AN ABSTRACT OF THE THESIS OF

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Title: Information and Analysis Techniques for Making Crop Selection Decisions

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Twenty managers of large diversified irrigated farms in the Willamette Valley area of Oregon were interviewed about the economic information and analysis techniques they use when making crop selection decisions. Two community college farm management instructors, two agricultural lenders, and two certified public accountants working with farmers were interviewed about how they think farmers make crop selection decisions, how they think farmers should make these decisions and the information and services they provide to help farmers make crop selection decisions.

Crop selection was agreed to be one of the most important decisions in the overall management of the farm. Profit was the primary management objective but diversification, crop rotation, labor schedule, soil suitability, and equipment requirements were also considered important factors in the decision. Production cost, commodity price, and yield information would be most useful if available by the end of September or early October to make decisions on fall crops and by the end of March to decide on spring crops.

Microeconomic marginal analysis, linear programming, and E-V analysis using Quadratic programming, although theoretically appropriate, have limited usefulness to farmers when making actual crop selection decisions. These techniques were not being used by the farmers interviewed even though some of them had business or economics training at the undergraduate or graduate level. These techniques are highly sensitive to parameter specifications and, in many cases, are inappropriately sophisticated when the availability and reliability of yield, price, and cost information is considered. In addition to price and yield variation, crop production costs were found to vary approximately 10-20% from year to year. Resulting from these combined variances, per acre crop gross margins were found to vary 100% or more.

Enterprise budgeting was found to be the only analysis technique commonly used. Ninety-five percent of the farmers interviewed tried to estimate the profit per acre they expected from each crop before planting, but only sixty percent wrote down these calculations. Ninety percent indicated that their past cost records were important in estimating costs, but only thirty-five percent kept records of their production costs for each crop.

Lenders and accountants were found to provide very little assistance in making crop selection decisions. The community college farm management instructors teach enterprise cost accounting and encourage its use in analyzing crop selection decisions.

An information and analysis system for crop selection decisions was proposed and tested in two case studies. This system stresses keeping enterprise cost records and using these records with other information to construct crop budget projections for each crop. The "Croplan" program for the HP 41C programmable calculator was used to analyze the riskiness of each crop. The program evaluates a triangular probability distribution for uncertain yields and prices given the highest likely, most likely, and lowest likely levels. Expected gross income per acre, expected margin per acre, and a break even probability are calculated. The farmer then ranks his crops in order or desirability based on expected margin and break even probability. The crop plan is then developed manually based on this ranking, subjectively satisfying other constraints or the crop budgets can be used as input for linear programming or other sophisticated techniques.

There is a need for more basic record keeping and enterprise cost analysis by farmers to generate accurate and reliable cost data. The improved record keeping will have a threefold benefit. First, a better understanding of relative profitability of each crop will aid crop selection decisions. Second, better cost control may be achieved through detailed analysis of the costs associated with each crop. Third, reliable records of historic cost, price and yield information will facilitate more valid use of sophisticated analysis techniques such as linear programming, or E-V analysis in the future.

Information and Analysis Techniques For Making Crop Selection Decisions

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PREFACE

Through his experience as a farm management consultant, the author became aware that although there are economic information and business analysis techniques theoretically appropriate for certain management decisions they are very seldom used, or used to the greatest advantage, by farm managers when making actual management decisions.

With both undergraduate and graduate level training in agricultural economics with an accounting minor, the author was thoroughly aware of what economic information and analysis techniques text books indicated farmers ought to use when making certain types of decisions. He was intrigued to find how rarely these were actually used by even the well educated farmers who fully understood the principles of economic analysis and managerial accounting. The author's own attempts to introduce the use of formal analysis techniques on his clients' "real world problems" were largely frustrating because the elements of the partial "decision budgets" or the coefficients of the equations were usually unknown. Specific cost information was rarely available. Farmer's real life decision problems were significantly more complex than text book models would accomodate. Where appropriate models could be found, the model's coefficients were often difficult to estimate. In these cases the sensitivity of the analysis model in comparison to the uncertainly of the coefficients allowed very little confidence in the indicated solutions.

