursery was the most important supplier of landscape plants and other plant material. However, there were complaints from consumers about high prices charged by nurserymen.

CHAPTER THREE

REVIEW OF LITERATURE

Literature Related to Environmental Horticulture

The importance to the environment of trees and/or environmental horticultural plants that are commonly called nursery and landscape plants is well recognized. Besides their contribution to human life, trees and plants are an essential segment of the ecosystem.

Purcell, et al. (1993) observed that in agriculture the ornamental horticultural sector is expanding over time. They found that potential exists for diversification in EHPs production and marketing to reduce income variability of producers. However, they noted that research in pricing, marketing, and management in this rapidly growing industry was scarce compared with other agricultural sectors. Cox, et al. (1994) found that employment in landscape services grew significantly in the United States over the past 20 years compared to the continued decline in employment in agricultural production. However, like Purcell, et al. (1994) they reported lack of data in landscaping services. Hubbard, et al. (1989) reported the absence of reliable economic-statistical data base for all segments of Georgia's ornamental industry. They advocated the establishment of a data base that would include gross sales, value added, employment, investment, input and source, outlets for products, and other pertinent information. They suggested that further research was needed on the growth of markets about ornamental horticultural products and services.

In general, there is a scarcity of data and information on EHPs. However, considerable efforts have been made by researchers to explore potentials of ornamental industry. Hall, et al. (1991) observed that "economic information concerning financial aspects of producing and marketing ornamental plants has been limited, even as ornamental plants production has become a viable alternative to traditional farm enterprises." However, some research in this area has been directed at exploring its potentials as alternatives to the production of traditional crop-livestock mixes. According to Johnson (1993), greenhouse and nursery crops are commercially produced in all 50 states. Greenhouse and nursery crops ranked in the top four commodity groups in 20 states. These crops, according to Johnson, ranked second most important among commodity groups in the states of California, Florida, New York, Maryland, and Oregon. These crops ranked number three or four in Texas, Alabama, Hawaii, Michigan, Ohio, Pennsylvania, and Oklahoma which are among the more important agricultural states in the U.S. (Johnson, 1993).

In 1987, the Southern Rural Development Center (SRDC) established a task force on small-scale agriculture to prepare an inventory of nontraditional agricultural commodity activities in the southern region of the U.S. One need identified by the task force was for more information on alternative or nontraditional agricultural enterprises. Plath and Matthews (1990) compiled the inventory reported by the task force. According to Plath and Matthews (1990), there was substantial interest in nontraditional or alternative agricultural commodities such as woody ornamental/landscape plants in the southern region. However, availability of data and other information on these commodities was difficult. They prepared a list of approximately 250 such commodities that were being raised by different producers in different states in the region. These commodities were woody ornamental, greenhouse/landscaping or nursery plants, flowers, roses, vegetables, fruits, fish, poultry, small animals, etc.

Witte (1992) prepared a list of over 800 woody ornamental plants that were being propagated by the Department of Ornamental Horticulture and Landscape Design in the trial garden at the University of Tennessee, Knoxville. Many of these plants were new cultivars or untested species collected under a research project (Hatch Project TEN 927). The objective of this project was to identify woody ornamentals that could be best suited under the climatic and geographic conditions of Tennessee.

Badenhop, Phillips, and Perry (1985) studied the development of resources and costs associated with two model nurseries differentiated by size including delineation of representative production systems for field-grown nursery products. The study represented USDA Climatic Zones 7 and 8. They reported that acreage in nursery stock production continued to expand in the 1980s. They established that large-size commercial field nurseries use buildings, machinery, and equipment more efficiently than small-size field nurseries. As a result, large-size nurseries have a lower cost per salable plant. Total cost per salable plant in the small nursery differentiated by species ranged from $1.03 to $8.29 and averaged $3.35 for all species. In the large nursery, cost for the same species ranged from $0.85 to $6.86 and averaged $2.82. Badenhop and Day (1986) studied costs of field-grown deciduous shrubs (Forsythia) for different firm sizes in USDA Climatic Zone 7. Total production costs for a salable deciduous shrub (Forsythia) were $1.03 and $0.85 for the small (50 acres) and large (100 acres) model nursery, respectively. However, variable costs were the same for both the small and large nursery, i-e; $0.54 per salable plant. The plants in the group were produced in a two-year production cycle with an average salable size of 2 to 3 feet. Deciduous shrubs are generally characterized as hardy, easy-to-grow, flowering plants with spreading or upright forms. Several spreading species including Crimson Pygmy Barberry (Berberis thunbergii 'Crimson Pygmy'), Cranberry Cotoneaster (Cotoneaster apiculatus), and Dwarf Winged Euonymus (Euonymus alatus compactus) are among the most important landscape plants produced in Zone 7. Other important upright plant types include varieties such as Doubleleaf Viburnum (Viburnum plicatum tomentosum), Crape Myrtle (Lagerstroemia indica), Old-fashioned Weigela (Weigela florida), and Border Forsythia (Forsythia x intermedia).

In another study, Badenhop and Day (1986) studied costs of a field-grown narrowleaf evergreen shrub (Andorra Juniper) for different firm sizes. They found that total costs were $4.23 and $3.66 for the small (50 acres) and large (100 acres) nursery, respectively. The variable costs were the same for both the small and large nursery per salable plant. These costs were based on a two-year production cycle after propagation, production in the field, and an average salable plant size of 2 feet.

Badenhop and Day (1986) studied costs of field-grown broadleaf evergreens (Manhattan Euonymus) for different sizes of firm. They found that total costs were $3.59 and $3.10 for the small (50 acres) and large (100 acres) nursery, respectively. The variable costs were the same for both the small and large nursery per salable plant. These costs were based on a two-year production cycle after propagation, production in the field, and an average salable plant size of 2 feet.

Badenhop, et al. (1973) studied homeowners' expenditure and use patterns on landscape plants and lawns in the South during 1970. They surveyed 840 homeowners in 45 standard metropolitan areas in eight states (Alabama, Arkansas, Florida, Georgia, Kentucky, Mississippi, Tennessee, and Virginia). The objective of the study was to know the demand for landscape plants, lawn materials, and related supplies. They found that Southern homeowners rated beautification the most important purpose of landscape plants. Economic effects on property value and neighborhood pride were rated as very important factors by the respondents. According to survey results, homeowners relied heavily on personal experience as their bases for information on landscape activities instead of other information sources. However, nurserymen were an important source of information used by homeowners. Badenhop, et al. (1973) found that lot value and level of education of the respondent were significantly important factors for landscaping activities. The study revealed that average expenditure for landscape plants, lawn material, and related supplies were $84 per homeowner in that period. Sixty-two percent of the expenditure was made for tools and equipment, while the remaining 38 percent was spent on purchase of shrubs and lawn grass and/or grass seed.

Another contribution made by Badenhop, et al. (1975) was the study of expenditure patterns for landscape plants by nonresidential landscape users in the South in 1972. The purpose of the study was to determine expenditure pattern for ornamental landscape plants between nonresidential firms and institutions. They categorized nonresidential users into industrial and commercial, office buildings, motels and hotels, school systems, colleges (also universities), public parks, golf courses, and highways. The study was based on a survey of 326 nonresidential users of landscape plant material in eight states (Alabama, Arkansas, Florida, Georgia, Kentucky, Mississippi, Tennessee, and Virginia). The market segment (nonresidential users) was considered a vital part in assessing total demand for landscape plant material that might be beneficial for producers and distributors of landscape plants. The survey found that average expenditure was about $6,250 for new and replacement landscape planting for industrial firms in 1972. The average expenditure for the same period for commercial firms, office buildings, motels and hotels, schools (public and private), colleges (including universities), public parks, golf courses, and highways, respectively, was $6,500, $1,319, $398, $62,000 (per school system), $5,200 (per college), $56,000 (per park), $143 (per golf course per acre) or $19,000 per course, and $7 million (about $990,000 per state).

Kaplan (1992) conducted a study on Poinsettias and reported that Poinsettias were a booming industry in the United States. Poinsettia is the most popular Christmas plant and is now the number-one potted flowering plant in the United

States. According to Kaplan (1992), in 1959 the wholesale value of Poinsettias was $8.9 million. In 1976 the wholesale value of Poinsettias was about $37.6 million. In 1991 the wholesale value of the Poinsettia crop reached nearly $170 million--an increase of more than 400 percent from 1976 (Kaplan, 1992).

Parry, et al. (1990) studied capital and labor requirements, associated costs, and net returns for 20-and 40-acre container nurseries operating in USDA Climatic Zone 9 in 1990. Cost figures were based on 1987-88 prices. The study considered five plant groups: azaleas (four species), narrowleaf evergreens (six species), broadleaf evergreens (six species), deciduous shrubs (four species), and deciduous trees (four species). One specie from each group was selected to represent the group for production analysis. They found that production costs were less in the 40-acre container nursery. The reasons assigned for the low costs were efficient use of equipment and low average overhead costs. Parry, et al. (1990) found that for the crop rotation cycle, the 20-and 40-acre nursery, respectively, generated approximately $510,000 and $1,175,000 in net returns. Parry, et al. (1990) studied costs associated with two model nurseries differentiated by size in 1985 based on 1984 prices. The researchers considered five plant groups: broadleaf evergreens, narrowleaf evergreens, deciduous shrubs, shade trees, and ornamental trees. They observed wide variation in production costs between different plant groups and nursery size. Costs per salable plant were lower in the large-size nursery compared to small-size nursery. Similarly, fixed costs per salable plant were lower in large-size nurseries than small-size nurseries. The Horticultural Research Institute (1968) compiled a report about nursery operations that was useful to nursery business people and researchers. The report provided a broad picture of the industry in terms of general resources, trends, operating costs, products, services, customers, and markets.

Coutu and Cohen (1978), in a study of the market potential for native woody ornamentals in North Carolina, developed cost comparisons of alternative cultural systems and illustrated preliminary applications of cost data on locational advantage. Gunter (1977), carried out a comparative business analysis of container-grown nurseries in Florida. His report on business analysis of container nurseries in Florida contained information on nursery sales, costs, returns, and production efficiency measures. Southern Regional projects (SM-33 and SM-34) examined the nursery industry for practices and trends related to the production and marketing of woody landscape plants in the South and the use of nursery products by southern consumers. The study is essentially a model for prospective farmers to substitute their own cost data to analyze the profitability of a venture being considered.

Smeal, et al. (1973) developed an economic model for the production of shade trees in Virginia. They estimated expenses associated with the production and operation of the enterprise and projected anticipated sales. A cash flow statement was developed showing the cost of establishing a business and the return that could be realized from the investment. Tilt studied five groups of plants in his study based on cultural characteristics that included slow-growing evergreens (Taxus, Buxus), rapid-growing evergreens (Juniperus, Pinus, Thuja), deciduous plants (Viburnum, Forsythia, Weigela, Ligustrum), shade trees (Acer, Tilia), and ornamental trees

(Malus, Prunus). Williams developed a list and description of fifty common shrubs for Tennesseans to use in landscaping their homes. Goble and Brown (1970) listed twenty woody ornamental plants that were commonly produced by nurserymen in Tennessee. They grouped these into four categories: (1) the most common broadleaf evergreens that include Abelia, Buxus, Euonymes, Ilex, and Mahonia, (2) narrowleaf evergreens including Juniperus, Pinus, Taxus, Thuja, and Tsuga, (3) deciduous shrubs including Forsythia, Hibiscus, Legustrum, Spiraea, and Hydrangea, and (4) shade and ornamental trees including Acer, Cornus, Malus, Populus, and Cercis. These plants were in high demand by consumers, retailers, wholesalers, other growers, and landscapers. They also observed that during the period 1957-70, growth in the nursery industry had not been confined to Tennessee alone. There had been considerable growth in the industry in most parts of the country.

Werken (1965) pointed out that many ornamental plants were not only used for their aesthetic value alone but they were grown as formal hedges for boundary designation, privacy screens, background, and other purposes, too. Development in building design, and population density combined with improved public concepts of landscape design has increased potential use of many new varieties of woody ornamentals. According to Werken (1965), the most commonly used hedge or screen species are privet, abelia, althea, hemlock, bush honeysuckle, and Japanese quince. Werken (1965) observed Tsuga, Abelia, Berberis, Thuja, Ilex were the most valuable and well-adapted evergreen species in Tennessee. Of the deciduous species, Spiraea, and Forsythia were well adapted. For hedge purposes Legustrum obtusifolium, Rosa multiflora, and Elageagnus pungens also performed well.

Phillips (1977), studied cost of production of seven woody ornamental plants based on their relative importance in the South and because they represented many other species with similar patterns and production costs. Those selected were juniper 'Pfitzeriana', azalea, pin oak, Burford holly, dogwood, and crape myrtle. Badenhop and Einert estimated costs of producing of juniper to salable sizes in Climatic Zone 7. They estimated labor and material requirements and variable, fixed, and overhead costs for producing plants in 1-gallon containers. Total costs per salable plant were $1.05 with $.63 consisting of variable costs, $.10 comprising fixed costs, and the remaining $.32 being overhead costs.

McConnel and Smith (1977) studied production system alternatives and cost of producing azaleas. According to them, nurserymen in various areas use different combinations of resources--land, labor, capital, and management--in producing azaleas for the market. The total costs for producing a gallon container of azaleas in various climatic zones in the South ranged from $.84 to $.98. Approximately 60 percent of the costs were variable and the remaining 40 percent consisted of fixed costs. About 42 percent of the variable costs was for propagation and the remaining 58 percent was for field production.

McNiel and Wright (1977) studied production system alternatives and cost of production of pin oak. Most of the pin oaks grown in the Southeast are found in climatic zone 7 that includes most of Arkansas, Virginia, and portions of Kentucky, North Carolina, Mississippi, Alabama, and Georgia. Variable production costs for

1 acre of pin oaks grown from 1-year seedlings to 3-year-old bare root plants were $1.48 per plant, with $.47 for the liners and the remainder for field production and harvesting. Fixed costs and overhead costs of producing 1 acre of pin oaks for 1-year seedling to 3-year-old salable plant were $2.70 per plant with $2.10 (77 percent) of this amount for general overhead.

Coutu and Vitelli (1981) conducted a study of transportation costs of some woody landscape plants based on per plant per mile from different origins within the South. Transport charges for 1-gallon juniper from Nashville to New York, Chicago, and Atlanta was $.23, $.11 and $.06 per plant for the whole trip, respectively. Transportation cost for 1-gallon azaleas from Raleigh to New York and Indianapolis was $.09 and $.11 per plant for the whole trip, respectively, and from Mobile to New York and Indianapolis was $.22 and $.13 per plant, respectively. Aylesworth (1972) estimated the cost of producing six common species of woody ornamental grown in Illinois. Specifically, the most profitable time to harvest the species was studied by analyzing input costs and the length of the production period.

Review of Literature on Risk Analysis

Incorporation of risk in farm management studies has been extensively explored by researchers in the field of farm management and production economics. Risk affects the behavior of economic agents. Thus, there is a potential to improve economic performance if risk is managed.

In surveying the farm management and production economics literature, Jensen (1977) cites Heady's observation in 1949 that risk and the dynamics of the firm were neglected areas of farm management research. Brake and Melchar (1977) reviewed the progress in understanding the origins of instability in agriculture, their relationship to farm income and resource allocation problems, and policy choices for resolving instability problems. Heady (1952) worked on the principles of diversification and devoted several chapters on risk analysis in his book, *Economics of Agricultural Production and Resource Use.* Research in farm management during the 1950s and 1960s focused on family-size farms and the consequences of greater financial leverage. Further developments in risk analysis were found in the book *Agricultural Decision Analysis* written jointly by Anderson, Dillon, and Hardaker (1977). The book is primarily based on the decision maker's personal evaluation of potential consequences and is a significant literary contribution in risk management analysis.

Knight (1921) suggested a distinction between risk and uncertainty that occupied the literature until the subjective concept of probability was introduced in modern decision theory. Von Neumann and Morgenstern (1947) reviewed and extended the expected utility approach to predict choices of individuals in risky situations. Savage (1954) brought focus to subjective probability concepts and their relationships to expected utility. Markowitz (1959) and Tobin (1958) developed portfolio theory. Markowitz (1959), Baumol (1963), Hanoch and Levy (1969), and Hadar and Russell (1969) developed different efficiency criteria for decision making. Arrow (1974) worked on the empirical analysis of various market and social responses to risk. Work of Arrow and Pratt (1964) provided an interpersonal comparison of risk attitudes. Efforts by Brainard and Cooper (1968), Hueth and Schmitz (1972), and Just, et al. (1978) incorporated analytical framework for the effects of risk on various aspects of international trade.

Diversification and Risk

Bruce Gardner (1987) discussed variability in production conditions related to input prices that encourage farmers to try different production methods. Variability in input and output prices encourages investment in information and innovation both in the production and marketing sectors. Kristjanson and Matlon (1990) in their innovative risk management study for West African Semi-Arid Tropics (WASAT) said that diversification of crops and cultivars is a common practice to stabilize agricultural income. Crop diversification reduces farm-level income variability to the extent that individual crop yields are not closely correlated across years.

Mundy, et al. (1989) using the E-V (expected income-variance) criterion, explored incorporation of risk into the farm income and diversification problem for burley tobacco production in Tennessee. The E-V approach was used to study tradeoffs between expected income (E) and associated risk or variance (V). They applied Quadratic Programming (QP) to assess alternatives to the production of burley tobacco using representative full- and part-time tobacco farms in Tennessee. They concluded that under risky conditions, dairy was the only alternative enterprise that compared favorably with tobacco.

Weimar and Hallam (1985) explained that the agricultural recession in the Midwest that started in mid-1980s prompted the search for profitable crops as alternatives to traditional crops. They studied thirteen fresh vegetable crops as alternatives to traditional row crops such as corn and soybeans in Iowa. The crops considered in the study included broccoli, snap beans, cabbage, sweet corn, cucumbers, muskmelons, leaf lettuce, green peppers, tablestock potatoes, summer and winter squash, tomatoes, and watermelons. They found that more than half of these crops could be grown profitably within the state of Iowa. Weimar and Hallam (1985) applied a quasi-substitution model using separable programming and MOTAD to investigate the opportunities for Iowa farmers to substitute local vegetable production for some traditional enterprises. They said that many Midwestern states were considering diversification into a broader range of crop enterprises. They concluded that Iowa had the potential to expand in a number of crops except cabbage, sweet corn, July market period muskmelons, green peppers, October market period potatoes, and watermelons.

Falatoonzadeh and Pope (1985) studied a blend of five very common risk management strategies to reduce net income variability for farmers using a representative dryland farm in Knox County, Texas. The management strategies studied were crop diversification, futures markets, forward pricing, cotton sellers' call options, and the Federal Crop Insurance Program (FCIP). They explained that uncertainty in agricultural production was caused by many factors such as weather, disease, technological innovations, and public and private institutional policies. They applied a quadratic programming model to study decision making in risk management assuming expected utility as a function of mean and variance of net income. They made two important assumptions in the study: (1) the production level and output prices of the firm were uncertain (random events with unknown probability distribution) and (2) input prices and quantities were known with certainty. They found that production and price risk could be reduced when a combination strategy was adopted that included a diversified cropping plan and participation in the futures market with implementation of FCIP.

Boggess, et al. (1985) conducted a survey in Florida and Alabama to discover farmer perceptions about sources of risk and risk management strategies. Over half the farmers surveyed mentioned production risk (related to weather and pests) being the major source of risk brought by rainfall variability, insects, weeds, and diseases. According to the survey, the most common management practices mentioned by the respondents to combat weather risk were irrigation, minimum tillage, subsoiling, and crop selection (wheat and sorghum). Chemical control was the dominant response to combat risk related to pest and diseases. Other common management responses to deal with pests/diseases related risk were using resistant varieties and scouting for insects and pests. The second most important category of risk after production risk mentioned by the respondents was market risk with variability in commodity prices being the important source of market risk. Variability in the costs of operating inputs and equipment were also important sources of this category. Boggess, et al.

(1985) concluded from the survey that forward contracting was the most common management response to variability in the commodity prices. They further observed that management strategies to manage risk adopted by the respondents and given high ranks were diversification and maintaining feed reserves (for livestock production).

Patrick, et al. (1985) reported similar results in a different survey of 149 agricultural producers conducted in 12 states under the Southern Regional Research Project S-180. The states that participated in the study were Alabama, Arizona, Florida, Georgia, Illinois, Indiana, Kansas, Mississippi, North Dakota, Oklahoma, Washington, and Wyoming. Patrick, et al. (1985) reported that in crop production, weather was considered the most important source of crop yield variability (and income variability). The second most important source of income variability in crop production was crop prices. Respondents also ranked inflation, input costs, disease and pests, world events, and safety and health as other important sources of risk in crop production. They observed that factors beyond the control of the decision maker contributed most significantly to variability of crop yield. The survey further reported that in livestock production, livestock prices were the most important source of income variability. Among the production responses, enterprise diversification was the most important strategy to manage variability associated with crop yield. However, maintaining feed reserves was considered the most important risk management strategy by the respondents in livestock production.

According to Pant, et al. (1972), the dominant and almost universally adopted strategy against production and income variability is a diversified cropping plan. The chief objectives behind such a strategy are steady year-to-year flows of farm income and the minimization of the probability of income falling below a minimum level required to sustain the farm family. Production diversification can potentially be successfully employed to manage price, yield and income risk if different crops, livestock, and/or other alternative enterprises react differently. The inherent logic has applications in any situation where choices must be made with respect to a future characterized by imperfect knowledge. Because variation in prices and/or yields of various enterprises are not usually highly positively correlated, a combination of enterprises may result in a more stable income than one enterprise alone. For example, when the yield of one crop is down, the other crop yield may not be reduced to the same extent (Castle & Nelson, 1987) and/or the yield of the other crop is increased. Patil, et al. (1969) showed that inclusion of horticultural crops such as mango, banana, and grapes as additional enterprises to the existing cropping plan strengthened the financial base of farmers in Maharashter, India. Singh (1972) observed that under the conditions of unstable crop yield, the farmer was interested in reducing the probability of income loss and diversification acts as a "safeguard" in a poor crop year in Uttar Pradesh, India.

According to Makehem and Malcolm (1986), diversification in the farm business could be valuable when there is variability in income due to price or weather conditions. Debertin (1984) observed that by applying the technique of diversification, farmers could manage both price and yield uncertainty. The most effective way in dealing with price and income variability would be the proper selection or combination of enterprises that are to be included in a diversified farm plan. Prices and outputs of prospective enterprises should move in opposite directions to each other. For example, efforts to reduce output variability may not be fruitful by growing wheat and raising beef cattle. Wheat output will be low in case rainfall is inadequate and beef cattle cannot be fed adequately on pasture with insufficient rainfall (Debertin, 1984). Upton (1987) explained that in parts of Africa, sorghum and maize are grown together. The former being drought-resistant but susceptible to bird damage while the latter to fails under drought conditions but is resistant to bird damage. Debertin (1984) emphasized that diversification as a strategy against risk may be more effective for dealing with price uncertainty. The process involves identifying such commodities whose prices are not positively related to each other.

Officer and Halter (1968) applied an interval measurement approach for measuring the intertemporal stability of risk preference among 23 Michigan farmers for two periods in 1979 and again in 1981. The objective was to know how risk preferences of individual farmers in the group had changed over the period under reference. Love and Robison (1984) studied the issue raised by Officer and Halter (1968) that if risk preference estimation was to be useful in decision making, the effect of time on preferences must be included in decision making.

Risk Modeling in Agriculture

In the literature, methods to quantify risk in agricultural production have been widely discussed and applied. Incorporation of risk into planning models has been based in large part on the expected utility (EU) hypothesis (Friedman and Savage, 1948). Conner, et al. (1972) argued that EU hypotheses have frequently been used in research. They applied an EU approach to incorporate risk into planning activities for reservoir-irrigation systems. They applied risk programming and simulation to develop a water resource system to study the effects of variability of available irrigation water on farmer decision making. Emphasis was given to the ways risk aversion affected the choice of enterprises and combination of enterprises. Similarly, risks have been studied using game theoretical models (Tadros and Casler, 1969). Markowitz (1959) applied the EU approach in selecting investment portfolios. The EU approach usually leads to tradeoffs between the expected level of income and the variance of income (E-V).

Boisvert and McCarl (1990) discussed different models of risk analysis in agricultural decision making. The programming models included the Expected Utility Maximization (EU) model, efficiency frontier programming, minimization of total absolute deviations (MOTAD), the focus loss model, Target MOTAD, mean-gini programming, direct expected maximizing non-linear programming (DEMP) model, exponential utility moment generation function (EUMGF) model, chance constrained programming, and quadratic programming (QP). The most common programming models used in risk analysis studies are discussed here briefly.

Linear Programming (LP)

Linear programming (LP) algorithms are used to maximize or minimize a linear objective function subject to resource restrictions. In agricultural studies, LP is applied to select maximum profit farm plans, to minimize cost for livestock feed rations, etc.

Hall, et al. (1991) applied LP to study optimal combinations of container-grown nursery crops for a small nursery in Climatic Zones 8 and 9 under alternative conditions in 1991. Five plant species were studied that included Kurume azalea, Burford holly, crape myrtle, Fraser photinia, and juniper. The study was subjected to three separate analyses. The first analysis constrained labor, the second constrained capital, and the third constrained cash flows. Crape myrtles and photinias were most sensitive to labor and capital constraints. Juniper production fluctuated when monthly cash flows were constrained.

Extensions of LP are also frequently applied in risk studies. Risk Programming is a very useful extension of LP. Target MOTAD, developed by Tauer (1983), is an alternative mathematical programming model to MOTAD. Tauer emphasized that Target MOTAD is computationally efficient and generates solutions meeting the efficiency criterion, second-degree stochastic dominance (SSD). Harper, et al. (1991) applied stochastic dominance analysis to select the preferred combination among six enterprises under six different classes of risk preferences. They studied the incorporation of double-crop soybeans into traditional rotations in Cherokee and Labette Counties in extreme southeast Kansas. Stochastic dominance analysis may be applied to select efficient cropping strategies while comparing the cumulative probability distribution of possible solutions for each strategy. Harper, et al. (1991) found that a two-year sequence of wheat double-cropped with soybeans proved to be the preferred combination for all classes of risk preferences.

Maruyama (1972) studied farm planning under uncertainty by applying a truncated maximin approach in linear programming under the assumption that input-output, constraints, and functional coefficients followed discrete joint probability distributions. The objective function was formulated in terms of variance. Special attention was given to the most adverse outcomes with respect to both the functional value and side constraints. Parametric analysis was applied to determine tradeoffs among the functional values, the adversity level, the tolerance probability, and the probability of infeasibility. Maruyama used the discrete nature of the probability distribution and the two-parameter decision criterion in terms of expectation and the worst possible outcome.

Efficiency Frontier (E-V)

The work of Markowitz (1959) provides a framework in decision theory when both expected returns and risk are to be considered and income variance is introduced as a measure of risk. An E-V is generated for the decision maker who faces production and market processes that relate income variance and expected income. Markowitz (1959) has suggested the use of quadratic programming (QP) for developing efficient plans that minimize variance for a given level of expected income.

Blank (1990) studied the risk-return tradeoffs among crop portfolios using a single index model (SIM). According to Blank (1990), using Markowitzs' mean-variance (E-V) analysis to generate portfolios implies that adding more crops to the enterprise mix reduces risk. Portfolio risk can be measured using the full covariance model of returns for enterprises under study. Purcell, et al. (1993) applied a portfolio approach to landscape plant production and marketing. A QP model was used to develop an optimal portfolio for nursery crop production in the southeastern region. MacMinn (1984) observed that portfolio risk is reduced by adding those enterprises that are negatively or weakly positively correlated with each other. Collins and Gbur (1991) applied E-V and safety-first methods in analyzing risk for proprietors with limited liability.

Minimization of Total Absolute Deviations (MOTAD)

The MOTAD model is a modified version of the LP technique. Linear programming combines enterprises that result in maximum profit. The optimum plan generated by LP may not be considered optimal by many producers if risk is considered. For example, an enterprise with a high gross margin on the average may show large year-to-year variability in returns. Such an enterprise may be viewed by the decision maker as a high risk enterprise although it returns a high profit on the average. On the other hand, an enterprise yielding the same level or lower profit for the same period on an average but with smaller year-to-year variability may be viewed less risky. The general LP model will choose the maximum profit enterprise without consideration of risk. However, many producers would like to choose less risky enterprises. The MOTAD model can be applied in considering the risk component by analyzing risk-return tradeoffs.

Hazell (1971) developed the MOTAD model as an alternative to quadratic programming. He criticized the E-V approach based on costly data requirements and developed a criterion based on expected income-mean absolute deviation (E-A) that is more computationally efficient. Parametric linear programming can be applied to solve the E-A criterion. Hazell (1971), while studying farm planning under uncertainty, applied a linear alternative to quadratic and semivariance programming. Hazell (1971) proposed the E-A criterion as compared to E-V criterion. In the E-A approach, the crucial parameters in the selection of a farm plan are considered by defining efficient E-A plans. Such plans have minimum mean absolute income deviation for a given expected income level, E. The criterion will generate the likelihood of occurrence of different income levels for a given farm plan. The E-A criterion has an advantage over the E-V criterion because a linear programming model that generates efficient E-A farm plans can be used instead of a nonlinear model. Boisvert and McCarl (1990) said that in the MOTAD model, risk is calculated by absolute deviations from mean returns rather than by the variance of total returns. Therefore, the original model developed by Hazell (1971) shows tradeoffs between expected profits and the absolute deviation of profits. Zink (1980) applied MOTAD to study economics of alternative enterprise combinations in

Wyoming. Schurle and Erven (1979) applied MOTAD in studying the tradeoffs between risk and returns in farm enterprise choices. Thomas, et al. (1972) applied separable programming (another extension of risk programming) on a crop-livestock farm in the Columbia Basin of Washington. The researchers proposed that separable programming could be used for incorporating expected income and income variance into enterprise selection. Farm enterprises could be selected that were efficient in terms of expected income and income variance. They concluded that standard deviations associated with net incomes from particular optimal enterprise organizations might be useful to farmers in appraising different financial strategies.

Target MOTAD

Another approach to risk modeling called Target MOTAD was forwarded by Tauer (1983). In this method, mean returns are maximized at some level of risk. The risk in the model is measured by the expected sum of negative deviations of the solution and results from a target level of return.

Zimet and Spreen (1986) performed an analysis of a representative farm in North Florida engaged in crop and livestock enterprises. The analysis involved the potential competition and complementarity between crops and livestock. A Target MOTAD model was applied for decision making under risky situations. They found that when income risk is not considered, peanuts, watermelon, and stocker cattle were included in the optimal solution. However, when risk was incorporated in the plan, the optimal solution changed and enterprises like cow/calf and irrigated soybeans were adopted in the solution besides peanuts, watermelon, and stocker cattle. They concluded that inclusion of the cow-calf enterprise in the farm diversification plan showed a desire for income stability and the productive use of farm resources including marginal land and surplus labor.

Misra and Spurlock (1991) used Target MOTAD to measure impact on profit over years arising from the timing of planting and harvesting of crops. They studied the impact on profit within a year due to variation in economic and weather-related factors in the Mississippi Delta region. The model was used to incorporate the impacts of uncertain suitable fieldwork timings on risk-return levels. The study included a single crop enterprise (cotton). They evaluated three maturity period management schemes given uncertainty in lint prices, yields, and time available for harvesting.

Loehman and Nelson studied optimal risk management strategies. They found that for production risk with identified physical causes, the nature of risk, production characteristics, risk preference, and prices determine optimal input use. They found that a more risk averse firm might produce greater expected output while using more inputs than a risk neutral firm. These results were contrary to Sandmo's (1971) findings in a price risk study that showed a more risk averse firm produced less output.

