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An economic analysis of selected sucker control systems for burley tobacco

Mark L. Cook

To the Graduate Council:

I am submitting herewith a thesis written by Mark L. Cook entitled "An economic analysis of selected sucker control systems for burley tobacco." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

S. Darrell Mundy, Major Professor

We have read this thesis and recommend its acceptance:

Luther H. Keller, Robert M. Ray

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

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

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AN ECONOMIC ANALYSIS OF SELECTED

SUCKER CONTROL SYSTEMS

FOR BURLEY TOBACCO

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Mark L. Cook

March 1988

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ABSTRACT

The primary objective of this analysis was to provide Tennessee burley tobacco producers with information on physical inputs, yield, quality, total value product (TVP), total factor costs (TFC), and net value product (NVP) associated with selected sucker control systems. The systems selected for this analysis consisted of one conventional system utilizing late topping and six alternative systems utilizing early topping. Paired comparisons were then made with the conventional system utilizing maleic hydrazide (KMH) within a partial budgeting framework. A secondary objective was to compare both agronomic and economic aspects associated with an alternative sucker control system utilizing KMH, machine applied, in conjunction with early topping to other chemical systems utilizing early topping.

To obtain data for agronomic and economic comparisons between systems, a field experiment was conducted over three consecutive years from 1983 through 1985 at the University of Tennessee Tobacco Experiment Station near Greeneville, Tennessee. Sucker control systems or treatments were composed of variables such as time of topping, type of sucker control chemical(s) used, sequence and frequency of chemical application, and mode of application. The alternative systems evaluated for comparison with the conventional or control system were chosen with these variables considered most important in selecting an improved system or set of systems that are well within the means of resource availability for typical Tennessee burley tobacco producers.

Total value product was determined for each system or treatment from observed yield and price data; price was also used as a proxy variable for quality. Costs directly and indirectly attributed to sucker control were estimated for each treatment and included in a partial budgeting framework along with TVP. Other costs of production were assumed constant across treatments. Net value product as well as added (reduced) NVP of paired comparisons were estimated for each treatment as a measure of net returns to quota, land, and management collectively. Similarly, added (reduced) NVP to each of four separate resources (plus management) and management alone was estimated.

Though the results of the three-year experiment were ambiguous in regard to statistical comparisons of the different systems, there was some indication of economic advantages in those systems topped at early flower. Paired mean comparisons revealed that each of the respective early-topped treatments produced results (dollars per acre) greater than the conventional or control treatment in regard to yield, price, and TVP. In addition, costs of production attributed to the control of suckers were less for the early-topped treatments than for the control with the exception of a multi-pass treatment in which Prime + was hand applied. Added NVP to quota, land, and management ranged from a positive difference of $133 to $483 per acre over the control. In a similar view, NVP to management and each of four separate factors of production were greater for the early-topped treatments.

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CHAPTER 1

INTRODUCTION

In 1986 there were 96 thousand farms listed in Tennessee (USDA, 1986a, p.371) of which over one-third produced tobacco (Grise, 1985, p.40). Tennessee burley tobacco producers marketed 64.7 million pounds of tobacco making them the major contributors to the state's total value of marketed tobacco which was $150 million. Currently, tobacco accounts for 7.5 percent of the total value of all Tennessee agricultural commodities marketed (USDA, 1987, pp.17-26).

Given the relative importance of burley tobacco to the state's agricultural economy, the need for ongoing research with the objective of improving the economic efficiency of the burley producer in a competitive world industry has been long understood. However, in recent years the need for research has become even more critical given that U.S. burley tobacco production (total acres) has been declining. The U.S. share of world exports has been declining because of high prices for domestic leaf and reduced quantity demanded in foreign markets. In addition, U.S. imports of burley tobacco have grown because of the availability of less expensive foreign-grown tobacco. Today, foreign imports account for over 33 percent of the tobacco used in U.S. cigarette production as compared to 14 percent 16 years ago (USDA ,1986b, p.6).

One aspect of burley tobacco production that has potential for improvement in economic efficiency is the method in which suckers are controlled. Currently, the majority of Tennessee producers top burley tobacco in the full flower stage and then chemically control suckers by applying the systemic growth inhibitor, maleic hydrazide (KMH). However, documented evidence exists that time of topping in flue-cured tobacco is significantly related to yield and value per acre (Marshall and Seltmann, 1964 and Elliot et al., 1966). Also, industry concerns regarding KMH residue are widespread especially for exported tobacco destined for countries such as West Germany where the maximum allowable level of KMH is 80 ppm. Finally, new sucker control chemicals are available that are similar in technical effectiveness to KMH. Therefore, producers are faced with the challenge of evaluating alternative chemical sucker control systems in conjunction with early topping for burley tobacco.

In evaluating alternative systems, the tobacco producer needs both agronomic information pertaining to yield and quality and economic information such as estimated costs and returns. Given this information, the producer can take advantage of analytical tools such as partial budgeting to evaluate the benefits of one alternative system in comparison with another.

ECONOMIC PROBLEM

In general, technological change is a characteristic of agriculture (Doll and Orazem, 1984, p.13). The manner in which the tobacco producer adjusts to change and deals with the managerial problem of allocating scarce resources within and among competing farm enterprises often depends upon his/her primary objectives. In this study, the assumption is made that his/her primary objective is improved economic efficiency, or more specifically, profit maximization (Doll and Orazem, 1984, p.61).

Within the context of production economics, marginal analysis dictates that in selecting an optimal sucker control system, the level of resource utilization should be increased or decreased, (depending upon an initial given location along the enterprise production curve), to the level at which the Marginal Factor Cost (MFC) of each variable input is equal to the Marginal Value Product (MVP) of the resulting output. Such an analysis can be done as long as the inputs are divisible and their availability is unlimited within the considered range; that is, the producer already owns or can readily purchase the inputs in quantities needed for optimal use. This assertion does not mean that the supply of inputs are unlimited. (Doll and Orazem, 1984, p.154). On the other hand, if inputs such as labor or capital are limited, the producer can still realize his/her primary objective by combining resources in such a way as to maximize profit or Net Value Product (NVP) to the most limiting farm resource within the production process of the enterprise.

One important condition needed to meet the criterion of marginal analysis for optimal input usage is some knowledge of the production function or the known relation between inputs and output of at least two input levels. Given that knowledge of the subproduction function(s) involving sucker control for burley tobacco is limited and that alternative sucker control systems are, more often than not, uniquely defined, (meaning that the input requirements vary among alternatives), the use of marginal analysis, although still applicable in the underlying production relationships, is not directly useable when only one input-output point is known. Nevertheless, partial budgeting techniques which are based on the concept of marginal analysis, can be used to evaluate the differences among alternative systems in terms of changes in total value product (TVP), total factor costs (TFC), and net value product (NVP) in comparison to a base system.

In searching for the optimal sucker control system by using partial budgeting, the producer must evaluate all relevant physical input requirements (those inputs that vary among alternatives) and possible effects on both quality (price) and output (yield). Similarly, each system should also be evaluated on the basis of costs of labor and materials (chemical), mode of chemical application, and other costs. The ability of the producer to match farm resources to system input requirements are critical in the decision-making process. For example, if the availability of chemical spraying equipment is lacking in the farm operation, the producer must evaluate systems in terms of chemical application by hand, consider the possibilities of acquiring custom services, or consider the possibility of purchasing chemical spraying equipment. Because of the high initial outlay for chemical spraying equipment and small per farm acreages, most Tennessee producers are reluctant to purchase such equipment for use in burley tobacco. In many cases, they instead choose to use hand sprayer equipment or custom services unless purchasing can be justified by a sufficient production acreage, the opportunity to provide custom services to other producers, or the opportunity for use in other enterprises in the farm operation.

RESEARCH PROBLEM AND JUSTIFICATION

As stated earlier, the majority of Tennessee burley tobacco producers control suckers in conjunction with late topping at full flower by applying maleic hydrazide (KMH). In other words, producers top when the majority of all plants in a given plot or field are in full flower meaning that the majority of the corollas on a given plant are open. In contrast, early flower refers to the bloom stage in which at least one corolla is open; early topping refers to topping when at least 50 percent of all plants are in early flower. Currently, documented evidence of improved quality and yield per acre in flue-cured tobacco topped early and the advent of new sucker control chemicals both suggest possible advantages to early topping in burley tobacco.

The quest for an improved sucker control system is often constrained by the lack of relevant information on which to base managerial decisions. Research provides the producer with some of the needed information. By evaluating farm experiments that simulate actual farm situations, researchers can evaluate numerous sucker control systems over a period of several years. Relationships between time of topping in conjunction with various sucker control systems and yield, quality, costs, and returns can be evaluated with the objective of providing the producer with relevant information for use on his/her particular farm.

RESEARCH OBJECTIVES

The primary objective of this analysis was to provide both agronomic (yield and quality) and economic (total returns, costs, net returns) data associated with selected sucker control systems utilizing early topping. Results were then compared with the conventional system utilizing maleic hydrazide (KMH) in conjunction with late topping within a partial budgeting framework. A secondary objective of this analysis was to compare both agronomic and economic data associated with an alternative sucker control system utilizing KMH in conjunction with early topping to other chemical systems utilizing early topping.

LITERATURE REVIEW

A review of literature revealed numerous studies evaluating the effects of time of topping and method of sucker control on tobacco yield and quality from an agronomic standpoint. However, the review revealed no directly comparable studies evaluating the economic advantages and disadvantages of alternative sucker control systems in conjunction with early topping as compared to conventional topping. However, one comparable economic analysis that evaluated alternatives within other technical stages of the burley tobacco production process was reviewed.

Regarding time of topping, Marshall and Seltmann (1964) noted that any delay in topping beyond the early flower stage resulted in an average loss of approximately 15 pounds per acre per day in flue-cured tobacco. They determined that value per hundredweight (cwt.) for hand-suckered plants was greatest for early-topped tobacco while maximum value per cwt. for tobacco treated with maleic hydrazide (MH) without a potassium base, occurred at the early flower stage. They also noted that total alkaloids decreased as time of topping was delayed. Elliot et.al. (1966) reported similar results for yield, dollars per acre, and alkaloid content for flue-cured tobacco, hand-suckered and topped at three stages of floral development. They found no significant differences among treatments in value per hundredweight at the .05 level of significance.

Seltmann, Ross, and Shaw (1969) conducted a study evaluating the effects of time of topping and method of sucker control on yield, value, and alkaloid content of burley tobacco. They found no significant effects on yield and acre value for hand-suckered (no chemical) and MH-treated plants topped at various stages of maturity (early and full flower stage). They found a slight increase in dollar value per hundredweight at the 10 percent level of significance. The highest values for total alkaloids were found among plants topped at the early flower stage. Gupton (1967), after testing several varieties of burley tobacco with respect to yield and quality, noted that all varieties should be topped between the 50 percent and full flower stage or no more than 80 days after transplanting.

Because of the potential for improved sucker control in burley tobacco through use of other systems in conjunction with early topping, treatments utilizing KMH along with other sucker control chemicals were evaluated in this study. The performance of KMH applied in conjunction with other chemicals has been the topic of past research. For example, one study noted 99 percent control of suckers in burley tobacco resulting from a treatment of Off-Shoot T-85 (4 percent formulated solution) applied prior to topping plants in the early to full flower stage followed by a treatment of KMH (170 mg active ingredients in 20 ml spray solution per plant) applied at topping or within 7 days thereafter (Link, Atkinson, Nichols, and Seltmann, 1982). The study also noted that this method of sucker control resulted in the lowest sucker removal time of 9 hours per hectare as compared to 11 hours per hectare for a single application of KMH and 19 hours per hectare for two sequential applications of Off-Shoot T-85.

Steffens (1980) noted a high level of sucker control in flue-cured tobacco from tank mixes of KMH and Prime +. This was later substantiated by Whitty and Wilcox (1985) who also emphasized time of application. They found that tank mixes of half the normal rates of Prime + (9.5 liters/hectare) and KMH (14.25 liters/ hectare) applied at the early flower stage, resulted in 99 percent control of suckers. They also noted that an early application of Prime + (15 percent active ingredients at a rate of 9.5 liters/hectare) applied during the elongated button stage (prior to early flower) provided 100 percent sucker control.

In selecting a sucker control system, one important variable to be considered by the producer is the method of application of sucker control chemicals. Stapleton and Barnes (1967, p.308), emphasized the need for data in selecting the most profitable machinery for a given farm operation while Link (1967, pp.310-317), provided a detailed method for the selection.

The most comparable study reviewed was that of Sasscer (1983) in which he evaluated various insecticide pest management strategies in burley tobacco from an economic standpoint. In his study, Sasscer evaluated the economic advantages and disadvantages of each strategy within a marginal analysis framework. He also used partial budgeting to evaluate changes in gross returns and breakeven analysis to aid in the evaluation of various foliar application alternatives.

CHAPTER 2

PROCEDURE

To collect the necessary data for evaluation of various sucker control systems in burley tobacco, an experiment was conducted over three consecutive years from 1983 to 1985, at the University of Tennessee Tobacco Experiment Station near Greeneville, Tennessee. The underlying hypothesis of the experiment was that time of topping (stage of flowering) is significantly related to yield, quality, costs, and returns. The experiment was designed to evaluate various sucker control systems utilizing early topping and to compare them with the conventional system (which utilizes late topping and one application of KMH) to determine advantages and/or disadvantages, if any, in terms of yield, quality, costs, and returns.

Several variables and their relationships when taken together, define a sucker control system or treatment. Time of topping, type of chemical agent or agents used, sequence and frequency of agent application, and mode of application all help define a particular system. The alternative systems evaluated in this study were chosen with these variables considered most important in selecting an improved system or set of systems that are generally within the means of resource availability for typical Tennessee burley tobacco producers.

EXPERIMENT DESIGN

The experiment design was a randomized complete block. Though the general experiment design was the same across all three years, there were slight differences among years with respect to number of treatments, number of replications, plot size, plant drill spacing, and tobacco variety. In 1983, ten treatments were evaluated in three replications. Each treatment plot contained six rows which were 65 feet long with 42-inch spacings between rows and 20-inch spacings between plants in the row. The burley tobacco variety used was Virginia 509. Ten treatments were also evaluated in 1984. However, each was replicated four times instead of three. Each treatment plot contained four rows which were 40 feet long with 42-inch spacings between rows and 17-inch spacings between plants in the row. Again, the variety used was Virginia 509. In 1985, twelve treatments were evaluated also with four replications. Each treatment plot was 30 feet long with 42-inch spacings between rows and 20-inch spacings between plants in the row. Virginia 509 was not used; instead, because of virus pressure, Greeneville 136, an advanced line, was grown. Though the number and description of treatments varied across years, seven treatments were common to all three years.

Although the experimental differences between years were less than ideal, certain other factors with the potential to create undue data biases were minimized. Variability of input use and cultural practices within technical stages of production other than sucker control were minimized as much as possible. By maintaining similar fertilization practices, weed control, pest management, harvesting and curing techniques, and market preparation across all treatments across all three years, yield, quality, costs, and returns variations can be attributed primarily to treatment (the method of sucker control), replication, and year effects.

THE FIELD EXPERIMENTS FOR 1983-1985

The experiment field site for each year was prepared for transplanting through use of conventional cultural practices (fall plowed and winter fallowed). To each plot (or treatment within a replication) the fungicide, Ridomil (1 gallon per acre); the herbicide, Prowl (2 pints per acre); and the insecticide, Lorsban (2 quarts per acre), were preplant incorporated in the spring. Orthene (1 pound per acre) was applied through the transplant water and as a foliar spray throughout the growing season as required based on the economic threshold which was determined by scouting the field. Also, in 1984 and 1985 the herbicide, Devrinol was used and in 1983 and 1985 the insecticide, Furadan was used. Plots were fertilized according to soil test recommendations with phosphorus, potash, and approximately one-third of the nitrogen banded at transplanting in 1983 and broadcasted in 1984 and 1985. The remainder of the recommended nitrogen was sidedressed two to three weeks after transplanting.