INFORMATION AND ANALYSIS TECHNIQUES FOR
MAKING CROP SELECTION DECISIONS

I. INTRODUCTION

General Situation

Managing a modern farm business is particularly challenging considering the risks and the number of uncontrollable factors, in agriculture, upon which success and profit depend. Successful managers concentrate on exercising their control over those factors that can be controlled. Crop selection or enterprise mix is one of those controllable factors.

The crop selection decision is an important one to farmers in the Willamette Valley. There is a wide variety of feasible crops for nearly every farming area and soil type in the Willamette Valley.[1/] Determining the optimum mix of crop enterprises each year can significantly affect the profitability of the farming business. Shifting from certain crops to other crops may have serious implications on the farm's financial condition. Large investments may be required for irrigation or other equipment specifically required for certain crops. Large losses may result upon the liquidation of that equipment if those crops are abandoned. In some areas

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1/ Refer to Table 13 for a partial list of crops.

there are significant entry barriers for some of the more lucrative row crops such as sweet corn and bush beans because of cannery contracts are often not readily available or may be expensive to acquire.

Crop selection is one of the most significant recurring management decisions farm managers in the Willmaette Valley or other diversified areas must face. It is therefore worthy of considerable attention and has accordingly been addressed by numerous authors. In recent years many articles have been published and several books have been written dealing with the economic information and analysis techniques that can be used to help farmers make these crop selection decisions.[2/] Unfortunately at the farm level, few of these techniques are being implemented. In some cases, these techniques have been tried and rejected by farmers (Lin, Dean and Moore).

This study is directed toward bridging the gap between the classroom theories of economic analysis and managerial accounting and the actual processes by which farmers make management decisions. It is intended that this study will contribute toward bridging the gap by exploring more fully the nature of the actual farm management decision process and by making recommendations on how portions of the theory can be practically applied. The author is not alone in identifying this gap. John Nix, in his review of the last thirty

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[2/] Adams, et al.; Beneke and Winterboer; Brink, et al.; Carver; Goldschmidt; Halter and Dean; Longworth and Menz; Nelson, et al.; Paris; Schurle, et al.; Scott; Scott and Baker; Thompson and Hazell; among others.

years of farm management, "Farm Management: The State of the Art (or Science)," comments on the problem and a promising trend in recent research toward simpler more practical techniques.

> It was, I feel, the increasing sense that the further development and the refinement of programming techniques was getting too far into the realms of obscurity, without even the remotest chance of practical usage that has caused a reaction against such further work amongst farm management researchers. Of course there were other reasons, such as the increasing doubts about the usefulness of any results obtained from such apparently complex and sophisticated techniques when future input and output prices were so uncertain . . . (P.286).

It is hoped that this study will be a further step in this trend toward simpler, more practical techniques.

Statement of the Problem

Much of the available farm management information and many of the recently developed computerized tools and analysis techniques theoretically appropriate to assist farmers in making crop selection decisions are not being widely used at the farm level. This situation may be the result of a combination of several factors. First, farmers may not be adequately aware of the appropriate information and analysis techniques available to them for making crop selection decisions. Second, this information and these techniques may not be in a form or presented at a level usable by most farmers. Third, much of the information and/or analysis techniques may not be appropriate or practical for use by farmers in making actual crop selection decisions.

This may be because the information and analysis techniques were developed with an inadequate understanding of the nature of crop selection decisions, and of the management capabilities of farmers.

The first two causes point to a need for more extensive and appropriate extension education programs. The author's personal experience working with well educated and informed farmers who were having difficulty integrating economic information and applying analysis techniques when making actual crop selection decisions indicated that inappropriateness and impracticality may be part of the problem. This study will explore this third possible cause for the lack of use of economic information and analysis techniques by farmers when making crop selection decisions.

Russell Ackoff, in his article "Management Misinformation Systems" suggests, "One can not specify what information is required for decision making until an explanatory model of the decision process and the system involved have been constructed and tested". More attention needs to be paid to the farmer and his situation so the nature of the crop selection decision he makes can be better understood. Only with this improved understanding can a realistic management information system and analysis approach be developed. The purpose of this study was to gain a better understanding of the nature of the crop selection decision and of the management processes used by farmers when making these decisions. It is hoped that this improved understanding will lead to recommendations on how to bridge the theory-practice gap.