Marketing Risk Models

Incorporation of risk in marketing of agricultural commodities involving different strategies has also drawn the attention of researchers. Bauer (1991) applied Target MOTAD to optimize marketing of sweet potatoes in North Carolina. The model was applied to develop a marketing strategy that minimized negative deviations from the target income over the period 1965-1985. Bauer (1991) argued that the optimum marketing decision based on expected net revenue was dependent on yield and prices and their variability and on the cost of storage. The important assumption underlying the Bauer study was that the decision that would minimize negative deviations over the previous period will minimize future negative deviations, i.e., future distributions of price and yield will be identical to historical distributions. Curtis, et al. (1987) studied risk-reducing marketing strategies for soybeans. The study examined expected returns and variation in returns of 103 soybean marketing strategies that were available to farmers from 1978 to 1983. The Target MOTAD model was used to find out efficient marketing strategy mixes. Risk-efficient portfolios of the strategies were developed using minimum absolute negative deviations below a target return level.

Anaman and Boggess (1986) applied a stochastic dominance criterion to determine risk-efficient sets of strategies for different groups of farmers in North Florida. Cumulative frequency distributions of income involving four pre-harvest marketing strategies was studied for decision making. They found that farmers behaved differently in choice of marketing strategy according to their risk attitude. Anaman and Boggess (1986) concluded that highly risk-averse farmers preferred forward contracting, whereas risk-loving farmers (also low-risk averse farmers) preferred cash sales. Moreover, selling in future markets led to higher income and greater risk than forward contracting but lower income and risk than cash sales.

Ethridge, et al. (1990) studied incorporation of risk associated with cattle prices and forage yields using linear programming and a Bayesian analysis for maximizing net ranch returns in the Southern Plains of Texas. Risk-efficient production/marketing strategies included strategies that assumed normal and low cattle prices and normal and low forage yields. A linear programming model was applied for optimal solutions that showed production strategies that would maximize net returns to the ranch under perfect knowledge of cattle prices and forage yield levels. Bayesian analysis was used to find out the optimal production strategy in the presence of uncertain cattle prices and forage yields.

Literature on Research Methodology Related to the Present Study

Purcell, et al. (1993) applied a portfolio approach to landscape plant production and marketing in Climatic Zones 8 and 9 (Georgia, Alabama, Mississippi, Louisiana, Florida, South Carolina, and much of Texas). Five ornamental landscape plant species were included: azalea, holly, crape myrtle, photinia, and juniper. Nominal price data for each plant species were used over a five-year period (1985-89). The selected plants species were analyzed over the five-year period to obtain expected returns and variances and covariances. They applied quadratic programming to study tradeoffs between return and risk at different risk levels. They found that net returns declined as the risk coefficient increased with changes in the product mix. In other words, part of the income had to be given up to reduce variability of income. The potential existed for diversification to reduce income variability in landscape plant production and marketing, given resource availability, input costs, and wholesale prices in the study region.

Kneen (1981) studied the comparison of costs for producing containerized and field-grown Juniperus chinensis 'Pfitzeriana' in USDA Climatic Zones 6 and 7. He applied a budgeting approach to find out the cost of production for this plant in Ohio (Climatic Zone 6). Model firms were selected and synthesized based on frontier production functions. According to Smith (1981), a frontier production function expresses the maximum product that is possible from various combinations of factors given the existing state of knowledge. It can be imagined as a "best practice" production function. In theory, it is considered the counterpart of enterprise budgets. It is derived by economic engineering methods to show the best possible production processes. Kneen (1981) collected data for input costs through personal interviews with selected Ohio nurserymen in 1980. Secondary sources were also used for this purpose. The format for cost analysis developed by the Southern Research Committee (S-103) was adopted. The format included two scale cost-models; a small-scale production facility (including 128,000 salable plants in containers per year or 90,000 salable field-grown plants per year) and a large-scale production facility (including 260,000 salable plants in containers per year or 180,000 salable field-grown plants per year). The models were synthesized for Ohio-grown Juniperus chinensis 'Pfitzeriana'(12-15 inch size) in USDA Climatic Zone 6. The variable and fixed costs were computed. Kneen (1981) concluded that the cost of production per plant for field-grown 'Pfitzeriana' juniper was higher than a two-gallon container-grown plant. It ranged from $0.09 to $1.26 per plant depending upon the size of operation. However, container facilities proved to be much more capital intensive than field grown facilities. The capital cost was over $23,600 per acre for a container-grown operation compared to $4,500 per acre in northern zone of Ohio and $5,780 in southern zone for a field-grown operation during 1980.

Held and Zink (1982) studied enterprise combinations for irrigated farms in the Torrington-Wheatland area in Wyoming using historical data for 11 years (1968-78) period. They used a representative farm analysis in studying risk-income tradeoffs for major crop and livestock enterprises. Income variability as measured by standard deviation was the basis of the study. Held and Zink (1982) found that there was a great variability in crop and livestock yields. The most profitable crops were found more risky. They concluded that net income variability was highly dependent on a particular farm plan (enterprise mix) and some net income had to be foregone to attain more stability under a cash-crop or crop-livestock system.

Zink and Held (1981), in a separate study, applied linear programming and MOTAD to study optimum enterprise combinations and risk-return tradeoffs for irrigated farms in the Torrington-Wheatland area in Wyoming. To analyze alternative enterprise combinations for maximum profitability, a representative farm was developed to incorporate data on input-output requirements, typical resource inventories, costs of crop enterprises, and expected yields. A linear programming model was applied to generate optimum enterprise combinations. Profit maximizing linear programming does not incorporate relative riskiness of selected enterprises. Risk as measured by income variability (or standard deviation) can result from year-to-year fluctuations in enterprise yields and/or their prices. Therefore, the maximum profit plan can also be a maximum risk plan. Considering a farmer's risk attitude, a farm plan giving fewer returns with low risk (income variability) may be selected. Zink and Held (1981) applied MOTAD to generate efficient frontiers or farm plans having minimum risk for some specified income levels (below the profit maximizing income level). They said that there was a tradeoff between return and risk where the producer has to forego some return to reduce risk. The data with respect to input-output relationships and expected costs and returns used for the maximization model were used for MOTAD. However, historical data of gross margins (gross revenue minus variable expenses) for each enterprise were needed to develop income deviations for the MOTAD linear programming matrix. Gross margins were calculated using a 11-year series (1968-78) for enterprise yields and prices. Zink and Held (1981) concluded that inclusion of low-risk crops as compared to high-risk crops and adopting a diversification plan of crop and livestock enterprises could be an effective way to reduce income variability and stabilize annual income.

Woolery and Adams (1980) conducted a comparative analysis of alternate crop-cattle feeding to study risk-return tradeoffs for selected crop-cattle feeding systems in four counties of Bighorn Basin in Wyoming. They applied a budgeting approach over a 21-year period (1956-76). They calculated net revenues for the 21-

year period and for a four-year period (1973-76), standard deviations of the net revenues, coefficient of variation, and variance-covariance matrices for the various crops, cattle feeding alternatives and integrated systems. Woolery and Adams (1980) noted that actual time series data reflect total variation due to all causes that are not a true measure of variability or risk. Thus, following Halter and Dean (1971), and Lin, et al. (1974), Woolery and Adams (1980) detrended the historical data to estimate random variability or variances to arrive at risk measures such as the coefficient of variation (CV) and for generating E-V frontiers. They concluded that feed crops (alfalfa hay, corn for grain, corn for silage and feed barley) indicated lower risk but lower returns compared to cash crops. They found that the cattle feeding alternatives were less risky compared to major crops (using objective means for 1956-76). However, these proved to be more risky when the analysis was based on more subjective means of income, i-e; 1973-76. They found that random variability was more for cattle feeding alternatives than crops. Woolery and Adams (1980) showed that inclusion of cattle feeding as an alternative enterprise led to a higher income and/or lower risk for the model over the 21-year period. They concluded that the negative correlation between cattle prices and cash crops was the main reason for income stability during the period.

Yahya and Adams (1977) studied some measures to quantify variability or risk for price, yield, and revenue for major crops and cropping systems in Wyoming. The study was based on total and random components of the data. The former is used to work out the total variation due to all factors, while the later represents variability due to random elements and is calculated from the detrended data. This approach has commonly been used to measure the risk in farm production. Yahya and Adams (1977) used historical data for 23 years (1952-74) for selected crops in Wyoming and its five crop reporting districts and three production regions. The data were detrended to estimate random variability based on random standard deviation and random coefficient of variation. They calculated mean, standard deviation, and coefficient of variation to measure variability for prices, yields, and gross revenues. The study used mean net income data for four years (1971-74) for a representative farm to study the variability in three production regions based on standard deviation, and coefficient of variation. They found that in general, yield was less variable at the state level compared to the regions. However, in one region, yield variability showed mixed results. It was low for irrigated crops and high for non-irrigated crops. They also found that in general, the random yield variability was lower for irrigated crops than for non-irrigated crops. Yahya and Adam (1977) found that the effect of crop diversification on net income was to reduce the net income variability in general.

Patrick (1992) studied risk management in Indiana agriculture. He used historical data for 26 years (1965-90) to examine yield variability for corn, soybeans, and wheat crops in Indiana, Tippecanoe County, and for a representative farm. He used the mean, standard deviation, and coefficient of variation to establish annual variation in yield and the relative variability among various crops. He found that over the 1965-90 period, the highest variation (risk) was observed in corn yield. Wheat happened to be the least risky enterprise. Patrick (1992) observed that yield variability increased at the farm level as compared to the county or state level as was hypothesized. He said that yield variability typically declines with an increase in geographic area because many responses or observations tend to even out or compress the variability outcomes.

In a separate study, Patrick (1979) measured variability associated with crop and livestock prices, crop and livestock yields, gross revenue, prices of inputs, return above direct costs, and farm income. Variability was measured and compared by computing the standard deviation and coefficient of variation of each crop and livestock enterprise included in the study. Major crop and livestock enterprises included in the study were corn, soybeans, oats, wheat, hay, pigs (per litter), and milk per cow, respectively. Nineteen years (1960-78) of historical state data for the enterprises were used for the analysis to compute the standard deviation and coefficient of variation for each enterprise. Moreover, variability indices for Tippecanoe County and the Purdue university agronomy farm were also computed for three major crops (corn, soybeans, and wheat) over the same period. Yield variability at the farm level was high compared with the county or state level. As the geographic area increased, mean yield tended to be less variable because unfavorable conditions in one area were offset by favorable conditions in another (Patrick, 1979).

Patrick (1979) found that gross revenue variability for selected enterprises showed highest variability for wheat and the lowest for dairy cows, followed by oats. He said that selection of enterprises and diversification were alternatives to reduce income variability. The results based on variability indices showed that risk was very high when only corn was raised. The risk coefficient declined when alternative crops were included in the plan. It declined more when livestock enterprises were added. Risk was lowest when the plan included all major crops and the dairy enterprise. Patrick (1979) concluded that risk could be managed by better farm planning but it could never be eliminated from farm production. Variability in income associated with variation in yields, prices, and costs must be recognized by the producers. However, this should be incorporated in planning and decision making.

Schurle and Erven (1979) studied farm enterprise choice by developing efficient frontiers using maximization linear programming and MOTAD models in Ohio. They analyzed choice between cash grain crops including corn, soybeans, and wheat and specialty crops including processing tomatoes and cucumbers. They applied a budgeting approach to calculate net returns for which standard deviations and coefficients of variation were estimated. The coefficient of variation was used as a measure of risk showing that grains crop showed substantially lower variation than specialty crops (high risk enterprises). Data required by the models were developed for a representative farm. Historical data to calculate revenues based on product prices and yields were collected from three farms considered similar in characteristics. A MOTAD model was applied using a basic linear programming matrix. They observed that diversification had a major effect on risk and net return. The associated risk was lower on the more diversified farm with lower levels of returns. The tradeoff between returns and risk was measured by the coefficient of variation that decreased with a decrease in net returns. The decline in the coefficient of variation showed that risk per dollar of expected return was reduced.

Held and Zink (1982) applied a static linear programming maximization model and a MOTAD model to evaluate enterprise combinations for an intensive irrigated farm in eastern Wyoming to study risk-return tradeoffs. An eleven-year historical data set (1968-78) of annual prices and irrigated crop yields was used in the analysis. Profitability of individual enterprises was computed in terms of gross margins (gross return minus variable costs). Gross margin (income) variability was computed over the 11-year period for each enterprise. The 11-year period was considered sufficiently long to establish price relationships. Gross margins were also computed for livestock enterprises for the same period. To study the variability, eleven-year expected gross margin, standard deviation, and coefficient of variation were estimated for each enterprise. The results showed that the income correlation between crops was relatively high, while the income correlation between crops and steers was negative. This negative correlation implied that diversification between crops and steers was more promising than diversification among crops only. If returns for two enterprises are negatively correlated, low annual returns of one are generally followed by high returns for the other and vice versa. The MOTAD model showed risk-return tradeoffs as showed by the reduction in the coefficient of variation at specified income levels. Activity of more risky enterprises declined, while it increased for less risky enterprises in the enterprise mix.

Woolery (1979) applied E-V analysis in studying risk management for crop and feeding systems in the Big Horn Basin in Wyoming. He used a 21-year historical regional data set on major crops including alfalfa, corn for grain, dried beans, corn for silage, malting barley, sugar beets, and feed barley. Twelve cattle alternatives were included in the study. Net income and associated means, standard deviations, coefficients of variation, correlations and variance-covariance matrices for major crop and livestock enterprises and the different alternative combinations were estimated. These statistics were estimated for both the total and random component of the time series. The random component was estimated by removing the trend in the data on yields, prices, etc. The obtained information was used in an E-V analysis. Cattle feeding operations were more profitable than crops except sugar beets and malting barley. Combinations of crops and/or cattle alternatives alone failed to manage risk effectively. However, cattle-crop mixes led to reduction in variability as measured by the coefficient of variation. Woolery (1979) concluded that an E-V approach to managing risk in farm production was a feasible tool. However, its computation might be limited by accessibility to quadratic programming. Though, theoretically and empirically it is appealing.

CHAPTER FOUR

METHODOLOGICAL APPROACH

PART-I Model Specification and Measures of Variability

The purpose of this chapter is to describe the procedure for achieving the objectives as stated in Chapter I. The objectives and repeated and their procedures are discussed below:

Objective 1.

To study and compare the level and variation in farm income (risk) of selected crop, livestock, fruit, vegetable, and EHPs enterprises in Tennessee.

Procedure

Income potential in a risky economic environment includes consideration of both the level of income and its variability and the tradeoff between the two measures. Income potential can be evaluated by computing expected (mean) gross margins or net returns. Standard deviations associated with gross margins, and coefficients of variation for farm activities are common methods to measure variability (Heady, 1952; Anderson and Dillon, 1992; Kay, 1986; Calkins and DiPietre, 1983; Woolery and Adams, 1981; Boehlje and Eidman, 1984; and Zink and

Held, 1982). Historical data on yields, prices, and variable costs of production were used to calculate gross margins. The expected (mean) gross margin, standard deviation, and coefficient of variation were calculated for each enterprise included in the study over a period of 18 years (1975-92) for Tennessee[2]. The coefficient of variation (standard deviation divided by the mean) is a relative, unitless measure explaining variation in income level per dollar of expected return. These statistics were used to compare income variability and associated risk among different enterprises. This part of the analysis was based for the most part on actual aggregate data on state-level yields, and prices and on costs from enterprise budgets for Tennessee.

To examine variability two measures were calculated. First, historical data were used to calculate standard deviations that represent the total variability. For the second measure, the systematic component or trend was removed using ordinary least squares simple regression with time as an independent variable. That is, the random component of the standard deviation was estimated to measure the random variability or risk associated with each enterprise. The total and random variability indices were computed based on the expected value (mean) and the standard deviation. The mean value for the recent past four years (1989-92) was used to calculate variability indices. This was done on the assumption that the expected value can be better predicted by the most recent mean value. Therefore, an assumption was made that the random component of the standard deviation of the

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[2]Exceptions occurred for the EHPs crops and one fruit and three vegetable crops because of lack of data.

historical data over the 18 years or, in other words, the random variability coefficient, is an estimate of the expected (future) standard deviation with the systematic component removed.

The following formulae were used to calculate the total variability indices (TVI) and random variability indices (RVI);

$$TVI = (\text{Total Variance})^{1/2}/\text{Mean}(1989\text{-}92) * 100$$

$$RVI = (\text{Random Variance})^{1/2}/\text{Mean}(1989\text{-}92) * 100$$

The total and random variability indices were estimated based on actual yields and prices, and gross margins for 18 years (1975-92) on the respective variables.

The lack of information by farmers poses great problems for making managerial decisions under risky situations. By assumption, the variability indices were judged by the researcher to be somewhat indicative of potential risks in considering future farm plans. That is, an enterprise having a higher RVI index was considered to be more risky due to potentially greater future income variance compared to an enterprise that had a lower RVI. In addition, if the TVI and RVI of any enterprise were similar in magnitude, then variations in yields, prices, and/or gross margins were assumed to be mainly due to random factors. Furthermore, the coefficient of variation provides a relative, unitless measure of variability. This measure provides comparison between alternative enterprises for a specific farm plan and for comparing income variability across several alternative plans.

Objective 2.

To examine the feasibility of farm plan diversification under risk by evaluating changes in income levels and variability when selected EHPs are allowed as alternatives with and/or as substitutes for conventional farm enterprises.

Among several important considerations that must be made by the farmer in planning a farm business are: (1) enterprise selection, and (2) the combination of enterprises and their levels in the farm plan. Biological, physical, and economic factors play significant roles in combining the most profitable enterprises on a farm (Castle, et al., 1984). However, another crucial consideration that must be considered is the variability of farm income or the risk associated with the selected enterprises. According to Woolery and Adams (1980), risk is related to both yield and price (input and output). For example, actual output prices and yields may be sharply different from expected prices and yields. The deviations of expected values from actual output values may be regarded as a monetary loss due to risk if the latter are below the former. Thus, enterprises having greater differences between actual values that are lower than expected values are considered more risky than those enterprises that have smaller differences. To reduce risk, the farmer can opt for those enterprises that have less variability (are more stable). Or he or she can select those enterprises that have higher variability (risk) but usually higher expected gains. All risk associated with agricultural production cannot be eliminated.

However, a producer may limit risk to some level by adopting alternate strategies such as diversification (Woolery and Adams, 1980).

Procedure

Risk in terms of income variability may stem from annual fluctuation in product yield and/or prices of outputs and inputs. Optimum enterprise combinations leading to maximum profit may also bring higher risk. Depending on the producer's attitude toward risk, an enterprise combination giving less income (than the profit maximizing combination) linked with reduced income variability (risk) may be preferred.

This part of the analysis is based on two models: (1) a general linear programming model (LP) to find the optimum profit with given constraints and resource availabilities and (2) a MOTAD model to study risk-return tradeoffs at specified income level(s).

<u>The General Linear Programming Model</u>

The general profit maximizing linear programming model (LP) is expressed as:

(1) Maximize $P = \Sigma^{n}_{j=1} C_j \ X_j$

(2) Subject to $A_{ij} \ X_j \leq B_i \ (i=1,...,m)$

$$X_j \geq 0 \text{ (for all js)}$$

where: P = net returns associated with farm enterprises

C_j = the return associated with jth activity or enterprise

X_j = the level of the jth activity

A_{ij} = the input-output coefficient indicating the unit of ith input required per unit of the jth activity

B_i = resource availability of the ith input on the farm

This analysis yields a maximum profit for the base farm plan. Information obtained in this model is used in the MOTAD model as explained below.

The MOTAD Model

The solution provided by the LP model gives maximum profit for a farm plan. However, there may be large income variation (risk) associated with that plan. Generally, a lower risk enterprise combination with equal or a relatively lower income level than a more risky maximum income combination of enterprises is preferred by the decision maker. The MOTAD version of the linear programming model can be applied to analyze risk-return tradeoffs under the assumption that the decision maker is averse to risk.

In this analysis, an adaption of Hazell's (1971) MOTAD model was applied. The major objective in the MOTAD model was to identify a series of risk minimizing solutions of farm enterprise combinations (farm plans) as income is varied parametrically. The risk in this application of the model was measured in terms of total absolute deviations (sA) of income or net return (gross margins) for all enterprises. Total absolute deviations over all years (sA) for a given plan were defined as:

$$sA = \Sigma^{s}_{t=1} \left| \Sigma^{n}_{j=1} (C_{tj} - \bar{U}_j) X_j \right|$$

where s = the time series in the study

A = the mean absolute deviation in gross margin in a year

C_{tj} = the gross margin of jth enterprise in year t

$\bar{U}_j$ = the mean (average) gross margin of the jth enterprise

$C_{tj} - \bar{U}_j$ = the deviation in gross margin of jth enterprise (d^+ or d^-)

X_j = the level of jth enterprise in the solution

Deviation in the gross margin of jth enterprise in year t may be either positive (d^+) or negative (d^-). These deviations are summed across all the enterprises appearing in the optimal solution for all the years. These deviations are then minimized in the objective function such that an enterprise mix is generated which minimizes total absolute deviations[3]. Essentially positive deviations are equal to negative deviations.

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[3]The MOTAD model minimizes only the negative deviations of gross margins. However, the objective function (minimized negative deviations) are multiplied by 2 and divided by the time series included in the study to estimate mean absolute deviation (MAD) as explained in the model.

The MOTAD model is summarized below:

(1) Minimize $sA = \Sigma^{s}_{t=1} (d^{+}_{t} + d^{-}_{t})$

(2) Subject to $\Sigma^{n}_{j=1} \bar{U}_j X_j = \lambda$ ($\lambda = 0$ to unbounded)

(3) $A_{ij} X_j \leq B_i \quad (i=1,...,m)$

(4) $\Sigma^{n}_{j=1} (C_{tj} - \bar{U}_j) X_j - d^{+}_{t} + d^{-}_{t} = 0$

$X_j , d^{+}_{t} , d^{-}_{t} \geq 0$ (for all j, t)

The MOTAD model uses the same input-output coefficient matrix as the linear programming model. However, the objective function in the LP model appears now as a constraint that is set at a specified income level (λ). Similarly, income deviations that portray risk appear as risk rows (equation 4 above). The value of λ is varied parametrically from zero up to the maximum solution level (total gross margins). This income level is obtained in the general linear programming model (used as a base to study the risk-return tradeoffs) under the given resource restrictions to generate risk-efficient farm plans. The MOTAD model generates minimum total absolute deviations (sA) in the objective function from the which mean absolute deviation (MAD) can be computed. The model minimizes risk for each level of λ as measured by the total absolute values of the negative deviations of gross margins. In other words, the standard deviations of net return (gross margin) to the farm are minimized. The standard deviation (S) can be computed from the MOTAD formulation using the following relationship (Schurle and Erven, 1979; Persaud and Mapp, 1979):

$$S = MAD\,[\pi * s]/2(s-1)]^{1/2}$$

where: s = the time series in the data set

π = a mathematical constant and equals 3.14286

MAD = mean absolute deviation

The mean absolute deviation can be computed directly from the MOTAD formulation using the following relationship:

MAD = TAD/s * 2, where TAD represents total absolute deviations of total gross margins for the farm plan generated by MOTAD.

PART-II Data Development

Data Sources

Major sources of data include the Farm Planning Manual (1992), Planning Manual for Fruit and Vegetables (1992), Planning Budgets for Nursery Stock and Christmas Trees (1989), Tennessee Agriculture (various issues), Tennessee Farm Facts (various issues), Tennessee Statistical Abstract (various issues), USDA's Agricultural Statistics (various issues), A Statistical Description of Agriculture in

Tennessee Statistics (1960-90), USDA's Environmental Horticulture Farm Businesses (1987-91), USDC's Agricultural Census (various issues), and North Carolina Agriculture Statistics (various issues).

Other important information was obtained through personal consultation with several professionals at the University of Tennessee: Drs. Darrell Mundy, Burton English, John Brooker, David Eastwood, Dan McLemore, Morgan Gray, Kim Jensen, and Mahadev Bhat in the Department of Agricultural Economics and Rural Sociology; Drs. Robert Jenkins and Denton Gerloff in Extension Agricultural Economics and Resource Development; Drs. Willard Witte, Mark Nash, and Thomas Samples in the Department of Ornamental Horticulture and Landscape Design; and Dr. Alvin Rutledge, in Extension Plant and Soil Science Department. In addition, telephone discussion with Mr. Bud Guinn, Tennessee state statistician, Nashville was also helpful. Telephone discussions were also held with agricultural statistics personnel employed by the states of North Carolina, Georgia, Kentucky, and South Carolina. The data problems related to EHPs were discussed on the telephone with Mr. Doyle Johnson, Specialty Crops, ERS, USDA, Washington, D.C. These discussions were held to resolve the problem of non-availability of time series data on EHPs and some traditional farm enterprises. These discussions were extremely helpful in resolving data problems.

To study risk and income tradeoffs in farm applications, information on gross margin levels and variability over relatively long periods has been utilized widely in earlier research (for example, Woolery and Adams, 1980; Zink and Held, 1981;

Yahya and Adams, 1977; Patrick, 1979; Persaud and Mapp, 1979).

Time series of historical data from 1975 to 1992 on yield, price, and costs of production of selected farm enterprises in Tennessee were used. The tradeoffs between the level of gross margin and variability in gross margin were analyzed. Twenty two farm enterprises including EHPs were included in the study. Farm enterprises were grouped in two categories; (1) traditional or conventional enterprises and (2) environmental horticulture plants (EHPs). EHPs included five field-grown plant groups: broadleaf evergreens, narrowleaf evergreens, deciduous shrubs, shade trees, and ornamental trees. Category (1) included the following crop, livestock, fruit, and vegetable enterprises: soybeans, tobacco, wheat, corn, cotton, sorghum, alfalfa hay, all other hay, tomatoes, snapbeans, dairy (60-cow unit), hogs farrow-to-finish (96-sow unit), beef cow/calf (30-cow herd), sweet corn, sweet potatoes, cabbage, and strawberries. Category (2) included the following five species (one species selected from five plant groups of EHPs): Euonymus kiautschovicus (Euonymus) size 1½ to 2 feet, Juniperus horizontalis (Andorra Juniper) size 1½ to 2 feet, Forsythia intermedia (Forsythia) size 2 to 3 feet, Acer rubrum (Red Maple) size 1½ to 1¾ feet, and Cornus florida (Dogwood) size 5 to 6 feet. Initially, apples, peaches, okra, and cantaloupes were part of the study. However, due to either partial or complete lack of data, these enterprises were excluded from the study.

Time series data on yield, price, and costs of production for 18 years (1975-1992) related to Tennessee were used to compute annual gross margins for each enterprise. Many problems arose regarding data availability, particularly for EHPs.

Moreover, data for a few conventional enterprises such as sweet corn, sweet potatoes, cabbage, and strawberries were also not available for Tennessee over this time period.

Because of the nature and magnitude of the problem of securing actual data for all of the 22 enterprises, data as reported in Tennessee farm planning budgets were used as the base from which to generate the time series data. Farm planning budgets have been used in the past as a base from which to generate time series data in risk analysis. For example, Persaud and Mapp (1979) in their application of MOTAD in studying alternate production and marketing strategies under risk in southwestern Oklahoma, used cost of production data based on crop and livestock budgets to generate cost of production series for 1965-1977. Mundy, et al. (1984) studied risk in the farm income and alternate enterprise problem for burley tobacco producers. They applied price and yield data for Tennessee from 1954 to 1984 using 1986 enterprise budgets as the base year to generate a time series of returns for conventional enterprises.

In addition, enterprise budget series for the period 1975-92 were also not readily available for the selected enterprises. Therefore, information reported in the 1992 budget issue was used as the base year information on yield, price, and cost of production. The base year data were used to generate the series for 1975-92 using indices. Two types of indices were used: (1) yield and price indices constructed from observed data of state-level average yield and price collected from secondary sources, and (2) indices on prices paid by farmers by input groups at the U.S. level to generate variable cost of production series for the period 1975-92. However, for sweet corn, sweet potatoes, cabbage, and strawberries, North Carolina state-level average yield and price data were used. These were used as proxies (based on the assumption that North Carolina data represented closely Tennessee economic and technical conditions) to form the respective indices.

The data problems related to EHPs were especially troublesome. Expert opinions[4] in the field of ornamental horticulture were sought to help address the problem. The steps taken to generate and complete the data set for all 22 enterprises is explained in the next sections.

Yield and Price Data

Actual yield and price data for the period 1975-92 are presented in Appendix Tables 2 and 3, respectively. These data were collected from secondary sources (Tennessee Agriculture--various issues, Tennessee Farm Facts--various issues, Tennessee Statistical Abstract--various issues, USDA Agricultural Statistics--various issues, A Statistical Description of Agriculture in Tennessee Statistics 1960-90, North Carolina Agriculture--various issues).

Actual Tennessee data for 13 conventional enterprises with respect to yield and price were available from secondary sources. These enterprises included soybeans, tobacco, wheat, corn, cotton, sorghum, alfalfa hay, all other hay, tomatoes, snapbeans, dairy, hogs and pigs, and beef cow/calf. Yield and price data for four

[4]Personal consultation with Dr. Willard Witte, the Department of Ornamental Horticulture and Landscape Design, the University of Tennessee, 1994.

other conventional enterprises including sweet corn, sweet potatoes, cabbage, and strawberries were from North Carolina. Price data for alfalfa hay and all other hay for the year 1975 were not available for Tennessee or North Carolina. Therefore, prices for both of the enterprises for 1975 was from the neighboring state of Georgia.

Tennessee state-level yield data for the beef cow/calf enterprise were calculated on the basis of total weight of cattle and calves (marketings) divided by total number of head marketed in a particular year. Similarly, yield data for hogs and pigs were calculated on the basis of state-level aggregate weight of hogs and pigs (marketings) divided by total number of head of hogs marketed in a particular year. Actual yield and price data for the dairy enterprise included were only in terms of milk per cow[5].

Yield and price indices based on actual (observed) yield and price for each enterprise were created for the series 1975-92 taking 1992 as the base year for most enterprises. Then the 1992 budgeted data on yield and price (taken from Tennessee enterprise budgets) for each enterprise were used as the respective yield and price bases to generate the yield and price series for 1975-92 that, in turn, were based on these indices. A similar procedure was utilized to obtain yield and price indices for sweet corn, sweet potatoes, cabbage, and strawberries with the actual data for these four enterprises being for North Carolina. These indices were then used to generate

[5]Planning budgets for 60-cow unit included revenue from the sale of baby calves and cull cows. This amount was separated from the revenue for milk sold. A separate series for the period 1975-92 for this source of revenue was generated based on the yield indices series of beef cow/calf (assuming baby calf selling and cull cow activities were closely associated with beef cow/calf activity) taking 1992 as base year. Later, this revenue was added to the dairy enterprise for each year before arriving at gross margins for the series.

yield and price series for these four enterprises with the 1992 Tennessee budgeted yields and prices (Farm Planning Manual, 1992) for the respective enterprise used as bases.

The data problems related to EHPs were different from those of conventional enterprises. Data on historical yields, prices, and costs of production for EHPs were not available. Also, the yield related to these enterprises was judged to be constant over time. According to expert opinion[6], the number of plants per acre will not vary much from year-to-year unless catastrophes occur. Moreover, according to expert opinion, such catastrophes occur infrequently (generally 50 years or more apart). Nevertheless, to attempt to create yield variability, some consideration was given to using temperature variability during the growing season as a proxy for yield variation in EHPs. However, variation in yield is not only dependent on temperature variation also on other meteorological, biological, and physical factors that are difficult to quantify and use as a proxy of yield variability of EHPs. Therefore, 1989 yields as reported for EHPs in the Tennessee nursery budgets (Planning Budgets for Nursery Stock and Christmas Trees, 1989) were assumed to be constant for the series. Data on actual historical prices were nonexistent for EHPs. Therefore, price series for EHPs for 1975-92 were generated based on the prices received index (all crops index) for Tennessee (Tennessee Agriculture, 1993). Prices received for selected EHPs as reported in the Tennessee nursery budgets (Planning Budgets for Nursery Stock and Christmas Trees, 1989) were used as the base. The indexed data on yield

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[6]Dr. Willard Witte, Ornamental Horticulture and Landscape Design, the University of Tennessee, 1994.

and price are shown in Appendix Tables 4 and 5, respectively

Cost of Production Data

The data used for variable costs of production are shown in Appendix Table 6. Time series data on cost of production (variable) for all the enterprises including EHPs were based on farm planning budgets for Tennessee (either 1989 or 1992). For conventional enterprises, 1992 was taken as the base year. Data on variable costs were broken down into different cost components. These included material, chemical, fertilizer, tractor, other machinery, seed, interest, labor, etc., for all the enterprises for the base year(s). For alfalfa hay and all other hay, establishment costs were prorated over five-years and four-years, respectively, and were included in the variable cost. Indices on prices paid by farmers for the United States were available for the different cost components for the period 1975-92. Therefore, the costs of production series were generated for the period 1975-1992 based on historical variation in the prices of the different cost components. For EHP enterprises, the year 1989 was taken as the base. Similar methods were used to generate the costs of production data series for 1975-92 for selected EHPs. Total variable costs were calculated by summing up the generated cost components based on cost of production indices for each year. For both conventional and EHPs enterprises, interest paid on operating capital on a six-month basis and wages paid to labor were included in the variable costs of production.