Prior to application of the various treatments, each plot was managed for weeds. Conventional cultural methods were once again applied. Plots were cultivated and hand-hoed as the need arose.

The application of the various sucker control treatments was made in accordance with labeled recommendations and restrictions with one exception. A description of treatments that were common to all three experiment years is shown in Table 2.1. Only the seven common treatments were evaluated in this study. The topping method, along with the chemical agent(s) used, rate of application and mode of application together make up the description of a particular treatment.

Treatment 1 was considered the most typical sucker control system utilized by Tennessee burley tobacco producers. Treatment 2 was designed to evaluate the effectiveness of the commonly used chemical agent, maleic hydrazide (KMH), a systemic growth regulator, in conjunction with early topping. For Treatment 3 a mixture (FST7) was used made up of a contact growth regulator, Off-Shoot T85, and a systemic sucker control agent, KMH. Treatment 4 was a multi-pass system using both contact and systemic chemical agents while Treatment 5 utilized a local systemic growth regulator, Prime +. Treatment 6 was also a multi-pass system. It utilized a tank mix of a systemic (KMH) and a local systemic (Prime +) followed by a second application of Prime +. The tank mix was an experimental mixture and was not federally labeled by the Environmental Protection Agency (EPA) for use on tobacco. Finally, Treatment 7 was another approach using Prime + designed to tap potential yield advantages on an individual plant basis thought to be associated with early topping and the longer period of sucker control given by Prime +.

Table 2.1. Descriptions Of Sucker Control Systems Used In Field Production Of Burley Tobacco, Tobacco Experiment Station, Greeneville, Tennessee, 1983-1985.

Treatment Number	Topping Method[a]	Sucker Control Method[b]
1[c]	At full flower, top all plants.	Machine apply KMH, 2 gallons per acre.
2	At 50 percent early flower, top all plants.	Machine apply KMH, 2 gallons per acre.
3	At 50 percent early flower, top all plants.	Machine apply FST-7, 3 gallons per acre.
4	At 50 percent early flower, top all plants.	Machine apply OST-85, 2 gallons per acre followed by KMH, 2 gallons per acre (5-10 days later).
5	At 50 percent early flower, top all plants.	Machine apply P+, 1 gallon per acre.
6	At 10 percent early flower, top flowering plants.	Hand apply tank mix, (.5 gallon P+ and 1 gallon KMH per acre).
	Top remaining plants at 50 percent early flower.	Machine apply P+, 1 gallon per acre.
7	Top plants as they come into early flower.	Hand apply P+, 1 gallon per acre.

[a]The term "early flower", as used in this analysis, refers to the bloom stage in which at least one corolla is open. The term "full flower"refers to bloom stage in which the majority of all corollas are open.

[b]Rates given in actual material, "machine" means applied with self-propelled high clearance sprayer, "hand" means applied with hand sprayer. The symbol "KMH" stands for maleic hydrazide, "OST-85" stands for Off-Shoot T-85, "FST-7" stands for FST-7, and "P+" stands for Prime +.

[c]Base or control treatment.

Prior to implementing each treatment, flower counts were taken. Each plot was topped according to treatment description and topping labor was recorded. Treatment sucker control agents were then applied and labor data for hand sprayed applications were recorded. Labor data for machine applications were later synthesized. Following treatment application, plots were inspected for degree of sucker control and remaining suckers were taken out by hand prior to harvest. Again labor data were recorded.

At harvest, all tobacco in each treatment was cut the same day according to widely accepted cultural practices. The center two rows of tobacco from each plot were used to obtain yield and quality data. The tobacco was then barned and cured in a manner that was consistent for all treatments.

In the market preparation stage, tobacco stalks were stripped of the cured leaves which were then placed in one of three grades corresponding to a particular stalk position and color. Each grade within a given plot was then weighed. Finally, a federal government quality grade was assigned by a USDA tobacco grader to the samples of all farm grades in the experiment.

CHEMICAL APPLICATION ALTERNATIVES

Two chemical application methods were utilized in this study, a manually operated hand sprayer and a self-propelled, high clearance (machine) sprayer. Labor data from treatments utilizing the hand sprayer were collected at the time of chemical application. Spraying labor requirements for the treatments utilizing the machine sprayer were later estimated or synthesized after the completion of the three-year experiment. Estimations of machine labor requirements involved making assumptions regarding field efficiencies, ground speeds, and boom widths that were considered feasible and typical for burley production conditions in Tennessee.

FRAMEWORK OF ECONOMIC ANALYSIS

The framework of the economic analysis used to evaluate the costs and returns associated with each sucker control system involved partial budgeting techniques. Each sucker control system represents only one bundle of inputs at a single usage level within the overall production process. Also, each system is uniquely defined as only one of several subproduction functions in only one of several possible overall production functions (meaning that it is a part of a production function for burley tobacco that is apart from the other systems each with its own function). Therefore, marginal analysis evaluating incremental changes within a single system was not used directly. As a result, concepts such as change in total value product (TVP), total factor costs (TFC), or net value product (NVP), which were used in this partial budgeting analysis, refer to comparisons made between alternative sucker control systems and a base system, each having unique production functions.

Partial budgeting as outlined by Boehlje and Eidman (1984, pp.237-241) is a method by which potential profit (gains or losses) resulting from changes in a pre-existing whole farm or enterprise plan can be estimated prior to the implementing of a given alternative. Instead of building complete budgets for each alternative burley tobacco production process utilizing a different sucker control system, partial budgets can be used to calculate only the changes in costs and returns that would occur as a result of implementing an alternative system instead of a base system while keeping all other costs of production constant.

The general framework for partial budgeting, after a basis for comparison has been established, involves first determining additional returns and reduced costs that would occur had an alternative system been implemented. Then, reduced returns and additional costs are calculated. Finally, the subtotal of reduced returns and additional costs is subtracted from the subtotal of additional returns and reduced costs to obtain an overall difference in terms of net income of the alternative system in comparison to the base system (Boehlje and Eidman, 1984, p.237).

In keeping within the context of production economics instead of using the underlying accounting terminology typically associated with partial budgeting, terminology common to production economics such as total physical product (TPP), total value product (TVP), total factor costs (TFC), and net value product (NVP) were used in this analysis. As a result of using such terminology, the traditional partial budgeting framework was altered by adding costs of production that were not directly or indirectly attributed to the control of suckers and assumed to be constant across treatments.

This step, though unnecessary, did not affect the results of the analysis, and was undertaken to obtain an NVP that was more manageable for discussion as well as more realistic.

FRAMEWORK OF STATISTICAL ANALYSIS

The statistical models used to analyze the experiment data were analysis-of-variance models of less than full rank which were constructed by using dummy variables in a regression model as outlined by Freund and Littell (1981, pp.85-116). This technique was used primarily because of an unbalanced design (which resulted from having three replications of treatments in 1983 and four replications in 1984 and 1985) and the nature of the initially formulated null hypotheses. The single equation statistical models consisted of the respective dependent variables', yield (TPP), quality (price), total value product TVP), total factor costs (TFC), and net value product (NVP). Other dependent variables included in the analysis were topping labor (TPL), clean-out labor (COL), and total labor (TOT) attributed to the control of suckers. Each of the above eight dependent variables were functions of the discrete class variables, year, treatment, and replication. Interaction between the discrete class variables was considered. However, because of limited degrees of freedom and the increased probability of incurring multicollinearity from added interaction variables, only the interaction between year and treatment effects was hypothesized to be agronomically and economically important.

To aid in the analysis of the null hypotheses concerning treatment comparisons (in addition to an overall analysis of variance), comparisons or "contrasts" of treatment means were undertaken in terms of the dependent variables using the computer program package, SAS, Release 6.02, 1985. As defined by Freund and Littell (1981, p.98) a "contrast" is a linear function in which the elements of the coefficient vector sum to zero for each effect (year, treatment, or replication). Using SAS, a sum of squares and resulting F statistic test were calculated for each treatment comparison or contrast. The minimum criterion for significance testing of differences between contrasted treatment means used in this analysis was the .05 level of significance.

Physical and agronomic data on variables such as yield, quality, and various labor components were analyzed statistically. Also, because of access to new computer systems and programming packages, economic data on variables such as TVP, TFC, and NVP were easily analyzed. By building budgets using an electronic spreadsheet (Lotus 1-2-3, Release 2, 1985) for all sucker control systems (treatments) across all replications and years, the necessary economic data for all observations were calculated for statistical analysis.

The null hypotheses and the resulting contrasting statements were formulized prior to the analysis of the data. The hypotheses were formulated with the tobacco producer in mind in an attempt to establish relevant questions from a manager's perspective.

The primary null hypothesis tested was that no significant difference existed in terms of the dependent variables between the control or base treatment, Treatment 1, and each of the treatments utilizing early topping, Treatments 2 through 7 due to treatment effect. A second relevant hypothesis tested was that no significant difference existed in terms of the same dependent variables between Treatment 2, utilizing KMH in conjunction with early topping, and other treatments utilizing early topping, Treatments 3 through 7, due to treatment effect. This hypothesis was formulated to determine advantages or disadvantages of switching to another sucker control chemical agent in the event that early topping was incorporated into the production of burley tobacco given that KMH is the most commonly used sucker control chemical agent in Tennessee.

YIELD

Yields were measured for each individual plot across all three years to obtain a measure of TPP associated with each sucker control system. At harvest, the center two rows of each plot were cut, barned, and cured. Each stalk was stripped of all leaves which were then graded and weighed. Yield for each plot was measured in terms of pounds per acre by dividing the plot plant density (plants per acre) by the number of plants harvested per plot and then multiplying by the total weight of all leaves graded per plot.

The growing conditions encountered at the Greeneville Experiment Station from 1983 through 1985 were normal to near normal at that location. The burley tobacco growing seasons, as evident by documented temperature and rainfall data, were well within a range considered normal for Tennessee with the exception of 1984 which received excessive rainfall during May and July. The station was spared for the most part the extreme drought conditions experienced by most of Tennessee during 1983.

PRICE AND QUALITY

The quality of cured leaf associated with each sucker control system was another concern of this analysis because of its potential effect on TVP. However, unlike yield, quality is difficult to quantify. A belt-wide average market price by federal grade for the 1986 season was used as a proxy variable for quality. Within a given plot (observation), tobacco leaves, after being stripped from stalks, were placed in one of three farm grades primarily according to stalk position and color and then assigned a USDA quality grade. Each grade was then weighed and this weight was multiplied by the established belt-wide market price for that assigned grade. The resulting products were then summed across assigned grades for that plot and divided by the total leaf weight per plot to obtain a weighted average market price per plot (observation).

Using any proxy variable has potential shortcomings. In this particular case, market prices are currently undergirded by a USDA price support system. Prior to each market season, a support price is established for each USDA quality grade. Because of institutional rigidity, the price support system is not always sensitive to changing market conditions. As a result, buyer perceptions of tobacco quality may differ from that of USDA. Therefore, market prices may not adequately reflect quality as set forth by USDA quality grades. Nevertheless, this system was used in the analysis because no method was currently available that better quantified the quality of burley tobacco.

CHANGE IN TOTAL VALUE PRODUCT

Within the context of a partial budgeting framework, change in total value product (TVP) for this analysis was difference (added or reduced) in TVP of a given sucker control system or treatment when compared to the TVP of the base treatment. By determining change in TVP in this manner, differences were evaluated in terms of combined yield and quality between pairs of treatments or treatment groups utilizing early topping in comparison to the conventional or base treatment utilizing late topping.

In general, change in TVP was calculated by first determining the total physical product (TPP) or yield of a given plot and then multiplying by the corresponding weighted average market price for burley tobacco. After calculating TVP for each individual plot, a simple overall mean TVP for each treatment was determined. This was done by summing all the individual plot TVP's of a single treatment and then dividing by the total number of replications across all three years within that particular treatment. After estimating the overall mean TVP of each treatment, a base treatment TVP was subtracted from each alternative treatment TVP to determine change in TVP.

DIRECT, INDIRECT, AND OTHER COSTS OF PRODUCTION

To compare input requirements of alternatives within a production process from an economic standpoint for making managerial decisions, only those inputs that are relevant to the decision making process need to be considered. In evaluating costs of alternative sucker control systems, only those costs (using 1986 prices) that were directly and indirectly attributed to a particular sucker control system were considered relevant. Therefore, all costs of production and marketing of burley tobacco that were not directly or indirectly attributed to the control of suckers, were assumed to be constant across all treatments and experimental years.

Costs that were directly attributed to sucker control included labor costs incurred from topping, spraying (for those treatments using hand sprayers), and clean-out of missed suckers prior to harvest. Other direct costs included the cost of owning and operating a hand sprayer system, the costs of the various sucker control chemical agents, and machinery costs attributed to those systems utilizing the self-propelled, high clearance sprayer.

Machine labor requirements were initially synthesized based on assumed machine field efficiencies, ground speeds, and boom widths that were deemed typical for Tennessee burley tobacco machine sprayer owners. However, further consideration led to the realization that an excessive number of assumptions would have to be made to determine other variable and fixed machine costs because of both the wide variety of machine types and scarcity of farmer-owned self-propelled, high clearance sprayers used in Tennessee burley tobacco production. The use of custom machine rates in the analysis was deemed to be more realistic. Therefore, budgets for those treatments using a machine sprayer contain a single custom machine rate (obtained for this analysis through a phone survey of local suppliers of custom services) instead of estimated costs of owning and operating a machine sprayer.

Costs that were indirectly attributed to sucker control included farm-to market hauling costs, custom grading costs, program or no-net costs incurred by producers who support the price support system, and a marketing cost or fee. Such costs were considered indirect because they are directly influenced by yield which in turn can be directly influenced by the sucker control system used.

Costs of production that were neither directly nor indirectly attributed to sucker control were treated as constants across all treatment budgets. Such costs were estimates from enterprise budgets developed by the University of Tennessee Agricultural Extension Service (Johnson et.al., 1986, pp. 8-9). Costs of production not initially included in treatment budgets were quota, land,

and management. Therefore, net value product (NVP) in this analysis was initially a measure of net returns to quota, land, and management on a per acre basis. However, burley tobacco producers attempt to maximize net returns to their most limiting resource in order to maximize overall net returns. Because individual producers vary in regard to their most limiting resource, NVP was also estimated as a measure of net returns to each of four factors of production (land, sucker control labor, nonlabor capital for sucker control, and quota) plus management. Return to management was included as a residual in each of the four residual returns because management is extremely difficult to quantify. Finally, with estimated, calculated and/or imputed costs to all factors of production except management, a residual return (NVP) to management was calculated.

CHANGE IN TOTAL FACTOR COSTS

Another aspect of the partial budgeting technique, besides the evaluation of change in TVP between alternative sucker control systems, was the evaluation of changes in total factor costs (TFC). Total factor costs within the framework of production economics includes both variable and fixed costs incurred from the use of required inputs within the production process. In this analysis, change in TFC refers to differences (added or reduced) in costs incurred by an alternative sucker control system when compared to a base system.

Change in TFC was determined in a manner similar to the determination of change in TVP. Overall treatment means were determined by summing the individual plot TFC's and then dividing by the total number of replications across all three years within a particular treatment. After the overall mean TFC of each treatment was estimated, each treatment utilizing early topping was subtracted from the base treatment to determine the change in TFC.

CHANGE IN NET VALUE PRODUCT

A primary objective of partial budgeting is to evaluate the differences in net value product (NVP) of alternative plans within an entire farm operation or single enterprise such as burley tobacco. Net value product can be defined as the difference in TVP and TFC associated with a given enterprise. In this analysis, change in NVP is the difference (added or reduced) in the net returns associated with a given sucker control system when compared to the base sucker control system.

Net value product (NVP) was calculated for each treatment plot and an overall treatment mean NVP was estimated for each sucker control system. An overall net advantage or disadvantage of selecting one alternative system over another was determined by subtracting the mean NVP of each alternative treatment from the base system.

CHAPTER 3

YIELD, QUALITY, TOTAL VALUE PRODUCT, AND CHANGE IN TOTAL VALUE PRODUCT

Results associated with each of the selected sucker control systems were obtained after compiling data from the Greeneville Tobacco Experiment Station and analyzing it as outlined in the previous chapter. In this chapter is presented the results of the three-year experiment in terms of yield (TPP), quality (price), total value product (TVP), and change in total value product (TVP) as calculated for each sucker control system.

YIELDS

Mean yields (pounds per acre) were estimated for each treatment across all years and replications and are presented in Table 3.1. Each treatment is ranked (third column) from 1 to 7 with 1 being the highest yield and 7 the lowest. Change in yield and percent change in yield are also presented as measures of differences in total physical product (TPP) of each alternative treatment, Treatments 2 through 7, compared to the base or control treatment, Treatment 1.

Each alternative treatment (using early topping) had yields greater than the control treatment utilizing maleic hydrazide (KMH) in conjunction with late topping. Treatment 5 (Prime +, 1 gallon per acre, machine applied) had the highest yield of 3023 pounds per acre which was 293 pounds or 9.7 percent greater than Treatment 1.

Table 3.1. Mean Yields with Ranking, Change in Yield, and Percent Change in Yield of Selected Sucker Control Systems for Burley Tobacco (Treatment 1 vs. Treatments 2-7).

Treatment Number[a]	Mean Yield[b] (lbs./acre)	Rank[c]	Change in Yield[d] (lbs./acre)	Percent Change in Yield[e]
1[f]	2731	7	----	----
2	2923	2	193	6.6
3	2775	6	45	1.6
4	2825	5	94	3.3
5	3023	1	293	9.7
6	2834	4	104	3.7
7	2866	3	136	4.7

[a]A description of treatments is in Table 2.1.

[b]Mean yield for each treatment is a simple average of observed data at Greeneville, Tennessee, across all years (1983-1985) and replications.

[c]Yields are ranked from highest to lowest with 1 being the highest and 7 the lowest.

[d]Change in yield for each treatment was calculated by subtracting the mean yield of the base or control treatment, Treatment 1, from each alternative treatment yield.

[e]Percent change in yield = $\frac{\text{alternative treatment yield - control yield}}{\text{control yield}} \times 100.$

[f]Control or base treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Treatment 2 (KMH, 2 gallons per acre, machine applied) had the second highest yield of 2923 pounds per acre which was 193 pounds or 6.6 percent greater than Treatment 1. Treatment 7 using Prime +, hand applied of 1 gallon per acre had the third highest yield of 2866 pounds per acre. Treatments 6 and 4 had yields of 2834 and 2825 pounds per acre, respectively. Treatment 3 using FST-7 had the smallest yield of the alternative treatments. At 2775 pounds per acre, its yield was only 45 pounds or 1.6 percent greater than Treatment 1.

The results of one aspect of the statistical analysis which contrasted or compared the mean yields of each alternative treatment to the control treatment are shown in Table 3.2. This analysis was done to test the null hypothesis of no difference, statistically, between the yield of each alternative treatment and the control treatment yield due to treatment effect at least at the .05 level of significance. The third column of the table is a listing of the mean yield contrasting statements (SAS, Release 6.02, 1985). The fourth and fifth columns list the results of a statistical analysis using an F distribution to test for significant differences between paired comparisons of treatment means. The fourth is a listing of the calculated F value while the fifth column is a listing of the probability that an F ratio that is greater than the calculated F ratio will occur by chance (Tashman and Lamborn, 1979, p.445). In other words, the fifth column is a listing of the probability of making an error in rejecting the null hypothesis.

Table 3.2. Results of Analysis of Variance of Mean Yield Comparisons Between Selected Sucker Control Systems for Burley Tobacco (Treatment 1 vs. Treatments 2-7).

Treatment Number[a]	Mean Yield[b] (lbs./acre)	Treatment Mean Yield Comparison[c]	F Value[d]	Probability > F[e]
1[f]	2731	----	----	----
2	2923	1 vs. 2	2.58	0.113
3	2775	1 vs. 3	0.14	0.712
4	2825	1 vs. 4	0.62	0.434
5	3023	1 vs. 5	5.98	0.017
6	2834	1 vs. 6	0.75	0.389
7	2866	1 vs. 7	1.28	0.261

[a]A description of treatments is in Table 2.1.

[b]Mean yield for each treatment is a simple average of observed data at Greeneville, Tennessee across all years (1983-1985) and replications.

[c]Listing of contrasting statements or treatment mean yields being compared.

[d]Calculated F value. Year and replication effect were significant at least at the .05 level of significance in explaining variation in yield (Appendix, Table A.1). However, overall treatment effect was nonsignificant at the .05 level.

[e]Probability of making an error in rejecting the null hypothesis of no difference between Treatment 1 and the respective alternative treatment. Treatment 5 mean yield is significantly different from the mean yield of Treatment 1 at the .017 level of significance.

[f]Control or base treatment used for paired comparison with each of Treatments 2 through 7.

Though each alternative treatment had yields greater than Treatment 1, only Treatment 5 had a mean yield that was significantly different, statistically, at least at the .05 level of significance. Treatment 2 with the second ranked mean yield as well as the other treatments were not significantly different from Treatment 1 at the .05 level of significance or better.

Tables 3.3 and 3.4 are similar to Tables 3.1 and 3.2 with one exception. The results of comparisons made between Treatment 2 and Treatments 3 through 7 are shown in Tables 3.3 and 3.4. Such comparisons were undertaken to test the null hypothesis of no difference in terms of yield due to treatment effect between Treatment 2 using KMH in conjunction with early topping and the other treatments using early topping. Only Treatment 5 had a mean yield that was greater than Treatment 2 (Table 3.3). However, as indicated in Table 3.4, no treatment yield was significantly different from Treatment 2 at the .05 level of significance.

PRICES AND QUALITY

A belt-wide seasonal average market price (1986) was used as a proxy variable for quality and a weighted average market price was calculated for each plot. The mean market price in dollars per hundredweight ($ per cwt.) for each treatment which is a simple average across all replications and years are shown in Table 5.

Table 3.3. Mean Yields with Ranking, Change in Yield, and Percent Change in Yield of Selected Sucker Control Systems for Burley Tobacco Topped at Early Flower (Treatment 2 vs. Treatments 3-7).

Treatment Number[a]	Mean Yield[b] (lbs./acre)	Rank[c]	Change in Yield[d] (lbs./acre)	Percent Change in Yield[e]
2[f]	2923	2	----	----
3	2775	6	-148	-5.1
4	2825	5	-98	-3.4
5	3023	1	100	3.4
6	2834	4	-89	-3.0
7	2866	3	-57	-2.0

[a]A description of treatments is in Table 2.1.

[b]Mean yield for each treatment is a simple average of observed data at Greeneville, Tennessee, across all years (1983-1985) and replications.

[c]Yields are ranked from highest to lowest with 1 being the highest and 6 the lowest.

[d]Change in yield for each treatment was calculated by subtracting the mean yield of Treatment 2 from from each alternative treatment yield.

[e]Percent change in yield = $\frac{\text{alternative treatment yield - Treatment 2 yield}}{\text{Treatment 2 yield}}$ X 100.

[f]Basis for paired comparisons with each of Treatments 3 through 7.

Table 3.4. Results of Analysis of Variance of Mean Yield Comparisons Between Selected Sucker Control Systems for Burley Tobacco Topped at Early Flower (Treatment 2 vs. Treatments 3-7).

Treatment Number[a]	Mean Yield[b] (lbs./acre)	Treatment Mean Yield Comparison[c]	F Value[d]	Probability > F[e]
2[f]	2923	----	----	----
3	2775	2 vs. 3	1.41	0.240
4	2825	2 vs. 4	0.62	0.434
5	3023	2 vs. 5	0.65	0.424
6	2834	2 vs. 6	0.51	0.480
7	2866	2 vs. 7	0.21	0.651

[a]A description of treatments is in Table 2.1.

[b]Mean yield for each treatment is simple average of observed data at Greeneville, Tennessee across all years (1983-1985) and replications.

[c]Listing of contrasting statements or treatment mean yields being compared.

[d]Calculated F value. Year and replication effect were significant at least at the .05 level of significance in explaining variation in yield (Appendix, Table A.2). However, overall treatment effect was nonsignificant at the .05 level.

[e]Probability of making an error in rejecting the null hypothesis of no difference between Treatment 2 and the respective alternative treatment.

[f]Basis for paired comparison with each of Treatments 3 through 7.

Table 3.5. Ranking and Mean Seasonal Average Market Price ($/cwt.) Received for Burley Tobacco Produced Under Selected Sucker Control Systems.

Treatment Number[a]	Mean Seasonal Average Market Price[b] ($/cwt.)	Rank[c]
1	151.04	3
2	149.91	7
3	150.29	6
4	151.06	2
5	151.59	1
6	150.57	5
7	150.67	4

[a]A description of treatments is in Table 2.1.

[b]Mean of weighted belt-wide seasonal average market price (1986) for a given treatment is a simple average across all years and replications (1983-1985).

[c]Prices are ranked from highest to lowest with 1 being the highest and 7 the lowest.

Each treatment is again ranked from 1 to 7. The highest average price of $151.59 per cwt. was for tobacco from Treatment 5 while tobacco from Treatment 4 had the second highest price of $151.06 per cwt. The control treatment, Treatment 1, had the third highest price of $151.04 per cwt. The fourth and fifth ranked prices belonged to Treatments 7 and 6, respectively, while Treatment 3 had the sixth ranked price. Treatment 2 had a price of $149.91 per cwt. which was the lowest price among all treatments.

The results of the statistical analysis which compared treatment mean prices are shown in Tables 3.6 and 3.7. Such comparisons were made to test the null hypotheses of no difference in terms of price between Treatment 1 and each alternative, Treatments 2 through 7, and that of no difference in terms of price between Treatment 2 and each alternative treatment, Treatments 3 through 7.

Table 3.6 contains results of mean market price comparisons made between Treatment 1 and each alternative treatment as indicated by the third, fourth, and fifth columns. None of the alternative treatments were significantly different from Treatment 1 at the .05 level of significance, including the highest ranked treatment, Treatment 5.

Table 3.7 contains results of mean market price comparisons made between Treatment 2 and Treatments 3 through 7. Again, there were no significant differences between these early-topped treatments, particularly between Treatment 2, the lowest ranked, and Treatment 5, the highest ranked.

Table 3.6. Results of Analysis of Variance of Mean Market Price (1986) Comparisons Between Selected Sucker Control Systems for Burley Tobacco (Treatment 1 vs. Treatments 2-7).

Treatment Number[a]	Mean Seasonal Average Market Price[b] ($/cwt.)	Treatment Mean Market Price Comparison[c]	F Value[d]	Probability > F[e]
1[f]	151.04	----	----	____
2	149.91	1 vs. 2	0.64	0.428
3	150.29	1 vs. 3	0.28	0.598
4	151.06	1 vs. 4	0.00	0.992
5	151.59	1 vs. 5	0.15	0.703
6	150.57	1 vs. 6	0.11	0.744
7	150.67	1 vs. 7	0.07	0.796

[a]A description of treatments is in Table 2.1.

[b]Mean of weighted belt-wide seasonal average market price (1986) for a given treatment is a simple average across all years and replications (1983-1985).

[c]Listing of contrasting statements or treatment mean prices being compared.

[d]Calculated F value. Year effect was significant at least at the .05 level of significance in explaining variation in price (Appendix, Table A.1). However, overall treatment and replication effects were nonsignificant at the .05 level.

[e]Probability of making an error in rejecting the null hypothesis of no difference between Treatment 1 and the respective alternative treatment.

[f]Control or base treatment used for comparison with each of Treatments 2 through 7.

Table 3.7. Results of Analysis of Variance of Mean Market Price (1986) Comparisons Between Selected Sucker Control Systems for Burley Tobacco Topped at Early Flower (Treatment 2 vs. Treatments 3-7).

Treatment Number[a]	Mean Seasonal Average Market Price[b] ($/cwt.)	Treatment Mean Market Price Comparison[c]	F Value[d]	Probability > F[e]
2[f]	149.91	----	----	----
3	150.29	2 vs. 3	0.07	0.793
4	151.06	2 vs. 4	0.64	0.428
5	151.59	2 vs. 5	1.36	0.248
6	150.57	2 vs. 6	0.22	0.644
7	150.67	2 vs. 7	0.28	0.598

[a]A description of treatments is in Table 2.1.

[b]Mean of weighted belt-wide seasonal average market price (1986) for a given treatment is a simple average across all years and replications (1983-1985).

[c]Listing of contrasting statements or treatment mean prices being compared.

[d]Calculated F value. Year effect was significant at least at the .05 level of significance in explaining variation in price (Appendix, Table A.1). However, overall treatment and replication effects were nonsignificant at the .05 level.

[e]Probability of making an error in rejecting the null hypothesis of no difference between Treatment 2 and the respective alternative treatment.

[f]Basis for paired comparison with each of Treatments 3 through 7.

TOTAL VALUE PRODUCT AND CHANGE IN TOTAL VALUE PRODUCT

Mean total value products (TVP) in dollars per acre were estimated for each treatment across all years and replications and are presented in Table 3.8. Each treatment is ranked from highest to lowest. Change in TVP and percent change in TVP are also presented as measures of differences in total revenue between the control treatment and each alternative treatment.

Again, all alternative treatments had greater TVP's than the control treatment (late-topped, KMH, machine applied) primarily because of the influence of yield on TVP. The highest TVP of $4612 per acre was for Treatment 5 which was $476 or 11.5 percent greater than Treatment 1. The second highest TVP of $4412 per acre was for Treatment 2 which was $276 or 6.7 percent greater than Treatment 1. Treatment 7 had the third highest TVP of $4345 per acre. Treatments 6 and 4 had TVP's of $4298 and $4293 per acre, respectively, while Treatment 3 had the smallest TVP among the alternative treatments topped at early flower of $4211 per acre which was 75 dollars or 1.8 percent greater than Treatment 1.

The results of the statistical analysis which contrasted the mean TVP's of each alternative treatment to the control treatment are shown in Table 3.9. The null hypothesis of no difference statistically between each of the alternative treatment TVP's and the control treatment TVP due to treatment effect was tested at the .05 level of significance. As with the mean yield comparisons, only Treatment 5 (Prime +, machine applied) had a TVP that was

Table 3.8. Mean Total Value Products (TVP) with Ranking, Change in TVP, and Percent Change in TVP of Selected Sucker Control Systems for Burley Tobacco (Treatment 1 vs. Treatments 2-7).

Treatment Number[a]	Mean Yield[b] ($/acre)	Rank[c]	Change in TVP[d] ($/acre)	Percent Change in TVP[e]
1[f]	4136	7	----	----
2	4412	2	276	6.7
3	4211	6	75	1.8
4	4293	5	157	3.8
5	4612	1	476	11.5
6	4298	4	162	3.9
7	4345	3	209	5.1

[a]A description of treatments is in Table 2.1.

[b]Mean TVP for each treatment is a simple average across all years (1983-1985) and replications. Total value product was calculated for each plot (yield or TPP x weighted 1986 price) prior to calculation of treatment means.