Livestock activities receive feed from certain crops raised on the farm or from purchased sources as feed. For example, the dairy requires corn silage, alfalfa hay, all other hay, and pasture. The beef cow/calf enterprise requires corn, all other hay, and pasture, and the farrow-to-finish hog activity requires corn as feed. Corn silage and pasture were not considered in this study as part of the 22 selected enterprises. Therefore, the variable cost for the 60-cow dairy unit included expenses incurred on production of the required corn silage and pasture. Similarly, variable costs for beef cow/calf activity included expenses for the production of pasture. However, corn, alfalfa hay, and all other hay activities were among the enterprises under consideration. Therefore, these three were treated as transfer activities in the model as explained later.

Calculation of Gross Margins

Gross revenues and gross margins for the series are reported in Appendix Tables 7 and 8, respectively. Gross margin was calculated for each enterprise on the basis of gross revenue less total variable cost. Gross revenue was calculated using the following relationship:

$$\text{Gross revenue} = \text{Yield} * \text{Price}$$

Gross margin for this study was defined as the residual income to land, management and physical infrastructures. Gross margin was calculated using the following relationship:

Gross margin = gross revenue - total variable cost

The gross margin for each enterprise was obtained on an annual basis. Gross margins for dairy, beef cow/calf, and farrow-to-finish hog production were determined for a 60-cow unit, 30-cow herd, and 96-sow unit, respectively. Gross margins for all other enterprises including EHPs were on a per acre basis. Gross margins for perennial crops such as strawberries and EHPs were annualized.

Nature of the Data

A few important considerations related to the data used in this study need to be emphasized. These factors should be kept in mind while interpreting the results and/or using the findings of this study. First, enterprise budgets of the type used here are prepared for planning purposes. Data reported in the budgets tend to represent the more productive and efficient producers and show higher production and efficiency levels. Therefore, such budgetary information tends to be somewhat optimistic compared to the average farm situation. Second, data used for all the enterprises in this study represented state level average yield, price, and costs of production. The variability in gross margins was likely compressed to a considerable but unknown extent due to aggregation. Generally, variability at the farm level will be greater. Third, yields for the EHPs were assumed to be constant. This assumption, though it appears unrealistic, was judged[7]

[7]Judgement of Dr. Willard Witte, the Department of Ornamental Horticulture and Landscape Design, the University of Tennessee, 1994.

to be appropriate for the perennial EHPs. Therefore, the variability or risk associated with gross margins of EHPs is the resulting variation solely from variation in prices received and cost of production and not from yield variation.

Data Development for the General Linear Programming and the MOTAD Models

To study risk-return tradeoffs that can lead to the generation of risk-efficient sets of farm plans based on the MOTAD model, historical data on yield, price, and cost of production were needed to arrive at annual gross margins (net returns) per unit of activity. The expected (mean) values of gross margins were calculated based on the series of gross margins that forms the objective function in the basic LP model. However, gross margins based on time series data on actual yield, price, and cost of production include a trend or systematic component.

As discussed earlier, the time series or historical data consist of two additive parts. According to Tinter (1940), these components are a mathematical expectation component and a random component. The former may also be classified as a systematic component or trend. Both yields and prices are affected by systematic sources of variation. In this way this part is to some extent predictable. The most common examples for systematic sources of variation are inflation, improvement in technology, and price cycles. In risk studies, this segment of time series data is not considered of vital importance due to its predictability. Mathematical and/or statistical techniques are applied to separate the systematic part from the random part. The random component is caused by random or stochastic events. Therefore, this source of variation in time series data is relatively unpredictable. In production risk studies, the random component of data is considered more relevant. The most common examples of random sources of variation in agricultural production are weather, insect and disease infestation, and other natural disasters. Due to its stochastic nature, the random component of the data measures random variability in farm income or the risk associated with farm production. Therefore, the focus of this study is on the random component of gross margins related to farm enterprises included in the study.

Two commonly used methods to detrend time series data are; (1) finite variate difference method and (2) linear regression with time as an independent variable. Because several observations are lost in each differencing in the variate difference method, method (2) was chosen to remove trend in the data set (Persaud and Mapp, 1979; Musser, et al., 1984; Patrick, 1979; Jensen, 1993). In this method, regression residuals of gross margins represent unexplained or random variability. Deviations in gross margins are calculated around the time trend. The expected (mean) value of gross margins that is the objective function in LP model now appears as a constraint in MOTAD at a specified level of expected income. The series of income deviations (1975-92) show the magnitude of risk associated with each enterprise. These deviations are introduced as risk appearing in the constraint for each year. Other requirements with respect to other constraints and resource availability are similar for both the LP model and MOTAD model.

Technical Coefficient Matrix

Information related to the technical coefficient matrix or input-output requirements are given in Appendix Table 9. Requirements for both the models were similar. Information given in the Farm Planning Manual (1992), Planning Manual for Fruit and Vegetables (1992), and Planning Budgets for Nursery Stock and Christmas Trees (1989) was used to calculate the coefficients for all enterprises. These requirements were needed by the activities in the form of land, labor, and capital. Labor hour requirements were determined on a per-acre basis for conventional and EHPs enterprises. For livestock activities, required labor hours were on a per unit basis such as, for example, a 60-cow dairy unit. Labor requirements were presented on a bi-monthly basis.

Similarly, operating and fixed capital requirements were calculated from enterprise budgets. The following relationship was used to determine these requirements;

Operating capital = Total variable expenses + interest on operating capital

Fixed capital = Fixed expenses + interest on fixed capital

Operating capital included expenses incurred on seed, fertilizer, chemicals, etc. Expenses incurred on permanent structures, depreciation, etc., were classified as fixed capital.

Development of Hypothetical Farms and Resource Availability

Three hypothetical farms were developed that employ different resources in the form of land, labor, and capital. These resources formed the right-hand side (RHS) in the basic LP and MOTAD models. The procedures adopted for determining the resource availabilities for the three hypothetical farms are discussed below and the results are shown in Appendix Table 10. The general notion was to create three hypothetical situations that varied primarily with respect to level of available resources. Therefore, only differences in quantity of resources were considered in the analysis. Quality of the various resources was assumed to be the same across the three farm situations. Furthermore, the three hypothetical farm situations were not assumed to be representative of typical farms in Tennessee. The emphasis in this study was on the tradeoffs between risks and returns and not on the representativeness of the right-hand side (resource situation) of the model. However, the resource situations for the medium and small hypothetical farms were constructed in part from the Tennessee study based on a representative farm analysis (Mundy, et al., 1989). The large farm was simply assumed to be more well endowed with resources than the other two situations. Choice of resource availabilities was essentially based on the judgement of Dr. Darrell Mundy[8]. An important goal was to formulate three distinctly different resource situations that were somewhat indicative of Tennessee conditions but that would allow analysis of risk-return

[8]Personal discussion with Dr. Darrell Mundy, Department of Agricultural Economics and Rural Sociology, the University of Tennessee, 1994.

tradeoffs without being inordinately constrained at the outset by one or more resources. Moreover, sensitivity analysis results from the models were assumed to be helpful in deciding on the ultimate criticalness of resource availabilities.

The land was divided into three categories: rowcrop land, hayland, and pasture. The acreages in Appendix Table 10 were assumed to be available on an annual basis. By assumption, the rowcrop land included continuous as well as the proportion of rotation cropland available on an annual basis.

Initially, capital requirements for each enterprise were determined based on the Farm Planning Manual (1992), Planning Manual for Fruit and Vegetables (1992), and Planning Budgets for Nursery Stock and Christmas Trees (1989). These requirements are shown in Appendix Table 9. The levels of available operating and fixed capital were set high enough not to prevent capital intensive enterprises such as dairy or hogs from initially entering the solutions at whole unit-levels for the large and medium farms. However, keeping in view the three farm sizes, capital was allocated differently among the large, medium, and small farms.

The large and medium farms were allocated equal amounts of labor. The labor availabilities for these farms were allocated given the assumption that one laborer (most likely the manager) works full-time for 600 hours on a bi-monthly basis up to a maximum of 3,000 hours during a year. Another assumption was that the manager can employ seasonal laborers as needed up to the maximum available quantities shown in Appendix Table 10. A limited amount of family labor was allowed for both of the situations as part-time and/or seasonal labor. Somewhat similar assumptions were for the small farm. However, seasonal labor was not allowed. Part-time family labor (120 hours) was available on a bi-monthly basis for the small farm.

Buying, Selling and Transfer Activities

Three types of livestock enterprises were included in the study: dairy, beef cow/calf, and farrow-to-finish hogs. The livestock activities required feed from five crops. The crops included corn, alfalfa hay, all other hay, corn silage, and pasture. Corn silage and pasture were not included as activities in the model. However, the costs were included in the respective gross margins of the livestock activities in which they were needed as feed as was explained above. In addition, their resource requirements for land, labor, and capital were included as part of the requirements in the livestock enterprises in which they were required. Three other crops; corn, alfalfa hay, and all other hay were allowed to be transferred as feed to livestock if appropriate. Buying and selling activities for these crops were also allowed in the model(s). The following input-output relationships were incorporated in the models:

1) Beef cow/calf and farrow-to-finish hogs operations required 47.7 and 21,216 bushels of corn per unit, respectively, as feed. Per acre yield of corn was 65.54 bushels based on the average of the indexed yield series.

2) The dairy operation required 90 tons of alfalfa hay and 32 tons of all other hay. Similarly, the beef cow/calf operation required 90.9 tons of all other hay. Per acre yield of alfalfa hay and all other hay was 2.75 and 1.92 tons, respectively, based

on the average of the indexed yield series.

3) There were buying and selling activities each for corn, alfalfa hay, and all other hay. Corn could be purchased for $3.12 per bushel and sold for $2.86 per bushel. Alfalfa hay could be purchased for $102.73 per ton and sold for $77.73 per ton. Similarly, all other hay could be purchased for $79.35 per ton and sold for $59.35 per ton. Selling prices were based on the average of the indexed price series. The selling price of each crop was less than the purchase price for the same crop. The cost differential[9] reflects the margin for handling and transportation.

Risk Component in the MOTAD Model

The development of the MOTAD model was accomplished by calculating the annual historical data for gross margins over a period of 18 years (1975-92). The risk component of the MOTAD model were the regression residuals generated by removing the time trend from the gross margin series. The regression residuals represented the unexplained or random variability translated as the risk associated with a specific enterprise. These deviations were used as estimates of deviations in gross margins for every year. In the MOTAD model, risk was measured by absolute deviation from the expected (mean) return. Thus, the model explained the tradeoffs between the expected gross margins and the absolute deviation of margins (Hazell, 1971). The income deviation matrix is presented in Appendix Table 11.

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[9]Based on personal discussion with Dr. Clark Garland, Extension Agricultural Economics and Resource Development, the University of Tennessee, 1994.

CHAPTER FIVE

RESULTS

PART-I Descriptive Analysis of Variability

This section includes a discussion of results on variability related to actual state-level average yields, prices, and gross margins for the period 1975-1992 in Tennessee.

Yield Variability

The yield variability statistics are given in Appendix Table 12. The standard deviation, TVI, and RVI for selected farm enterprises in Tennessee are presented. Mean yields for the period 1975-1992 and 1989-92 are also shown.

The column under RVI in the table shows random variability indices that range from a high of 28.68 percent for snapbeans to a low of 2.11 percent for dairy. Mathia (1975), in the study of North Carolina crop variability, adopted 15 percent as an arbitrary variability index value that separates high and low random variability for crop yields. Based on the Mathia assumption, yields of most of the crops were considered stable in Tennessee during the period. However, snapbeans and tomatoes were relatively unstable enterprises based on yield during the period. Cotton, corn and wheat yields were somewhat stable; whereas, soybeans, tobacco, sorghum, alfalfa hay, all other hay, dairy, beef cow/calf, and hog and pig yields remained relatively more stable farm enterprises in Tennessee during the 1975-92 period.

In terms of TVIs, snapbeans were the highest at 28.71 percent and dairy the lowest at 4.98 percent. However, TVI and RVI were very close to each other for tobacco, wheat, snapbeans, beef cow/calf, and hogs and pigs. This closeness indicates that yield variability in these enterprises was mainly due to the random component.

Price Variability

The price variability statistics are given in Appendix Table 13. The standard deviation, TVI, and RVI for selected Tennessee farm enterprises are presented. The table also includes the mean price for the period 1989-92 and actual price for the year 1992. The column under RVI in the table shows random variability indices that ranged from a high of 20.04 percent for corn to a low of 5.08 percent for snapbeans. Other enterprises that showed relatively high random variability were soybeans and sorghum. All other enterprises were relatively stable based on price variability. However, TVI and RVI were very close to each other for soybeans, wheat, corn, cotton, sorghum, all other hay, and hog and pigs. This closeness suggests that price variability was mainly due to random events for all these enterprises in Tennessee during the period.

Gross Margin Variability

The gross margin for each enterprise was computed by subtracting total variable cost from gross revenue as explained in Chapter IV. The gross margin variability statistics are given in Appendix Table 14. The standard deviation, TVI, and RVI for selected farm enterprises in Tennessee are presented. The table also includes the mean gross margin for the period 1975-1992 and 1989-92. Graphs for variability of important enterprises are also shown in Appendix Figures 8 through 13.

The results in the column under RVI in the table show random variability indices. These indices range from a high of 176.34 percent for all other hay to a low of 9.98 percent for maple (an EHP enterprise). Based on these statistics, some examples of unstable enterprises were tobacco, tomatoes, sorghum, corn, cotton, soybeans, and snapbeans. On the other hand, some examples such as euonymus, juniper, forsythia, dogwood, maple, alfalfa hay, dairy, beef cow/calf, and farrow-to-finish hogs were relatively more stable in Tennessee during the period. All EHPs had the least variability in gross margins. This result may be attributed in large part to the assumption of constant yield for the EHPs enterprises and the use of highly aggregated price indices as measures of price variability for EHPs.

When TVI and RVI both were evaluated, TVI and RVI were very close for maple, tobacco, wheat, snapbeans, juniper, forsythia, euonymus, dogwood, corn, cotton, sorghum, all other hay, tomatoes, farrow-to-finish hogs, sweet potatoes, and cabbage. Therefore, the gross margin variability in these enterprises was mainly due to the random component.

PART-II The General Linear Programming Solution

This section includes general linear programming results for the three hypothetical farm situations, referred to simply as large, medium, and small farms as discussed in Chapter IV. The optimal solutions for the three farms are shown in Appendix Table 15.

Large Farm

The optimal solution for the large farm included total gross margins of $315,655 with a standard deviation of $76,839 and a coefficient of variation (CV) equal to 24.3 percent. The standard deviation of the gross margins were the highest for the large farm as compared to the other two farm sizes as expected. Usually, high returns are accompanied by high risk (explained by the magnitude of the standard deviation). However, the CV for the large farm turned out to be low compared to the medium and small farms also as expected[10].

The enterprise mix for the optimum solution for the large farm included one EHPs species, euonymus, allocated at a level of 7 acres. This allocation suggests the potential of this EHP as an alternative enterprise with conventional farm enterprises even when risks are ignored as in this income-maximization model. A high proportion of land was allocated to snapbeans (257 acres) and sweet corn (54 acres).

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[10]Historical yield, price, and cost of production data that served as the origin of variability in this study were size neutral. Therefore, the gross margins standard deviations for the different farm situations are somewhat size neutral due to the nature of the data. However, the mean income levels varied widely across the farm sizes and were not size neutral. Therefore, the CV became larger as mean gross margin became smaller when the standard deviation did not vary downward as much as farm size was reduced.

There were 1.7 units (96-sow unit) of farrow-to-finish hogs, along with a corn buying activity of 36,106 bushels. None of other 22 enterprises under consideration entered the optimal solution.

Sensitivity or range analysis for the large farm showed that euonymus would stay at the same level (7 acres) as long as its current coefficient in the objective function ($6,078.75) is not increased by $14,657 or decreased by $393. This analysis suggests that euonymus was solution sensitive on the lower bound, whereas relatively less sensitive on the upper bound for the large farm.

In the linear programming solution no consideration was given to risk or variability of gross margin. Therefore, the maximum net return was subject to large fluctuations in year-to-year income.

Medium Farm

The optimal solution for the medium farm included total gross margins of $187,853 with a standard deviation of $61,932 and a coefficient of variation (CV) equal to 33 percent. The standard deviation was lower than the large farm and higher than the small farm as expected. The CV for the medium farm was higher than the large farm but lower than the small farm as expected.

The enterprise mix at the optimal solution for the medium farm included one species of EHPs, euonymus, allocated to 4.5 acres of land which was less than the allocation to the large farm. Again, the presence of this activity in the solution suggests the potential of EHPs as alternative enterprises with conventional farm enterprises. As compared to the large farm, the medium farm tended to be more diversified. The enterprise mix, besides euonymus, included alfalfa hay (85 acres), tomatoes (18 acres), snapbeans (42 acres), farrow-to-finish hogs (1.87 units), corn buying (39,638 bushels), and alfalfa hay selling (235 tons).

Sensitivity or range analysis for the medium farm showed that euonymus would stay at the same level (4.5 acres) as long as its current coefficient in the objective function ($6,078.75) is not increased by $7,576 or decreased by $399. This analysis suggests that euonymus was more solution sensitive on the upper bound and a little less sensitive on the lower bound for the medium farm as compared to the large farm. Furthermore, euonymus was solution sensitive on the lower bound for this farm.

Small Farm

The optimal solution for the small farm included total gross margins of $43,329 with a standard deviation of $15,460 and a coefficient of variation (CV) equal to 35.7 percent. The standard deviation turned out be the lowest among all farm categories as expected. Usually, low levels of income are accompanied by low standard deviations. However, the CV for the small farm turned out to be the highest among all farm categories as expected and as explained above in foot note 10.

The enterprise mix for the small farm included two species of EHPs, euonymus and dogwood. Land allocated to euonymus was 1.45 acres which was lower than the amount of land allocated to the same crop for the large and medium farms. Dogwood entered at 0.2 acres of land in the optimal solution. Again, the presence of these two activities indicate the potential of EHPs as alternative enterprises with conventional farm enterprises. As compared to large and medium farms, the small farm tended to be more diversified. The enterprise mix, besides euonymus and dogwood, included alfalfa hay (13 acres), tomatoes (2.5 acres) snapbeans (2.5 acres), farrow-to-finish hogs (0.6 units), corn buying (14,227 bushels), alfalfa hay selling (36 tons), and strawberries (0.4 acres).

Sensitivity or range analysis for the small farm showed that euonymus would stay at the same level (1.45 acres) as long as its current coefficient in the objective function ($6,078.75) is not increased by $874 or decreased by $1,689. This analysis suggests that euonymus was more solution sensitive on the upper bound and less sensitive on the lower bound on small farm. Similarly, dogwood would stay at the same level (0.2 acres) as long as its current coefficient in the objective function ($5602.46) is not increased by $1,983.8 or decreased by $1,428.5. This analysis suggests that dogwood was not as solution sensitive on the upper bound but slightly more so on the lower bound than euonymus on the small farm.

Differences in enterprise mix were apparent when all three hypothetical farms situations were compared. For example, with the medium and small farms, greater emphasis was placed on more enterprises than on the large farm. Moreover, the results suggest that, EHPs are showing some potential for inclusion in the farm plan across all farm sizes.

PART-III The MOTAD Solution

This section discusses the risk-return tradeoffs when conventional and EHPs enterprises were combined based on historical average yields and prices. Linear programming solutions (maximum total gross margin) for these farms as discussed in Part II of this chapter were used as a base or beginning solution in initiating the MOTAD analysis for each farm situation. Total gross margin levels were varied parametrically (systematically lowered in an decremental fashion) to study the risk-return tradeoffs. MOTAD analyses were done on each of the three hypothetical farm situations.

Large Farm

The results obtained by varying income level (λ) parametrically by an arbitrary equal decrement of $30,000 from the general LP total gross margins ($315,655) are shown in Appendix Table 16. There are 11 basic solutions (A through K) as shown in the table. The solution for farm Plan A corresponds to the general linear programming solution that maximized expected income. Farm Plans B through K were generated by MOTAD by varying the income levels and minimizing negative deviations on total gross margins as discussed in Chapter IV. The standard deviations associated with each income level were computed using formulae also discussed in Chapter IV.

A risk-efficient frontier was plotted using income level (total gross margin) and associated risk (standard deviation) as shown in Appendix Figure 16. An efficiency frontier shows risk efficient tradeoffs between risk and returns when the expected income level is varied parametrically. Each point on the frontier has a unique enterprise mix (farm plan) that corresponds to a risk-return level. In moving along the frontier downward from the highest point (farm Plan A--maximum return-risk) to the lowest point (farm Plan K--lowest return-risk), the farmer is foregoing income to minimize risk. Depending on the farmer's risk attitude, he or she can operate anywhere on the frontier from point A downward and risk is reduced at the chosen income level. Furthermore, a farmer can choose a plan that results in a risk-return combination that falls below the frontier. However, such combinations, although feasible, are not risk efficient. In contrast, a farmer cannot choose a farm plan that results in a risk-return combination that falls above the frontier because all such combinations are infeasible.

The enterprise mix changed substantially along the frontier. As the income level was lowered, more diversified enterprise mixes were observed (Appendix Table 16). Tomatoes, snapbeans, and farrow-to-finish hogs generally declined in volume of production. Snapbeans disappeared from the solution at the $105,655 return level and the EHP, maple entered at 0.7 acres. Maple remained in the solution at the lowest income level of $15,655. Likewise, farrow-to-finish hogs dropped to a near zero level at the $15,655 income level. Similarly, tomatoes dropped out at the $195,655 return level and tobacco entered at 3 acres and remained in the solution as income levels were lowered to $105,655. Tobacco was not present in the LP maximization solution. Similarly, cotton that was not in the income maximization solution entered the plan at the $135,655 income level and stayed in subsequent plans through the lowest income level of $15,655. Similarly, corn, cabbage, strawberries, alfalfa hay and alfalfa hay selling activities that were not in the maximization solution entered the solution at reduced risk-income levels. These enterprises remained in the solution through the lowest income level of $15,655.

Results in Appendix Table 16 show that one or two EHPs were generally included in the enterprise mix at most risk-return levels. At least one EHPs (euonymus or maple) appeared in almost all large farm plans. Given the nature of the MOTAD model, these enterprises contributed to risk reduction along with other enterprises in the solutions. Based on the magnitude of the coefficient of variation (CV), the income levels and associated risks were lower with the more diversified farm plans as expected. As the gross margin was reduced parametrically, the CV fell, showing a percentage reduction in risk per dollar of expected income (gross margin). The CV ranged from a high of 24.3 percent in Plan A (equivalent to the LP solution) to a low of 3.2 percent (Plans J and K) at the lowest two income levels.

On the large farm, euonymus was in the enterprise mix for six of the alternative plans and maple for four plans. How well an enterprise contributes to managing risk depends on the variability of the gross margin of the individual enterprise (Appendix Table 14) and the correlation of its gross margin with the gross margins of other enterprises (Appendix Table 19). Generally, two enterprises exhibiting negative correlation offer greater opportunity for stabilizing income through diversification. If the correlation between two enterprises is negative or weakly positive, diversification among such enterprises can lead to stability in farm income and lower risk. Based on the results in Appendix Table 19 euonymus and maple are either negative or not highly positively correlated with many conventional farm enterprises. Hence, the results suggest some potential in reducing risk if these new alternatives are combined with conventional enterprises in farm plans.

Detailed sensitivity or range analyses for the optimal farm plans were done. Because the focus of this study is on EHPs, only the sensitivity results for EHPs are discussed here[11]. Euonymus was not solution sensitive at higher income levels (Plans B and E). However, when income was constrained, euonymus was highly sensitive in Plan F (income level $165,655) and became extremely sensitive in Plans G (income level $135,655) and H (income level $105,655). The sensitivity range were $574 to $493 for Plan F, $51 to $13 for plan G, and $31 to $43 for Plan H. When income was constrained further, euonymus disappeared from the solution. On the other hand, maple was extremely sensitive at higher income levels (maple entered the solution at the income level of $105,655). The sensitivity range at that level was $57 to $ 44. However, sensitivity to the solution declined as income was further constrained (Plan I--income level $75,655 and Plan J--income level $45,655). The sensitivity range for Plan I was $165 to $370 and for Plan J the range was $181 to $2,284. Maple was essentially solution insensitive at the lowest income level $15,655 (Plan K).

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[11]Detailed sensitivity results for all the farm plans for the three hypothetical farm situations are available from the author.

Medium Farm

The results obtained by varying the income level (λ) parametrically by an arbitrary equal decrement of $18,000 from the general LP total gross margin ($187,853) are shown in Appendix Table 17. There were 11 basic solutions (A through K) obtained in the same manner as for the large farm. A risk-efficient frontier was plotted using income level (total gross margin) and associated risk (standard deviation) as shown in Appendix Figure 15.

As with the large farm, the enterprise mix changed substantially along the frontier from A to K. As the income level was lowered parametrically, more diversified enterprise mixes made up the optimum farm plans (Appendix Table 17). Alfalfa hay, snapbeans, and farrow-to-finish hogs generally declined in volume of production with snapbeans disappearing from the solution and farrow-to-finish hogs dropped to a near zero level at income levels of $61,853 and $25,853 and below, respectively. Euonymus remained in the solution down to an income level of $79,853 after which it did not appear. However, at the $61,853 level, maple entered the solution (2.6 acres). Maple remained in the solution through the lowest income level of $7,853. Similarly, tomatoes dropped out at $115,853 return level but reentered the optimum enterprise mix at the $61,853 return level and remained in the solution at a very low level down through the lowest income level of $7,853. Tobacco and cotton were not present in the initial LP maximization solution (Plan A). However, both activities entered the plans at income levels of $115,853 and $61,853, respectively. Tobacco disappeared when income was lowered below $115,853 and then reappeared at the $61,853 income level. However, cotton stayed in the solution down through the lowest return level of $7,853. Sweet corn, sweet potatoes, cabbage, and strawberries were not present in the maximization solution. These enterprises entered various farm plans at lower income levels. Except for sweet potatoes, the other three enterprises stayed in the solutions through the lowest income level of $7,853. Sweet potatoes disappeared from the optimum solution as the income level was constrained to an income level of $43,853.

Appendix Table 17 results show that one of two species of EHPs entered the optimum enterprise mix for Plans A through K for the medium farm. Either euonymus or maple appeared in all the medium farm plans. Based on the magnitude of the coefficient of variation, the income levels and associated risks were lower with the more diversified farm plans. The CV ranged from a high of 33 percent (farm Plan A--LP solution) to a low of 3.2 percent (farm Plans I through K) at substantially lower gross margin levels.

As with the large farm, euonymus and maple were the only two EHPs that entered the optimal solutions. Consequently, the same discussion as for the large farm on the simple correlations of each of these two EHPs with conventional enterprises (Appendix Table 19) applied here for the medium farm.

Euonymus was not solution sensitive at higher income levels (Plans A through C). However, when income was constrained it showed extreme sensitivity in Plans F (income level $97,853) and G (income level $79,853). The sensitivity range for Plan F was $253 to $318 and $44 to $318. When income was constrained further, euonymus disappeared from the solution. On the other hand, maple was extremely sensitive at higher income levels (maple entered the solution at the income level of $61,853). The sensitivity range at that level was $82 to $6. However, solution sensitivity declined as income was further constrained (Plan I-income level $43,853 and Plan J--income level $25,853). The sensitivity range for Plan I was $181 to $2,284 and remained the same for Plan J. Maple was essentially solution insensitive at the lowest income level of $7,853 (Plan K).

Small Farm

The results obtained by varying the income level (λ) parametrically by arbitrary equal decrements of $4,000 from the general LP total gross margin maximization solution ($43,329) are presented in Appendix Table 18. Again there were 11 basic solutions (A through K) obtained in a manner similar to the other two hypothetical farms. A risk-efficient frontier was plotted using income level (total gross margins) and associated risk (standard deviation) which is shown in Appendix Figure 14.

As with the other two hypothetical farms, the enterprise mix changed substantially along the frontier from A to K. As the income level was parametrically lowered, a more diversified optimal enterprise mix was observed (Appendix Table 18). Euonymus, dogwood, alfalfa hay, tomatoes, snapbeans, farrow-to-finish hogs, strawberries, corn buying, and alfalfa hay selling activities were present in the maximizing solution. Alfalfa hay, alfalfa hay selling and strawberries appeared in all optimum plans. After remaining in the solution for several income levels euonymus, and tomatoes disappeared from the optimal solutions as income was lowered. However, tomatoes after disappearing at the income level of $15,329 came back in the solution at an extremely low acreage level at the income level of $7,329 and remained through the lowest income level. Farrow-to-finish hogs dropped to a near zero level at the $11,329 (Plan I) and dropped further when income was constrained to lower levels (Plans J and K). Maple, cotton, corn, cabbage, sweet potatoes, and sweet corn entered the solution at various income levels. Except sweet potatoes and corn, the other four enterprises remained in the optimal solution at the lowest income level of $3,329.

One or more EHPs appeared in each of small farm Plans (A through K). Three species of EHPs, euonymus, dogwood, and maple appeared in different solutions. Based on the magnitude of the coefficient of variation, the income levels and associated risks were lower with the more diversified farm plans. The CV ranged from a high of 35.7 percent (farm Plan A--LP solution) to a low of 3.2 percent (farm Plans I through K) at substantially lower gross margin levels.

As with the medium farm, euonymus and maple were the only two EHPs that entered the optimal solutions (dogwood appeared in maximization solution). Consequently, the same discussion as for the medium farm on the simple correlations of each of these two EHPs with conventional enterprises (Appendix Table 19) applied here for the small farm.

Euonymus and dogwood both were not solution sensitive in the maximization solution (Plan A). However, at constrained income levels (Plans B and C), euonymus was more solution sensitive on the upper bound than on the lower bound. The sensitivity range for Plan B was $442 to $9,563 and $342 to $2,545. When income was constrained further, euonymus became relatively less sensitive (sensitivity ranged between $6,876 to $2,545, Plan D--income level $31,329). However, it was extremely sensitive in Plans G (income level $19,329) and H (income level $15,329). The sensitivity range was $148 to $511 for Plan G and $112 to $556 for Plan H. Euonymus disappeared from the optimal solution when income was further constrained at the level of $11,329 (Plan I). On the other hand, maple was extremely sensitive at higher income levels (maple entered the solution at the income level of $19,329--Plan G, sensitivity range $565 to $257). However, solution sensitivity increased as income was further constrained (Plan H--income level $15,329 and Plan I--income level $11,329). The sensitivity range was $556 to $174 for Plan H and $196 to $175 for Plan I. When income was further constrained, maple was more sensitive on the upper bound than on the lower bound. However, at the lowest income level $3,329 (Plan K) maple was solution insensitive.