[c]Mean TVP's are ranked from highest to lowest with 1 being the highest and 7 the lowest.

[d]Change in TVP for each treatment was calculated by subtracting the mean TVP of the base treatment, Treatment 1, from each alternative treatment TVP.

[e]Percent change in TVP = $\frac{\text{alternative treatment TVP} - \text{base TVP}}{\text{base TVP}} \times 100.$

[f]Control or base treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Table 3.9. Results of Analysis of Variance of Mean TVP Comparisons Between Selected Sucker Control Systems for Burley Tobacco (Treatment 1 vs. Treatments 2-7).

Treatment Number[a]	Mean TVP[b] ($/acre)	Treatment TVP Comparison[c]	F value[d]	Probability > F[e]
1[f]	4136	----	----	----
2	4412	1 vs. 2	1.83	0.181
3	4211	1 vs. 3	0.14	0.714
4	4293	1 vs. 4	0.59	0.445
5	4612	1 vs. 5	5.44	0.023
6	4298	1 vs. 6	0.63	0.432
7	4345	1 vs. 7	1.05	0.309

[a]A description of treatments is in Table 2.1.

[b]Mean TVP for each treatment is a simple average across all years (1983-1985) and replications. Total value product was calculated for each plot (yield or TPP x weighted 1986 price) prior to calculation of treatment means.

[c]Listing of contrasting statements or treatment mean TVP's being compared.

[d]Calculated F value. Year and replication effects were significant at least at the .05 level of significance in explaining variation in TVP (Appendix, Table A.1). However, overall treatment effect was nonsignificant at the .05 level.

[e]Probability of making an error in rejecting the null hypothesis of no difference in Treatment 1 and the respective alternative treatment.Treatment 5 mean TVP is significantly different from the mean TVP of Treatment 1 at the .023 level of significance.

[f]Control or base treatment used for paired comparison with each of Treatments 2 through 7.

significantly different from Treatment 1. All other alternative treatments were not significantly different from Treatment 1.

Tables 3.10 and 3.11 contain the results of comparisons made between Treatments 2 and Treatments 3 through 7 to test the null hypothesis of no statistical difference due to treatment effect in terms of TVP between Treatment 2 using KMH machine applied in conjunction with early topping and the other treatments using early topping and chemical combinations that differed from Treatment 2.

The highest ranked treatment, Treatment 5, had a TVP that was $200 per acre or 4.5 percent greater than Treatment 2. All other early-topped treatments had $67 to $201 per acre less TVP than Treatment 2 (Table 3.10). As presented by Table 3.11 however, none of the early topped treatments, including Treatment 5, were significantly different from Treatment 2 at the .05 level of significance or better.

Table 3.10. Mean Total Value Products (TVP) with Ranking, Change in TVP, and Percent Change in TVP for Selected Sucker Control Systems for Burley Tobacco Topped at Early Flower (Treatment 2 vs. Treatments 3-7).

Treatment Number[a]	Mean Yield[b] ($/acre)	Rank[c]	Change in TVP[d] ($/acre)	Percent Change in TVP[e]
2	4412	2	----	----
3	4211	6	-201	-4.6
4	4293	5	-119	-2.7
5	4612	1	200	4.5
6	4298	4	-114	-2.6
7	4345	3	-67	-1.5

[a]A description of treatments is in Table 2.1.

[b]Mean TVP for each treatment is a simple average across all years (1983-1985) and replications. Total value product was calculated for each plot (yield or TPP x 1986 weighted price) prior to calculation of treatment means.

[c]Mean TVP's are ranked from highest to lowest 1 with one being the highest and 6 the lowest.

[d]Change in TVP for each treatment was calculated by subtracting the mean TVP of Treatment 2 from each alternative treatment TVP.

$$^{e}\text{Percent change in TVP} = \frac{\text{alternative treatment TVP} - \text{Treatment 2 TVP}}{\text{Treatment 2 TVP}} \times 100$$

[f]Basis for paired comparison with each of Treatments 3 through 7.

Table 3.11. Results of Analysis of Variance of Mean TVP Comparisons Between Selected Sucker Control Systems for Burley Tobacco Topped at Early Flower (Treatment 2 vs. Treatments 3-7).

Treatment Number[a]	Mean TVP[b] ($/acre)	Treatment TVP Comparison[c]	F value[d]	Probability > F[e]
2[f]	4412	----	----	----
3	4211	2 vs. 3	0.91	0.344
4	4293	2 vs. 4	0.32	0.573
5	4612	2 vs. 5	0.90	0.347
6	4298	2 vs. 6	0.30	0.589
7	4345	2 vs. 7	0.10	0.752

[a]A description of treatments is in Table 2.1.

[b]Mean TVP for each treatment is a simple average across all years (1983-1985) and replications. Total value product was calculated for each plot (yield or TPP x weighted 1986 price) prior to calculation of treatment means.

[c]Listing of contrasting statements or treatment mean TVP's being compared.

[d]Calculated F value. Year and effect was significant at least at the .05 level of significance in explaining variation in TVP (Appendix, Table A.2). However, overall treatment and replication effects were nonsignificant at the .05 level.

[e]Probability of making an error in rejecting the null hypothesis of no difference between Treatment 2 and the respective alternative treatment.

[f]Basis for paired comparison with each of Treatments 3 through 7.

CHAPTER 4

TOTAL FACTOR COSTS AND CHANGE IN TOTAL FACTOR COSTS

In this chapter is presented the total factor costs (TFC) associated with the productive process of burley tobacco and specific changes in TFC across the selected sucker control systems. In this analysis, total factor costs (TFC) refer to all costs of production and marketing with the exception of quota, land, and managerial costs, as outlined in Chapter 2. Only those costs that were directly and indirectly attributed to a particular sucker control system varied among treatments. Other costs of production were considered constant across treatments and were included in this analysis only to obtain a net value product (NVP) for each treatment budget that was more manageable and realistic.

DIRECT COSTS ASSOCIATED WITH SELECTED SUCKER CONTROL SYSTEMS

Direct costs, incurred as a result of implementing a given sucker control system, are presented in Tables 4.1 through 4.9. Mean labor and labor costs are presented in Tables 4.1 through 4.7 while sucker control chemical and sprayer application equipment costs are presented in Table 4.8. A summary of all direct costs associated with each selected sucker control system is shown in Table 4.9.

Table 4.1. Mean Topping Labor with Associated Costs, Ranking, and Mean Comparisons (Treatment 1 vs. Treatments 2-7) of Selected Sucker Control Systems for Burley Tobacco.

Treatment Number[a]	Mean Topping Labor[b]	Mean Topping Labor Costs[c]	Rank[d]	Treatment 1 vs. Treatments 2-7[e]
	(labor-hrs./acre)	($/acre)		($/acre)
1[f]	18.05	81.24	1	----
2	8.36	37.61	6	-43.63
3	8.64	38.89	3	-42.35
4	8.44	37.98	5	-43.26
5	8.52	38.32	4	-42.92
6	8.02	36.09	7	-45.15
7	12.09	54.41	2	-26.83

[a]A description of treatments is in Table 2.1.

[b]Mean topping labor requirement of each treatment is a simple average of observed data at Greeneville, Tennessee across all years (1983-1985) and replications.

[c]Mean topping labor cost for each treatment was calculated by multiplying the labor requirement of each treatment plot by the wage rate ($4.50/hour) and then determining a simple average across all years (1983-1985) and replications.

[d]Mean topping labor costs are ranked from highest to lowest with 1 being the highest and 7 the lowest.

[e]Mean topping labor cost comparisons with Treatment 1 were calculated by subtracting the mean labor cost incurred by Treatment 1 from each respective alternative treatment mean labor cost.

[f]Control or base treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Table 4.2. Results of Analysis of Variance of Mean Topping Labor Comparisons Between Selected Sucker Control Systems for Burley Tobacco (Treatment 1 vs. Treatments 2-7).

Treatment Number[a]	Mean Topping Labor[b] (labor-hrs./acre)	Treatment Mean Topping Labor Comparison[c]	F Value[d]	Probability > F[e]
1[f]	18.05	----	----	----
2	8.36	1 vs. 2	19.76	0.0001
3	8.64	1 vs. 3	18.62	0.0001
4	8.44	1 vs. 4	19.44	0.0001
5	8.52	1 vs. 5	19.12	0.0001
6	8.02	1 vs. 6	21.16	0.0001
7	12.09	1 vs. 7	7.48	0.0080

[a]A description of treatments is in Table 2.1.

[b]Mean topping labor for each treatment is a simple average of observed data at Greeneville, Tennessee across all years (1983-1985) and replications.

[c]Listing of contrasting statements or topping labor treatment means being compared.

[d]Calculated F value. Year and treatment effects were significant at least at the .05 level of significance in explaining variation in topping labor (Appendix, Table A.1).

[e]Probability of making an error in rejecting the null hypothesis of no difference between Treatment 1 and each of Treatments 2 through 7. All topping labor means of Treatments 2 through 6 were significantly different from Treatment 1 at the .0001 level of significance. Treatment 7 was significantly different at the .008 level of significance.

[f]Base or control treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Table 4.3. Mean Spraying Labor with Associated Costs, Ranking, and Mean Comparisons (Treatment 1 vs. Treatments 2-7) of Selected Sucker Control Systems for Burley Tobacco.

Treatment Number[a]	Mean Spraying Labor[b] (labor-hrs./acre)	Mean Spraying Labor and Custom Rate Costs[c] ($/acre)			Treatment 1 vs. Treatments 2-7[d] ($/acre)
		Hand	Machine	Total	
1[e]	----	0.00	25.00	25.00	----
2	----	0.00	25.00	25.00	0.00
3	----	0.00	25.00	25.00	0.00
4	----	0.00	50.00	50.00	25.00
5	----	0.00	25.00	25.00	0.00
6	2.22	9.99	25.00	34.99	9.99
7	10.52	47.34	00.00	47.34	22.34

[a]A description of treatments is in Table 2.1.

[b]Mean spraying labor requirement of each treatment is a simple average of observed data at Greeneville, Tennessee, across all years (1983-1985) and replications for those treatments using hand sprayer applications only (Treatments 6 and 7).

[c]Mean spraying labor cost for each treatment was calculated by multiplying the labor requirement of each treatment plot by the wage rate ($4.50/hour) and then determining a simple average across all years and replications for those treatments using hand applications. For those treatments using machine applications, a custom rate of $25.00 per spraying per acre was used. This rate included both a charge for labor and for machine use.

[d]Mean spraying labor cost comparisons with Treatment 1 were calculated by subtracting the mean spraying cost incurred by Treatment 1 from each respective alternative treatment mean spraying labor cost.

[e]Control or base treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Table 4.4. Mean Clean-Out Labor with Associated Costs, Ranking, and Mean Comparisons (Treatment 1 vs. Treatments 2-7) of Selected Sucker Control Systems for Burley Tobacco.

Treatment Number[a]	Mean Clean-out Labor[b]	Mean Clean-out Labor Costs[c]	Rank[d]	Treatment 1 vs. Treatments 2-7[e]
	(labor-hrs./acre)	($/acre)		($/acre)
1[f]	8.89	40.02	1	----
2	6.64	29.87	2	-10.15
3	1.78	8.02	7	-32.00
4	3.61	16.24	3	-23.78
5	3.50	15.76	4	-24.26
6	2.89	13.00	6	-27.02
7	3.05	13.73	5	-26.29

[a]A description of treatments is in Table 2.1.

[b]Mean clean-out labor requirement of each treatment is a simple average of observed labor requirements at Greeneville, Tennessee across all years (1983-1985) and replications.

[c]Mean clean-out labor cost for each treatment was calculated by multiplying the labor requirement of each treatment plot by an assumed 1986 wage rate ($4.50/hour) and then determining a simple average across all years (1983-1985) and replications.

[d]Mean clean-out labor costs are ranked from highest to lowest with 1 being the highest and 7 the lowest.

[e]Mean clean-out labor cost comparisons with Treatment 1 were calculated by subtracting the mean clean-out labor cost incurred by Treatment 1 from each respective alternative treatment mean clean-out labor cost.

[f]Control or base treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Table 4.5. Results of Analysis of Variance of Mean Clean-Out Labor Comparisons Between Selected Sucker Control Systems for Burley Tobacco (Treatment 1 vs. Treatments 2-7).

Treatment Number[a]	Mean Clean-out Labor[b]	Treatment Mean Clean-out Labor Comparison[c]	F Value[d]	Probability > F[e]
	(labor-hrs./acre)			
1[f]	8.89	----	----	----
2	6.64	1 vs. 2	1.34	0.2520
3	1.78	1 vs. 3	13.26	0.0005
4	3.61	1 vs. 4	7.33	0.0086
5	3.50	1 vs. 5	7.62	0.0075
6	2.89	1 vs. 6	9.45	0.0031
7	3.05	1 vs. 7	8.95	0.0039

[a]A description of treatments is in Table 2.1.

[b]Mean clean-out labor for each treatment is a simple average of observed data at Greeneville, Tennessee across all years (1983-1985) and replications.

[c]Listing of contrasting statements or clean-out treatment means being compared.

[d]Calculated F value. Treatment and replication effects were significant at least at the .05 level of significance in explaining variation in clean-out labor (Appendix, Table A.1).

[e]Probability of making an error in rejecting the null hypothesis of no difference between Treatment 1 and each of Treatments 2 through 7. Mean clean-out labor for Treatments 3 through 7 were significantly different from Treatment 1 at the .0086 level of significance or better.

[f]Base or control treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Table 4.6. Total Mean Sucker Control Labor with Associated Costs, Ranking, and Mean Comparisons (Treatment 1 vs. Treatments 2-7) of Selected Sucker Control Systems for Burley Tobacco.

Treatment Number[a]	Total Mean Labor[b]	Total Mean Labor Costs[c]	Rank[d]	Treatment 1 vs. Treatments 2-7[e]
	(labor-hrs./acre)	($/acre)		($/acre)
1[f]	26.94	146.26	1	----
2	15.00	92.48	4	-53.78
3	10.42	71.91	7	-74.35
4	12.05	104.22	3	-42.04
5	12.02	79.08	6	-67.18
6	13.13	84.09	5	-62.18
7	25.66	115.47	2	-30.79

[a]A description of treatments is in Table 2.1.

[b]Total mean sucker labor for each treatment is a simple average of observed data at Greeneville, Tennessee across all years (1983-1985) and replications (spraying labor not included for Treatments 1 through 5 because spraying was custom hired.

[c]Total mean labor cost for each treatment is summation of labor costs presented in Tables 4.1-4.4 (includes machine custom rate).

[d]Total mean labor costs are ranked from highest to lowest with 1 being the highest and 7 the lowest.

[e]Total mean labor cost comparisons with Treatment 1 were calculated by subtracting the total mean labor cost incurred by Treatment 1 from each respective alternative treatment total mean labor cost.

[f]Control or base treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Table 4.7. Results of Analysis of Variance of Total Mean Sucker Labor Comparisons Between Selected Sucker Control Systems for Burley Tobacco (Treatment 1 vs. Treatments 2-7).

Treatment Number[a]	Total Mean Labor[b] (labor-hrs./acre)	Treatment Mean Total Labor Comparison[c]	F Value[d]	Probability > F[e]
1[f]	26.94	----	----	----
2	15.00	1 vs. 2	25.87	0.0001
3	10.42	1 vs. 3	49.44	0.0001
4	12.05	1 vs. 4	40.20	0.0001
5	12.02	1 vs. 5	40.36	0.0001
6	13.13	1 vs. 6	46.58	0.0001
7	25.66	1 vs. 7	25.23	0.0001

[a]A description of treatments is in Table 2.1.

[b]Total mean sucker labor for each treatment is a simple average of observed data at Greeneville, Tennessee across all years (1983-1985) and replications (spraying labor not included for Treatments 1 through 5 because spraying was custom hired.

[c]Listing of contrasting statements or total sucker labor treatment means being compared.

[d]Calculated F value. Year, treatment and replication effects were significant at least at the .05 level of significance in explaining variation in total labor (Appendix, Table A.1).

[e]Probability of making an error in rejecting the null hypothesis of no difference between Treatment 1 and each of Treatments 2 through 7. All total labor means of Treatments 2 through 7 were significantly different from Treatment 1 at the .0001 level of significance.

[f]Base or control treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Table 4.8. Sucker Control Chemical Costs and Sprayer Application Equipment Costs for Selected Sucker Control Systems for Burley Tobacco.

Treatment Number[a]	Sucker Control Chemical Costs[b] ($/acre)	Sprayer Application Equipment Costs[c] ($/acre)		
		Hand		Machine
		variable	fixed	Custom Rate
1[d]	12.10	0.00	0.00	25.00
2	12.10	0.00	0.00	25.00
3	25.74	0.00	0.00	25.00
4	25.70	0.00	0.00	50.00
5	37.70	0.00	0.00	25.00
6	41.47	5.28	5.28	25.00
7	37.70	5.28	5.28	0.00

[a]A description of treatments is in Table 2.1.

[b]Sucker control chemicals were priced on a per gallon basis through a 1986 phone survey of local dealers. Maleic hydrazide (KMH) was priced at $6.05 per gallon, OST-85 at $6.80 per gallon, FST-7 at $8.58 per gallon, and Prime + at $37.70 per gallon. Cost per acre was calculated in accordance with treatment description.

[c]Sprayer application equipment cost was calculated for both hand and machine applications. For machine applications, a custom rate of $25.00 per spraying per acre was used. For hand applications, an initial cost (fixed cost) of $80.00 per hand sprayer prorated over 5 years was used. Operating cost (variable cost) was assumed to be 20% of initial cost. Only one-third of both fixed and variable costs was attributed to sucker control because a sprayer is used in other phases of production such as insect control.

[d]Control or base treatment (late topping, KMH, machine applied).

Table 4.9. Total Direct Costs Associated with Selected Sucker Control Systems for Burley Tobacco.

Treatment Number[a]	Total Labor Costs[b]	Chemical Cost[c]	Application Equipment Cost[d]		Interest Expense[e]	Total Direct Costs[f]	Treatment 1 vs. Treatments 1-7[g]	Rank[h]
	- - - - - -	- - - - - -	- - dollars/acre - -		- - - - - -	- - - - - -	- - - - - -	
			variable cost	fixed cost				
1[i]	146.26	12.10	0.00	0.00	8.71	167.07	----	2
2	92.48	12.10	0.00	0.00	5.75	110.33	-54.28	6
3	71.91	25.74	0.00	0.00	5.37	103.02	-61.27	7
4	104.22	25.70	0.00	0.00	7.15	137.07	-28.70	4
5	79.08	37.70	0.00	0.00	6.42	123.20	-41.97	5
6	84.09	41.47	5.28	5.28	7.49	143.61	-23.46	3
7	115.47	37.70	5.28	5.28	9.30	173.03	5.96	1

[a] A description of treatments is in Table 2.1.

[b] From Table 4.4 (includes custom rate of $25.00 per spraying per acre).

[c] From Table 4.5.

[d] Includes cost of owning and operating a hand sprayer only. Cost incurred from custom machine applications is included in labor cost.

Table 4.9 (continued)

[e]Interest expense on direct variable and fixed costs (labor, sucker control chemicals, and application equipment) at a rate of 11% per year for 6 months.

[f]Total direct costs are the sum total of labor, chemical, application equipment, and interest cost attributed to the control of suckers.

[g]Total direct cost comparisons with Treatment 1 were calculated by subtracting total direct costs incurred by Treatment 1 from each respective alternative treatment total direct costs.

[h]Total direct costs are ranked from highest to lowest with 1 being the highest and 7 the lowest.

[i]Control or base treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Mean topping labor (labor-hours per acre) and mean topping labor costs (dollars per acre) were estimated for each treatment across all years and replications and are presented in Table 4.1. Mean topping labor costs were determined by multiplying the labor requirement of each treatment plot by the wage rate ($4.50 per labor-hour) and then determining a simple average across all years and replications. Each treatment is ranked (fourth column) from 1 to 7 with 1 being the highest and 7 the lowest. Treatment comparisons are also presented as measures of differences in topping labor requirements between the base or control treatment, Treatment 1, and each alternative treatment, Treatments 2 through 7.

Each alternative treatment (using early topping) had topping labor requirements and costs less than the base treatment utilizing maleic hydrazide (KMH) in conjunction with late topping. Treatment 6 (multi-pass system using Prime + and KMH) had the lowest topping labor requirement (8.02 labor-hours per acre) and cost ($36.09 per acre) which was $45.15 per acre less than Treatment 1. Treatment 2 (single-pass system using KMH) had the second lowest topping labor requirement of 8.36 labor-hours per acre at a cost of $37.61 per acre which was $43.63 less than Treatment 1. Treatment 4 had the third lowest topping labor requirement and cost while the highest yielding treatment, Treatment 5, had the fourth lowest topping labor requirement and cost. Treatment 3 had the fifth lowest (or third highest) topping labor requirement and cost while Treatment 7 was the most costly of the alternative treatments.

Table 4.2 contains the results of the statistical analysis which compared mean topping labor of Treatment 1 to each of the respective alternative treatments. Similar to tables in Chapter 3, the third column is again a listing of contrasting statements while the fourth and fifth columns present the results of the analysis of variance for each treatment mean comparison (SAS, Release 6.02). As indicated, each of the alternative treatments, Treatments 2 through 7, were significantly different from Treatment 1 at least at the .05 level of significance. Mean topping labor comparisons made between Treatment 2 and each of Treatments 3 through 7 showed that only Treatment 6 was significantly different from Treatment 2 at the .05 level of significance or better (Appendix, Table A.3).

Mean spraying labor and costs are presented in Table 4.3. Spraying labor requirements were observed only for those treatments using hand-sprayed applications. For those treatments using machine applications, a custom rate of $25.00 per spraying per acre was used.

Treatments 1 through 3 and Treatment 5, all of which used machine applications, incurred the same cost of spraying, $25.00 per acre. Treatment 4, a multi-pass system using machine applications, incurred the highest cost of spraying at $50.00 per acre. Treatment 6, a multi-pass system using hand-sprayed applications, had a spraying labor requirement of 2.22 labor-hours per acre at a cost of $9.99 per acre in addition to a machine application of $25.00 per acre for a $55.99 per acre total. Treatment 7, using hand-sprayed applications, required 10.52 labor-hours per acre at a cost of $47.34 per acre.

Prior to harvest, plots were inspected for degree of sucker control and remaining suckers were taken out by hand. Table 4.4 contains mean clean-out labor and clean-out labor costs for each treatment. Again, Treatment 1 was the most costly or least effective in controlling suckers, requiring 8.89 labor-hours per acre or $40.02 per acre. Treatment 3 (FST-7, 3 gallons per acre, machine applied) was the most effective at controlling suckers requiring only 1.78 labor-hours per acre or $8.02 per acre which was $32.00 less than Treatment 1. Treatment 6 was the second most effective treatment, requiring 2.89 labor-hours per acre or $13.00 per acre which was $27.02 less than Treatment 1. Treatments 7 and 5 had clean-out costs of $13.73 and $15.76 per acre, respectively, while Treatment 4 had a clean-out cost of $16.24 per acre. Treatment 2 was the least effective of the alternative treatments requiring 6.64 labor-hours per acre at a cost of $29.87 per acre which was $10.15 less than Treatment 1.

Results of the analysis of variance of treatment mean clean-out labor comparisons are presented in Table 4.5. Each alternative treatment with the exception of Treatment 2 was significantly different from Treatment 1 at least at the .05 level of significance. Mean clean-out labor comparisons made between Treatment 2 and each of Treatments 3 through 7 showed that all were significantly different from Treatment 2 at the .05 level of significance or better (Appendix, Table A.4).

Total sucker labor requirements and sucker labor costs incurred by each sucker control system are presented in Table 4.6. Treatment 1 was the most costly at $146.26 per acre. Treatment 3 was the least costly at $71.91 per acre which was $74.35 less than Treatment 1. Treatment 5 was the second least costly at $79.08 per acre or $67.18 less than Treatment 1. Treatments 6 and 2 had sucker labor costs of $84.09 and $92.48 per acre respectively while Treatment 4 incurred sucker labor costs of $104.22 per acre. Treatment 7 had the highest total sucker labor cost of the alternative treatments at $115.47 per acre which was $30.79 less than Treatment 1.

Statistical results of treatment mean comparisons (total sucker labor, excluding spraying labor for Treatments 1 through 5) are again presented in Table 4.7. Not surprisingly, each of Treatments 2 through 7 were significantly less than Treatment 1 at least at the .05 level of significance. Comparisons made with Treatment 2 and each of Treatments 3 through 7 showed that Treatments 3 and 6 were significantly different at the .05 level of significance or better (Appendix, Table A.5).

Other direct costs, other than labor costs, associated with each sucker control system are presented in Table 4.8. Sucker control chemical costs which were obtained from local dealers (dollars per gallon), were determined for each treatment in accordance with treatment description. Sprayer application equipment costs for both hand and machine applications are presented. The cost for machine applications (custom rate of $25.00 per spraying per acre are the same as presented in Table 4.3). For hand applications, one-third of an initial cost (fixed cost) of $80.00 per hand sprayer prorated over five years ($5.28 per year) was used. Operating cost (variable cost) was assumed to be 20 percent of initial cost or $5.28 per year.

A summary of all direct costs is presented in Table 4.9 for each sucker control system. Labor, chemical, and application equipment costs are all included as well as an interest expense at a rate of 11 percent per year for 6 months on operating and fixed capital. Total direct costs are ranked from 1 to 7 with 1 being the highest and 7 the lowest. Treatment comparisons are presented as measures of differences in total direct costs between Treatment 1 and each alternative treatment.

Treatment 1 was the second most costly in terms of direct costs at $167.07 per acre. Treatment 3 was the least costly at $103.02 per acre which was $61.27 less than Treatment 1. Treatment 2 was the second least costly at $110.33 per acre which was $54.28 less than Treatment 1. Treatment 5 was the third lowest costing treatment at $123.20 per acre while Treatment 4 was fourth at $137.08 per acre. Treatment 6 had total direct costs of $23.75 per acre less than Treatment 1 while Treatment 7 was the most costly system at $173.03 per acre or $5.67 more than Treatment 1.

INDIRECT COSTS ASSOCIATED WITH SELECTED SUCKER CONTROL SYSTEMS

Costs that varied from treatment to treatment but could not be directly attributed to a given sucker control system, are presented in Table 4.10. Total indirect costs were calculated for each treatment plot and a simple average was determined for each treatment across all years (1983-1985) and replications. Program costs at $3.30 per cwt. included the cost of grading and a no-net cost of the burley tobacco market price support system. Farm-to-market hauling costs were estimated at $1.00 per cwt. while the marketing fee was estimated at $1.00 per cwt. plus 4.5 percent of TVP (Johnson et. al., 1986, pp.8-9).

Because the indirect costs varied directly with yield, the alternative treatments with higher yields than the base treatment had higher total indirect costs than the base. The highest yielding treatment, Treatment 5, incurred the highest indirect costs at $367.77 per acre, $36.92 greater than Treatment 1. Treatment 2 had the second highest indirect costs at $353.47 per acre, $22.62 greater than Treatment 1. Treatment 7 had the third highest indirect costs of $347.44 per acre while Treatment 6 had the fourth highest at $343.60 per acre. Treatment 4 incurred indirect costs of $342.89 per acre while Treatment 3 incurred the lowest indirect costs of the alternative treatments at $336.58 per acre which was only $5.73 greater than Treatment 1.

OTHER COSTS OF PRODUCTION IN BURLEY TOBACCO

Partial budgeting focuses only on changes in costs and returns. Nevertheless, estimated costs of production for stages of production other than sucker control, assumed to be the same across treatments, were included in this analysis to obtain a more

Table 4.10. Mean Indirect Costs and Total Mean Indirect Costs Associated with Selected Sucker Control Systems for Burley Tobacco, Knoxville, Tennessee, 1986.

Treatment Number[a]	Program Costs[b]	Farm to Market Hauling Costs[c]	Marketing Fee[d]	Total Indirect Costs[e]	Treatment 1 vs. Treatments 2-7[f]	Rank[g]
	- - - - - - - - - -	- - - - - - - - - -	dollars/acre	- - - - - - - - - -	- - - - - - - - - -	
1[h]	90.12	27.31	213.43	330.85	---	7
2	96.46	29.23	227.77	353.47	22.62	2
3	91.58	27.75	217.26	336.58	5.73	6
4	93.23	28.25	221.42	342.89	12.04	5
5	99.76	30.23	237.77	367.77	36.92	1
6	93.52	28.34	221.73	343.60	12.75	4
7	94.58	28.66	224.19	347.44	16.59	3

[a]A description of treatments is in Table 2.1.

[b]No-net cost and grading cost ($3.30/cwt.).

[c]Farm-to-market hauling costs were estimated to be $1.00 per cwt.

Table 4.10 (continued)

[d]Marketing fee was estimated to be 4.5% of TVP plus $1.00 per cwt.

[e]Total indirect costs are the summation of program, hauling, and marketing costs.

[f]Total indirect cost comparisons with Treatment 1 were calculated by subtracting total indirect costs incurred by Treatment 1 from each respective alternative treatment indirect costs.

[g]Total indirect costs are ranked from highest to lowest with 1 being the highest and 7 the lowest.

[h]Control or base treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

realistic net value product (NVP) for each treatment budget. This step was not necessary, but allowed for greater expository treatment of the information gleaned from the data and made the results on NVP more realistic.

Estimates of other costs of production by category are shown in Table 4.11. Plant bed variable costs were estimated at $93 per acre while field and other variable costs were estimated at $396 per acre. Total fixed costs were estimated at $336 per acre while interest on both variable and fixed costs was estimated at $318 per acre. Labor costs (also variable) were estimated at $1238 per acre. Total estimated costs added to each treatment budget was $2381 per acre.

TOTAL FACTOR COSTS AND CHANGE IN TOTAL FACTOR COSTS

After determining direct and indirect costs for each sucker control system, other costs of production were added to obtain a total factor cost (TFC) value for each treatment plot (observation) budget. Mean TFC's (dollars per acre) were calculated for each treatment across all years (1983-1985) and replications using 1986 input prices, and are presented in Table 4.12. Change in TFC (dollars per acre) and percent change in TFC are presented as measures of differences in TFC of each alternative treatment, Treatments 2 through 7, in comparison to the base treatment, Treatment 1.

Of the alternative treatments (using early topping), only Treatment 7 had a TFC greater than the base treatment at $2901 per

Table 4.11. Estimated Costs of Production for Stages of Production Other Than Sucker Control for Burley Tobacco, Knoxville, Tennessee, 1986.

Cost Category[a]	Amount ($/acre)
Plant Bed Variable Costs	93.00
Field and Other Variable Costs	396.00
Fixed Costs	336.00
Interest on Variable and Fixed Costs	318.00
Labor	1238.00
Total	2381.00

[a]Costs are estimates from farm enterprise budgets developed by the University of Tennessee Agricultural Extension Service (Johnson et. al., 1986,pp.8-9). See Appendix Table A.6.