Some General Comparison Across Farm Sizes

In an overall comparison across the hypothetical farm sizes, the optimal solution and the sensitivity analyses indicated that the two species of EHPs, euonymus and maple behaved in a some what different manner in reducing risk but the pattern of behavior was similar for all three farm situations. The presence of euonymus in the optimal solutions was relatively stable at higher levels of income in all farm situations. However, as income was constrained at lower levels to reduce risk, it tended to disappear from the optimal solution. On the other hand, the presence of maple in the solution was relatively stable at lower income-risk levels in all farm situations. Dogwood only appeared once at a low level of production in Plan A for the small farm. Plan A was equivalent to the linear programming maximum gross margin solution. This EHP enterprise did not enter any plans in which the tradeoff between risk and returns was considered (Plans B through K).

Similarly, the other two EHPs, juniper and forsythia, never entered any optimal solutions for any of the farms. Sensitivity analyses for large farm situations (plans) indicated that at higher income levels, both species showed a wide range in which the basis was unchanged (Plans B through E). For example, the sensitivity range was between infinity to $21,574 for euonymus and infinity to $24,677 for forsythia in Plan B. The range in Plan E was infinity to $2,701 for euonymus and infinity to $3,350 for forsythia. However, at small income levels (Plans G through K), juniper and forsythia indicated solution sensitivity on the lower bound (the range was infinity to $511 for euonymus and infinity to $669 for forsythia in Plan G). For medium farm situations (plans), sensitivity analyses for juniper and forsythia at higher income levels showed a wide range in which the basis was unchanged (Plans B through G). For example, the sensitivity range was between infinity to $25,505 for euonymus and infinity to $33,846 for forsythia in Plan B. The range in Plan G was infinity to $1,194 for euonymus and infinity to $1,522 for forsythia. However, at small income levels (Plans H through K), both species showed solution sensitivity on the lower bound (the range was infinity to $369 for euonymus and infinity to $474 for forsythia in Plan H. Sensitivity results for small farm situations (plans) were similar to those found in medium farm situation (plans).

CHAPTER SIX

SUMMARY, CONCLUSIONS AND IMPLICATIONS, LIMITATIONS AND FUTURE RESEARCH NEEDS

Summary

Introduction and Objectives of the Study

Farm production is exposed to risk. The farming business depends on several factors over which the farmer has no control. Factors such as weather, pest and diseases, market conditions, biological processes, changing technology, government policy, farmer goals and preferences, and social interaction are some examples that must be considered in farm planning and management. There are several production responses to manage risk or variability. These actions or strategies are generally related to a tradeoff between risk and return; that is, to reduce year-to-year variability (risk) of income, one must be willing to accept a reduced level of average income. Some examples of the important production strategies are choosing low risk enterprises, enterprise diversification, and maintaining flexibility. Enterprise selection is an important criterion because variability of yields and farm income tends to differ substantially among enterprises.

Production diversification has long been practiced as a strategy for stabilizing income and managing risk in agricultural production. Diversification in farm production involves adoption of several production activities instead of a single activity by the producer. Farmers are diversifying by growing a combination of traditional commodities or enterprises such as crop-livestock mixes on their farms to enhance their incomes and to manage risk. There are other alternatives available that can be considered for inclusion in the farm diversification plan other than traditional commodities. These alternatives are the nontraditional agricultural commodities or enterprises such as environmental horticulture plants (EHPs), flowers, vegetables, fruits, fish, poultry, forestry products, small animals, etc. One of these nontraditional commodity groups is EHPs. This group can be identified as alternatives for possible inclusion in farm diversification plans.

This research study explored the potential of EHPs for inclusion in farm diversification plans as an alternative(s) with conventional or traditional crop-livestock enterprise(s) in Tennessee. A risk programming model, minimization of total absolute deviations (MOTAD) was used to analyze risk-return tradeoffs when EHPs were included as alternative(s) with conventional farm enterprises in the model.

Objectives of the Study

The general purpose of this research study was to assess income and risk potential for selected traditional crop, vegetable, fruit and livestock enterprises when they are combined with EHPs. The analysis was based on a combination of (1) state-level historical data from Tennessee (where possible) of yield, price, and cost of production of major crop, livestock, vegetable, fruit, and EHPs enterprises over a period of 18 years (1975-1992), and (2) Tennessee enterprise budget data for 1992 for conventional enterprises and 1989 for EHPs.

Specific objectives were:

1) To study and compare the level and variation in farm income (risk) of selected crop, livestock, fruit, vegetable, and EHP enterprises in Tennessee.

2) To examine the feasibility of farm plan diversification under risk by evaluating changes in income levels and variability when selected EHPs are allowed as alternatives with and/or as substitutes for conventional farm enterprises.

Methodological Approach

Risk in farm production can be quantified by computing variance and/or standard deviation of the gross margins or net returns associated with enterprises included in the farm plan. Standard deviation is a common statistic used to interpret the magnitude of risk associated with farm enterprises.

To achieve objective 1, the extent of income variability for 22 farm enterprises was measured by calculating expected (mean) gross margins or net returns. The standard deviation and coefficient of variation were computed for each enterprise. The latter statistics were used as relative measures to compare variability between enterprises. Enterprises included the following 17 conventional enterprises: soybeans, tobacco, wheat, corn, cotton, sorghum, alfalfa hay, all other hay, tomatoes, snapbeans, dairy (60-cow unit), hogs farrow-to-finish (96-sow unit), beef cow/calf (30-cow herd), sweet corn, sweet potatoes, cabbage, and strawberries. Also, five EHPs enterprises were also included: Euonymus kiautschovicus (Euonymus), Juniperus horizontalis (Andorra Juniper), Forsythia intermedia (Forsythia), Acer rubrum (Red Maple), and Cornus florida (Dogwood). Initially, apples, peaches, okra, and cantaloupes were part of the study. However, due to either partial or complete lack of data, these enterprises were excluded. For the selected conventional enterprises, enterprise budget data for the year 1992 were used as the base year to generate data on yields, prices, and variable costs of production based on indices. Indices for yield and prices for conventional enterprises were formed using actual aggregate data on state-level yields and prices for Tennessee for the period 1975-92. Cost of production data for all enterprises were generated using Tennessee budget cost data and cost component indices of prices paid by farmers at the U.S. level. Actual data for a few enterprises such as sweet corn, sweet potatoes, cantaloupes, and strawberries were not available for Tennessee. Therefore, data from the neighboring state of North Carolina were used as proxies to form the indices of yield and prices for these enterprises.

Historical data series for the EHPs were essentially nonexistent. Therefore, budget information contained in Tennessee nursery stock budgets for 1989 were used to generate data for variable costs of production and gross returns for each of the five EHP enterprises. Variable costs of production were generated in the same manner as for the conventional enterprises. Yield was assumed to be constant over time given the nature of these perennial crops. The price received series for each of the EHP enterprises for the 1975-92 period was generated using the prices received for all crops index for Tennessee taking 1989 as base year. The expected (mean) gross margin, standard deviation, and coefficient of variation were calculated for each enterprise included in the study over a period of 18 years (1975-92) for Tennessee. These statistics were used to compare income variability and associated risk among the different enterprises.

To examine variability, two measures were calculated. First, historical data were used to calculate standard deviations that represent the total variability. For the second measure, the systematic component or trend was removed by a simple regression ordinary least squares technique using time as an independent variable. That is, the random component of the standard deviation was the variability component of interest in this study. It was estimated to measure the random variability or risk associated with each enterprise. The total and random variability indices (TVI and RVI) were computed based on the expected value (mean) and standard deviation. The mean value for the recent past four years (1989-92) was used to calculate variability indices. This approach was taken on the assumption that the expected value for the future can be better predicted by the most recent mean value. Therefore, an assumption was made that the random component of the standard deviation of the historical data over the 18 years or, in other words, the random variability coefficient, is an estimate of the expected (future) standard deviation with the systematic component removed.

If the TVI and RVI of any enterprise were similar in magnitude, then variations in yields, prices, and/or gross margins were mainly due to random factors. Furthermore, the coefficient of variation was computed to evaluate and compare the variability of the alternative enterprises were compared.

To achieve objective 2, consideration was given to risk-return tradeoffs at specified levels of income. Profit maximization is considered a major goal in farm planning and management. However, profit maximization is not the only objective for a rational producer. There are other factors that affect farmer decisions and actions. For example, cash flow and risk as measured by income variability are considered important. Generally, efforts are made to combine enterprises in such a way to get a more stable income over a long period. To reduce risk the farmer can opt for those enterprises that have less variability (are more stable) or select those enterprises that have higher variability (risk) but higher expected gains. Although all risk associated with agricultural production cannot be eliminated, a producer may limit risk by adopting alternative strategies such as diversification.

To study tradeoffs between risk and return two mathematical models were applied: (1) a general linear programming (LP) model to determine the optimum profit with given constraints and resource availabilities, and (2) a general form of the MOTAD model to study risk-return tradeoffs at specified level(s) of income with given constraints and resource availabilities.

Three hypothetical farm situations were constituted. The three farms were simply named large, medium, and small primarily because their main distinguishing characteristics were differences in land, labor, and capital endowments. The three hypothetical farm situations were analyzed using LP and MOTAD models.

Results

Descriptive Analysis of Variability

Yield and price variability statistics for selected enterprises for the period 1975-92 were estimated. Variability was estimated by the standard deviation and the coefficient of variation was also computed as a relative measure. Based on yield variability, the RVI for snapbean yield variability was the highest (28.68 percent) whereas dairy was the lowest (2.11 percent). Cotton, corn and wheat yields were relatively stable; soybeans, tobacco, sorghum, alfalfa hay, all other hay, dairy, beef cow/calf, and hog and pigs yields were more stable in Tennessee during the period 1975-92. Based on the TVI, snapbean yield variability was the highest at 28.71 percent and dairy the lowest at 4.98 percent. The TVI and RVI were of similar magnitude for tobacco, wheat, snapbeans, beef cow/calf, and hogs and pigs. This closeness indicated that yield variability in these enterprises was mainly due to the random component.

The RVI based on price variability ranged from a high of 20.04 percent for corn to a low of 5.08 percent for snapbeans. Other enterprises that had relatively high random variability were soybeans and sorghum. All other enterprises were relatively stable based on price variability. However, TVI and RVI were very close to each other for soybeans, wheat, corn, cotton, sorghum, all other hay, and hogs and pigs, indicating that price variability was mainly due to random events for all these enterprises in Tennessee during the period.

The random variability indices for gross margins ranged from a high of 176.34 percent for all other hay to a low of 9.98 percent for maple (an EHP enterprise). Based on these statistics, other relatively unstable enterprises were tobacco, tomatoes, sorghum, corn, cotton, soybeans, and snapbeans. On the other hand, euonymus, juniper, forsythia, dogwood, alfalfa hay, dairy, beef cow/calf, and farrow-to-finish hogs were relatively stable in Tennessee during the period. EHPs as a group tended to have the least variability in gross margins. This low variability was likely due in large part to the assumption of constant yields for EHPs. When TVI and RVI both were evaluated, TVI and RVI on gross margins were very close for maple, tobacco, wheat, snapbeans, juniper, forsythia, euonymus, dogwood, corn, cotton, sorghum, all other hay, tomatoes, farrow-to-finish hogs, sweet potatoes, and cabbage. This closeness indicated that gross margin variability for these enterprises was mainly due to the random component.

The General Linear Programming Solution

Large Farm

The optimal solution for the large farm included total gross margins of $315,655 with a standard deviation of $76,839 and a coefficient of variation (CV) of

24.3 percent. The standard deviation of gross margins was highest for the large farm compared to the other two farm sizes as expected. The enterprises included in the optimum solution included euonymus, tomatoes, snapbeans, farrow-to-finish hogs, sweet corn, and corn buying. Sensitivity or range analysis for the large farm showed that euonymus would remain in the solution at the same level (7 acres) as long as its current coefficient in the objective function ($6,078.75) was not increased by over $14,657 or decreased by $393.

Medium Farm

The optimal solution for the medium farm included a total gross margin of $187,853 with a standard deviation of $61,932 and a CV of 33 percent. The standard deviation of gross margins was lower than the large farm and higher than the small farm. However, the CV for the medium farm was higher than the large farm but lower than the small farm.

The enterprises included in the optimum solution included euonymus, alfalfa hay, tomatoes, snapbeans, farrow-to-finish hogs, corn buying, and alfalfa hay selling. Sensitivity or range analysis for the medium farm showed that euonymus would stay at the same level (4.5 acres) in the optimum solution as long as its current coefficient in the objective function ($6,078.75) is not increased by over $7,576 or decreased by $399.

Small Farm

The optimal solution for the small farm included a total gross margin of $43,329 with a standard deviation of $15,460 and a CV of 35.7 percent. The standard deviation turned out be the lowest among all farm categories as expected. However, the CV for the small farm turned out to be the highest among all farm categories.

The enterprises included in the optimum solution included euonymus, dogwood, alfalfa hay, tomatoes, snapbeans, farrow-to-finish hogs, strawberries, corn buying, and alfalfa hay selling. Sensitivity or range analysis for the small farm showed that euonymus would stay at the same level (1.45 acres) in the optimum solution as long as its current coefficient in the objective function ($6,078.75) not increased by $874 or decreased by $1,689. Similarly, dogwood would stay at the same level (0.2 acres) as long as its current coefficient in the objective function ($5602.46) is not increased by $1,984 or decreased by $1,429.

Differences in the pattern of enterprise mix were apparent when all three hypothetical farms situations were compared. For example, with the medium and small farms, greater emphasis was placed on more enterprises than on the large farm. Moreover, the results suggest that, depending on the level of resource availability, EHPs are showing some potential for inclusion in the farm plan. The presence of at least one EHP in all three farm situations suggests their potential for generating income in this income maximization model in which the risk-return tradeoff was ignored.

The MOTAD Solution

Large Farm

The results were obtained by varying income the level (λ) parametrically by an arbitrary equal decrement of $30,000 from the general LP total gross margin ($315,655). There were 11 basic solutions generated using the MOTAD model.

The enterprise mix changed substantially when income was lowered parametrically. As income level was lowered, more diversified enterprise mixes were observed. Tomatoes, snapbeans, and farrow-to-finish hogs generally declined in volume of production. Snapbeans disappeared from the solution at the $105,655 return level and the EHP, maple entered at 0.7 acres. Maple remained in the solution at the lowest income level of $15,655. Likewise, farrow-to-finish hogs also dropped to a near zero level at the $15,655 income level. Tobacco entered at 3 acres and remained in the solution as income levels were lowered to $105,655. Tobacco was not present in the LP maximization solution. Similarly, cotton that was not in the income maximization solution entered the plan at the $135,655 income level and stayed in subsequent plans through the lowest income level of $15,655. Similarly, corn, cabbage, strawberries, alfalfa hay and alfalfa hay selling activities that were not in the maximization solution entered the solution at reduced risk-income levels. These enterprises stayed in the solution at the lowest income level of $15,655.

Results show that one or two EHPs were generally included in the enterprise mix at most risk-return levels. At least one EHP (euonymus or maple) appeared in nine of the eleven plans for the large farm. Given the nature of the MOTAD model, these enterprises contributed to risk reduction along with other enterprises in the optimum solution. On the large farm, euonymus was in the enterprise mix for six of the alternative plans and maple for four plans. Detailed sensitivity or range analyses for the optimal farm plans were performed. Euonymus was not solution sensitive at higher income levels. However, when income was constrained it showed high sensitivity. When income was constrained further, euonymus disappeared from the solution. On the other hand, maple was extremely sensitive at higher income levels. For euonymus, the sensitivity range were \$574 to \$493 for Plan F, \$51 to \$13 for plan G, and \$31 to \$43 for Plan H. For maple, the sensitivity range was \$57 to \$ 44 at an income level of \$105,655. However, sensitivity to the solution declined as income was further constrained.

Medium Farm

The results were obtained by varying income level (λ) parametrically by an arbitrary equal decrement of \$18,000 from the general LP total gross margin (\$187,853). There were 11 basic solutions generated using the MOTAD model in the same manner as for the large farm.

As with the large farm, the enterprise mix changed substantially when the income level was lowered parametrically and more diversified enterprise mixes emerged. Alfalfa hay, snapbeans, and farrow-to-finish hogs generally declined in volume of production. Euonymus remained in the solution down to an income level of $79,853 after which it did not appear. However, at the $61,853 level, maple entered the solution (2.6 acres). Maple remained in the solution through the lowest income level of $7,853. Similarly, tomatoes dropped out at $115,853 return level but reentered the optimum enterprise mix at the $61,853 return level and remained in the solution at a very low level down through the lowest income level of $7,853. Tobacco and cotton were not present in the initial LP maximization solution. However, both activities entered the plans at income levels of $115,853 and $61,853, respectively. Tobacco disappeared when income was lowered below $115,853 and then reappeared at the $61,853 income level. However, cotton stayed in the solution down through the lowest return level of $7,853. Sweet corn, sweet potatoes, cabbage, and strawberries were not present in the maximization solution. These enterprises entered various farm plans at lower income levels. Except for sweet potatoes, the other three enterprises stayed in the solutions through the lowest income level of $7,853. Sweet potatoes disappeared from the optimum solution as the income level was constrained to an income level of $43,853.

As with the large farm, euonymus and maple were the only two EHPs that entered the optimal solutions. Euonymus was not solution sensitive at higher income levels. The sensitivity range for Plan F was $253 to $318 and $44 to $318. However, as income was constrained further it began to show extreme sensitivity. Finally euonymus disappeared from the solution as income was lowered. On the other hand, maple was extremely sensitive at higher income levels. Solution sensitivity declined as income was further constrained and maple entered the optimum solutions. Maple was solution insensitive at the lowest income level $7,853 (sensitivity ranged between $181 to $2,284).

Small Farm

The results were obtained by varying the income level (λ) parametrically by an arbitrary equal decrement of $4,000 from the general LP total gross margin ($43,329). There were 11 basic solutions generated using the MOTAD model in the same manner as for the medium and large farms.

As with the other two hypothetical farms the enterprise mix changed substantially when the income level was parametrically lowered and a more diversified optimal enterprise mix emerged. Euonymus, dogwood, alfalfa hay, tomatoes, snapbeans, farrow-to-finish hogs, strawberries, corn buying and alfalfa hay selling activities were present in the maximizing solution. Tomatoes after disappearing at the income level of $15,329 came back in the solution at an extremely low acreage level at the income level of $7,329 and remained through the lowest income level. Maple, cotton, corn, cabbage, sweet potatoes, and sweet corn entered the solution at various income levels. Except sweet potatoes and corn the other four enterprises remained in the optimal solution at the lowest income level $3,329.

One or more EHPs appeared in each of the small farm plans. Three species of EHPs, euonymus, dogwood, and maple appeared in different solutions (dogwood appeared in maximization solution). Euonymus and dogwood both were not solution sensitive in the maximization solution. However, at constrained income levels, euonymus was more solution sensitive on the upper bound than on the lower bound. When income was constrained further, euonymus was extremely sensitive. Euonymus disappeared from the optimal solution when income was further constrained at the level of $11,329. On the other hand, maple was extremely sensitive at higher income levels. However, solution sensitivity increased as income was further constrained. When income was further constrained, maple was more sensitive on the upper bound than on the lower bound. However, at the lowest income level of $3,329, maple was solution insensitive.

Conclusions and Implications

Based on the results of the analysis of yield variability of the selected traditional commodities, state-level total yield variability (systematic and random) is less in general for soybeans, tobacco, sorghum, alfalfa hay, all other hay, dairy, beef cow/calf, and hogs and pigs as compared to snapbeans, cotton, and corn. However, random yield variability, taken alone, is quite high for tobacco, wheat, snapbeans, beef cow/calf, and hogs and pigs. Based on the historical price data from 1975 to 1992, state-level prices are highly variable for corn as compared to other traditional enterprises. However, random price variability, taken alone, is high for soybeans, wheat, corn, cotton, sorghum, all other hay, and hogs and pigs. Similarly, gross margin variability is high for all other hay. Low gross margin variability for all of the EHPs (lowest for maple) results in the large part from the assumption of constant yields and highly aggregated price indices. Other enterprises such as tobacco, tomatoes, sorghum, corn, cotton, soybeans, and snapbeans show instability in gross margins. In particular, random variability component of gross margins is high for maple, tobacco, wheat, snapbeans, juniper, forsythia, euonymus, dogwood, corn, cotton, sorghum, all other hay, tomatoes, farrow-to-finish hogs, sweet potatoes, and cabbage.

The general LP solutions suggest that the coefficient of variation for gross margins increases as farm resource endowments decrease. Therefore, one might conclude that variability of gross margins as a proportion of the mean tends to decline as the farming unit gets larger. That may indeed be a reasonable conclusion. However, the results from this study cannot be used to support such a conclusion because of the highly aggregated data sources used as proxies for farm-level yield, price, and cost variability.

As expected, the enterprise mix likely varies greatly across different resource situations. Furthermore, in this study, farm plans tended to be more diversified in the small and medium farm situations as compared to the large farm situation. Nevertheless, the results cannot be used to suggest any relationship between diversification intensity and farm size because of the aggregated data and the underlying characteristics of the linear programming algorithm.

The results from this study show in general that production diversification can be an effective strategy for managing risk associated with variability in year-to-year farm returns. Moreover, some EHPs appear to have potential as profitable, risk-reducing alternative enterprises with traditional enterprises on farms of different resources endowments.

The MOTAD analysis generated risk efficient farm plans for three different hypothetical resource situations (farms). It was observed that risk is reduced substantially when some income is foregone through diversification. The risk efficient frontier (of farm plans) shows the most efficient tradeoffs between risk and return when some income is foregone to reduce risk. At the lowest risk-return range on the risk-efficient frontier, the tradeoff from moving to a lower risk level is much more costly in terms of the proportion of income foregone compared to the proportional reduction in risk relative to the same income sacrifice at the high risk-return range. For example, with the large farm, moving from Plan A to B ($30,000 income reduction), a 9.5 percent income was sacrificed while the standard deviation (or risk) was reduced by 37.5 percent. However, moving from Plan J to K ($30,000 income reduction), 65.7 percent of income was sacrificed while reduction in risk stood also at 65.7 percent. Similar patterns were observed for medium and small farm resource situations. Therefore, a conclusion is that risk-return tradeoffs are subject to diminishing returns to income sacrifice as risks are reduced. Each individual decision maker, depending on his or her risk aversion, must decide the level of the risk premium (income sacrifice) that is appropriate.

Five species of EHPs were included in the study. Three EHPs enterprises euonymus, maple, and dogwood under the conditions and assumptions of this analysis appear to be potential alternatives for consideration by producers and change agents for inclusion in farm diversification plans. The optimal farm plans generated by MOTAD frequently included euonymus and maple. The two EHPs were present in several solutions for the three farm situations. Inclusion of EHPs with other traditional enterprises in farm plans for farms with different resource endowments can lead to reduced risk. Therefore, risk can be managed more effectively if these are combined with other traditional enterprises on farms of varying resource situations.

Dairy, beef cow/calf, tobacco, and cotton enterprises are important in Tennessee agriculture. However, both dairy and beef cow/calf were not in the maximization solution or in farm plans generated by MOTAD. Furthermore, tobacco and cotton entered only sporadically and at minimum levels. On the other hand, the farrow-to-finish hogs appeared in almost all optimum plans. This outcome looks unusual. This situation can be better understood if gross margins and resource requirements are revisited. Dairy is both a labor and capital (fixed and variable) intensive enterprise contributing considerably less to the objective function as compared to farrow-to-finish hogs. Land requirements for the dairy was also high. Similarly, beef cow/calf required large land and relatively high capital requirements coupled with a very low contribution to the objective function. The maximization model picks up a combination of enterprises that yields maximum returns subject to input requirements and resource availability. Similarly, MOTAD generates farm plans such that risk is minimized subject to input requirements and resource availability, and the income constraint. During the selection process, dairy and beef cow/calf might have been dropped by both the models based on overall selection criteria. Tobacco and cotton both had high random component variability on gross margins that tended to place them at a disadvantage in the MOTAD analysis. High resource requirements relative to their contribution to the objective function also likely placed them at a disadvantage to other optimal enterprises in the LP and MOTAD.

Limitations of the Study

A major limitation of this study was that time series data at the farm level were not available to study directly the variability aspects of farm income under various diversification schemes. Therefore, state-level average yield and price data were used to study variability or risk in farm production. At the aggregate level, variability tends to be relatively compressed. Therefore, the magnitude of variability in the results may be comparatively low as compared to actual farm-level situations. However, these results may, even with the compressed variability, be helpful by providing some guidelines for farm level enterprise selection for reducing income risks. The relative variability of the different enterprises should be meaningful to decision makers. The MOTAD modeling process as used here, coupled with actual farm-level data, should be most useful in addressing diversification issues and particularly in managing risk.

Another major limitation of this study was the lack of time series data on yields, prices, and costs of production for EHPs and a few conventional enterprises.

To overcome this problem, Tennessee budgetary data were used as a base coupled with yield and price series from various sources to generate the data series. Therefore, the results might not reflect actual conditions and may need to be modified for specific situations. Special consideration should be given while interpreting the results. Similarly, the constant yield assumption for EHPs must be kept in mind.

There is a wide range of EHPs that could have been included in the study. However, due to limited data, only five selected species of EHPs were included. The results possibly could have been strengthened if a greater number of EHPs were studied.

The gravity of the problem of data was such that a few potentially important conventional enterprises such as apples, peaches, okra, cantaloupes, and broilers were excluded from the study. Some of these or other omitted enterprises possibly could have improved the results.

Detailed descriptions of the production techniques including cultural practices and other needed technical and economic knowledge required for producing and marketing EHPs were beyond the scope of this study. The typical farmer would have to gain substantial knowledge about the nontraditional EHPs if he or she were interested in producing and marketing such products. This knowledge can be gained through a variety of sources including but not limited to printed material, full-term and short courses organized by public secondary schools, community colleges, and universities involved in ornamental horticulture.

Labor availability is another problem that may arise with the production of EHPs as farm enterprises. These enterprises are relatively labor intensive with extreme labor demand peaks during the production cycle. Labor requirements can be large at the time of planting, transplanting, harvesting, and marketing. Shortage of labor during peak periods may cause substantial economic losses to the producer. Timely availability of labor is highly critical in producing EHPs. Therefore, the producer should keep the labor situation in his or her mind when preparing farm plans in which EHPs are included with conventional enterprises. The sources of labor supply should specifically be considered.

Due to limited time and other resources, the general LP and MOTAD analyses were not specified in a manner that incorporated several aspects that are important in many modern farm businesses. Some examples include part-time farming, crop rotations, soil conservation practices, other sizes of livestock operations, poultry production, and government farm policy related to certain traditional enterprises.

Serious limitations arose from using budgetary data that were essentially size neutral. Input-output coefficients were the same regardless of farm size. This data characteristic, coupled with the compressed variability problems discussed above, tended to compress the likely realistic diversity that typically exists across farms of various sizes.

Future Research Needs

This research is a beginning point in studying EHPs as alternatives in farm plans with traditional farm enterprises. There are many aspects that could not be included in the study. Furthermore, there are many aspects related to EHPs that need further investigation and research. For example, this study can be extended by the following:

1) Other species of EHPs need to be introduced in the analysis.
2) The static and dynamic relationships between and among alternative combinations of enterprises such as EHPs-fruits-vegetables, EHPs-field crops, EHPs-crops-livestock or other combinations need further investigation.
3) More attention needs to be given to the resource endowment under various farm situations to improve the realism of the results. For example, besides three classes of land in this study, more classes of land such as two or more classes of rowcrop land and forest land needed to be considered.
4) The study can further be extended by considering water quality and soil conservation practices including but not limited to crop rotations, conservation tillage, and others.
5) Enterprises such as poultry, aqua culture, and others need to be included
6) Actual farm-level data are needed to enhance the usefulness of risk studies such as this. Better information on input-output relationships (production functions) on farms of various sizes including the variability in these

coefficients (farm yields) through time, coupled with actual historical farm-level price and cost information, would allow direct application of this type of analysis to decision making and planning. Or, without such historical data or only with limited objective data available, a more subjective approach based on the subjective perceptions of the decision maker about the future could be incorporated into this type of analysis.

Some closely related areas with a focus on EHPs for additional research consideration are as follows:

1) Market potentials of EHPs as farm enterprises (local, regional, state, national, and international).

2) The contribution of EHPs as crops to soil conservation practices and water quality

3) Demand for EHPs.

4) Economic and environmental impacts of EHPs (local, national, and global).

5) Analysis of whole-farm management systems for producing EHPs with other traditional farm enterprises.

REFERENCES

REFERENCES

Anaman, K.A., and W.G. Boggess. *"A Stochastic Dominance Analysis of Alternative Marketing Strategies for Mixed Crop Farms in North Florida".* So. J. Agr. Econ., 18(2)1986:257-279.

Anderson,J.R., J.L. Dillon, and B. Hardaker. *Agricultural Decision Analysis.* Iowa State University Press, Ames, Iowa. 1977. Ch. 1, 4-8.

__________________________. *Risk Analysis in Dryland Farming System.* FAO, Rome. 1992.

Anderson, K.B., and J.E. Ikerd. *"Whole Farm Risk-Rating Microcomputer Model".* So. J. Agr. Econ., 17:1(1985): 183-187.

Antle, J.M. *"Incorporating Risk in Production Analysis."* American Journal of Agricultural Economics 65 (1983):1099-1106.

Aylesworth, J.Q. *"Economic Factors Affecting Production Location and Time to Harvest Selected Woody Ornamental Plants in Illinois".* Unpublished Ph.D dissertation, Department of Agricultural Economics, University of Illinois, Urbana-Champaign, 1972.

Babb, E.M., and B.F. Long. *"The Role of Alternative Agricultural Enterprises in a Changing Agricultural Economy".* So. J. Agr. Econ., 19(1) July 1987:7-15.

Bacon, J.R. *"Economic Analysis of Four Apple Orchard Technologies under Three Marketing Alternatives"*-- Master Theses. Dept. of Ag. Econ. & Rur. Sociology, The Univ. of Tenn., Knoxville. December, 1985.

Badenhop, M.B., and J.W. Day. *Costs of Field-Grown Deciduous Shrubs (Forsythia) Differentiated by Size of Farm.* Knoxville: The University of Tennessee, Agricultural Experiment Station, Issue 137, Winter 1986.

__________________________. *Cost of Field-Grown Narrowleaf Evergreen Shrubs (Andorra Juniper) Differentiated by Size of Firm.* Knoxville: The university of Tennessee, Ag. Exp. Station, Issue 137, Winter, 1986.

__________________________. *Cost of Field-Grown Broadleaf Evergreen Shrubs ('Manhattan' Euonymus) differentiated by Size of Firm.* Knoxville: The university of Tennessee, Ag. Exp. Station, Issue 138, Winter, 1986.

___________., T.D. Phillips, and F.B. Perry, Jr. *Cost of Establishing and Operating Field Nurseries Differentiated by Size of Firm and Species of Plant in USDA Climatic Zones 7 and 8.* Auburn University: Southern Cooperative Series Bulletin 311. Department of Research Information, Alabama Agricultural Experiment Station. December, 1985.

____________., A.E. Einert., C. Price., and C.N. Smith. *Landscape Plants and Lawns in the South: Homeowners' Expenditure and Use Pattern.* Southern Coop. Series Bul.180. November, 1973.

______________________________________. *Non-Residential Landscape Uses in the South.* Southern Coop. Series, Bul.195. December,1975.

_____________., W.T. Witte, and T.E. Glasgow. *Production System and Costs for Producing Balled and Burlapped Trees of Dogwood Cultivars, Tennessee, 1984.* Agr. Exp. Sta., The Univ. of Tenn., Knoxville. May 1985.

Barry,P.J. *Risk Management in Agriculture ed.* Ames: Iowa State University Press, 1984.

________., J.A. Hopkins, and C.B. Baker. *Financial Management in Agriculture.* Interstate Printers & Publishers, Inc. Danville, Ill. 1988. Ch. 1, 2, 8, and 9.

Bauer, L.L. *"A Target MOTAD Analysis of Sweet Potato Marketing."* So. J. Agr. econ., 23(2)1991: 123-129.