Table 4.12. Mean Total Factor Costs (TFC) with Ranking, Change in TFC, and Percent Change in TFC of Selected Sucker Control Systems for Burley Tobacco (Treatment 1 vs. Treatments 2-7).

Treatment Number[a]	TFC[b] ($/acre)	Rank[c]	Change in TFC[d] ($/acre)	Percent Change In TFC[e]
1[f]	2,879	2	----	----
2	2,845	6	-34	-1.19
3	2,821	7	-58	-2.03
4	2,861	5	-18	-0.62
5	2,872	3	-7	-0.24
6	2,868	4	-11	-0.39
7	2,901	1	22	0.77

[a]A description of treatments is in Table 2.1.

[b]Mean TFC for each treatment is a simple average across all years (1983-1985) and replications.

[c]Mean TFC's are ranked from highest to lowest with 1 being the highest and 7 the lowest.

[d]Change in TFC for each treatment was calculated by subtracting the base or control treatment, Treatment 1, mean TFC from each respective alternative treatment mean TFC.

[e]Percent change in TFC = $\frac{\text{alternative treatment TFC} - \text{base TFC}}{\text{base TFC}} \times 100.$

[f]Base or control treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

acre which was $22 greater than Treatment 1. Treatment 3 was the least costly of all treatments at $2821 per acre which was $58 or approximately 2 percent less than Treatment 1. Treatment 2 had a TFC of $2845 per acre which was $34 less than Treatment 1 while Treatment 4 had a TFC $18 less than the base treatment. Treatment 6 had the fourth ranked TFC of all treatments at $2868 per acre, $11 less than Treatment 1, while Treatment 5 had a TFC of $2872 per acre, only $7 less than the base treatment.

Table 4.13 contains the results of the statistical analysis which compared mean TFC's of each alternative treatment to the mean TFC of the base treatment. This was done to test the null hypothesis of no statistical difference, due to treatment effect between each of the alternative treatment mean TFC's and the base treatment TFC within at the .05 level of significance or better. Though five of the six alternative treatments utilizing early topping had estimated TFC's that were less than Treatment 1, only Treatment 3 (FST-7, machine applied) had a mean TFC that was significantly less at least at the .05 level of significance. Treatment 2 with the second lowest TFC as well as the other treatments were not significantly different from Treatment 1.

In Tables 4.14 and 4.15 are presented results of mean TFC comparisons between Treatment 2 and Treatments 3 through 7 to test the null hypothesis of no difference due to treatment effect between Treatment 2 using KMH in conjunction with early flower

Table 4.13. Results of Analysis of Variance of Mean TFC Comparisons Between Selected Sucker Control Systems for Burley Tobacco (Treatment 1 vs. Treatments 2-7).

Treatment Number[a]	Mean TFC[b] ($/acre)	Treatment Mean TFC Comparison[c]	F Value[d]	Probability > F[e]
1[f]	2,879	----	----	----
2	2,845	1 vs. 2	3.79	0.056
3	2,821	1 vs. 3	11.06	0.002
4	2,861	1 vs. 4	1.05	0.309
5	2,872	1 vs. 5	0.16	0.693
6	2,868	1 vs. 6	0.41	0.525
7	2,901	1 vs. 7	1.61	0.209

[a]A description of treatments is in Table 2.1.

[b]Mean TFC for each treatment is a simple average across all years (1983-1985) and replications.

[c]Listing of contrasting statements or treatment mean TFC's being compared.

[d]Calculated F value. Year and treatment effects were significant at least at the .05 level of significance in explaining variation in TFC (Appendix, Table A.1).

[e]Probability of making an error in rejecting the null hypothesis of no difference between Treatment 1 and each of Treatments 2 through 7. The mean TFC of Treatment 3 only was significantly different from Treatment 1 at the .05 level of significance or better(.002 level).

[f]Base or control treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Table 4.14. Mean Total Factor Costs (TFC) with Ranking, Change in TFC, and Percent Change in TFC of Selected Sucker Control Systems for Burley Tobacco Topped at Early Flower (Treatment 2 vs. Treatments 3-7).

Treatment Number[a]	TFC[b] ($/acre)	Rank[c]	Change in TFC[d] ($/acre)	Percent Change In TFC[e]
2[f]	2,845	5	----	----
3	2,821	6	-24	-0.85
4	2,861	4	16	0.58
5	2,872	2	27	0.96
6	2,868	3	23	0.80
7	2,901	1	56	1.98

[a]A description of treatments is in Table 2.1.

[b]Mean TFC for each treatment is a simple average across all years (1983-1985) and replications.

[c]Mean TFC's are ranked from highest to lowest with 1 being the highest and 6 the lowest.

[d]Change in TFC for each treatment was calculated by subtracting Treatment 2 mean TFC from each alternative treatment mean TFC.

[e]Percent change in TFC = $\frac{\text{alternative treatment TFC - Treatment 2 TFC}}{\text{Treatment 2 TFC}} \times 100.$

[f]Basis for paired comparison with with each of Treatments 3 through 7.

Table 4.15. Results of Analysis of Variance of Mean TFC Comparisons Among Selected Sucker Control Systems for Burley Tobacco (Treatment 2 vs. Treatments 3-7).

Treatment Number[a]	Mean TFC[b] ($/acre)	Treatment Mean TFC Comparison[c]	F Value[d]	Probability > F[e]
2[f]	2,845	----	----	----
3	2,821	2 vs. 3	1.74	0.192
4	2,861	2 vs. 4	0.78	0.382
5	2,872	2 vs. 5	2.20	0.144
6	2,868	2 vs. 6	1.56	0.217
7	2,901	2 vs. 7	9.47	0.003

[a]A description of treatments is in Table 2.1.

[b]Mean TFC for each treatment is a simple average across all years (1983-1985) replications.

[c]Listing of contrasting statements or treatment mean TFC's being compared.

[d]Calculated F value. Year and treatment effects were significant at least at the .05 level of significance in explaining variation in TFC (Appendix, Table A.2).

[e]Probability of making an error in rejecting the null hypothesis of no difference between Treatment 2 and the respective alternative treatments. The mean TFC of Treatment 7 only was significantly different from Treatment 2 at least at the .05 level of significance (.003 level).

[f]Basis for paired comparison with each of Treatments 3 through 7.

topping and the other treatments using early flower topping. Only Treatment 3 had an estimated TFC less than Treatment 2 (Table 4.14). However, as indicated in Table 4.15, only Treatment 7, which was more costly, was significantly different from Treatment 2 at the .05 level of significance or better.

CHAPTER 5

NET VALUE PRODUCT AND CHANGE IN NET VALUE PRODUCT

In Chapter 3 results of the three-year experiment were presented in terms of yield (TPP), quality (using 1986 prices), total value product (TVP), and changes in TVP while presented in Chapter 4 were total factor costs (TFC) incurred from the productive process of burley tobacco with varied sucker control systems. Presented in this chapter is net value product (NVP) as a measure of net returns to quota, land, and management collectively as estimated for each selected sucker control system. Also presented are NVP's to each of four factors of production (plus management) and management alone.

NET VALUE PRODUCT TO QUOTA, LAND, AND MANAGEMENT

Mean NVP's (dollars per acre) to quota, land, and management collectively were estimated for each treatment across all years and replications and are presented in Table 5.1. As with yield, TVP, and TFC, treatments were ranked from 1 to 7 and changes in NVP were calculated as a measure of differences (added or reduced) in net returns between Treatment 1 and each alternative treatment.

As expected after reviewing results presented in Chapters 3 and 4, each alternative treatment had NVP's at least 10 percent greater than the base treatment. The highest NVP at $1740 per acre was for Treatment 5 which was $483 or 38 percent greater than

Table 5.1. Mean Net Value Product (NVP) with Ranking, Change in NVP, and Percent Change in NVP of Selected Sucker Control Systems for Burley Tobacco (Treatment 1 vs. Treatments 2-7).

Treatment Number[a]	Mean NVP[b] ($/acre)	Rank[c]	Change in NVP[d] ($/acre)	Percent Change in NVP[e]
1[f]	1257	7	----	----
2	1567	2	310	25
3	1391	6	133	11
4	1432	4	175	14
5	1740	1	483	38
6	1430	5	173	14
7	1444	3	187	15

[a]A description of treatments is in Table 2.1.

[b]Mean NVP for each treatment is a simple average across all years (1983-1985) replications.

[c]Mean NVP's are ranked from highest to lowest with 1 being the highest and 7 the lowest.

[d]Change in NVP for each treatment was calculated by subtracting the base or control treatment, Treatment 1, mean NVP from each respective alternative treatment mean NVP.

[e]Percent change in NVP = $\frac{\text{alternative treatment NVP - base NVP}}{\text{base NVP}} \times 100$

[f]Base or control treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Treatment 1. Treatment 2 ranked second with an NVP of $1567 per acre which was $310 or 25 percent greater than Treatment 1. Treatment 7, the most costly of all treatments, had the third highest NVP at $1444 per acre while Treatment 4 was ranked fourth at $1432 per acre. Treatment 6 had an NVP of $1430 per acre while Treatment 3 had the lowest NVP of the alternative treatments at $1391 per acre which was 11 percent greater than Treatment 1. In Table 5.2, only the NVP of Treatment 5 was significantly different from Treatment 1 due to treatment effect at the .05 level of significance or better.

Tables 5.3 and 5.4 contain results of mean NVP comparisons between Treatment 2 and Treatments 3 through 7 which were undertaken to evaluate the NVP of Treatment 2 using KMH in conjunction with early topping in comparison with the other treatments using early topping. As indicated in Table 5.1, only Treatment 5 had an NVP higher than Treatment 2 (Table 5.3) which was $173 per acre or 11 percent greater. However, as indicated in Table 5.4, Treatment 5 was not significantly greater than Treatment 2 due to treatment effect at least at the .05 level of significance. Also the NVP of no other alternative treatment was significantly lower than Treatment 2.

Up until this point, each component within the partial budgeting framework has been analyzed separately. Tables 5.5 and 5.6 present a summary of changes in mean TVP's, TFC's, and NVP's associated with the productive process of burley tobacco across

Table 5.2. Results of Analysis of Variance of Mean NVP Comparisons Between Selected Sucker Control Systems for Burley Tobacco (Treatment 1 vs. Treatments 2-7).

Treatment Number[a]	Mean NVP[b] ($/acre)	Treatment Mean NVP Comparison[c]	F Value[d]	Probability > F[e]
1[f]	1257	----	----	----
2	1567	1 vs. 2	2.64	0.109
3	1391	1 vs. 3	0.49	0.487
4	1432	1 vs. 4	0.84	0.363
5	1740	1 vs. 5	6.41	0.014
6	1430	1 vs. 6	0.82	0.369
7	1444	1 vs. 7	0.96	0.331

[a] A description of treatments is in Table 2.1.

[b] Mean NVP for each treatment is a simple average across all years and(1983-1985) replications.

[c] Listing of contrasting statements or treatment mean NVP's being compared.

[d] Calculated F value. Year and replication effects were significant at least at the .05 level of significance in explaining variation in NVP (Appendix, Table A.1). However, overall treatment effect was nonsignificant at the .05 level.

[e] Probability of making an error in rejecting the null hypothesis of no difference between Treatment 1 and each of the respective alternative treatments. Treatment 5 mean NVP is significantly different from the mean NVP of Treatment 1 at the .014 level of significance.

[f] Base or control treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Table 5.3. Mean Net Value Product (NVP) with Ranking, Change in NVP, and Percent Change in NVP of Selected Sucker Control Systems for Burley Tobacco Topped at Early Flower (Treatment 2 vs. Treatments 3-7).

Treatment Number[a]	Mean NVP[b] ($/acre)	Rank[c]	Change in NVP[d] ($/acre)	Percent Change In NVP[e]
2[f]	1567	2	----	----
3	1391	6	-177	-11
4	1432	4	-135	-9
5	1740	1	173	11
6	1430	5	-137	-9
7	1444	3	-123	-8

[a] A description of treatments is in Table 2.1.

[b] Mean NVP for each treatment is a simple average across all years and (1983-1985) replications.

[c] Mean NVP's are ranked from highest to lowest with 1 being the highest and 6 the lowest.

[d] Change in NVP for each treatment was calculated by subtracting Treatment 2 mean NVP from each respective alternative treatment mean NVP.

[e] $$\text{Percent change in NVP} = \frac{\text{alternative treatment NVP} - \text{Treatment 2 NVP}}{\text{Treatment 2 NVP}} \times 100$$

[f] Basis for paired comparison with each of Treatments 3 through 7.

Table 5.4. Results of Analysis of Variance of Mean NVP Comparisons Between Selected Sucker Control Systems for Burley Tobacco Topped at Early Flower (Treatment 2 vs. Treatments 3-7).

Treatment Number[a]	Mean NVP[b]	Treatment Mean NVP Comparison[c]	F Value[d]	Probability > F[e]
	($/acre)			
2[f]	1567	----	----	----
3	1391	2 vs. 3	0.82	0.368
4	1432	2 vs. 4	0.48	0.489
5	1740	2 vs. 5	0.79	0.379
6	1430	2 vs. 6	0.50	0.483
7	1444	2 vs. 7	0.40	0.529

[a]A description of treatments is in Table 2.1.

[b]Mean NVP for each treatment is a simple average across all years and (1983-1985) replications.

[c]Listing of contrasting statements or treatment mean NVP's being compared.

[d]Calculated F value. Year effect was significant at least at the .05 level of significance in explaining variation in NVP (Appendix, Table A.2). However, overall treatment and replication effects were nonsignificant at the .05 level.

[e]Probability of making an error in rejecting the null hypothesis of no difference between Treatment 2 and each of the respective alternative treatments.

[f]Basis for paired comparison with each of Treatments 3 through 7.

Table 5.5. Summary of Added (Reduced) Mean Total Value Products (TVP), Total Factor Costs (TFC), and Net Value Products (NVP) of Selected Sucker Control Systems for Burley Tobacco when Compared to the Base Treatment within a Partial Budgeting Framework.

Treatment Number[a]	Mean TVP[b]	Added (Reduced) TCP[c]	Mean TFC[d]	Added (Reduced) TFC[e]	Mean NVP[f]	Added (Reduced) NVP[g]
	dollars/acre					
1[h]	4136	----	2879	----	1257	----
2	4412	276	2845	(34)	1567	310
3	4211	75	2821	(58)	1391	133
4	4293	157	2861	(18)	1432	175
5	4612	476	2872	(7)	1740	483
6	4298	161	2868	(11)	1430	173
7	4345	209	2901	22	1444	187

[a]A description of treatments is in Table 2.1.

[b]From Table 3.8.

[c]Added (Reduced) TVP = Mean TVP of respective alternative treatments - Mean TVP of base treatment, Treatment 1.

[d]From Table 4.9.

[e]Added (Reduced) TFC = Mean TFC of respective alternative treatments - Mean TFC of base treatment, Treatment 1.

[f]From Table 5.1.

[g]Added (Reduced) NVP = Mean NVP of respective alternative treatments - Mean NVP of base treatment, Treatment 1.

[h]Base or control treatment (late topping, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Table 5.6. Summary of Added (Reduced) Mean Total Value Products (TVP), Total Factor Costs (TFC), and Net Value Products (NVP) of Selected Sucker Control Systems for Burley Tobacco when Compared to Treatment 2 within a Partial Budgeting Framework.

Treatment Number[a]	Mean TVP[b]	Added (Reduced) TCP[c]	Mean TFC[d]	Added (Reduced) TFC[e]	Mean NVP[f]	Added (Reduced) NVP[g]
	- - - - - -	- - - -	- - - - dollars/acre	- - - -	- - - -	- - - -
2[h]	4412	----	2845	----	1567	----
3	4211	(201)	2821	(24)	1391	(176)
4	4293	(119)	2861	16	1432	(135)
5	4612	200	2872	27	1740	173
6	4298	(114)	2868	23	1430	(137)
7	4345	(67)	2901	56	1444	(123)

[a]A description of treatments is in Table 2.1.

[b]From Table 3.8.

[c]Added (Reduced) TVP = Mean TVP of alternative treatments - Mean TVP of Treatment 2.

[d]From Table 4.9.

[e]Added (Reduced) TFC = Mean TFC of alternative treatments - Mean TFC of Treatment 2.

[f]From Table 5.1.

[g]Added (Reduced) NVP = Mean NVP of alternative treatments - Mean NVP of Treatment 2.

[h]Basis for paired comparison, Treatment 2 (early topping, KMH, machine applied) with each of Treatments 3 through 7.

each of the selected sucker control systems when compared to the base treatment or Treatment 2. Terminology has been altered slightly and is more in line with partial budgeting terminology to present a more vivid picture of variations in TVP, TFC, and NVP between treatments.

As indicated in Table 5.5, each alternative treatment had higher returns and lower costs than Treatment 1 in each category with the exception of Treatment 7 which was more costly but still produced a greater NVP. Only Treatment 5 was more economically attractive than Treatment 2 as indicated in Table 5.6. Treatment 5 was both more productive in terms of TVP and less costly than Treatment 2.

NET VALUE PRODUCT TO EACH OF FOUR FACTORS OF PRODUCTION PLUS MANAGEMENT AND MANAGEMENT ALONE

Burley tobacco producers attempt to maximize NVP to their most limiting resource in order to maximize overall NVP from burley tobacco. Because producers vary in regard to their most limiting resource(s), NVP was estimated as a measure of net returns to various factors of production. The results illustrate how NVP to a specific factor of production varies across each selected sucker control system.

In Table 5.7 is presented the results of estimated NVP's to management and each of land, sucker control labor, nonlabor capital for sucker control, and quota. Management was included in the residual return to each of the other four factors because it is a

Table 5.7. Mean Net Products (NVP) to Land, Sucker Control Labor, Nonlabor Capital for Sucker Control, Quota, and Management of Selected Sucker Control Systems for burley Tobacco[a]

Treatment Number[b]	NVP to Land and Management ($/acre)	NVP to Sucker Control Labor and Management ($/labor-hour)	NVP to Nonlabor Capital and Management (for Sucker Control) and Management ($/$100 nonlabor Capital)	NVP to Quota and Management ($/100 pounds)	NVP to Management ($/$1000 TVP)
1	574.25	22.11	225.92	42.37	114.66
2	836.25	53.58	285.78	50.19	166.87
3	697.25	61.83	252.08	46.52	141.83
4	725.75	56.43	246.98	47.15	145.76
5	984.25	78.06	302.40	54.25	191.73
6	721.50	51.83	245.17	46.93	144.60
3	727.50	28.95	254.94	46.89	144.42

[a]The values estimated or imputed for each resource were: land--$100 per acre annual charge; Labor--$4.50 per hour; nonlabor capital for sucker control--11% per year for 6 months; quota--$.25 per pound. No value was estimated for management; it was included in the residual return to each of the other resources.

[b]A description of treatments is in Table 2.1.

resource that is difficult to estimate. The sixth column of Table 5.7 is a listing of NVP to management alone for each treatment.

Consistent with the results presented in Tables 5.1 through 5.6, Treatment 5 (early-topped, Prime +, machine applied) had the highest NVP to each factor while Treatment 1, had the lowest. Treatment 2 (early-topped, KMH, machine applied) had the second highest NVP to each factor except sucker control labor plus management (dollars per labor-hour). Each of Treatments 3 through 5 had greater NVP's to sucker control labor and management.

Variation between treatments in regard to NVP to each respective factor of production is better illustrated in Tables 5.8 and 5.9. In Table 5.8 is a listing of results of comparisons made between Treatment 1 (late-topped, KMH, machine applied) and each early-topped treatment, Treatments 2 through 7. In Table 5.9 is a listing of results of comparisons made between Treatment 2 and each of Treatments 3 through 7.

Table 5.8. Added (Reduced) Mean Net Value Products (NVP) to Land, Sucker Control Labor, Nonlabor Capital for Sucker Control, Quota, and Management for Selected Sucker Control Systems for Burley Tobacco when Compared to Treatment 1 within a Partial Budgeting Framework.

Treatment Number[a]	NVP to Land and Management ($/acre)	NVP to Sucker Control Labor and Management ($/labor-hour)	NVP to Nonlabor Capital and Management (for Sucker Control) and Management ($/$100 nonlabor Capital)	NVP to Quota and Management ($/100 pounds)	NVP to Management ($/$1000 TVP)
			Added (Reduced)		
1[b]	--	--	--	--	--
2	262.00	31.47	59.86	7.82	52.21
3	123.00	39.71	26.16	4.15	27.17
4	151.50	34.32	21.06	4.78	31.10
5	410.00	55.95	76.48	11.88	77.07
6	147.25	29.72	19.25	4.56	29.94
7	153.25	6.84	29.02	4.52	29.76

[a]A description of treatments is in Table 2.1.

[b]Base or control treatment (late-topped, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

Table 5.9. Added (Reduced) Mean Net Value Products (NVP) to Land, Sucker Control Labor, Nonlabor Capital for Sucker Control, Quota, and Management for Selected Sucker Control Systems for Burley Tobacco when Compared to Treatment 2 within a Partial Budgeting Framework.

Treatment Number[a]	NVP to Land and Management ($/acre)	NVP to Sucker Control Labor and Management ($/labor-hour)	NVP to Nonlabor Capital and Management (for Sucker Control) and Management ($/$100 nonlabor Capital)	NVP to Quota and Management ($/100 pounds)	NVP to Management ($/$1000 TVP)
			Added (Reduced)		
2[b]	--	--	--	--	--
3	(139.00)	8.24	(33.70)	(3.67)	(25.04)
4	(110.50)	2.85	(38.80)	(3.04)	(21.11)
5	148.00	24.48	16.20	4.06	24.86
6	(114.75)	(1.75)	(40.61)	(3.26)	(22.27)
7	(108.75)	(24.63)	(30.84)	(3.30)	(22.45)

[a]A description of treatments is in Table 2.1.

[b]Base or control treatment (late-topped, KMH, machine applied) used for paired comparison with each of Treatments 2 through 7.

CHAPTER 6

SUMMARY, CONCLUSIONS, AND IMPLICATIONS FOR FURTHER RESEARCH

SUMMARY

Research problem and objectives. The majority of Tennessee burley tobacco producers control suckers by topping in the late flower stage and applying maleic hydrazide (KMH). Because of documented evidence of improved quality and yield per acre in flue-cured tobacco topped in the early flower stage, concerns of KMH residues, and the advent of new sucker control chemicals, burley producers seek more efficient sucker control systems for burley tobacco. To maintain or enhance net returns, producers need relevant information on costs and returns for various sucker control systems. Research can provide such information by determining total physical product (TPP) or yield, output quality, total value product (yield times price or TVP), total factor costs (TFC), and net value product (NVP) associated with various sucker control systems and by comparing these variables among the systems.

The primary objective of this analysis was to provide tobacco producers information on physical inputs, yield, quality, TVP, TFC, and NVP associated with six selected sucker control systems utilizing early topping and one typical conventional system using late topping. Paired comparisons were made between each respective early-topped system and the conventional system utilizing KMH in conjunction with late topping within a partial budgeting framework. A secondary objective was to compare both agronomic and economic data associated with an alternative sucker system utilizing machine applied KMH in conjunction with early topping to other systems utilizing early topping.

<u>Procedure</u>. To obtain data for agronomic and economic comparisons among selected sucker control systems, field experiments were conducted at the Tobacco Experiment Station from 1983 through 1985. Sucker control systems or treatments were composed of several variables such as time of topping, type of chemical(s) used, sequence and frequency of chemical application, and mode of application. Alternative systems (early topped) chosen for comparison with the control or base system (late topped) were chosen with these variables in mind in the hope of selecting an improved system or set of systems that are well within the means of resource availability for Tennessee burley tobacco producers.

Because of access to new computer systems and programming packages, budgets were easily built for each treatment plot. Yield, price, and total value product (TVP) were calculated on a per acre or hundredweight basis. Price was used as a proxy variable for quality and determined from 1986 belt-wide seasonal average market prices corresponding to USDA quality grades for all farm grades by plot for the three experiment years, 1983-1985. Total factor costs (TFC), both direct and indirect, associated with the control of suckers were also determined for each treatment plot. Other costs of production were estimated and assumed constant across all treatments. Therefore, all costs of production for each treatment plot were included except quota, land, and managerial costs. As a result, net value product (NVP) was calculated for each treatment plot as a residual measure of net returns to quota, land, and management.

After determining TVP, TFC, and NVP, statistical comparisons using each of these variables individually were made between the control or base treatment using KMH in conjunction with late topping and the alternative treatments. Comparisons were also made between Treatment 2, using KMH in conjunction with early topping, and the other alternative treatments. Such comparisons were made to evaluate possible significant differences due to treatment effect in terms of TVP, TFC, or NVP between those treatments being compared.

Finally, treatment mean TVP's, TFC's, and NVP's were compared within a partial budgeting framework to evaluate any net advantages or disadvantages in terms of net returns to quota, land, and management between the base treatment and alternative treatments. Accordingly, comparisons were made between Treatment 2 and the other alternative treatments.

RESULTS SUMMARY AND CONCLUSIONS

Yield, quality, total value product, and change in total value product. The results obtained from the three-year experiment indicated that yields associated with each selected sucker control system utilizing early topping were greater than the control or base system, Treatment 1, utilizing late topping. Treatment 5 (Prime +, 1 gallon per acre, machine applied) had the highest positive yield difference of 293 pounds per acre over Treatment 1 while Treatment 3 (FST-7, 3 gallons per acre, machine applied) had the lowest positive difference of the alternative treatments, 45 pounds per acre. Only Treatment 5 was significantly higher, than the control at least at the .05 level of significance. Comparisons made between Treatment 2 (KMH, 2 gallons per acre, machine applied), which was the second highest yielding treatment, and the other alternative treatments indicated that none were significantly different, statistically, (higher or lower) including the highest yielding treatment, Treatment 5.

One explanation of greater yields associated with early topped systems focuses on the ability of individual plants to apply resources to leaf growth or weight instead of reproduction. Instead of applying resources to the development of fully matured reproductive systems and subsequent sucker growth, early topped and sprayed plants have a longer time period to apply resources to extensive leaf growth or weight gain prior harvest.

Price, as a proxy variable for quality, revealed ambiguous results for quality. The range of prices from top to bottom was only $.68 per cwt. with tobacco of Treatment 5 producing the highest weighted average price and Treatment 2 the lowest. Statistical mean comparisons of treatments on price showed no significant differences at the .05 level of significance or better.

Because of the influence of yield on total value product (TVP) and the ambiguous results associated with price, treatment results with regard to TVP were similar to results associated with yield.

For each alternative treatment, TVP was greater than the base or control treatment. The highest positive difference in TVP over Treatment 1 at $476 per acre was for Treatment 5 while the results of Treatment 3 had the lowest positive difference of the alternative treatments, $75 per acre greater than Treatment 1. Only Treatment 5 was significantly different from Treatment 1. Comparisons made between Treatment 2 and other early topped treatments indicated no significant differences in TVP.

Direct and indirect costs. Direct costs (labor, chemicals, and equipment costs), incurred as a result of implementing a given sucker control system, were highest for Treatment 7 (Prime +, 1 gallon per acre, hand applied) while the base treatment, Treatment 1, had the second highest. The lowest yielding treatment, Treatment 3, also incurred the lowest direct costs.

Topping and spraying labor were two primary reasons for the relatively high direct costs of Treatment 7. This system was designed to take full advantage of possible untapped yield potential associated with each individual plant and, therefore, was a multi-pass system (with at least three passes). Such systems have the potential to reduce topping efficiency in terms of labor hours per acre and are not conducive to machine applications. Therefore, it incurred relatively high topping costs (second to Treatment 1) and spraying costs (because of spraying labor and the cost of owning and operating a hand sprayer). Other systems in this analysis primarily used machine applications, thus, incurring an estimated custom rate cost for each spraying. Also, Treatment 7 used the most expensive sucker control chemical, Prime +.

Treatment 1, also incurring relatively high direct costs, did so as a result of high topping and clean-out labor. Because this system was topped late, plant stalks were larger and tougher, making topping more difficult than for early topped plants. Also, preexisting suckers, taken out by hand prior to spraying, were larger and more numerous. Clean-out labor, resulting from the need to hand remove suckers missed by a given system, were greatest for Treatment 1 (Treatment 2 had the second highest clean-out labor and resulting cost) indicating a lessor degree of sucker control possibly because of time of topping, the chemical agent (KMH) applied, and/or other cultural conditions. Treatments using Prime +, Treatments 4 through 7, generally incurred relatively similar clean-out costs which were $23 to $27 per acre less than Treatment 1.

Treatment 3 incurred the smallest clean-out cost at $8.02 per acre, $32 less than Treatment 1, indicating a high degree of sucker control. Low clean-out costs combined with relatively low topping and spraying costs were primary reasons for Treatment 3 having the lowest direct costs.

Indirect costs (program, hauling, and marketing costs), which varied from treatment to treatment but could not be directly attributed to the control of suckers, varied directly with yield. Therefore, Treatment 5, the highest yielding treatment, incurred the highest indirect costs, and Treatment 1, the lowest yielding treatment, incurred the lowest indirect costs.

Total factor costs and change in total factor costs. Total factor costs (TFC) measured direct, indirect, and other costs of production which were considered constant across all treatments. Total factor costs were lowest for Treatments 3 and 2, respectively. Treatment 7 incurred the highest total factor costs while the base treatment incurred the second highest. Treatments 4, 5, and 6 ranked 5, 3, and 4, respectively. Only Treatment 3 was significantly different on a per acre basis from the base treatment at least at the .05 level. Mean comparisons made between Treatment 2 and the other alternative treatments indicated that none were significantly different at the .05 level, including Treatment 3, the least costly system.

Treatment 3 incurred the lowest TFC because of both low direct costs and low indirect costs (resulting from relatively low yields). Low chemical cost combined with other moderately low direct costs resulted in a low TFC for Treatment 2. The highest yielding treatment, Treatment 5, incurred the third highest TFC primarily because of higher indirect costs.

Though direct costs associated with each alternative sucker control system were considerably less than direct costs of the base system with the exception of Treatment 7, higher yielding alternative systems were discounted because of indirect costs. In other words, advantages attributed to a particular alternative treatment in comparison to the base treatment (in terms of direct costs) were slightly offset by relatively high indirect costs resulting from increased yields.

Net value product and change in net value product. Net value product measuring net returns to quota, land, and management ranged from $1257 per acre for Treatment 1 to $1740 per acre for Treatment 5, a difference of $483 per acre. Treatments 2 and 7 were ranked 2 and 3, respectively. Treatment 3, the least costly with the smallest NVP of the nonbase alternative treatments was $133 per acre higher than the base treatment. Statistically, only Treatment 5 was significantly greater than the base treatment at the .05 level of significance or better in terms of NVP. Statistical mean NVP comparisons made between Treatment 2 and the other alternative treatments indicated that none were significantly higher (Treatment 5) or lower (Treatments 3, 4, 6, and 7).