Beattie, D.J. *Principles, Practices, and Comparative Costs of Overwintering Container-Grown Landscape Plants.* Penn. State Univ., So. Coop. Bul. 313. May, 1986.

Blank, S.C. *"Returns to Limited Crop Diversification".* Western Journal of Agricultural Economics. Vol.15, Number 2. December, 1990.

Boehlje, M.D., and L.D. Trede. *Risk Management in Agriculture.* J. Am. Soc. Farm managers & Rur. Appraisers 41: 20-27. 1977.

____________, and V.R. Eidman. *Farm Management.* New York: John Wiley and Sons. 1984.

Boisvert, R.N., and B. McCarl. *Agricultural Risk Modeling Using Mathematical Programming.* So. Coop. Series Bull. 356. July, 1990.

Boggess, W.G., K.A. Anaman, and G.D. Hanson. *"Importance, Causes, and Management Responses to Farm Risks: Evidence from Florida and Alabama".* So. J. Agr. Econ., 17(2) 1985:105-116.

Brink, L., and B. McCarl. "The Tradeoff Between Expected Return and Risk among Cornbelt Farmers." Am. J. Agr. Econ., 60(2) :259-268.

Brooker, J.R. *A Statistical Description of Agriculture in Tennessee: 1960-1990.*

____________ and S.C. Turner. *Trade Flows and Marketing Practices within the United States Nursery Industry.* The U. of Tenn., Ag. Experimental Station, Knoxville, Tennessee. October, 1990.

Carson, J.E. *Economic Value and Structure of the Tennessee Turfgrass Industry in 1991*-- Master Theses. Dept. of Ag. Econ., and Rur. Sociology, The Univ. of Tenn., Knoxville. May 1993.

Carter, H.O., and G.W. Dean. *"Income, Price, and Yield Variability for Principal California Crops and Cropping Systems."* Hilgardia 30(6):175-218

Castle, E.N., M.H. Becker, and A.G. Nelson. *Farm Business Management*. 3rd ed. New York: Macmillan Publishing Company, 1987.

Cheema, H.S. *"Developing Optimum Cropping Plans for a Typical Punjab Farm with Multiple objectives by using Compromise Programming."* Indian Journal of Agricultural Economics 43(2) 1988:P.163.

Collins, R.A., and E.E. Gbur. *"Risk Analysis for Proprietors with Limited Liability."* W. J. Agr. Econ 16(1) July 1991.

Conner, J.R., R.J. Freund, and M.R. Godwin. *"Risk Programming: An Aid in Planning Reservoir-Irrigation Systems".* Amer. J. Agr. Econ., 54 (2) 1972:249-254.

Coutu, A.J., and M.A. Cohen. *Exploratory Analysis of the Market Potential for Native Woody Ornamental.* Center for Rural Resource Development, North Carolina State University, Raleigh, Report No.12, August, 1978.

_________., and M.A. Vitelli. *Transfer Costs as They Influence Regional Competition.* Economics of Producing and Marketing Woody Landscape Plants Ed. Southern Coop. Series. 1981.

_________. and B.W. Ellertsen. *Farm Forestry Planning through Linear Programming.* Tenn. Valley Authority, Norris, TN. December, 1960.

Cox, L.J., J.R. Hollyer, and J. Leones. *"Landscape Services: An Urban Agricultural Sector".* J. of Agribusiness, vol. 10, No. 1 (1994), PP. 13-26.

Crafton, V., T.D. Phillips, and T. Blessington. *Costs of Producing Woody Ornamental*

Plants. Miss. Agr. Exp. Sta. July, 1982.

_________________________. *Programming Container-Grown Woody Ornamental Crops.* Miss. Agr. Exp. Sta. August, 1984.

Csaki, C. *Simulation and System Analysis in Agriculture*. New York: Elsivier Science Publishing Company, 1976.

Cuc, L.T. *"Homegrown Advantage"*. CERES, The FAO Review. No. 138, Vol. 24, FAO, Via Delle Tevme di Caracalla, 00100-Rome. 1992.

Curtis, C.E., G.H. Pfeiffer, L.L.Lutgen, and S.D. Frank. *"A Target MOTAD Approach to Marketing Strategy Selection for Soybeans."* N. Central J. Agr. Econ. 9(2) July 1987.195-206.

Debertin, D.L. *Agricultural Production Economics. McMillan Publishing Company, New York. 1984. Ch. 19-22.*

Dickerson, H.L., M.B. Badenhop, and J.W. Day. *Cost of Producing and Marketing Rooted Cuttings of Three Woody Ornamental Species in Tennessee, 1980.* Ag. Exp. Sta., The Univ. of Tenn., knoxville, TN. Bul. 624. April, 1983.

Dillon, J.L., and J.R. Anderson. *The Analysis of Response in Crop and Livestock Production.* Pergamon press, Oxford, U.K. 1990. Ch. 2-3, 5-7.

Dirr, M.A. *Manual of Woody Landscape Plants,* 4th ed. Champaign: Stipes Publishing Company, Illinois, 1990.

Doll, J.P., and Frank Orazem. *Production Economics--Theory with Applications, 2nd Ed.* John Wiley & Sons, New York. 1984. Ch. 8-9.

English, B.C., K.M. Hale, R.K. Roberts, and S.D. Mundy. *"Overview of Agriculture in Tennessee."* **A Statistical Description of Agriculture in Tennessee, 1960-1990,** Loewen, K.H., K.M. Hale, B.C. English, and Sean Coady (ed). Research Report #91-17, Agricultural Experiment Station, The University of Tennessee, Knoxville, August 1991.

Eidman, V. *"Planning an Integrated Approach to Farm Risk Management*. Journal of Agribusiness Management 3 (1985):11-16.

Ethridge, D.E., P. Zhang, B.E. Dahl, R.T. Ervin, and J. Rushemeza. *"Cattle Ranching Production and Marketing Strategies Under Combined Price and Weather Risks."* W. J. Agr. Econ 15(2) December 1990.

Falatoonzadeh, H., J.R. Conner, and R.D. Pope. *"Risk Management Strategies to Reduce Net Income Variability for Farmers".* So. J. Agr. Econ., 17(1) July 1985:117-130.

Ferguson, E.J., and J.E. Shamblin in *Risk and Uncertainty Ed.* American Institute of Industrial Engineers, Norcross, Georgia. 1975.

Fleisher, B. *Agricultural Risk Management*. Boulder: Lynne Rienner Publishers, 1990.

Food and Agriculture Organization. *CERES.* No: 6, Vol: 24. 1992. FAO, via delle Tivme di Caracalla, 00100-Rome.

Fleischer, G.A. *Risk and Uncertainty Ed.* American Institute of Industrial Engineers, Norcross, Georgia. 1975.

Fradrick, W.H., Jr. *100 Great Garden Plants.* Alfred A. knopf, New York, 1975.

Friedman, M., and L.J. Savage. *"The Utility Analysis of Choices Involving Risk".* J. Polit. Econ., 56(1948):279-304.

Furuta, T. *Environmental Plant Production and Marketing.* Cox Publishing Co. Arcadia, CA, USA. 1976.

Gardner, B. *Economics of Agricultural Policies*. New York: Macmillan Publishing Company, 1987.

Gardner, B.D. "Instability in U.S. Agriculture: Discussion,"*American Journal of agricultural Economics* 59 (1977):188-191.

Goble, W.E. and W.H. Brown. *Marketing Woody Ornamental: Practices and Trends of Nurseries in Tennessee in 1965.* Knoxville: The University of Tennessee, Agricultural Experiment Station, Bulletin 472, October 1970.

Goodman, W.R. *A comparison of Alternative Measures of Risk and Applications of Risk-Programming Models for Optimal Farm Planning of Burley Tobacco Farms in Tennessee.* Ph.D Dissertation. Dept. of Ag. Econ. & Rur. Sociology, The Univ. of Tenn. Knoxville. 1988.

Gunter, D.L. *Business Analysis of Container Nurseries in Florida, 1976.* Food and Resource Economics Department, University of Florida, Gainesville, Florida, Report No.83, November, 1977.

Hadar, J., W. Russell, and T. Seo. "Gains from Diversification," *Review of Economic Studies*, 44 (1977):363-368.

Hall, C.R., T.D. Phillips, and F.E. Stegelin. *Optimal Product Mix and Monthly Cash Flows for Container-Grown Landscape Plants in Climatic Zones 8 and 9.* Southern Coop. Series. Bull.365. October, 1991.

Halter,A.N., and Dean.G.W. *Decisions Under Uncertainty with Research Applications.* Cincinnati: South-Western Publishing. 1971.

Harsh,S.B., L.J. Connor, and G.D. Schwab. *"Managing the Farm Business."* Prentice-Hall Inc. Englewood Cliffs, N.J. 1981.

Harper,J.K., J.R. Williams, R.O. Burton, Jr., and K.W. Kelly. *"Effect of Risk Preferences on Incorporation of Double-Crop Soybeans into Traditional Rotations".* Review of Agricultural Economics 13(2), July 1991.

Hazell, P.B.R., and P. Scandizzo. "Farmers' Expectations, Risk Aversion, and Market Equilibrium under Risk," *American Journal of Agricultural Economics* 59 (1977):204-209.

______________. *"A Linear Alternative to Quadratic and Semivariance for Farm Planning Under Uncertainty."* Am. J. Agr. Econ.,53(1971):53-62.

______________., and R.D. Norton. *Mathematical Programming for Economic Analysis in Agriculture.* New York: McMillan Publishing Co. 1986.

Heady, E.O. "Diversification in Resource Allocation and Minimization of Income Variability," *Journal of Farm Economics* 34 (1952):482-496.

_________, E.W. Kehrberg, and E.H.Jebe. *"Economic Instability and Choices Involving Income and Risk in Primary or Crop production."* Ag. Experiment Station, Iowa State College, Ames, Iowa. Research Bulletin 404. January, 1954.

Hilton, R.J. *Agrologist*. Vol. 7/2 Spring 1978. Agricultural Institute of Canada.
Johnson, S. "The Theory of Combination of Enterprise of Individual Farms," *Journal of Farm Economics* 15 (1933):656-667.

Horticultural Research Institute, Inc. *Scope of Nursery Industry, Research Summary,* 833 Southern Building, Washington, D.C. 1968.

Hubbard, E.E., J.C. Purcell, and G.L. Wade. *An Economic Profile of the Commercial Landscape Industry in Georgia.* Georgia Ag. Exp. St. The Univ. of Georgia, Research Report 573, December, 1989.

Jensen Kim. *Agriculture Price Analysis*. Kinko's copy center, Knoxville, TN, Fall, 1993.

Jodha, N.S., and S.D. Purohit. *"Weather Instability and Crop Instability in the Dry Regions of Rajasthan."*
in Readings in Asian Farm Management Ed.

Johnson, D.C. *"The U.S. Green Industry's Economic Data Needs, Opportunities and Prospects: What are USDA's Economic Agencies Doing?* Presentation at the AAEA Annual Meetings. "Nursery/Greenhouse Symposium", Baltimore, MD., August, 1992.

____________. *Agriculture Outlook Conference, 1994.* USDA, ERS. 1993.

____________., and T.M. Johnson. *Financial Performance of U.S. Floriculture and Environmental Horticulture Farm Businesses, 1987-1991.* USDA, ERS. Stat. Bull. 862. 1993.

Johnson, J.E., J.W. Pease, L.A. Johnson, G.M. Hopper. *"Tree Crops for Marginal Farmland: Christmas Trees".* The University of Tennessee. Agricultural Extension Service. October, 1992.

Johnson, L.A., and K.M. Tilt. *Planning Budgets for Nursery Stock and Christmas Trees.* Agri. Exp. Station. The University of Tennessee, Knoxville. January, 1989.

Jolly, R.W. *"Risk Management in Agricultural Production,"* American Journal of Agricultural Economics 65 (1983):1107-1113.

Just, R.E. *"An Investigation of the Importance of Risk in Farmers' Decisions.* American Journal of Agricultural Economics 56 (1974):14-25.

Kaiser, E., and M.D. Boehlje. *"A Multi-period Risk Programming Model for Farm Planning."* N. Cen. J. Agr. Econ., 2(1980):

Kaplan, J.K. "A Blooming Industry-Poinsettias Leads the way in Sales". Agricultural Research. USDA-Agricultural Research Services, Washington, D.C. December, 1992: pp. 4-7

Kneen, H.H. *Comparison of Containerized and Field Grown Juniperus Chinensis 'Pfitzeriana' in USDA Climatic Zones 6 and 7.* MS Theses. Dep. Agr. Econ. and Rur, Soc., The Ohio State Univ., Columbus, Ohio, 1981.

Knight, F. *Risk, Uncertainty and Profit.* Boston: Houghton-Miffin Company, 1921.

Kohls, R.L. *Marketing of Agricultural Products.* The Macmillan Co., New York, 1988.

Kristjanson, P., and P.J. Malton. *Farmer Risk Management Strategies: The Case of The West African Semi-Arid Tropics.* Selected Paper presented at the AAEA Annual

Meetings: Aug.4-8, 1990, Vancouver, B.C.

Lee, T.H. *"Planning Multiple Crop Diversification for Agricultural Development"*-- Some suggestions for developing countries. Readings in Asian Farm Management ed.

Loehman, E., and C. Nelson. *"Optimal Risk Management, Risk Aversion, and Production Function Properties".* J. Ag. & Resource Econ. 17(2):219-231.

Loewen, K.H., et al. *"A Statistical Description of Agriculture in Tennessee 1960-1990."* Ag. Exp Station, Univ. of Tenn, Knoxville. 1991.

Love, R.O., and L.J. Robison. *"An Empirical Analysis of the Intertemporal Stability of Risk Preference".* So. J. Agr. Econ., 16(1) July 1984:159-168.

MacMinn, R.D. *"A General Diversification Theorem: A Note."* J. Finance 39(1984):541-50.

Made, G ("Ger"). van der. *New Challenges in World Horticultural Markets and Prospects for U.S. Green Industry Exports.* Presidential address, Agriculture Outlook Conference, 1994, Session 11, Washington DC.

Makeham, J.P., and L.R. Malcolm. *The Economics of Tropical Farm Management.* Cambridge University Press, Cambridge, U.K. 1986. ch. 8-10.

Mapp, H., M. Haden, O. Walker, and T. Persaud. *"Analysis of Risk Management Strategies for Agricultural Producers."* American Journal of Agricultural Economics 61 (1979):1071-1077.

Markowitz, H. *Portfolio Selection: Efficient Diversification of Investments.* New York: John Wiley and Sons, 1959.

____________. *"portfolio Selection".* J. of Finance 12(1952):77-91.

Maruyama, Y. *"A Truncated Maximin Approach to Farm Planning Under Uncertainty with Discrete Probability Distributions."* Am. J. Agr. Econ 54(2) May 1972.

Massey, Jr., McConnell. D.B., and Smith, C.N., McNiel, R., and Wright, R.D., Coutu, A.J., and Vitelli, V.A. *Economics of Producing & Marketing Woody Landscape Plants.* Muscle Shoals: National Fertilizer Development Center, Alabama, 1977.

Mathia, G.A. *Measurement of Price, Yield, and Sales Variability Indexes for Selected North Carolina Crops.* Research Report No. 36, North Carolina State University, Raleigh. 1975.

McNeil, B. *Agrologist*. Vol. 7(2) Spring, 1978. Agricultural Institute of Canada.

Misra, S.K., and S.R. Spurlock. *"Incorporating the Impacts of Uncertain Fieldwork Time on Whole-Farm Risk-Return Levels: A Target MOTAD Approach."* Southern Journal of Agricultural Economics.Vol. 23, Number 2. December, 1991.

Mundy, S.D., W.R. Goodman, and S.G. Isaacs. *"The Incorporation of Risk Into the Farm Income and Alternative Enterprise Problem for Burley Tobacco Producers".* Tobacco Science. 33 (1989):20-25.

North Carolina Dep. of Agriculture. *Agriculture Statistics*--various issues

Officer, R.R., and A.N. Halter. *"Utility Analysis in Practical Setting".* Amer. J. Agr. Econ., 50(1968):257-277.

Pant, S.P., A.S. Baghel, and K.D. Kukreti. *"Production Patterns for Income Stability in the Dry Farming Areas of Madhya Pradesh".* Indian Journal of Agricultural Economics: Vol 27 (4) pp:136-142. 1972.

Patil, T.Y., B.J. Hinge, and K.D. Rajmane. *"Economic Problems of Horticultural Plantations in Maharashter".* Indian Journal of Agricultural Economics. Vol: 24 (4) pp: 249-255.

Patrick, G.F. *Risk and Variability in Indiana Agriculture.* Station Bull. No. 234, Agr. Exp. St., Purdue Univ, West Lafayette, Indiana. July, 1979.

___________. *Managing Risk in Agriculture.* NCR, Ext. Publication No.406, Purdue Univ., West Lafayette, Indiana. 1992.

Patrick, G.R., P.N. Wilson, P.J. Barry, W.G. Boggess, and D.L. Young. *"Risk Perception and Management Responses: Producer-Generated Hypotheses for Risk Modeling".* So. J. Agr. Econ., 17(2) 1985: 231-238.

Perry, F.B.Jr., T.D. Phillips, L.E. Wilson, and J.L. Adrian. *Establishing and Operation of 20-and 40-Acre Container Nurseries in Climatic Zone 9.* Southern Coop. Series. Bull.341. April, 1990.

___________________________, R.D. Taylor, E.M. Smith,and M.B. Badenhop. *Cost of Establishing and Operating Field Nurseries Differentiated by Size of Firm and Species of Plants in USDA Climatic Zones 7 and 8.* Southern Coop. Series. Bull.327. September, 1987.

Phillips, L.E. *Urban Trees.* New York: McGraw-Hill, Inc. 1993.

Plath, J.C., and Harry Matthews. *"Inventory of Non-traditional Agricultural Commodity Activities in the Southern Region"*. Southern Rural Development Center, Mississippi State, MS 39762. December 1990.

Puhazhenhi, V. *"Risk Management in Different Farm Situations: An Application of Game Theory."* Indian Journal of Agricultural Economics 42(2) 1987: P.173.

Purcell, D.L., S.C. Turner, J. Houston, and C. Hall. *"A Portfolio Approach to Landscape Plant Production and Marketing"*. J. Agr. and Applied Econ. 25(2), December, 1993: 13-26.

Raleigh, S.M.Jr., and R.C. Smith. *Marketing Nursery Products.* Agr. Exp. St., Univ. of Delaware. Bul.352. January, 1965.

______________________________.*Consumers Purchases of Ornamentals.* Agr. Exp. St., Delaware. Bul.354. May, 1965.

Robison, L.J., and P.J. Barry. *The Competitive Firms' Response to Risk.* New York: McMillan Publishing Co. 1987.

Rousmarret, J.A., J.M. Boussard, and I.J. Singh. *Risk, Uncertainty, and Agricultural Development.*

Salvatore, D. *Managerial Economics.* McGraw-Hill Inc. New York, 1989.

Sandmo, A. *"On the Theory of the Competitive Firm Under Price Uncertainty".* Amer. Econ. Rev. 61(1971):65-73.

Savage, L.J. *The Theory of Statistical Decisions.* J. Amer. Stat. Association, 46(1951):55-67.

Schaefer, P.R. *American Journal of Alternative Agriculture.* No: 3 & 4, Vol: 4. 1989. Greenbelt, Maryland

Schuh, G.E., and S. Barghouti. *"Agricultural Diversification in Asia".* Journal of Finance & Development. June, 1988.

Schurle, B.W. *An Analysis of the Return-Risk Tradeoffs Associated with Tomatoes Production in Northwestern Ohio.* Unpublished Ph.D Dissertation. The Ohio State Univ. 1977.

__________., and Erven. *"Sensitivity of Efficient Frontiers Developed for Farm Enterprise Choice Decisions".* Am. J. Agr. Econ.,61 (1979), pp. 506-511.

Sharma, A.C., and B.R. Garg. *"An Evaluation of Watershed and Area Development Project in Punjab, India."* Indian Journal of Agricultural Economics. 33(4). 1978.

Singh, I.J. *"A Feasibility Study of Crop Insurance in Uttar Pradesh".* Indian Journal of Agricultural Economics. Vol: 27 (2) pp: 51-55. 1972

Smith, C.N. *"Regional Advantages in Producing and Marketing Woody Ornamentals,"* SAW 80-19 (Revised), Univ. of Florida, Gainesville, Florida, 1981.

Sonka, S.T., and G.F. Patrick. *Risk Management and Decision Making in Agricultural Firms.* In P.J. Barry Ed. *Risk Management in Agriculture.* Ames: Iowa State University Press. Ch.8.97-101. 1984.

Southern Cooperative Series. *Marketing Woody Ornamental. "Practices and Trends of Nurseries in the South."* Bul.143. April, 1969.

__________________________. *Governmental Landscaping Regulations in Seven Southern States.* Bull. 194. April, 1975.

Stanton, B.F., J.E. Jinkins, M.C. Ahearn, and G.D. Hanson. *"Perspective on Farm Size and Structure Provided by Value-Added Measures".* The J. Agr. Econ. Res., Vol. 44, No. 2. USDA, ERS, Washington DC.

Strickland, R.P., C. Johnson, and R.P. Williams. *"Ranking of States and Commodities by Cash Receipts 1991."* USDA, Washington, D.C. 1992.

Sturrock, F. *Farm Accounting and Management.* Pitman Books Limited, Long Acre, London WC2. 1982. Ch.20.

Tadros, M.E., G.L. Casler. *"A Game Theoretical Model for Farm Planning Under Uncertainty".* Amer. J. Agr. Econ., 51(1969)1164-1167.

Tennessee Valley Authority. *Economics of Producing and Marketing Woody Landscape Plants.* Bull. Y-149. 1979.

The American Horticultural Society, Mount Vernon, Virginia. *Fundamentals of Gardening.* 1982.

Thomas, W., L. Blakeslee, L. Rogers, and N. Whittlesey. *"Separable Programming for Considering Risk in Farm Planning".* Amer. J. Agr. Econ., 54(2)1972:260-266.

Tauer, L.W. *"Target MOTAD."* Am. J. Agr. Econ., 65(1983):606-610.

Tennessee Dept. of Agriculture. "*Tennessee Farm Facts.*" Various Issues.

Tennessee Dept. of Agriculture. *"Tennessee Agriculture."* Various Issues.

The University of Tennessee, Ag. Exp. Sta., Knoxville. *Farm Planning Manual*, 1992.

______________________________. *Planning Manual for Fruit and Vegetables*, 1992.

______________________________. *Planning Budgets for Nursery Stock and Christmas Trees*, 1989.

Tinter, G. *The Variate Difference Method.* Mimeograph No. 5, Cowles Commission for Research in Economics. Principia Press, Bloomington, Indiana. 1940.

Tilt, K. *Beginning in the Nursery Business.* The University of Tennessee, Dep. Orn. Hort. & Landscape Design, Knoxville. Undated.

Upton, M. *African Farm Management.* Cambridge University Press, Cambridge, U.K. 1987. Ch. 1-2, 5, 14, 16.

_______. *Farm Management in Africa.* Oxford University Press, London. U.K. 1973. Ch. 4-5, 14-16.

U.S.D.A. *Agricultural Statistics*. Washington DC, various issues.

______. *Rural Trends and Conditions,* Washington DC. 2, 4, 1991.

U.S.D.C. *Census of Agriculture.* Washington DC, various issues.

U.S.D.L. *Occupational Outlook Handbook: 1990-91 Ed.*, Bull. 2350, US Bureau of Labor Statistics, Washington DC, April, 1990.

Vickers, B.B. (ed). *"Tennessee Statistical Abstract."* College of Business Administration, Univ. of Tenn., Knoxville. Various Issues.

Wald, A. *Statistical Decision Theory.* New York: John Wiley & Sons, Inc. 1954.

Weimar, M.R., and A. Hallam. *"Risk, Diversification, and Vegetables as an Alternative Crop for Midwestern Agriculture."* N. Central J. Agr. Econ., 10:1(1988): 75-89.

Williams, D. *Selecting Shrubs for Landscaping in Tennessee.* The University of Tennessee, Ag. Exp.Station, Knoxville. Undated.

Witte, W.T. *"Woody Ornamental Research/Teaching Garden"*. Nursery Crop Research, OHLD Dept, The University of Tennessee, Knoxville. June, 1992.

Woolery, B.A. *A Methodological Inquiry into Agricultural Risk Management Emphasizing Crop and Cattle Feeding Systems within The Big Horn Basin, Wyoming--Master Thesis.* Univ. of Wyoming, May, 1979.

Woolery, B.A., and R.M. Adams. *A Tradeoff Between Return and Risk for Selected Bighorn Basin Crop and Cattle Feeding System.* RJ-149. Agr. Exp. Sta., Univ. of Wyoming, Laramie. February, 1980.

________________________. *Cattle Feeding and Cash Crops: A Comparison of Risk and Returns.* B-759. Agr. Exp. Sta., Univ. of Wyoming, Laramie. September, 1981.

Yahya, M.T., and R.M. Adams. *Some Measures of Price, Yield, and Revenue Variability for Wyoming Crops and Cropping Systems.* RJ-115. Agr. Exp. Sta., Univ. of Wyoming, Laramie. September, 1977.

Young, D.L. *Risk Concepts and Measures for Decision Analysis.* In P.J. Barry (Ed.) *Risk Management in Agriculture.* Ames: Iowa State University Press.P.31. 1984.

Young, R.P., and P.J. Barry. *"Holding Financial Assets as a Risk Response: A Portfolio Analysis of Illinois Grain Farms".* N. Cen. J. Agr. Econ., (:1(1987):77-84.

Zink, R.A. *Economics of Alternative Enterprise Combination: Torrington-Wheatland Area, Wyoming.* Unpublished M.S. Theses. Univ. of Wyoming.

________., and L.J. Held. *Optimum Enterprise Combination and Risk-Return Tradeoffs for Irrigated Farms: Torrington-Wheatland Area.* RJ-168. Agr. Exp. Sta., Univ. of Wyoming, Laramie. September, 1981.

________________________. *Enterprise Combination for Irrigated Farms in Torrington-Wheatland Area: Income and Risk.* B-771. Agr. Exp. Sta., Univ. of Wyoming, Laramie. January, 1982.

________________________. *"Farm Enterprise Choice: Risk-Return Tradeoffs for Cash-Crop vs Crop-Livestock System."* N. Cen. J. Agr. Econ., 4(1982):11-20.

Zimet, D.J., and T.H. Spreen. *"A Target MOTAD Analysis of a Crop and Livestock Farm in Jefferson County, Florida".* So. J. Agr. Econ., 18(2) December 1986: 175-185.

APPENDICES

APPENDIX TABLES

Appendix Table 1. Production by Selected Enterprises, Tennessee, 1983-1987 and 1988-1992: Mean production value, and Percentage change

Crop	Mean acreage		Rank		Percentage change	Mean Production Value		Rank		Percentage change
	1988-92	1983-87	1988-92	1983-87	1988-92 as percent of 1983-87	1988-92	1983-87	1988-92	1983-87	1988-92 as percent of 1983-87
	--1000 acres--				Percent	--1000 dollars--				Percent
Soybeans	1200	1638	2	1	-26.73	198019	220430	2	1	-10.16
Tobacco	56.3	61.66	8	8	-8.69	198141	190274	1	2	+4.13
Wheat	500	540	5	4	-7.40	52795	44635	5	5	+18.28
Corn	662	818	3	3	-19.07	1599	1897.6	9	9	-15.73
Cotton	554	336	4	5	+64.88	168394	107188	3	3	+57.14
Sorghum	58	224	7	6	-74.1	68.6	78.8	12	12	-12.94
Alfalfa hay	84	116	6	7	-27.58	24712	27766	6	6	-11
All other hay	1528	1358	1	2	+12.52	137011	105222	4	4	+30.21
Snapbeans	5.60	5.46	9	9	+2.56	1920.6	1999	8	8	-3.92
Tomatoes	4.56	4.28	10	10	+6.54	17156	16285	7	7	+5.35
Apples	1.74	1.52	11	11	+14.47	1747.6	1569.6	10	10	+11.34
Peaches	1.62	1.32	12	12	+22.72	1342.8	904.6	11	11	+48.44

Source: Tennessee Agriculture, various issues

Appendix Table 2. Actual yield data for selected farm enterprises: Tennessee, 1975-92

Enterprise	Soybeans	Tobacco	Wheat	Corn	Cotton	Sorghum	Alfalfa hay	All other hay	Tomatoes	Snap-beans	Dairy	Cow/Calf	Hogs/pigs	Sweet Corn	Sweet Potatoes	Cabbage	Straw-berries
Year	bu/acre	lbs/ acre	bu/acre	bu/acre	lbs/ acre	bu/acre	ton/ acre	ton/ acre	lugs/acre	bu/acre	cwt/60 unit	cwt/30 unit	cwt/ head	cwt/acre	cwt/acre	cwt/acre	cwt/acre
1975	25	2038	31	60	339	48	2.35	1.45	675	57.3	5668.2	231.8	1.88	54	130	147	23
1976	22.5	2040	37	79	295	52	2.4	1.45	725	55.9	5988.6	224.2	1.86	65	130	156	21
1977	23.5	1997	36	68	407	51	2.45	1.4	550	152.8	6291.6	203.9	1.80	60	130	138	20
1978	23.5	2126	35	69	490	51	2.4	1.45	525	148.1	5951.4	198.8	1.90	53	130	147	15
1979	27	1745	34	85	357	51	2.5	1.55	500	121.9	5946.0	201.6	2.11	49	120	162	25
1980	18	1728	38	46	349	50	2.4	1.4	550	152.8	6283.2	195.6	2.04	56	115	145	29
1981	25	2053	44	84	496	62	2.5	1.55	600	170.2	6448.8	181.2	2.11	65	120	146	28
1982	26.5	2156	36	90	638	65	3	1.5	625	173.5	6461.4	185.3	2.18	70	135	150	26
1983	16	1621	33	48	337	53	2.5	1.4	500	121.9	6279.0	197.8	2.06	60	120	142	40
1984	26	2062	40	95	498	80	3	1.65	1000	143.4	6207.6	216.4	2.15	60	135	150	36
1985	31	2065	32	98	600	80	3.8	1.8	1400	150.8	6385.8	223.6	2.22	65	150	160	32
1986	25	1682	33	74	567	65	3	1.4	1050	95.8	6597.0	215.0	2.18	54	150	155	35
1987	23	1766	40	91	700	70	2.7	1.6	900	134.0	6687.6	215.7	1.98	70	130	160	38
1988	26	1920	50	73	529	65	2.1	1.4	900	93.8	6740.4	205.3	2.07	60	130	180	60
1989	24	1754	42	107	497	75	3.1	2	700	117.3	6711.6	201.1	2.22	65	120	160	42
1990	27	2094	36	86	461	77	3.6	2.1	1000	119.3	6725.4	200.5	2.08	65	145	170	60
1991	30	1969	24	86	552	65	3.5	1.9	900	111.2	6757.8	208.0	2.09	60	135	160	55
1992	35	2030	48	124	651	80	3.6	2.1	800	119.3	6806.4	206.5	2.15	60	120	150	55
Mean 75-92	25.2	1935.9	37.2	81.3	486.8	63.3	2.8	1.6	772.2	124.4	6385.4	206.2	2.1	60.6	130.3	154.3	35.6
Mean 89-92	29.0	1961.8	37.5	100.8	540.3	74.3	3.5	2.0	850.0	116.7	6750.3	204.0	2.1	62.5	130.0	160.0	53.0

Source: Tennessee Agriculture, various issues and North Carolina Agriculture Statistics, various issues

Appendix Table 3. Actual price data for selected farm enterprises: Tennessee, 1975-92