In summary, tentative conclusions drawn from this analysis as to why NVP was generally higher for early-topped systems than for the base system stem from results indicating that early-topped systems were generally more productive in terms of yield and less costly with the exception of Treatment 7. In general, one could argue that topping and sucker control initiated at the early flower stage appear to be preferable, economically, to late flower. However, one must contend with the statistical analysis indicating that only the results of Treatment 5 presented an advantage in terms of NVP over the base treatment. From a partial budgeting standpoint, each of the early topped treatments represent an improvement over the base treatment. However, on all other paired comparisons, statistical results indicate that only Treatment 5 would be an improvement over the base treatment. Obviously, a decision criterion is needed regarding how much of a difference in terms of NVP (dollars per acre) between alternatives is significant, or quite possibly, the issue should be left to the individual producer to decide.

Other observations of the results indicate that multi-pass systems (Treatments 4, 6, and 7) do not enhance yield or returns potential of individual plants in comparison to single-pass systems (Treatments 2, 3, and 5). The results also temper concerns regarding custom applications of Prime + which requires more precision in application than does KMH or FST-7 for example.

Because of the popularity of KMH throughout the Tennessee growing region, comparisons were made between Treatment 2 (KMH, early topped) and Treatments 3 through 7 to evaluate possible advantages in switching to other sucker control chemicals for use in conjunction with early topping. As indicated by the results, only Treatment 5 produced a greater NVP at $1740 per acre, $173 greater than Treatment 2. However, statistical results of the mean NVP comparisons indicated that none of the alternative treatments were more economically attractive than Treatment 2. Again, the question of the significance of $173 per acre or more specifically, the relevance of the minimum criterion for significance testing to typical farm situations should be evaluated more closely.

Burley tobacco producers attempt to maximize NVP to their most limiting resource in order to maximize overall NVP from burley tobacco. Because producers vary in regard to their most limiting resource(s), NVP's to management and four other factors of production, land, sucker control labor, nonlabor capital for sucker control, and quota were estimated. Consistent with other results, Treatment 5 had the highest NVP to each factor while Treatment 1, had the lowest. Treatment 2 had the second highest NVP to each factor except sucker control labor plus management (dollars per labor-hour). Each of Treatments 3 through 5 had greater NVP's to sucker control labor.

Finally, there are advantages and disadvantages associated with each sucker control system which are not easily quantifiable but bear mentioning. For example, some degree of risk is associated with the use of chemical agents within a certain sucker control system. Though performing relatively well in this analysis in conjunction with early topping, KMH often lacks the long term sucker control of Prime +. Maleic hydrazide is more sensitive than Prime + to weather and other cultural conditions at application and throughout the control period and can lose its effectiveness under certain conditions. When harvesting is delayed, for any reason, KMH has a tendency to lose its ability to ward off extensive sucker growth.

However, KMH is more conducive to machine application and subsequent custom application because it does not require the more precise, directed spraying technique required by Prime +. Therefore, precision is often a concern in applying Prime + especially in conjunction with a custom applied sucker control system.

Another concern with Prime + is the possibility of residual carry-over in the soil into subsequent crop years. The residual tends to act as a herbicidal agent by retarding germination and stunting growth of some subsequent crops including tobacco. To date, research results are inconclusive on this concern.

IMPLICATIONS FOR FURTHER RESEARCH

This study was undertaken to evaluate selected sucker control systems in conjunction with early topping on the basis of yield, quality, total value product, total factor costs, and net value product for comparison with the conventional system utilizing late topping and maleic hydrazide. Though data were obtained in part from a three-year field experiment, continued replication of the field experiment would add confidence to the results and subsequent preliminary conclusions drawn from this analysis. Not only would a continuation of the experiment enhance the validity of current results, but also serve to update current information and subsequent conclusions.

As mentioned in Chapter 2, the overall layout of the experiment was primarily the same across all three experimental years. However, there were subtle differences resulting in deviations from the ideal for experimental design. For example, treatments were replicated four times in 1984 and 1985 but only three times in 1983. In 1983 and 1984 the burley variety, Virginia 509, was used while in 1985, Greeneville 136 (later known as Tennessee 86) was used. Future research should strive to improve, within reason, on such inconsistencies.

Future research should also strive to expand the range of treatments analyzed, primarily in terms of mode of application. This analysis included a broad range of treatments in terms of sucker control chemicals, but was limited in terms of mode of application. It would be insightful to duplicate current treatments while allowing the mode of application to vary among like treatments to include hand, self-propelled high clearance (and/or custom), and tractor mounted, multiple-row offset sprayers as well as dropline-semimechanical systems that approximate the precision of hand sprayers. Such expansions of treatments would allow partial budgets to incorporate a broader range of application alternatives which are available to Tennessee burley tobacco producers.

Whitty and Wilcox (1985) evaluated the effects of tank mixes of Prime + and maleic hydrazide as sucker control mixtures used in conjunction with early topping on flue-cured tobacco. Though the rationale behind such mixtures may seem illogical, there may be practical applications of such systems which are single-pass systems using one application of the tank mix instead of a multi-pass system as used in this analysis) for burley tobacco. As noted by Whitty and Wilcox, tank mixes of half rates of both Prime + and maleic hydrazide resulted in near perfect sucker control. Such tank mixes may have implications in further reducing concerns over precision of machine (custom) applications of Prime + and residues left by both maleic hydrazide and Prime +.

Finally, the data collected and analyzed through this study have implications for future research given the advent of low cost data base systems. Results of this study can easily be incorporated into a general information system or "budget generator" for burley tobacco. Such a system would include management control mechanisms which would allow comparisons of actual results with targeted performance and the modifying of targets or objectives which become outdated by time or changes in managerial techniques (Blackie and Dent, 1974, pp.167-172). The use of such information systems will enable researchers to evaluate a given stage (or system) of production in relation to other stages of production within a given enterprise in the hope of establishing an overall optimal productive scheme for that enterprise.

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APPENDIX

Table A.1. Overall Results of Analysis of Variance of Statistical Models Used in Analysis of Selected Sucker Control Systems for Burley Tobacco.

Dependent Variable[a]	Discrete Class Variables[b]		
	Year	Treatment	Replication
Yield	141.50 (0.0001)	1.44 (0.2120)	4.05 (0.0106)
Price	68.43 (0.0001)	0.31 (0.9310)	0.52 (0.6732)
TVP	143.96 (0.0001)	1.23 (0.3023)	3.48 (0.0207)
TPL	20.79 (0.0001)	5.98 (0.0001)	1.16 (0.3336)
COL	2.26 (0.1129)	3.28 (0.0071)	2.88 (0.0424)
TOT	12.89 (0.0001)	12.04 (0.0001)	3.28 (0.0262)
TFC	113.35 (0.0001)	4.29 (0.0010)	2.57 (0.0620)
NVP	140.70 (0.0001)	1.38 (0.2355)	3.58 (0.0185)

[a]Dependent variables of analysis-of-variance models where "yield" refers to total physical product, "price" is a proxy variable for quality, "TVP" stands for total value product, "TPL" stands for topping labor, "COL" stands for clean-out labor, "TOT" stands for total labor attributed to sucker control (with the exception of spraying labor for Treatments 1 through 5), "TFC" stands for total factor costs, and "NVP" stands for net value product.

[b]Discrete class variables with calculated F values (significance levels in parentheses). Year and treatment interaction was considered for each model and was only significant in explaining variation in topping labor (F value = 18.04), clean-out labor (F value = 7.17), and total labor (F value = 5.30) at least at the .05 level of significance.

Table A.2. Overall Results of Analysis of Variance of Statistical Models Used in Analysis of Selected Sucker Control Systems for Burley Tobacco Topped at Early Flower.

Dependent Variables[a]	Discrete Class Variables[b]		
	Year	Treatment	Replication
Yield	118.16 (0.0001)	1.09 (0.3790)	3.02 (0.0375)
Price	66.56 (0.0001)	0.34 (0.8884)	0.34 (0.7980)
TVP	123.61 (0.0001)	0.95 (0.4591)	2.58 (0.0630)
TPL	23.47 (0.0001)	3.60 (0.0069)	0.78 (0.5087)
COL	4.99 (0.0102)	2.97 (0.0192)	1.92 (0.1373)
TOT	16.97 (0.0001)	2.58 (0.0360)	1.99 (0.1261)
TFC	83.81 (0.0001)	4.38 (0.0020)	1.86 (0.1468)
NVP	125.25 (0.0001)	1.00 (0.4278)	2.65 (0.0581)

[a]Dependent variables of analysis-of-variance models where "yield" refers to total physical product, "price" is a proxy variable for quality, "TVP" stands for total value product, "TPL" stands for topping labor, "COL" stands for clean-out labor, "TOT" stands for total labor attributed to sucker control (with the exception of spraying labor for Treatments 1 through 5), "TFC" stands for total factor costs, and "NVP" stands for net value product.

[b]Discrete class variables with calculated F values (significance levels in parentheses). Year and treatment interaction was considered for each model and was only significant in explaining variation in topping labor (F value = 4.04), clean-out labor (F value = 13.69), and total labor (F value = 9.80) at least at the .05 level of significance.

Table A.3. Results of Analysis of Variance of Mean Topping Labor Comparisons Between Selected Sucker Control Systems for Burley Tobacco Topped at Early Flower (Treatment 2 vs. Treatments 3-7).

Treatment Number[a]	Mean Clean-Out Labor[b] (labor-hrs/acre)	Treatment Mean Clean-Out Labor Comparison[c]	F Value[d]	Probability > F[e]
2[f]	8.36	----	----	----
3	8.64	2 vs. 3	0.06	0.8054
4	8.44	2 vs. 4	0.00	0.9458
5	8.52	2 vs. 5	0.02	0.8913
6	8.02	2 vs. 6	0.09	0.7689
7	12.09	2 vs. 7	10.61	0.0019

[a]A description of treatments is in Table 2.1.

[b]Mean topping labor for each treatment is a simple average of observed data at Greeneville, Tennessee across all years (1983-1985) and replications.

[c]Listing of contrasting statements of topping labor treatment means being compared.

[d]Calculated F value. Year and treatment effects were significant at the .05 level of significance in explaining variation in topping labor (Appendix, Table A.2).

[e]Probability of making an error in rejecting the null hypothesis of no difference between Treatment 2 and each of Treatments 3 through 7. Treatment 7 was significantly different from Treatment 2 at the .0019 level of significance.

[f]Basis for paired comparison with each of Treatments 3 through 7.

Table A.4. Results of Analysis of Variance of Mean Clean-Out Labor Comparisons Between Selected Sucker Control Systems for Burley Tobacco Topped at Early Flower (Treatment 2 vs. Treatments 3-7).

Treatment Number[a]	Mean Clean-Out Labor[b] (labor-hrs/acre)	Treatment Mean Clean-Out Labor Comparison[c]	F Value[d]	Probability > F[e]
2[f]	6.64	----	----	----
3	1.78	2 vs. 3	13.32	0.0006
4	3.61	2 vs. 4	5.19	0.0266
5	3.50	2 vs. 5	5.56	0.0220
6	2.89	2 vs. 6	7.93	0.0067
7	3.05	2 vs. 7	7.26	0.0093

[a]A description of treatments is in Table 2.1.

[b]Mean clean-out labor for each treatment is a simple average of observed data at Greeneville, Tennessee across all years (1983-1985) and replications.

[c]Listing of contrasting statements of clean-out labor treatment means being compared.

[d]Calculated F value. Year and treatment effects were significant at least at the .05 level of significance in explaining variation in clean-out labor (Appendix, Table A.2).

[e]Probability of making an error in rejecting the null hypothesis of no difference between Treatment 2 and each of Treatments 3 through 7. Each of Treatments 3 through 7 were significantly different from Treatment 2 at least at the .05 level of significance.

[f]Basis for paired comparison with each of Treatments 3 through 7.

Table A.5. Results of Analysis of Variance of Mean Total Sucker Labor Comparisons Between Selected Sucker Control Systems for Burley Tobacco Topped at Early Flower (Treatment 2 vs. Treatments 3-7).

Treatment Number[a]	Mean Total Labor[b] (labor-hrs/acre)	Treatment Mean Total Labor Comparison[c]	F Value[d]	Probability > F[e]
2[f]	15.00	----	----	----
3	10.42	2 vs. 3	7.71	0.0123
4	12.05	2 vs. 4	2.79	0.1007
5	12.02	2 vs. 5	2.84	0.0974
6	13.13	2 vs. 6	5.36	0.0243
7	25.66	2 vs. 7	0.01	0.9334

[a]A description of treatments is in Table 2.1.

[b]Mean total sucker labor (excluding spraying labor) for each treatment is a simple average of observed data at Greeneville, Tennessee across all years (1983-1985) and replications.

[c]Listing of contrasting statements of total sucker labor treatment means being compared.

[d]Calculated F value. Year, treatment, and replication effects were each significant at least at the .05 level of significance in explaining variation in total sucker labor (Appendix, Table A.2).

[e]Probability of making an error in rejecting the null hypothesis of no difference between Treatment 2 and each of Treatments 3 through 7. Treatments 3 and 6 were significantly different from Treatment 2 at least at the .05 level of significance.

[f]Basis for paired comparison with each of Treatments 3 through 7.

Table A.6. Estimated Burley Tobacco Budget Excluding Direct and Indirect Costs Attributed to the Control of Suckers, Knoxville, Tennessee 1986.[a]

Item	Description[b]	Unit	Quantity	Price ($)	Amount ($)
Plant Bed Variable Costs					
Seed	Hybrid 1/12 oz.	Pk.	2.00	5.00	10.00
Fertilizer	4-16-4	Cwt.	0.50	10.00	5.00
Gas Cover	103'x 10 1/2'	3 Mil.	1.00	13.35	13.00
Bed Cover	100'x 9, Polester		1.00	22.90	23.00
Insecticide	Disyston	9 Oz.	1.00	1.90	2.00
Herbicide	Enide 90 W.P.	Lb.	0.25	6.55	2.00
Fungicide	Ridomil	Qt.	0.03	33.50	1.00
Fumigant	Methyl Bromide	1 1/2 Lb.	5.00	1.95	10.00
Applicator	Prorated 3 yrs.		3.00	1.00	3.00
Machinery		Hr.			25.00
				Total	93.00
Field and Other Variable Costs					
Cover Crop	Wheat, Rye, Barley	Bu.	2.00	5.50	11.00
Fertilizer	5-10-15	Cwt.	15.00	9.50	143.00
	Nitrogen	Lb.	90.00	0.20	18.00
Lime		Ton	0.40	12.00	5.00
Insect	Furdan 15G	Lb.	24.00	1.63	39.00
Control	Orthene 75 W.P.	Lb.	2.00	7.00	14.00
Disease Control	Ridomil	Qt.	2.00	33.50	67.00
Herbicide	Prowl 4 E.C.	Pt.	2.50	6.00	15.00
Machinery	Fuel	Ac.	1.00	41.25	41.00
Machinery	Repairs	Ac.	1.00	43.51	44.00
				Total	396.00
Fixed Costs					
Machinery		Ac.	1.00	88.48	88.48
Tobacco Sticks	Prorated over 8 yrs.		1600.00	0.15	30.00
Barn					218.00
				Total	336.00

Table A.6. (Continued)

Item	Description[b]	Unit	Quantity	Price ($)	Amount ($)
Interest Expense					
Operating Capital	(6 months)	Ac.	489.23	0.11	27.00
Fixed Capital	Equipment @ Barn	Ac.			291.00
				Total	318.00
Labor Cost					
Excludes Sucker Control Labor		Hr.	275.04	4.50	1238.00
				Total	1238.00
Total Cost of Production Excluding Direct and Indirect Costs to Control Suckers					2381.00

[a]Estimated costs of production were derived from University of Tennessee Agricultural Extension Service field crop budgets (Johnson et al., 1986, pp. 8-9).

[b]Description of items were assumed to be the same across all three experimental years of this analysis.

VITA

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