Enterprise	Soybeans	Tobacco	Wheat	Corn	Cotton	Sorghum	Alfalfa hay	All other hay	Tomatoes	Snap-beans	Dairy	Cow/Calf	Hogs/pigs	Sweet Corn	Sweet Potatoes	Cabbage	Straw-berries
Year	dollar/bu	dollar/ lb	dollar/bu	dollar/bu	dollar/bu	dollar/bu	dollar/ton	dollar/ton	dollar/lug	dollar/bu	dollar/cwt	dollar/cwt	dollar/cwt	dollar/cwt	dollar/cwt	dollar/cwt	dollar/cwt
1975	5.75	1.03	2.87	2.60	0.63	2.30	49.00	55.00	4.78	2.65	8.75	25.60	45.90	8.38	7.25	4.43	42.40
1976	6.00	1.17	3.05	2.50	0.64	2.22	49.55	41.85	2.62	2.87	9.70	32.05	42.90	7.13	5.40	4.47	46.00
1977	5.68	1.19	2.25	2.10	0.49	1.66	51.54	43.90	5.32	2.48	9.75	32.65	38.90	7.15	9.20	4.67	44.00
1978	6.73	1.26	2.90	2.40	0.61	2.24	62.53	49.95	5.26	2.61	10.60	49.40	46.70	9.00	9.57	7.76	35.00
1979	6.35	1.38	3.80	2.85	0.63	2.34	65.00	48.50	4.64	2.73	12.20	71.90	41.70	10.00	7.60	4.85	43.00
1980	7.88	1.61	3.80	3.49	0.78	2.97	67.00	42.50	4.24	3.15	13.30	61.20	38.20	9.30	13.40	8.25	41.60
1981	6.06	1.78	3.50	2.70	0.55	2.21	67.00	46.00	4.70	3.15	13.90	51.65	43.80	10.30	14.00	4.81	41.00
1982	5.57	1.72	3.00	2.65	0.58	1.90	66.00	43.50	4.62	3.04	13.60	49.65	51.40	9.80	6.50	5.32	45.00
1983	7.96	1.80	3.30	3.65	0.69	2.97	70.50	46.00	4.00	2.99	13.60	50.65	46.70	10.20	15.70	9.00	34.00
1984	5.97	1.79	3.30	2.90	0.57	2.24	72.00	49.50	4.60	3.04	13.70	49.35	47.10	11.10	15.00	5.50	41.80
1985	5.08	1.57	3.00	2.30	0.54	1.88	72.00	49.00	3.80	3.03	13.50	50.50	43.20	11.20	7.50	6.00	40.00
1986	4.87	1.52	2.50	1.65	0.49	1.34	88.00	55.50	4.00	2.97	13.10	49.40	45.70	12.40	11.40	7.50	50.50
1987	5.61	1.55	2.60	1.95	0.63	1.55	98.00	45.50	4.60	2.91	13.40	62.40	50.40	9.60	10.00	8.00	50.00
1988	7.64	1.71	3.44	2.75	0.54	2.41	100.00	53.50	5.60	3.13	13.10	70.15	41.60	12.70	14.40	8.50	46.30
1989	5.99	1.73	3.65	2.50	0.63	2.32	88.00	45.00	5.00	3.58	13.80	73.35	39.90	15.80	18.70	8.00	54.00
1990	5.95	1.78	3.03	2.43	0.66	2.26	102.00	44.50	4.80	3.43	14.70	76.80	50.40	15.20	8.40	7.00	51.00
1991	5.73	1.83	2.85	2.50	0.54	2.35	92.00	47.00	4.20	3.58	12.70	79.35	46.80	14.50	10.00	9.50	58.10
1992	5.60	1.85	3.40	2.05	0.53	1.96	97.00	48.00	4.20	3.39	14.00	72.35	39.30	13.80	9.65	8.00	57.50
Mean 75-92	6.13	1.57	3.12	2.55	0.59	2.17	75.40	47.48	4.50	3.04	12.63	56.02	44.48	10.98	10.76	6.75	45.62
Mean 89-92	5.82	1.80	3.23	2.37	0.59	2.22	94.75	46.13	4.55	3.50	13.80	75.46	44.10	14.83	11.69	8.13	55.15

Source: Tennessee Agriculture, various issues and North Carolina Agriculture Statistics, various issues

Appendix Table 4. Indexed yield data for selected farm enterprises: Tennessee, 1975-92

Enterprise	Euonymus	Juniper	Forsythia	Maple	Dogwood	Soybeans	Tobacco	Wheat	Corn	Cotton	Sorghum	Alfalfa hay	All other hay	Tomatoes	Snap-beans	Dairy	Cow/Calf	Hogs/pigs	Sweet Corn	Sweet Potatoes	Cabbage	Straw-berries
Year	plants/acre	plants/acre	plants/acre	plants/acre	plants/acre	bu/acre	lbs/ acre	bu/acre	bu/acre	lbs/ acre	bu/acre	ton/ acre	ton/ acre	lugs/acre	bu/acre	cwt/60 unit	cwt/30 unit	cwt/head	cwt/acre	cwt/acre	cwt/acre	cwt/acre
1975	4052	3408	10800	2069	2707	21.4	2208.7	29.1	48.4	338.5	48.0	2.28	1.73	1181.3	72.1	9493.6	172.0	34.53	120.0	216.7	281.8	296.5
1976	4052	3408	10800	2069	2707	19.3	2210.8	34.7	63.7	294.5	52.0	2.33	1.73	1268.8	70.4	10030.3	166.3	34.10	144.4	216.7	299.0	270.7
1977	4052	3408	10800	2069	2707	20.1	2164.2	33.8	54.8	406.4	51.0	2.38	1.67	962.5	192.1	10537.8	151.3	33.07	133.3	216.7	264.5	257.8
1978	4052	3408	10800	2069	2707	20.1	2304.0	32.8	55.6	489.2	51.0	2.33	1.73	918.8	186.2	9968.0	147.4	34.91	117.7	216.7	281.8	193.4
1979	4052	3408	10800	2069	2707	23.1	1891.1	31.9	68.5	356.5	51.0	2.43	1.85	875.0	153.4	9958.9	149.5	38.73	108.9	200.0	310.5	322.3
1980	4052	3408	10800	2069	2707	15.4	1872.7	35.6	37.1	348.5	50.0	2.33	1.67	962.5	192.1	10523.7	151.3	37.48	124.4	191.7	277.9	373.8
1981	4052	3408	10800	2069	2707	21.4	2224.9	41.3	67.7	495.2	62.0	2.43	1.85	1050.0	214.0	10801.1	166.3	38.68	144.4	200.0	279.8	360.9
1982	4052	3408	10800	2069	2707	22.7	2336.6	33.8	72.6	637.0	65.0	2.92	1.79	1093.8	218.3	10822.2	172.0	40.13	155.5	225.0	287.5	335.2
1983	4052	3408	10800	2069	2707	13.7	1756.7	30.9	38.7	336.5	53.0	2.43	1.67	875.0	153.4	10516.7	146.7	37.83	133.3	200.0	272.2	515.6
1984	4052	3408	10800	2069	2707	22.3	2234.7	37.5	76.6	497.2	80.0	2.92	1.96	1750.0	180.3	10397.1	160.5	39.45	133.3	225.0	287.5	464.1
1985	4052	3408	10800	2069	2707	26.6	2237.9	30.0	79.0	599.1	80.0	3.69	2.14	2450.0	189.6	10695.5	165.9	40.70	144.4	250.0	306.7	412.5
1986	4052	3408	10800	2069	2707	21.4	1822.9	30.9	59.7	566.1	65.0	2.92	1.67	1837.5	120.5	11049.3	159.4	40.11	120.0	250.0	297.1	451.2
1987	4052	3408	10800	2069	2707	19.7	1913.9	37.5	73.4	698.9	70.0	2.63	1.90	1575.0	168.5	11201.0	160.0	36.42	155.5	216.7	306.7	489.9
1988	4052	3408	10800	2069	2707	22.3	2080.8	46.9	58.9	528.2	65.0	2.04	1.67	1575.0	118.0	11289.5	152.3	38.09	133.3	216.7	345.0	773.5
1989	4052	3408	10800	2069	2707	20.6	1900.9	39.4	86.3	496.2	75.0	3.01	2.38	1225.0	147.5	11241.2	149.2	40.83	144.4	200.0	306.7	541.4
1990	4052	3408	10800	2069	2707	23.1	2269.4	33.8	69.4	460.3	77.0	3.50	2.50	1750.0	150.0	11264.3	148.7	38.16	144.4	241.7	325.8	773.5
1991	4052	3408	10800	2069	2707	25.7	2133.9	22.5	69.4	551.2	65.0	3.40	2.26	1575.0	139.9	11318.6	154.3	38.48	133.3	225.0	306.7	709.0
1992	4052	3408	10800	2069	2707	30.0	2200.0	45.0	100.0	650.0	80.0	3.50	2.50	1400.0	150.0	11400.0	153.2	39.45	133.3	200.0	287.5	709.0
Mean 75-92	4052	3408	10800	2069	2707	21.6	2098.0	34.8	65.5	486.1	63.3	2.75	1.92	1351.4	156.5	10694.9	157.0	37.8	134.7	217.1	295.8	458.3
Mean 89-92	4052	3408	10800	2069	2707	24.9	2126.0	35.2	81.3	539.4	74.3	3.35	2.41	1487.5	146.8	11306.0	151.3	39.2	138.9	216.7	306.7	683.2

Appendix Table 5. Indexed price data for selected farm enterprises: Tennessee, 1975-92

Enterprise	Euonymus	Juniper	Forsythia	Maple	Dogwood	Soybeans	Tobacco	Wheat	Corn	Cotton	Sorghum	Alfalfa hay	All other hay	Tomatoes	Snap-beans	Dairy	Cow/Calf	Hogs/pigs	Sweet Corn	Sweet Potatoes	Cabbage	Straw-berries
Year	dollar/plant	dollar/plant	dollar/plant	dollar/plant	dollar/plant	dollar/bu	dollar/ lb	dollar/bu	dollar/bu	dollar/bu	dollar/bu	dollar/ton	dollar/ton	dollar/lug	dollar/bu	dollar/cwt	dollar/cwt	dollar/cwt	dollar/cwt	dollar/cwt	dollar/cwt	dollar/cwt
1975	4.01	5.49	1.53	18.32	12.21	6.16	0.98	2.53	2.92	0.69	2.35	50.52	68.75	6.69	5.47	7.50	25.36	52.30	6.83	8.26	4.70	26.07
1976	4.19	5.75	1.60	19.16	12.77	6.43	1.11	2.69	2.80	0.70	2.27	51.08	52.31	3.66	5.92	8.31	31.74	48.88	5.81	6.16	4.75	28.29
1977	4.61	6.32	1.75	21.05	14.04	6.09	1.13	1.99	2.36	0.54	1.69	53.13	54.88	7.44	5.12	8.36	32.34	44.32	5.83	10.49	4.96	27.06
1978	4.47	6.13	1.70	20.42	13.61	7.21	1.19	2.56	2.69	0.67	2.29	64.46	62.44	7.36	5.40	9.09	48.93	53.21	7.34	10.91	8.25	21.52
1979	4.93	6.76	1.88	22.53	15.02	6.80	1.30	3.35	3.20	0.69	2.39	67.01	60.63	6.49	5.64	10.46	71.21	47.51	8.15	8.66	5.15	26.44
1980	5.30	7.26	2.02	24.21	16.14	8.44	1.52	3.35	3.92	0.86	3.03	69.07	53.13	5.93	6.51	11.40	60.62	43.53	7.58	15.27	8.77	25.58
1981	5.53	7.58	2.11	25.26	16.84	6.49	1.68	3.09	3.03	0.60	2.26	69.07	57.50	6.57	6.51	11.91	51.16	49.91	8.40	15.96	5.11	25.21
1982	5.02	6.88	1.91	22.95	15.30	5.97	1.63	2.65	2.97	0.64	1.94	68.04	54.38	6.46	6.29	11.66	49.18	58.57	7.99	7.41	5.65	27.67
1983	5.53	7.58	2.11	25.26	16.84	8.53	1.70	2.91	4.10	0.76	3.03	72.68	57.50	5.60	6.17	11.66	50.17	53.21	8.32	17.90	9.56	20.91
1984	5.71	7.83	2.18	26.11	17.40	6.40	1.70	2.91	3.25	0.63	2.29	74.23	61.88	6.43	6.29	11.74	48.88	53.67	9.05	17.10	5.84	25.71
1985	4.97	6.82	1.89	22.74	15.16	5.44	1.49	2.65	2.58	0.59	1.92	74.23	61.25	5.32	6.26	11.57	50.02	49.22	9.13	8.55	6.38	24.60
1986	4.42	6.06	1.68	20.21	13.47	5.22	1.44	2.21	1.85	0.54	1.37	90.72	69.38	5.60	6.14	11.23	48.93	52.07	10.11	12.99	7.97	31.06
1987	4.38	6.00	1.67	20.00	13.33	6.01	1.47	2.29	2.19	0.69	1.58	101.03	56.88	6.43	6.01	11.49	61.80	57.43	7.83	11.40	8.50	30.75
1988	5.25	7.20	2.00	24.00	16.00	8.19	1.61	3.04	3.09	0.59	2.46	103.09	66.88	7.83	6.48	11.23	69.48	47.40	10.35	16.41	9.03	28.47
1989	5.25	7.20	2.00	24.00	16.00	6.42	1.64	3.22	2.80	0.69	2.37	90.72	56.25	6.99	7.40	11.83	72.65	45.46	12.88	21.32	8.50	33.21
1990	5.16	7.07	1.96	23.58	15.72	6.38	1.69	2.67	2.73	0.73	2.31	105.15	55.63	6.71	7.09	12.60	76.07	57.43	12.39	9.58	7.44	31.36
1991	5.11	7.01	1.95	23.37	15.58	6.14	1.74	2.51	2.80	0.59	2.40	94.85	58.75	5.88	7.40	10.89	78.59	53.33	12.39	9.58	7.44	31.36
1992	5.02	6.88	1.91	22.95	15.30	6.00	1.75	3.00	2.30	0.58	2.00	100.00	60.00	5.88	7.00	12.00	71.66	44.78	11.25	11.00	8.50	35.36
Mean 75-92	4.68	6.41	1.78	21.37	14.25	6.23	1.41	2.61	2.71	0.62	2.10	73.64	56.23	5.96	5.95	10.26	52.57	48.01	8.51	11.52	6.66	26.35
Mean 89-92	5.13	7.04	1.96	23.47	15.65	6.23	1.70	2.85	2.66	0.65	2.27	97.68	57.66	6.36	7.22	11.83	74.74	50.25	12.23	12.87	7.97	32.82

Appendix Table 6. Cost of production for selected farm enterprises: Tennessee, 1975-92

Enterprise	Euonymus	Juniper	Forsythia	Maple	Dogwood	Soybeans	Tobacco	Wheat	Corn	Cotton	Sorghum
Year	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre
1975	4707.0	5153.8	3081.9	4823.2	7135.4	56.0	1214.5	51.5	101.0	124.3	81.7
1976	5095.5	5532.0	3352.4	5261.8	7741.5	58.9	1300.1	49.5	97.3	127.6	83.5
1977	5393.8	5767.0	3560.0	5602.4	8238.7	59.2	1359.7	50.6	98.1	127.9	82.7
1978	5789.4	6202.0	3844.7	6020.0	8952.8	60.5	1438.9	52.1	100.1	130.5	83.6
1979	6459.7	7004.9	4327.9	6712.0	10163.5	65.1	1585.8	56.5	108.1	140.6	89.7
1980	7070.2	7747.9	4847.5	7434.3	11504.0	72.7	1730.4	65.8	125.6	159.3	101.5
1981	7701.1	8403.8	5367.4	8198.0	12791.7	80.0	1878.4	72.4	137.9	174.6	111.2
1982	8133.7	8842.1	5772.3	8787.4	13806.2	85.3	1976.4	75.4	143.7	185.3	117.8
1983	8308.1	8954.7	5922.0	9052.4	14129.8	88.1	2019.7	75.5	143.9	190.0	120.4
1984	8429.4	9115.1	5988.6	9186.2	14264.9	91.2	2056.1	78.6	149.5	196.6	124.5
1985	8416.2	8958.0	5890.8	9150.9	19629.7	90.8	2065.4	76.8	146.1	194.6	122.9
1986	8465.4	8756.6	5836.6	9185.1	13644.5	89.3	2088.4	73.7	140.2	190.1	119.8
1987	8645.3	8870.8	5821.0	9275.8	13480.6	89.3	2139.7	72.8	138.1	189.1	118.8
1988	8948.0	9304.1	5953.9	9517.4	13763.1	92.9	2219.4	76.6	145.5	197.9	124.0
1989	9568.0	9850.7	6283.7	10111.1	14419.9	99.2	2385.4	81.4	154.8	210.7	132.5
1990	9837.1	10146.3	6414.3	10347.8	14685.1	100.3	2445.2	81.0	153.8	212.3	133.0
1991	10214.7	10416.9	6636.1	10769.4	15111.5	105.2	2552.2	83.3	158.9	222.2	139.4
1992	9944.2	10204.3	6512.5	10491.5	14929.1	100.8	2469.1	81.3	154.3	213.1	133.5
Mean 75-92	7840.37	8290.61	5300.77	8329.27	12688.45	82.48	1940.27	69.71	133.15	177.04	112.24
Mean 89-92	9891.01	10154.56	6461.67	10429.95	14786.39	101.36	2462.97	81.75	155.44	214.61	134.58

Enterprise	Alfalfa hay	All other hay	Tomatoes	Snap-beans	Dairy	Cow/Calf	Hogs/pigs	Sweet Corn	Sweet Potatoes	Cabbage	Straw-berries
Year	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/unit	dollar/unit	dollar/sow	dollar/acre	dollar/acre	dollar/acre	dollar/acre
1975	126.1	71.7	3481.5	216.3	74039.7	3578.8	691.2	508.5	639.0	748.9	4264.2
1976	127.3	72.0	3690.2	226.9	77179.3	3767.2	719.2	534.7	665.6	778.2	4553.4
1977	129.4	74.6	3834.5	228.5	76987.3	3741.0	717.1	546.9	700.6	817.3	4748.8
1978	133.3	77.8	4145.0	233.2	77889.5	3770.2	722.8	576.4	740.2	859.8	5083.3
1979	146.7	84.9	4726.0	249.7	87243.2	4178.4	810.7	641.1	808.6	934.2	5701.0
1980	169.4	96.7	5259.1	276.8	97666.2	4651.6	911.3	711.0	887.0	1022.2	6281.2
1981	185.7	105.9	5677.9	306.9	106189.7	5074.6	995.3	773.8	982.1	1137.1	6834.5
1982	193.7	111.3	5931.7	326.7	102669.3	5005.8	958.3	812.5	1027.0	1188.3	7177.5
1983	195.3	113.1	5947.9	336.7	109506.2	5329.9	1028.8	821.6	1042.1	1205.4	7264.6
1984	200.9	117.3	6052.6	349.0	110969.3	5403.1	1042.5	840.2	1074.3	1245.9	7400.1
1985	198.6	116.3	5891.6	348.1	100476.0	4985.9	935.9	826.0	1073.5	1246.5	7302.8
1986	191.3	113.8	5674.9	342.3	95933.1	4821.6	890.6	805.7	1064.3	1233.9	7178.6
1987	191.1	114.4	5734.3	342.0	93375.2	4710.8	860.6	811.1	1079.2	1249.2	7279.3
1988	200.1	120.4	6067.1	353.1	107404.8	5279.8	997.0	848.6	1112.0	1282.8	7596.4
1989	213.8	128.0	6393.4	378.9	114147.5	5632.2	1056.7	902.8	1198.7	1386.2	8081.0
1990	217.2	129.3	6589.8	382.8	111302.4	5522.9	1023.3	922.3	1219.1	1406.4	8298.2
1991	225.4	134.1	6704.0	399.5	110330.0	5562.0	1009.6	950.0	1252.5	1442.0	8526.0
1992	217.8	129.9	6613.6	384.3	107787.2	5394.8	987.5	926.7	1227.7	1415.7	8354.2
Mean 75-92	181.28	106.20	5467.50	315.63	97838.66	4800.59	908.78	764.44	988.53	1144.45	6773.61
Mean 89-92	218.53	130.32	6575.22	386.35	110891.78	5527.98	1019.24	925.43	1224.49	1412.58	8314.85

Appendix Table 7. Gross revenue for selected farm enterprises: Tennessee, 1975-92

Enterprise	Euonymus	Juniper	Forsythia	Maple	Dogwood	Soybeans	Tobacco	Wheat	Corn	Cotton	Sorghum
Year	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre
1975	16234.7	18726.1	16484.2	37895.4	33053.9	132.0	2154.3	73.6	141.1	235.1	112.7
1976	16981.1	19587.0	17242.1	39637.7	34573.6	124.0	2451.6	93.4	178.7	206.2	117.8
1977	18660.5	21524.2	18947.4	43557.9	37993.0	122.6	2445.0	67.0	129.2	219.6	86.4
1978	18100.7	20878.5	18378.9	42251.2	36853.2	145.2	2751.3	84.0	149.8	330.2	116.6
1979	19966.8	23030.9	20273.7	46606.9	40652.5	157.5	2464.2	106.9	219.2	247.2	121.8
1980	21459.6	24752.8	21789.5	50091.6	43691.9	130.3	2855.2	119.4	145.3	300.9	151.5
1981	22392.6	25829.1	22736.8	52269.5	45591.6	139.1	3741.9	127.4	205.2	298.7	139.8
1982	20340.0	23461.4	20652.6	47478.1	41412.4	135.6	3812.4	89.3	215.8	407.4	126.0
1983	22392.6	25829.1	22736.8	52269.5	45591.6	117.0	2989.5	90.1	158.5	254.2	160.6
1984	23139.1	26690.0	23494.7	54011.8	47111.3	142.5	3792.2	109.2	249.3	310.9	182.9
1985	20153.4	23246.1	20463.2	47042.5	41032.4	144.6	3329.3	79.4	203.9	354.1	153.5
1986	17914.1	20663.2	18189.5	41815.6	36473.3	111.8	2630.7	68.2	110.5	305.9	88.9
1987	17727.5	20448.0	18000.0	41380.0	36093.3	118.5	2811.0	86.0	160.6	485.5	110.7
1988	21273.0	24537.6	21600.0	49656.0	43312.0	182.4	3359.6	142.3	181.6	313.9	159.8
1989	21273.0	24537.6	21600.0	49656.0	43312.0	132.0	3115.9	126.8	242.0	344.7	177.6
1990	20899.8	24107.1	21221.1	48784.8	42552.1	147.5	3831.7	90.2	189.1	334.0	177.6
1991	20713.2	23891.9	21031.6	48349.3	42172.2	157.9	3706.0	56.6	194.5	327.6	155.9
1992	20340.0	23461.4	20652.6	47478.1	41412.4	180.0	3850.0	135.0	230.0	377.0	160.0
Mean 75-92	19997.86	23066.78	20305.26	46679.54	40715.81	140.03	3116.22	96.93	183.58	314.05	138.88
Mean 89-92	20806.49	23999.49	21126.32	48567.05	42362.18	154.36	3625.91	102.16	213.91	345.81	167.75

Enterprise	Alfalfa hay	All other hay	Tomatoes	Snap-beans	Dairy	Cow/Calf	Hogs/pigs	Sweet Corn	Sweet Potatoes	Cabbage	Straw-berries
Year	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/ unit	lar/30 cow h	dollar/sow	dollar/acre	dollar/acre	dollar/acre	dollar/acre
1975	115.4	118.7	7898.2	394.2	75926.0	4360.0	1805.7	819.6	1790.6	1326.2	7730.8
1976	119.2	90.3	4649.8	416.6	89308.4	5278.4	1667.0	839.4	1333.7	1420.1	7657.8
1977	126.6	91.5	7162.6	983.5	94090.2	4891.5	1466.0	777.0	2272.2	1312.4	6976.1
1978	150.4	107.8	6759.9	1005.0	99681.4	7212.6	1857.7	863.9	2363.6	2323.0	4161.9
1979	162.9	111.9	5679.2	865.5	117408.8	10649.8	1840.4	887.5	1732.6	1600.0	8521.9
1980	161.2	88.5	5708.5	1250.1	131262.7	9168.7	1631.5	943.2	2927.6	2436.1	9563.6
1981	167.9	106.1	6903.1	1392.7	138217.3	8506.3	1930.3	1212.6	3191.7	1430.1	9100.6
1982	198.5	97.1	7068.4	1373.0	135316.9	8456.0	2350.3	1242.4	1667.1	1623.6	9275.0
1983	176.7	95.8	4895.8	945.9	131940.1	7358.2	2013.2	1108.4	3579.3	2602.6	10781.2
1984	216.5	121.5	11260.4	1134.5	131197.4	7845.9	2117.2	1206.2	3847.2	1680.1	11929.1
1985	274.2	131.3	13022.9	1186.9	133080.9	8295.8	2003.4	1318.5	2137.3	1955.0	10147.0
1986	264.6	115.6	10281.3	739.5	133182.9	7801.6	2088.7	1212.7	3248.7	2367.4	14011.6
1987	265.2	108.3	10134.4	1013.5	140165.8	9889.0	2091.4	1217.1	2469.8	2606.7	15062.0
1988	210.5	111.5	12337.5	764.0	139708.5	10579.2	1805.5	1380.1	3556.5	3115.8	22022.2
1989	273.4	133.9	8567.7	1091.4	146502.1	10837.1	1856.2	1860.0	4263.2	2606.7	17979.2
1990	368.0	139.1	11750.0	1063.9	156101.7	11311.2	2191.7	1789.4	2314.0	2423.4	24257.7
1991	322.7	132.9	9253.1	1035.3	137852.7	12125.7	2051.8	1651.8	2154.4	2280.8	22236.2
1992	350.0	150.0	8225.0	1050.0	150150.0	10974.7	1766.6	1499.6	2200.0	2443.8	25070.2
Mean 75-92	217.99	113.99	8419.88	983.64	126727.43	8641.20	1918.59	1212.75	2613.86	2086.31	13137.99
Mean 89-92	328.55	138.97	9448.96	1060.15	147651.62	11312.19	1966.55	1700.21	2732.90	2438.66	22385.84

Appendix Table 8. Gross margin for selected farm enterprises: Tennessee, 1975-92

Enterprise	Euonymus	Juniper	Forsythia	Maple	Dogwood	Soybeans	Tobacco	Wheat	Corn	Cotton	Sorghum
Year	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/acre
1975	5763.8	3393.1	3350.6	6614.4	5181.3	76.0	939.8	22.1	40.2	110.8	30.9
1976	5942.8	3513.7	3472.4	6875.2	5363.9	65.1	1151.5	43.9	81.4	78.6	34.3
1977	6633.3	3939.3	3846.8	7591.1	5948.1	63.4	1085.4	16.4	31.2	91.7	3.7
1978	6155.6	3669.1	3633.6	7246.2	5577.4	84.7	1312.4	31.9	49.7	199.7	33.0
1979	6753.5	4006.5	3986.4	7979.0	6094.8	92.4	878.4	50.3	111.1	106.6	32.1
1980	7194.7	4251.2	4235.5	8531.5	6434.4	57.5	1124.8	53.7	19.6	141.6	50.0
1981	7345.8	4356.3	4342.4	8814.3	6556.6	59.2	1863.5	55.0	67.3	124.2	28.6
1982	6103.2	3654.8	3720.1	7738.1	5518.2	50.2	1836.0	13.9	72.1	222.1	8.2
1983	7042.3	4218.6	4203.7	8643.4	6289.0	28.8	969.7	14.6	14.7	64.2	40.2
1984	7354.8	4393.7	4376.5	8965.1	6565.8	51.4	1736.1	30.6	99.7	114.3	58.4
1985	5868.6	3572.0	3643.1	7578.3	4277.5	53.8	1263.9	2.6	57.9	159.5	30.6
1986	4724.3	2976.7	3088.2	6526.1	4563.1	22.5	542.3	-5.5	-29.7	115.8	-31.0
1987	4541.1	2894.3	3044.7	6420.8	4519.9	29.2	671.3	13.3	22.5	296.4	-8.1
1988	6162.5	3808.4	3911.5	8027.7	5906.6	89.6	1140.2	65.6	36.1	116.0	35.8
1989	5852.5	3671.7	3829.1	7909.0	5775.2	32.9	730.5	45.4	87.3	134.0	45.1
1990	5531.4	3490.2	3701.7	7687.4	5570.3	47.2	1386.5	9.2	35.3	121.7	44.6
1991	5249.2	3368.7	3598.9	7516.0	5409.0	52.7	1153.8	-26.7	35.7	105.3	16.5
1992	5197.9	3314.3	3535.0	7397.3	5293.6	79.3	1380.9	53.7	75.7	163.9	26.5
Mean 75-92	6078.75	3694.04	3751.12	7670.06	5602.46	57.55	1175.95	27.23	50.43	137.02	26.65
Mean 89-92	5457.74	3461.23	3666.16	7627.42	5512.03	53.00	1162.94	20.40	58.48	131.21	33.17

Enterprise	Alfalfa hay	All other hay	Tomatoes	Snap-beans	Dairy	Cow/Calf	Hogs/pigs	Sweet Corn	Sweet Potatoes	Cabbage	Straw-berries
Year	dollar/acre	dollar/acre	dollar/acre	dollar/acre	dollar/unit	dollar/unit	dollar/unit	dollar/acre	dollar/acre	dollar/acre	dollar/acre
1975	-10.7	47.0	4416.7	177.8	1886.2	781.2	106995.6	311.0	1151.5	577.3	866.6
1976	-8.1	18.3	959.6	189.7	12129.1	1511.2	90995.9	304.7	668.1	641.9	776.1
1977	-2.9	16.8	3328.1	755.0	17102.9	1150.5	71897.2	230.0	1571.6	495.1	556.8
1978	17.1	29.9	2614.9	771.8	21791.9	3442.4	108949.6	287.5	1623.4	1463.2	-230.4
1979	16.2	27.0	953.2	615.8	30165.7	6471.4	98848.1	246.4	924.1	665.9	705.2
1980	-8.3	-8.2	449.4	973.4	33596.5	4517.1	69145.1	232.2	2040.6	1413.9	820.6
1981	-17.8	0.2	1225.2	1085.8	32027.6	3431.7	89766.1	438.8	2209.6	293.0	566.5
1982	4.8	-14.2	1136.7	1046.4	32647.6	3450.1	133632.0	429.9	640.1	435.2	524.4
1983	-18.7	-17.2	-1052.0	609.2	22433.9	2028.3	94497.3	286.8	2537.2	1397.2	879.2
1984	15.6	4.2	5207.8	785.4	20228.1	2442.8	103174.6	366.1	2772.8	434.2	1132.2
1985	75.6	14.9	7131.3	838.8	32604.9	3309.9	102482.0	492.5	1063.8	708.5	711.1
1986	73.3	1.8	4606.4	397.2	37249.8	2979.9	115014.4	407.1	2184.4	1133.5	1708.3
1987	74.1	-6.1	4400.1	671.5	46790.6	5178.2	118156.3	406.0	1390.6	1357.5	1945.7
1988	10.4	-9.0	6270.4	410.9	32303.7	5299.4	77617.5	531.5	2444.5	1833.0	3606.4
1989	59.6	5.9	2174.3	712.6	32354.6	5204.9	76756.2	957.2	3064.5	1220.5	2474.6
1990	150.9	9.8	5160.2	681.1	44799.3	5788.3	112166.0	867.1	1094.9	1017.0	3989.9
1991	97.3	-1.2	2549.1	635.8	27522.7	6563.7	100047.9	701.8	901.9	838.6	3427.5
1992	132.2	20.1	1611.4	665.7	42362.8	5580.0	74795.6	573.0	972.4	1028.0	4179.0
Mean 75-92	36.71	7.79	2952.38	668.00	28888.77	3840.61	96940.96	448.31	1625.33	941.87	1591.10
Mean 89-92	110.02	8.65	2873.74	673.80	36759.85	5784.21	90941.41	774.78	1508.41	1026.07	3517.75

Appendix Table 9. Input-output coefficients for selected farm enterprises in Tennessee

Enterprise	Euonymus	Juniper	Forsythia	Maple	Dog-wood	Soy-beans	Tobacco	Wheat	Corn	Cotton	Sor-ghum	Alfalfa hay	All other hay	Tomatoes	Snap-beans	Dairy	Cow/calf	Farrow-to-finish hogs	Sweet corn	Sweet Potatoes	Cabbage	Straw-berries
Objective	6078.75	3694.04	3751.12	7670.06	5602.46	57.55	1175.95	27.23	50.43	137.02	26.65	36.71	7.79	2952.38	668.00	28888.77	3840.61	96940.96	448.31	1625.33	941.87	1591.10
Total land	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	88.2	52.5	3	1	1	1	1
Rowcrop land						1	1		1	1	1			1	1	48.2			1	1	1	
Other crop/hayland	1	1	1	1	1			1				1	1									1
Pasture																40	52.5	3				
Labor																						
Jan-Feb	8.57	131.25	258.02	17.33	15.46	0	0	0	0	0	0	0	0	0	0	608	81	451	0	20	2.34	1.35
Mar-Apr	131.17	193.64	258.22	37.85	61.73	0.99	1.33	1.04	0.53	1.18	0.76	0	0	82.39	1.43	643.54	41	451	1.89	1.89	2.52	24.68
May-Jun	31.5	34.49	28.48	58.03	108.8	1.21	39.5	0.64	1.44	0.9	1.89	5.41	2.92	48.13	9.4	670.9	70.25	442	3.6	25.98	72.42	412.41
Jul-Aug	64.33	34.49	26.45	64.41	264.7	0	31.96	0.16	0	0.9	0	2.9	3.4	29.2	0	625.55	82.32	451	33.2	0.65	16.15	76.37
Sep-Oct	63.45	75.2	21.71	118.38	94.62	0.48	68.13	0	0.82	1.86	0.8	2.59	0	0	0	768.16	44	442	0	26.5	0	30.64
Nov-Dec	34.28	114.5	158.37	123.48	20	0.48	160.4	0	0.2	0.91	0	0	0	0	0	622	58	451	0	24.5	12	11.64
Capital																						
Operating	3414.00	7229.00	2903.00	3767.00	7817.00	84.34	915.46	71.67	138.70	183.01	115.51	160.62	96.64	5835.12	327.49	104504.00	7875.15	1339.55	723.61	1012.11	862.21	1200.88
Fixed	6997.00	8163.10	9329.00	11661.60	11662.0	68.04	618.46	40.26	65.68	134.74	64.91	131.65	110.15	203.39	61.17	18386.00	1665.57	223.47	86.07	1013.02	80.64	648.27

Source: Farm Planning Manual, 1992 and Planning Budgets for Nursery Stock and Christmas Trees, 1989, The University of Tennessee.

Appendix Table 10. Resource availability on hypothetical farms

		Large farm	Medium farm	Small farm
Resource	Unit			
Total land	acre	800	250	75
Rowcrop land	"	320	60	5
Rowcrop & hayland	"	380	90	15
Pasture	"	100	100	55
Operating capital	dollars	200,000	150,000	25,000
Fixed capital	"	70,000	50,000	15,000
Labor				
Jan-Feb	hours	1,000	1,000	360
Mar-Apr	"	4,000	4,000	720
May-Jun	"	4,000	4,000	720
Jul-Aug	"	4,000	4,000	720
Sep-Oct	"	4,000	4,000	720
Nov-Dec	"	1,000	1,000	360

Appendix Table 11. The income deviation matrix for selected farm enterprises, Tennessee, 1975-92

YEAR	JUNIPER	FORSYTHIA	ACER	CORNUS	SOYBEAN	TOBACCO	WHEAT	CORN	COTTON	SORGHUM	ALFAHAY	OTHER HAY	EUONYMUS
1	-542.884	-488.644	-1007.13	-672.58	7.1710	-265.336	-13.2934	-16.4990	-9.011	1.9597	20.2011	27.8256	-973.50
2	-393.743	-356.433	-752.09	-460.39	-2.4191	-50.218	9.4446	25.4360	-43.235	5.6508	14.8426	0.4724	-717.05
3	60.279	28.352	-41.87	153.37	-2.7779	-112.900	-17.0310	-24.0638	-32.199	-24.7069	12.1002	0.3436	50.98
4	-181.456	-174.564	-392.44	-187.75	19.9044	117.562	-0.6626	-4.7312	73.800	4.8263	24.1076	14.7842	-349.24
5	184.389	188.678	334.61	359.25	28.8580	-312.949	18.7787	57.3246	-21.322	4.2130	15.2692	13.1754	326.15
6	457.581	448.100	881.37	728.39	-4.6512	-63.157	23.0740	-33.3622	11.657	22.4356	-17.1717	-20.6412	844.80
7	591.131	565.331	1158.51	880.22	-1.6861	678.963	25.3244	15.0604	-7.811	1.3169	-34.6176	-10.9743	1073.31
8	-81.901	-46.574	76.64	-128.66	-9.3202	654.904	-14.7553	20.6034	88.091	-18.8130	-20.0140	-23.9776	-91.81
9	510.320	447.393	976.21	671.73	-29.3975	-207.918	-13.1033	-36.1371	-71.844	13.4453	-51.4204	-25.6905	924.78
10	713.918	630.592	1292.21	978.12	-5.5053	561.862	3.8924	49.6604	-23.752	31.8851	-25.1008	-2.8682	1314.83
11	-79.318	-92.491	-100.28	-1280.60	-1.7217	93.118	-23.1635	8.5601	19.460	4.3565	26.9700	9.1542	-93.92
12	-646.239	-637.009	-1158.23	-965.48	-31.6944	-625.040	-30.2796	-78.2939	-26.238	-56.9176	16.7063	-2.6512	-1160.72
13	-700.124	-670.104	-1269.19	-979.09	-23.6684	-492.602	-10.5866	-25.3549	152.289	-33.7579	9.5912	-9.1718	-1266.45
14	242.403	207.047	331.99	437.19	37.9887	-20.343	42.7325	-10.9963	-30.072	10.3936	-62.1037	-10.7172	432.43
15	134.212	134.939	207.53	335.40	-17.3872	-426.569	23.4755	40.8759	-14.152	19.9255	-20.7860	5.4956	199.90
16	-18.846	17.923	-19.73	160.03	-1.7371	232.834	-11.7464	-10.3567	-28.498	19.7090	62.4843	10.6830	-43.77
17	-111.852	-74.521	-196.88	28.36	5.0756	3.629	-46.7273	-9.2313	-46.840	-8.1014	0.9951	1.0434	-248.42
18	-137.870	-128.013	-321.23	-57.50	32.9683	234.161	34.6271	31.5057	9.677	2.1797	27.9466	23.7145	-222.30

YEAR	TOMATOES	SNAPBEANS	DAIRY	COW/CALF	FARROW/FIN	SWEET CORN	SWEET POT	CABBAGE	STRAWBERRY
1	2444.87	-441.714	-13575.99	-1051.84	9626.75	125.436	-292.82	-111.108	1126.18
2	-1127.57	-435.494	-4912.67	-558.06	-6322.66	88.208	-797.54	-76.287	817.92
3	1125.57	124.103	-1518.54	-1154.94	-25370.97	-17.378	84.61	-252.863	380.93
4	297.01	135.197	1590.86	900.74	11731.77	9.194	115.17	685.348	-623.97
5	-1480.09	-26.563	8385.06	3693.61	1680.57	-62.878	-605.44	-141.804	93.90
6	-2099.22	325.341	10236.31	1503.13	-27972.08	-107.917	489.82	576.403	-8.46
7	-1438.77	432.071	7087.84	181.54	-7300.68	67.714	637.50	-574.325	-480.27
8	-1642.68	386.902	6128.24	-36.20	36615.52	27.996	-953.35	-461.900	-740.13
9	-3946.75	-55.914	-5665.07	-1694.22	-2468.84	-146.047	922.50	470.242	-603.08
10	2197.74	114.570	-9450.48	-1515.90	6258.78	-97.696	1136.87	-522.557	-567.72
11	4005.93	162.239	1346.72	-884.94	5616.57	-2.190	-593.50	-278.116	-1206.62
12	1365.61	-285.029	4412.01	-1451.13	18199.25	-118.497	505.86	117.064	-427.15
13	1043.96	-16.476	12373.25	510.93	21391.58	-150.488	-309.25	311.234	-407.46
14	2798.90	-282.725	-3693.24	395.94	-19096.96	-55.935	723.37	756.923	1035.59
15	-1412.51	13.183	-5221.93	65.27	-19907.93	338.945	1322.10	114.605	-314.02
16	1457.97	-23.952	5643.17	412.52	15552.27	217.899	-668.84	-118.759	983.57
17	-1268.46	-75.000	-13213.00	951.74	3484.50	21.679	-883.12	-326.755	203.52
18	-2321.52	-50.736	47.47	-268.19	-21717.43	-138.043	-833.94	-167.344	737.26

Appendix Table 12. Yield variability for selected farm enterprises, Tennessee, 1975-92

Enterprise		Yield		Standard deviation		Coefficient of variation (CV)		Random variability as percent of total variability	Random variability
		1975-92	1989-92	1975-92					
	Units	-- unit per acre --		-- unit per acre --		Percent		Percent	Rank
		Mean	Mean	Total	Random	TVI	RVI		
Snapbeans	ton.	1.856	1.74	0.499	0.499	28.71	28.68	99.89	1
Tomatoes	cwt.	154.44	170	48.53	40.94	28.54	24.08	84.38	2
Cotton	lbs.	486.83	540.25	120	90.307	22.21	16.71	75.23	3
Wheat	bu.	37.166	37.5	6.233	6.054	16.62	16.14	97.11	4
Corn	bu.	81.27	100.75	19.477	15.778	19.33	15.66	81	5
Soybeans	bu.	25.22	29	4.325	3.776	14.91	13.02	97.32	6
Alfalfa hay	ton.	2.83	3.45	0.517	0.376	14.95	10.9	72.9	7
Bef cow/calf	cwt.	6.16	6.316	0.613	0.607	9.7	9.61	99.07	8
Sorghum	bu.	63.33	74.25	11.677	7.017	15.72	9.45	60.11	9
Tobacco	lbs.	1935.9	1961.75	170.9	169.522	8.71	8.64	99.19	10
All other hay	ton.	1.616	2.025	0.251	0.170	12.39	8.39	67.71	11
Hogs/Pigs	cwt.	2.19	2.144	0.178	0.171	8.3	7.975	96.08	12
Dairy	cwt.	106.4239	112.505	5.608	2.379	4.98	2.11	42.37	13

Appendix Table 13. Price variability for selected farm enterprises, Tennessee, 1975-92

Enterprise		Prices		Standard deviation		Coefficient of variation (CV)		Random variability as percent of total variability	Random variability
		1992	1989-92	1975-92					
	Units	-- dollar per unit --		-- dollar per unit --		Percent		Percent	Rank
		Actual	Mean	Total	Random	TVI	RVI		
Corn	bu.	2.05	2.37	0.491	0.475	20.72	20.04	96.72	1
Sorghum	bu.	1.96	2.22	0.419	0.416	18.90	18.74	99.15	2
Soybeans	bu.	5.6	5.81	0.833	0.872	15.20	15	98.68	3
Tomatoes	cwt.	21	22.75	3.374	3.363	18.83	14.78	78.49	4
Wheat	bu.	3.4	3.23	0.436	0.434	13.50	13.43	99.48	5
Beef cow/calf	cwt.	72.35	75.46	16.014	9.616	21.22	12.73	59.99	6
Cotton	lbs.	52.6	58.8	7.436	7.218	12.64	12.28	97.15	7
Hogs/Pigs	cwt.	39.3	44.10	4.077	4.046	9.24	9.16	99.14	8
Tobacco	lbs.	1.84	1.8	0.258	0.154	14.33	8.55	59.66	9
Dairy	cwt.	14	13.8	1.726	1.120	12.5	8.115	64.92	10
All other hay	ton.	48	50.13	3.7	3.534	7.40	7.05	95.27	11
Alfalfa hay	ton.	97	94.75	17.011	6.032	18	6.37	35.38	12
Snapbeans	ton.	227	234.25	21.186	11.894	9.04	5.08	56.19	13

Appendix Table 14. Gross margin variabilty for selected farm enterprises, Tennessee, 1975-92

Enterprise	Unit	Gross margin		Standard deviation		Coefficient of variation CV		Random variability as percent of total variability	Random variability
		1975_92	1989_92	1975_92					
		__ dollars per unit __		__ dollars per unit __		Percent			
		Mean	Mean	Total	Random	TVI	RVI	Percent	Rank
All other hay	acre	7.79	8.65	16.84	15.25	194.73	176.34	90.56	1
Wheat	acre	27.23	20.40	24.73	24.19	121.21	118.56	97.82	2
Tomatoes	acre	2952.38	2873.74	2233.16	2146.57	77.71	74.70	96.12	3
Sorghum	acre	26.65	33.17	21.88	21.83	65.97	65.82	99.77	4
Corn	acre	50.43	58.48	34.66	34.44	59.27	58.90	99.37	5
Sweet potato	acre	1625.33	1508.41	764.07	755.57	50.65	50.09	98.89	6
Cotton	acre	137.02	131.21	55.84	54.79	42.56	41.76	98.12	7
Cabbage	acre	941.87	1026.07	440.28	410.48	42.91	40.00	93.23	8
Soybeans	acre	57.55	53.00	21.11	19.89	39.83	37.53	94.22	9
Snapbeans	acre	668.00	673.80	253.22	251.38	37.58	37.31	99.27	10
Tobacco	acre	1175.95	1162.94	374.9	374.45	32.24	32.20	99.88	11
Alfalfa hay	acre	36.71	110.02	52.83	31.46	48.02	28.59	59.55	12
Cow /calf	30 cow	3840.61	5784.21	1817.44	1308.94	31.42	22.63	72.02	13
Dairy	60 cow	28888.77	36759.85	11448.52	7743.25	31.14	21.06	67.64	14
Strawberries	acre	1591.10	3517.75	1359.93	705.98	38.66	20.07	51.91	15
Farrow-to-finish hogs	96 sow	96940.96	90941.41	17899.66	17897.64	19.68	19.68	99.99	16
Sweet corn	acre	448.31	774.78	211.47	132.27	27.29	17.07	62.55	17
Euonymus	acre	6078.75	5457.74	852.65	745.61	15.62	13.66	87.45	18
Dogwood	acre	7670.06	5512.03	680.38	661.81	12.34	12.01	97.27	19
Juniper	acre	3694.04	3461.23	438.65	411.5	12.67	11.89	93.81	20
Forsythia	acre	3751.12	3666.16	387.43	383.46	10.57	10.46	98.98	21
Maple	acre	5602.47	7627.42	761.92	761.32	9.99	9.98	99.92	22

Appendix Table 15. Linear programming solution for three hypothetical farms

				Enterprise mix*									
	Gross margin	Standard Deviation	Coefficient of variation CV	Euonymus	Dogwood	Alfalfa hay	Tomatoes	Snap-beans	Farrow-to-finish hogs	Sweet corn	Straw-berries	Corn buying	Alfalfa hay selling
Farm	dollars	dollars	percent	acres	acres	acres	acres	acres	96 sow unit	acres	acres	bushels	tons
Large	315 655	76 839	24.3	7			9	257	1.7	54		36106	
Medium	187 853	61 932	33.0	4.5		85	18	42	1.87			39638	235
Small	43 329	15 460	35.7	1.45	0.2	13	2.5	2.5	0.6		0.4	14227	36

* Twenty two enterprises were considered (Appendix Table 4) plus four transfer activities

Appendix Table 16. Risk and return tradeoffs and enterprise mix for eleven farm plans for the large farm

				Enterprise mix															
	Gross margin	Standard Deviation	Coefficient of variation CV	Euonymus	Maple	Tobacco	Corn	Cotton	Alfalfa hay	Tomatoes	Snap-beans	Farrow-to-finish hogs	Sweet corn	Sweet potatoes	Cabbage	Straw-berries	Corn buying	Corn Selling	Alfalfa hay selling
Farm Plan	dollars	dollars	percent	acres	acres	acres	acres	acres	acres	acres	acres	96 sow unit	acres	acres	acres	acres	bushels	bushels	tons
A*	315 655	76 839	24.3	7						9	257	1.7	54				36106		
B	285 655	48 008	16.8	1.3			111		209	7	119	1.5	73	10			24730		575
C	255 655	30 929	12.1				157		355	6.4	79	0.6	74		4		2451		976
D	225 655	19 508	8.6				181.5		281.5	1	35	0.5	78	10.6	14				774
E	195 655	11 335	5.8	0.3		3	255		291		18	0.19	17	7	20			12520	801
F	165 655	8 085	4.9	3		2.5	209		192		6.4	0.24	11.5	2.4	22	1.5		8484	528
G	135 655	5 481	4.0	4		3	75	8	213		7	0.23	5	3.6	11	4			587
H	105 655	3 965	3.8	4	0.7	3	50	33	140	0.1		0.15		4	4.4	3			385
I	75 655	2 536	3.4		4		21.6	29	90	0.2		0.06	2	1.3	2	2			246
J	45 655	1 480	3.2		3			24	48	0.1		0.016	4		2	1	356		131
K	15 655	507	3.2		1			8	16	0.05		0.006	1		0.6	0.5	122		45

* Corresponds to the linear programming solution in which income was maximized

Appendix Table 17. Risk and return tradeoffs and enterprise mix for eleven farm plans for the medium farm

				Enterprise mix														
	Gross margin	Standard Deviation	Coefficient of variation CV	Euonymus	Maple	Tobacco	Corn	Cotton	Alfalfa hay	Tomatoes	Snap-beans	Farrow-to-finish hogs	Sweet corn	Sweet potatoes	Cabbage	Straw-berries	Corn buying	Alfalfa hay selling
Farm Plan	dollars	dollars	percent	acres	acres	acres	acres	acres	acres	acres	acres	96 sow unit	acres	acres	acres	acres	bushels	tons
A*	187 853	61 932	33.0	4.5					85	18	42	1.87					39638	235
B	169 853	45 214	26.6	4.5					81	9	51	1.7				4	37570	224
C	151 853	31 307	20.6	4.6					82	3.3	48	1.5			9	3.6	32691	225
D	133 853	17 843	13.3	3.2					84	3	31	0.9		11	15	3	19288	230
E	115 853	9 272	8.0	3.7		0.3			82	1	22	0.6	17	6	14	4	12301	226
F	97 853	5 049	5.2	4.2			22		80		14.4	0.3	12	2	9	5.5	5632	221
G	79 853	3 166	4.0	4.5			50		82		3	0.15	2	1.5	4	3.5	73	225
H	61 853	2 169	3.5		2.6	1.19	24	18	86	0.1		0.07	0.3	2	2	1.5		236
I	43 853	1 421	3.2		3			23	46	0.1		0.01	4		2	1	342	126
J	25 853	838	3.2		1.75			13	27	0.1		0.009	2.4		1	0.8	202	74
K	7 853	255	3.2		0.5			4	8	0.02		0.003	0.7		0.3	0.2	61	23

* Corresponds to the linear programming solution in which income was maximized

Appendix Table 18. Risk and return tradeoffs and enterprise mix for eleven farm plans for the small farm

	Gross margin	Standard Deviation	Coefficient of variation CV	Enterprise mix: Euonymus	Maple	Dogwood	Corn	Cotton	Alfalfa hay	Tomatoes	Snap-beans	Farrow-to-finish hogs	Sweet corn	Sweet potatoes	Cabbage	Straw-berries	Corn buying	Alfalfa hay selling
Farm Plan	dollars	dollars	percent	acres	acres	acres	acres	acres	acres	acres	acres	96 sow unit	acres	acres	acres	acres	bushels	tons
A*	43 329	15 460	35.7	1.45		0.2			13	2.5	2.5	0.6				0.4	14227	36
B	39 329	11 775	29.9	2					13	1	2	0.6			2	0.3	12798	35.5
C	35 329	8 744	24.8	1.4					13	0.6		0.48		3	1.4	0.4	10277	36
D	31 329	6 247	19.9	1.2					13	0.7		0.3		4		0.7	7235	36
E	27 329	3 939	14.4	1.4					13	0.5	1.2	0.2		3	1	1	4773	35
F	23 329	1 745	7.5	1.7					12	0.3	2.5	0.1		0.4	2	1	2381	34
G	19 329	934	4.8	1.6	0.1		0.4		13	0.2		0.04	3		1.4	0.6	920	35
H	15 329	558	3.6	0.02	1		2.6		13.5	0.04		0.02	1.5		1	0.4	332	37
I	11 329	375	3.3		0.7			3	14			0.008	1		0.4	0.1	169	38
J	7 329	238	3.2		0.5			4	8	0.02		0.003	0.7		0.3	0.2	57	21
K	3 329	108	3.2		0.2			2	3	0.01		0.001	0.3		0.1	0.1	26	10

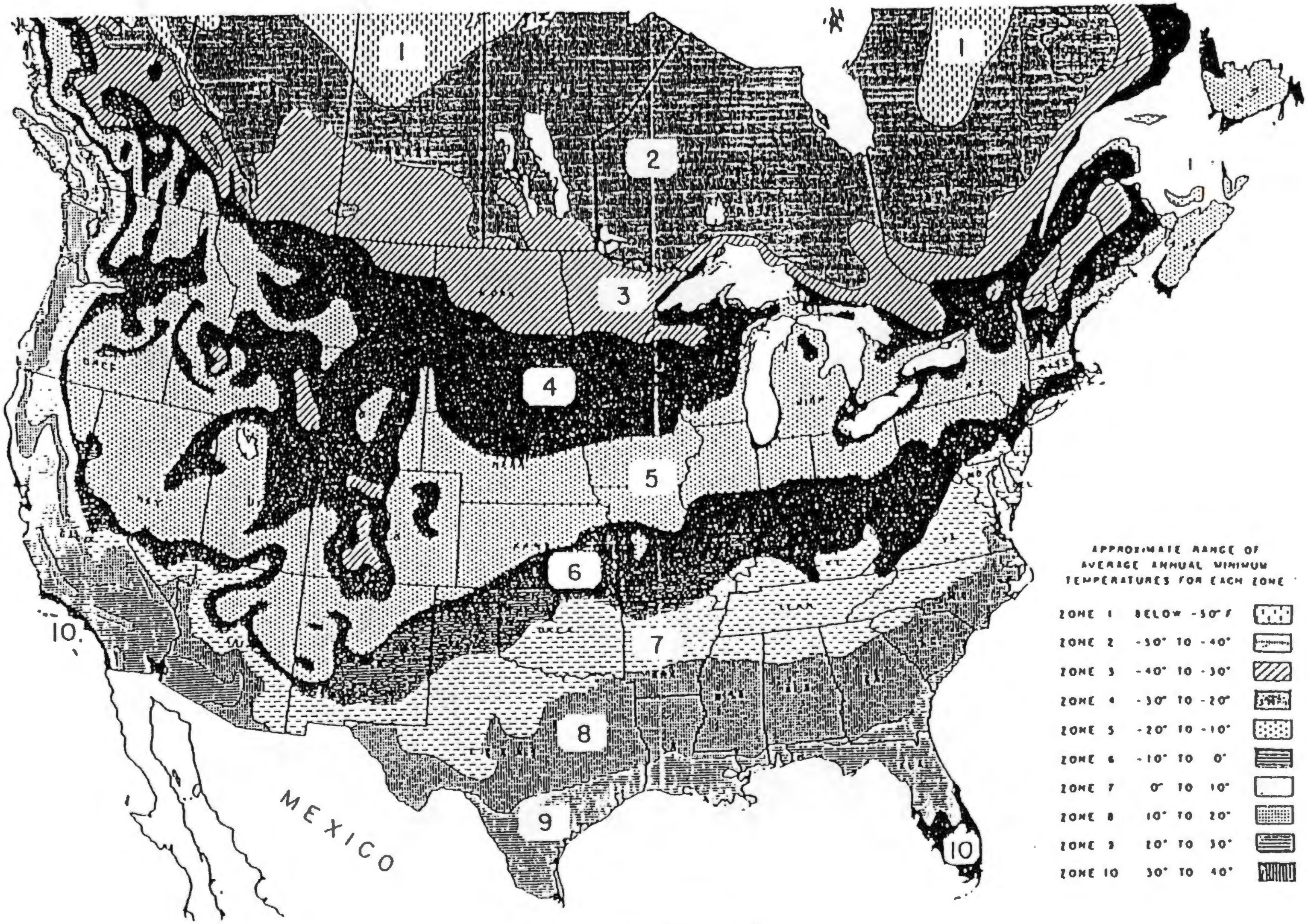
* Corresponds to the linear programming solution in which income was maximized

Appendix Table 19. Correlation coefficients of enterprise random gross margins

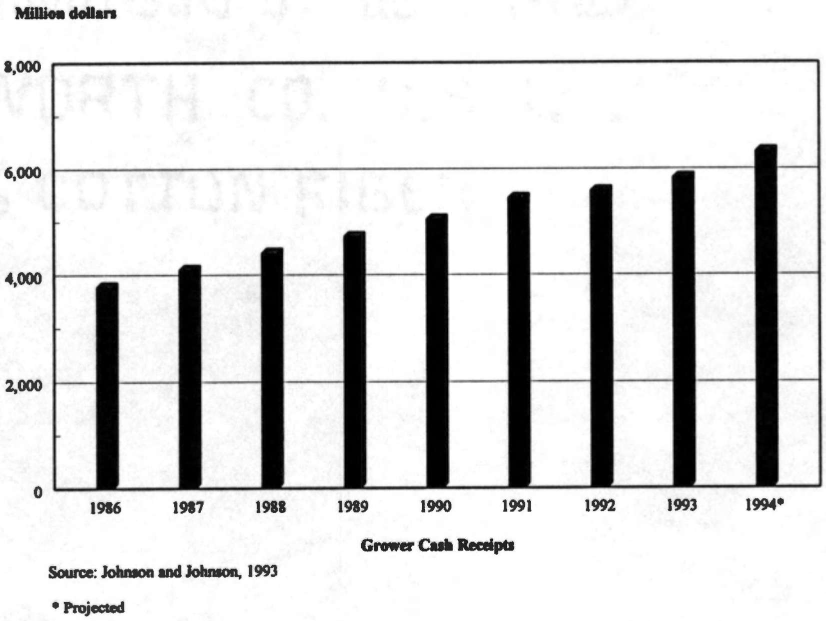
ENTERPRISE	EUONYMUS	JUNIPER	FORSYTHIA	ACER	CORNUS	SOYBEANS	TOBACCO	WHEAT	CORN	COTTON	SORGHUM
EUONYMUS	1.00000	0.99919	0.99723	0.99627	0.88098	0.11550	0.52473	0.42722	0.35791	-0.38622	0.67372
JUNIPER	0.99919	1.00000	0.99810	0.99437	0.89096	0.11706	0.50925	0.42473	0.35384	-0.40028	0.67319
FORSYTHIA	0.99723	0.99810	1.00000	0.99503	0.89896	0.13201	0.52556	0.42875	0.37185	-0.39743	0.68895
ACER	0.99627	0.99437	0.99503	1.00000	0.87519	0.07126	0.54207	0.39129	0.35173	-0.36256	0.65438
CORNUS	0.88098	0.89096	0.89896	0.87519	1.00000	0.17162	0.41906	0.49771	0.31589	-0.41322	0.60849
SOYBEANS	0.11550	0.11706	0.13201	0.07126	0.17162	1.00000	0.26209	0.51320	0.43971	-0.06519	0.32836
TOBACCO	0.52473	0.50925	0.52556	0.54207	0.41906	0.26209	1.00000	0.17084	0.44930	0.06334	0.37755
WHEAT	0.42722	0.42473	0.42875	0.39129	0.49771	0.51320	0.17084	1.00000	0.45871	-0.02646	0.49159
CORN	0.35791	0.35384	0.37185	0.35173	0.31589	0.43971	0.44930	0.45871	1.00000	0.00379	0.53929
COTTON	-0.38622	-0.40028	-0.39743	-0.36256	-0.41322	-0.06519	0.06334	-0.02646	0.00379	1.00000	-0.32685
SORGHUM	0.67372	0.67319	0.68895	0.65438	0.60849	0.32836	0.37755	0.49159	0.53929	-0.32685	1.00000
ALFALFA HAY	-0.59621	-0.59569	-0.58050	-0.60245	-0.57304	0.09280	-0.14870	-0.35946	-0.02702	0.17026	-0.21175
OTHER HAY	-0.40619	-0.40014	-0.39128	-0.44570	-0.35693	0.49092	-0.15457	0.01191	0.28368	-0.06010	0.08206
TOMATOES	-0.27991	-0.28447	-0.30605	-0.31080	-0.45612	0.11329	-0.05442	-0.21257	-0.14339	0.12489	-0.12034
SNAPBEANS	0.54686	0.53856	0.54780	0.58116	0.38363	-0.10828	0.58443	0.08008	0.20048	0.36429	0.13367
DAIRY	-0.03735	-0.04888	-0.04270	-0.01209	-0.08274	-0.10139	0.00980	0.20587	-0.11465	0.55402	-0.28342
COW/CALF	0.07674	0.08385	0.11827	0.08772	0.19835	0.49091	-0.06404	0.31975	0.32111	0.21002	0.15127
FARROW/FIN	-0.42433	-0.44059	-0.43466	-0.37052	-0.46185	-0.31741	0.10830	-0.58880	-0.10411	0.46475	-0.38889
SWEET CORN	-0.06374	-0.05027	-0.01667	-0.04902	0.01947	-0.03253	0.06489	0.01959	0.30091	-0.16557	0.30184
SWEET POT	0.52504	0.53406	0.50309	0.50576	0.51291	-0.30305	-0.12813	0.32573	-0.13101	-0.25683	0.26501
CABBAGE	-0.09706	-0.08956	-0.10377	-0.12286	-0.00886	0.07548	-0.50444	0.26553	-0.45700	0.12237	0.06921
STRAWBERRY	-0.21467	-0.20192	-0.18169	-0.25355	0.07629	0.49261	-0.13771	0.27291	-0.01651	-0.36803	0.14635

	ALFALFA HAY	OTHER HAY	TOMATOES	SNAPBEANS	DAIRY	COW/CALF	FARROW/FIN	SWEET CORN	SWEETPOT	CABBAGE	STRAWBARRY
EUONYMUS	-0.59621	-0.40619	-0.27991	0.54686	-0.03735	0.07674	-0.42433	-0.06374	0.52504	-0.09706	-0.21467
JUNIPER	-0.59569	-0.40014	-0.28447	0.53856	-0.04888	0.08385	-0.44059	-0.05027	0.53406	-0.08956	-0.20192
FORSYTHIA	-0.58050	-0.39128	-0.30605	0.54780	-0.04270	0.11827	-0.43466	-0.01667	0.50309	-0.10377	-0.18169
ACER	-0.60245	-0.44570	-0.31080	0.58116	-0.01209	0.08772	-0.37052	-0.04902	0.50576	-0.12286	-0.25355
CORNUS	-0.57304	-0.35693	-0.45612	0.38363	-0.08274	0.19835	-0.46185	0.01947	0.51291	-0.00886	0.07629
SOYBEANS	0.09280	0.49092	0.11329	-0.10828	-0.10139	0.49091	-0.31741	-0.03253	-0.30305	0.07548	0.49261
TOBACCO	-0.14870	-0.15457	-0.05442	0.58443	0.00980	-0.06404	0.10830	0.06489	-0.12813	-0.50444	-0.13771
WHEAT	-0.35946	0.01191	-0.21257	0.08008	0.20587	0.31975	-0.58880	0.01959	0.32573	0.26553	0.27291
CORN	-0.02702	0.28368	-0.14339	0.20048	-0.11465	0.32111	-0.10411	0.30091	-0.13101	-0.45700	-0.01651
COTTON	0.17026	-0.06010	0.12489	0.36429	0.55402	0.21002	0.46475	-0.16557	-0.25683	0.12237	-0.36803
SORGHUM	-0.21175	0.08206	-0.12034	0.13367	-0.28342	0.15127	-0.38889	0.30184	0.26501	0.06921	0.14635
ALFALFA HAY	1.00000	0.70306	0.27757	-0.19015	0.16731	0.11208	0.28213	0.20536	-0.64200	-0.21992	0.22145
OTHER HAY	0.70306	1.00000	0.34371	-0.40619	-0.28110	0.10016	-0.03583	0.31761	-0.34838	-0.17687	0.40092
TOMATOES	0.27757	0.34371	1.00000	-0.24264	-0.12461	-0.25969	0.22769	0.07788	-0.00305	-0.04866	0.07595
SNAPBEANS	-0.19015	-0.40619	-0.24264	1.00000	0.49933	0.20475	0.00833	-0.06151	0.11321	-0.24992	-0.61703
DAIRY	0.16731	-0.28110	-0.12461	0.49933	1.00000	0.45396	0.16151	-0.24922	-0.13596	0.14213	-0.29242
COW/CALF	0.11208	0.10016	-0.25969	0.20475	0.45396	1.00000	-0.06096	0.03535	-0.28334	0.16933	0.11355
FARROW/FIN	0.28213	-0.03583	0.22769	0.00833	0.16151	-0.06096	1.00000	-0.00531	-0.36652	-0.22824	-0.34160
SWEET CORN	0.20536	0.31761	0.07788	-0.06151	-0.24922	0.03535	-0.00531	1.00000	-0.00342	-0.22334	0.22269
SWEET POT	-0.64200	-0.34838	-0.00305	0.11321	-0.13596	-0.28334	-0.36652	-0.00342	1.00000	0.33526	-0.26218
CABBAGE	-0.21992	-0.17687	-0.04866	-0.24992	0.14213	0.16933	-0.22824	-0.22334	0.33526	1.00000	0.10171
STRAWBERRY	0.22145	0.40092	0.07595	-0.61703	-0.29242	0.11355	-0.34160	0.22269	-0.26218	0.10171	1.00000

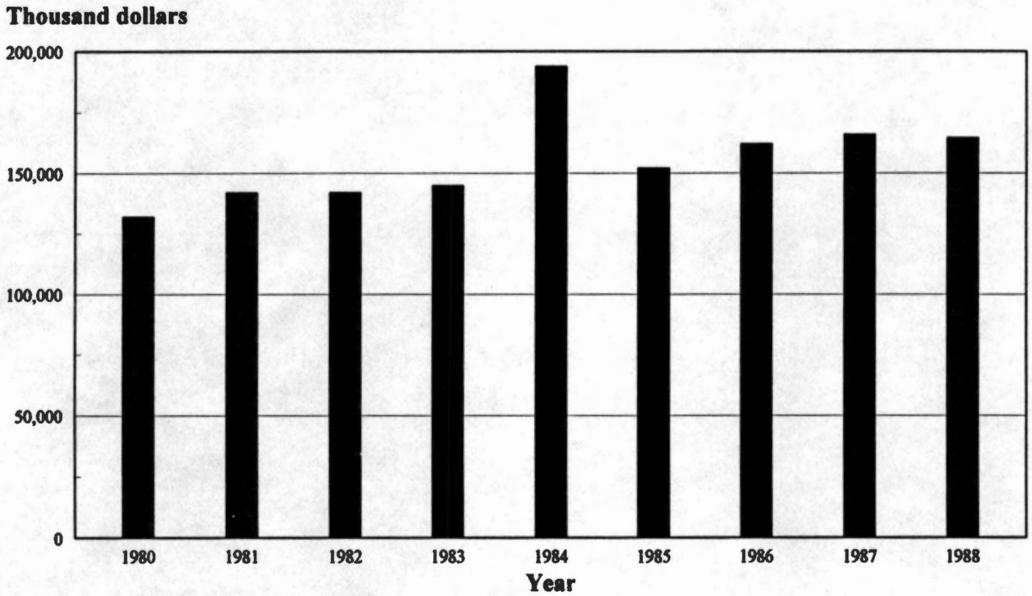
APPENDIX FIGURES



Appendix Figure 1
USDA plant hardiness zones

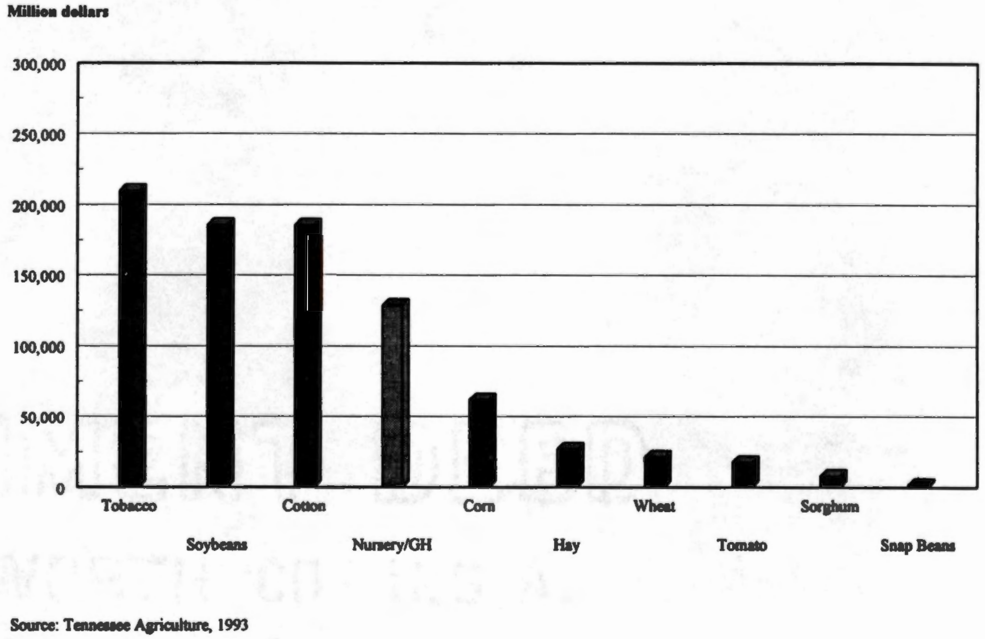


Appendix Figure 2
Environmental Horticulture Plants:
Grower Cash Receipts in the U.S: 1986-1994

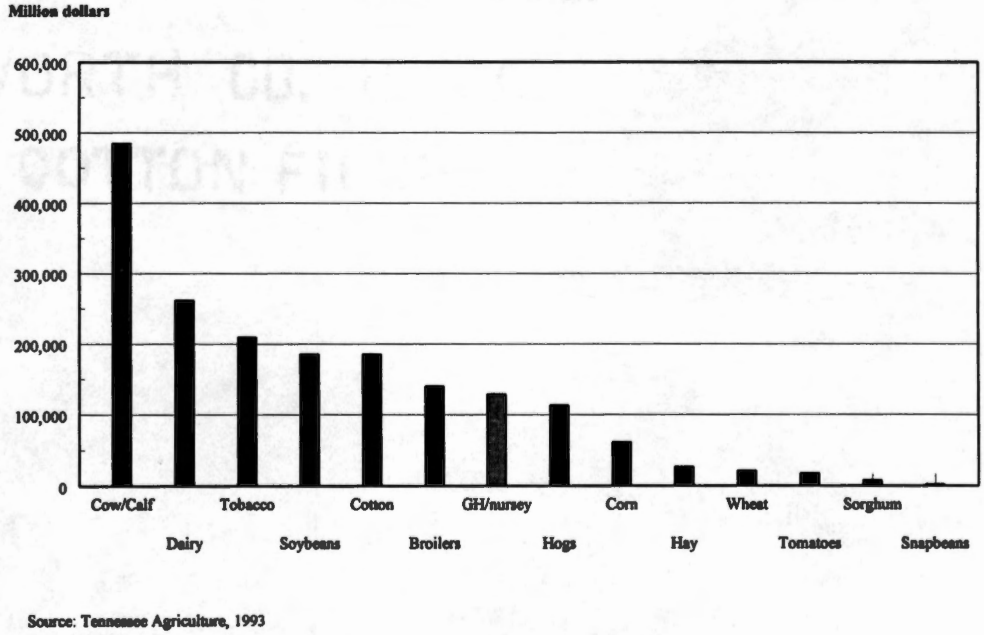


Source: Tennessee Agriculture, various issues

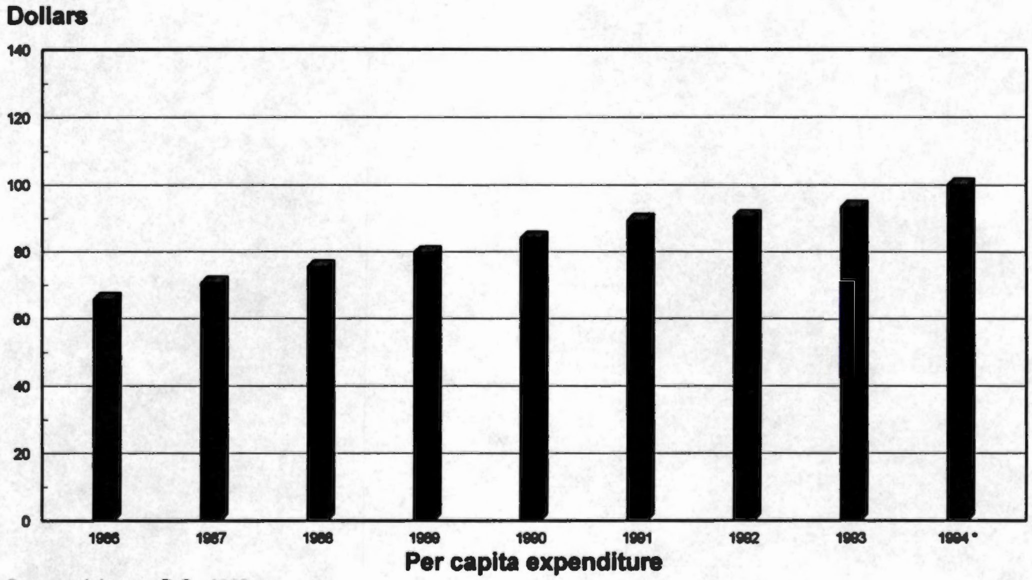
Appendix Figure 3
Cash Receipts from Greenhouse and NurseryProducts:
Tennessee, 1980-1988



Appendix Figure 4
Nursery and greenhouse cash receipts fromfarm marketing in Tennessee: comparison with selected traditional crop enterprises, 1991



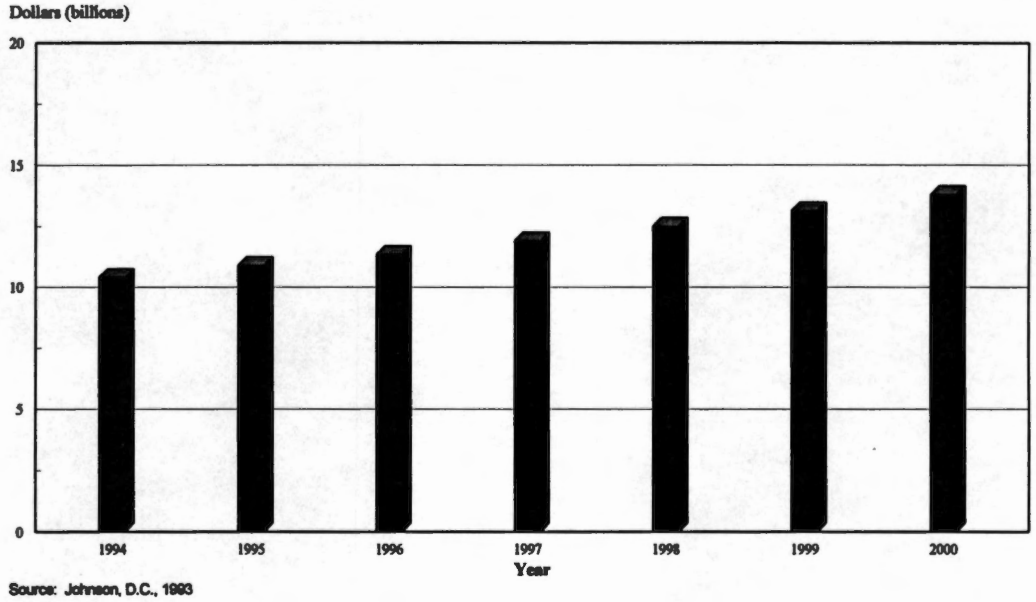
Appendix Figure 5
Nursery and greenhouse cash receipts from farm marketing in Tennessee: comparison with major traditional crop and livestock enterprises, 1991



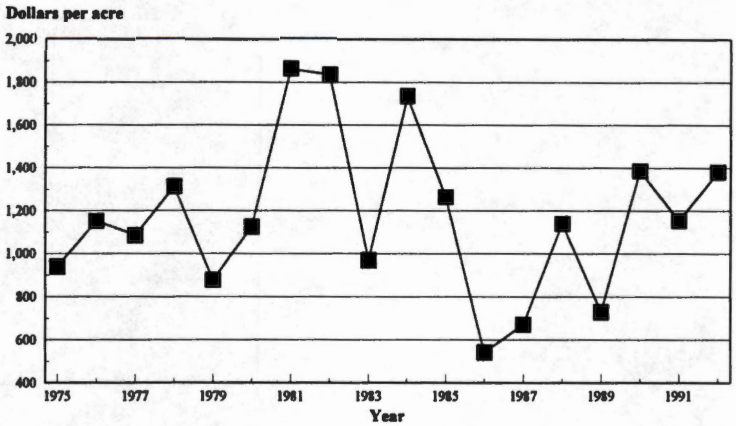
Source: Johnson, D.C., 1993

* Projected

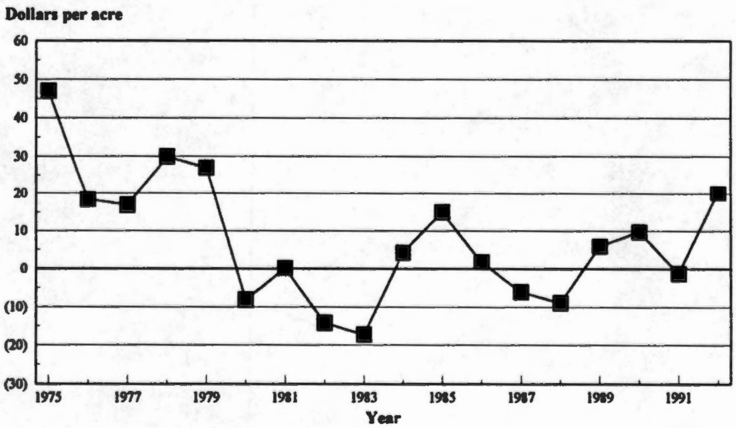
Appendix Figure 6
Per capita expenditure on environmental horticulture plants in the U.S., 1986-1994



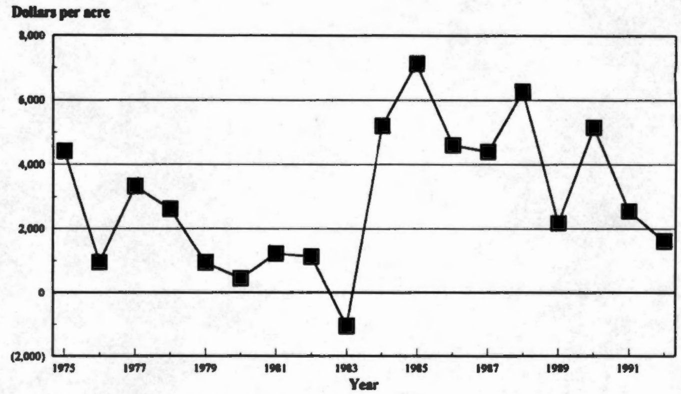
Appendix Figure 7
Future projections for greenhouse and nursery grower receipts, 1994-2000



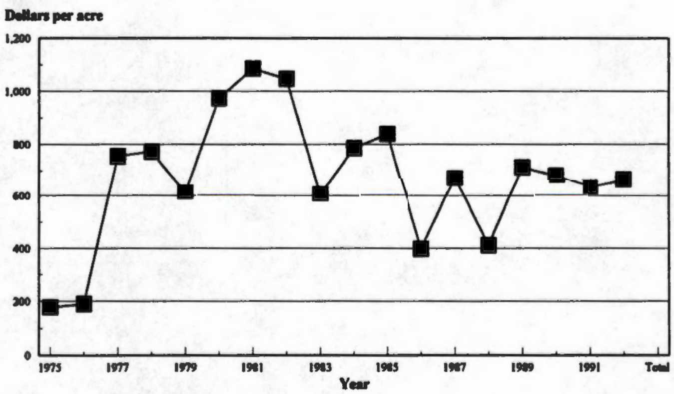
Appendix Figure 8
Tobacco gross margin variability: Tennessee, 1975-1992



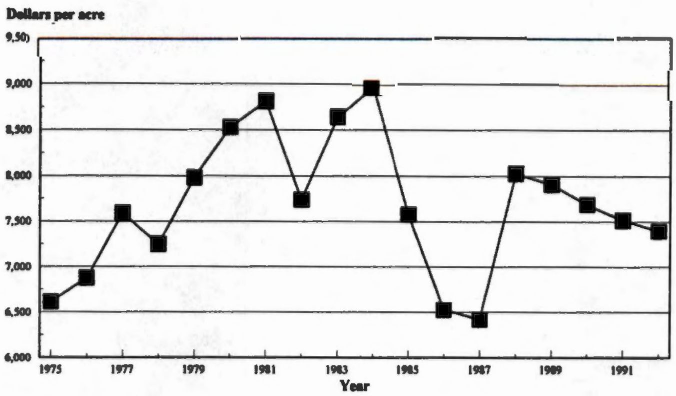
Appendix Figure 9
All other hay gross margin variability: Tennessee, 1975-1992



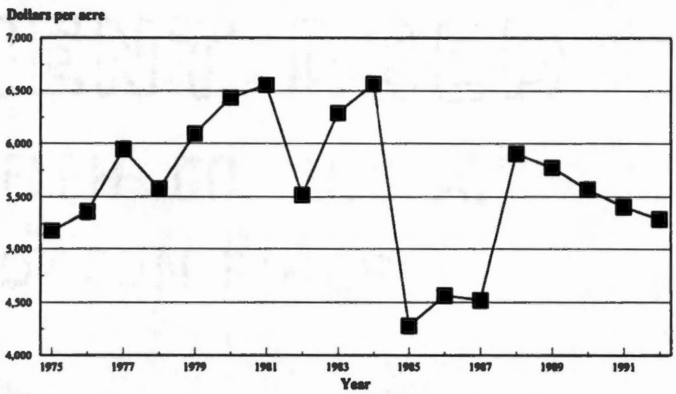
Appendix Figure 10
Tomatoes gross margin variability: Tennessee, 1975-1992



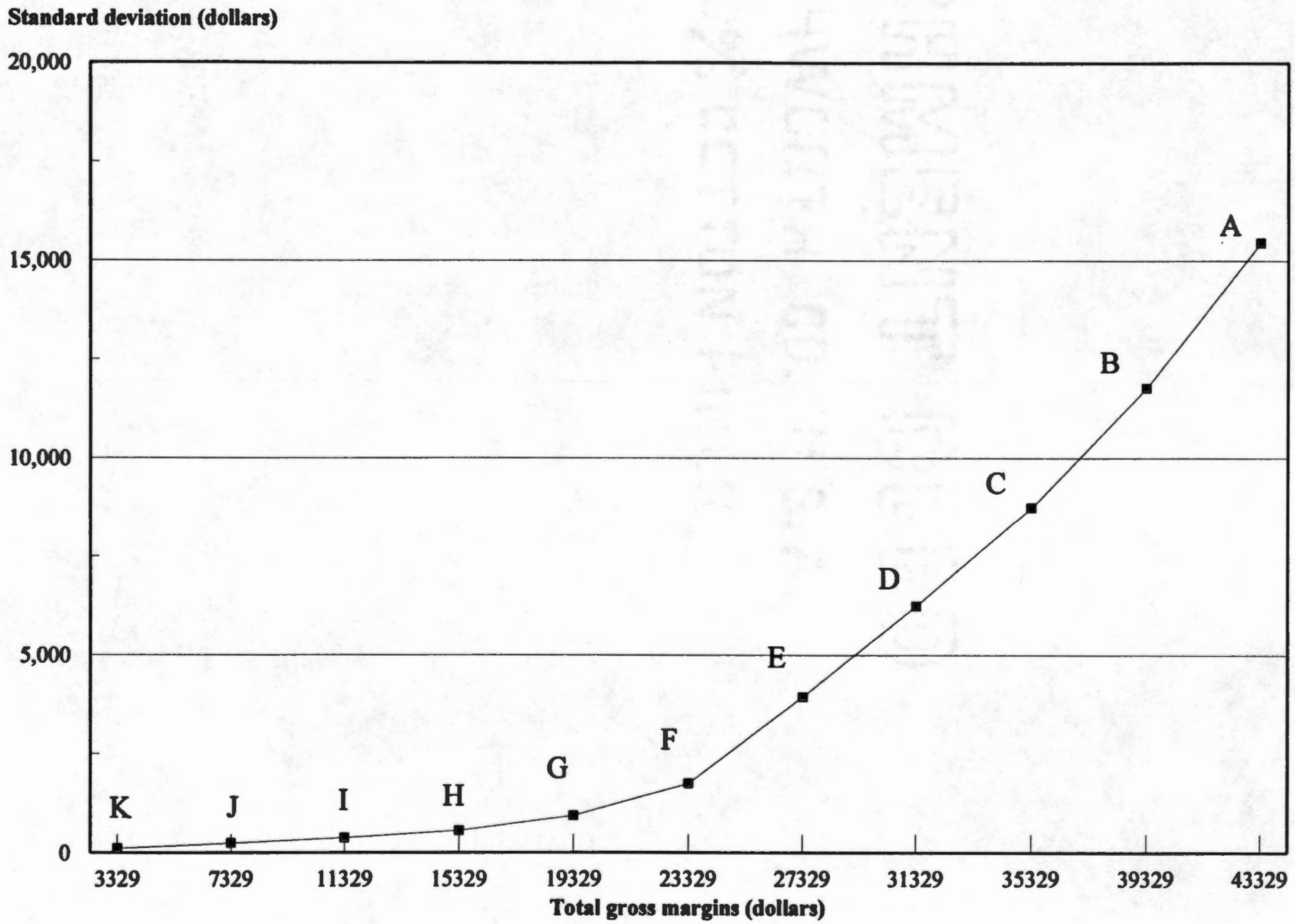
Appendix Figure 11
Snapbeans gross margin variability: Tennessee, 1975-1992



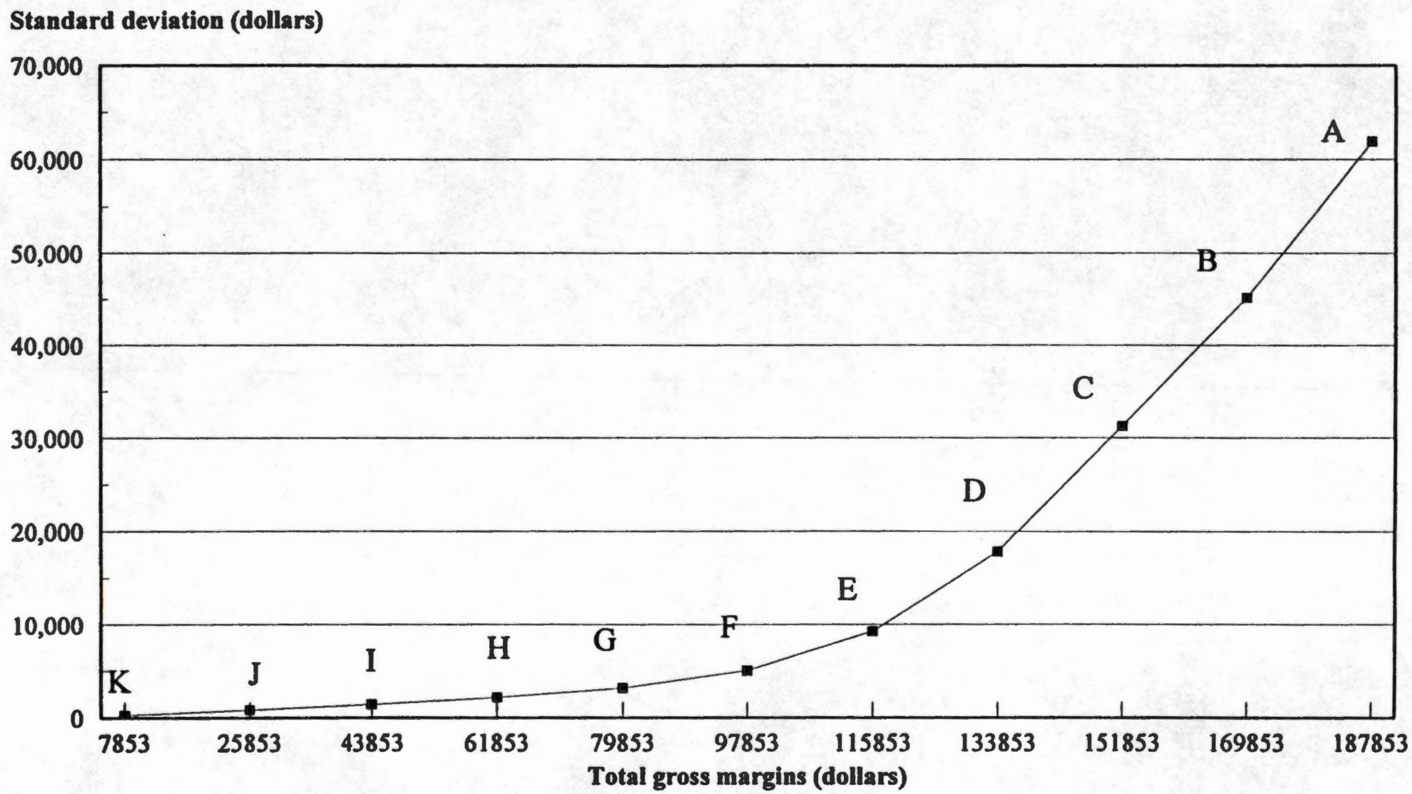
Appendix Figure 12
Maples gross margin variability: Tennessee, 1975-1992



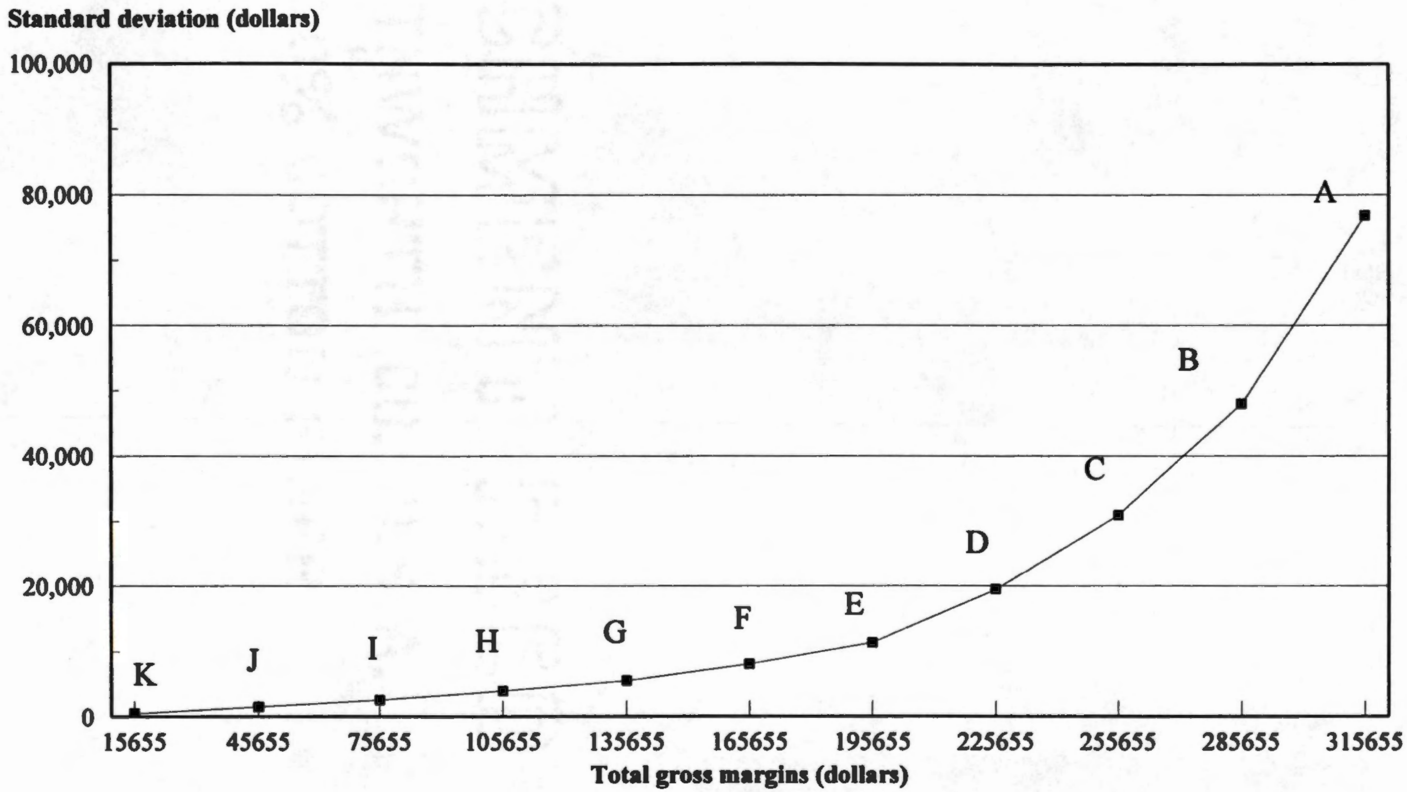
Appendix Figure 13
Dogwood gross margin variability: Tennessee, 1975-1992



Appendix Figure 14
Risk efficient frontier for the small farm



Appendix Figure 15
Risk efficient frontier for the medium farm



Appenidx Figure 16
Risk efficient frontier for the large farm

VITA

Sarfraz Ahmad was born June 8, 1951 in Village Ahmad Nagar, Gujranwala district in Punjab, Pakistan. He is the youngest son of Jannet Bibi and Mian Abdul Hameed. His father died when he was a year old. The entire family came under the guardianship of his maternal uncle, Mr. M.H.Sufi, a versatile and prominent personality in recent times. Mr. Sufi served in different high civilian positions in the Pakistan government during his service career. Both, Mr. Sufi (deceased 1987) and his wife, Mrs. Kishwar Sufi (deceased 1993) were a blend of great human values. Sarfraz spent his childhood and most of his life time under the able guidance, supervision, and parental companionship of both these personalities.

He obtained secondary level education in his native village and graduated in 1967. In the same year, he entered the University of Agriculture, Faisalabad, one of the oldest institution in agricultural education in Asia. He completed his Master's degree in agricultural economics in 1975.

He served the Airports Development Authority (ADA) of Pakistan from 1975 to 1984 as a landscape planner and specialist. Later, in 1984 he was selected as assistant professor in Barani Agricultural College, Rawalpindi. He taught courses in agricultural economics, farm management, sociology, and economics. He prepared the initial draft of a post-graduate program in agricultural economics at Barani. Besides teaching, he organized short courses for ladies in landscaping and ornamental horticulture at Barani. He also served in different administrative assignments from time to time. In 1987, he was sent by the government to the U.S.A., Turkey, England, and Tunisia as a member of an expert committee to study the teaching and research system related to dryland farming in different institutions.

He was nominated by the government to pursue Ph.D studies funded by USAID in 1989. He came to the University of Tennessee, Knoxville as USAID-Government of Pakistan Concurrent Fellow in Spring, 1990. After completion of his studies in the U.S., he plans to return to Pakistan where he will continue in his position at the Barani Agricultural University. During his stay in the United States he attended annual meetings of AAEA as a member held at Vancouver (Canada), Manhattan (Kansas), and Baltimore (Maryland). He is also a member of Gamma Sigma Delta, an honorary professional agricultural society.

He was married to Nusrat, in 1980. They have four children; Maryiam, Sarah, Sana, and Adil.

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