Objectives of the Research

The objectives of this study are as follows:

I. Review the business analysis techniques theoretically appropriate for making enterprise mix decisions and critique these techniques in light of the practical limitations of the "real world" farm management situation.

II. Gain a better empirical understanding of the crop selection decisions made by managers of large diversified farms in the Willamette Valley.

   A. Describe when they make crop selection decisions.

   B. Determine the economic information they currently use and the factors they consider when making crop selection decisions.

   C. Determine what analysis techniques they use, if any.

   D. Determine the economic information farmers feel they need to make crop selection decisions that is not currently available.

   E. Explore the factors which discourage or restrict the use of available economic information.

III. As pertains to crop selection decisions, explore the information and services offered by agricultural lenders, extension service personnel, community college farm management instructors, and public accountants.

A. Determine how they think farm managers make crop selection decisions.

B. Determine how they think farm managers should make crop selection decisions.

C. Identify what services and information they provide or recommend to farm managers.

IV. Inventory the economic information available for making crop selection decisions and describe the "value" or "usefulness" of that information.

V. Propose a crop selection information system that is based on available information or potentially available information, that is consistent with economic and management theory and is compatible with the management abilities of farmers.

VI. Test this proposed system by using it to help several farmers work through actual crop selection decisions and describe these case studies.

General Research Procedure

Twenty large diversified Willamette Valley farmers were randomly selected and interviewed about the crops they grow and how they make crop selection decisions. These interviews had a semi-structured format with the interviewer using a questionnaire to solicit specific responses to questions as well as lead into a general discussion with the farmer about the information and analysis techniques he uses to make crop selection decisions.

The author used revised questionnaires and a similar interviewing format when interviewing agricultural lenders, community college farm management instructors, and public accountants in the service person portion of this study. The proposed crop selection information system was gradually developed by the author through his experience as a farm management consultant specializing in computerized enterprise cost accounting for farmers. This system incorporates several recommendations made by clients of the author and was revised and tested with their cooperation.

II. THEORETICAL FOUNDATIONS TO CROP SELECTION DECISIONS

Economic Theory

Product Mix Optimization

The portion of micro-economic theory relevant to crop selection decisions is often referred to as the "theory of the firm". Specifically, the crop selection decision is a profit maximization decision in a multi-product multi-input case with some fixed inputs. Economic theory analyzes costs and revenues on the margin. Put simply, the economist wants to know whether or not each individual unit of output will be profitable and tries to determine exactly how many units of each product should be produced to maximize profits.

Product mix optimization by marginal analysis is typically predicated upon a number of simplifying assumptions: first, the manager is a profit maximizer: second, all input and output prices and production function coefficients are known with certainty; third, all production functions are continuous and curvilinear in shape with negative second derivatives, making them concave toward the origin within the relevant range of activity; fourth, all inputs and outputs are infinitely divisible; and fifth, both input and output prices are constant with respect to output and input levels.

Two or more outputs are often produced jointly in a single production process. In the simplest case, the quantities of the two outputs can be expressed as a function of a single input. The product transformation curve is the locus of all output combinations that can be produced with a given level of input. The production relation is normally assumed to have concave product transformation curves as indicated in Figure 1. The product transformation curve indicates each combination of output 1 and output 2 that can be produced with a given level of an input X needed for the production of both. The manager desiring to maximize profits obtainable from a limited supply of the necessary input does so by producing the optimum combination of outputs 1 and 2. This combination is where the slope of the product transformation curve is equal to the ratio of the output prices. In graphical terms he will operate at the point at which an isorevenue line (ratio of output prices) is tangent to a particular product transformation curve. If he desires to maximize profit he must equate the value of marginal productivity of the input with respect to each output to the price of the input. The second order conditions require that the product transformation curve be strictly concave in the neighborhood of a point for which the first order conditions are satisfied (Henderson and Quandt).

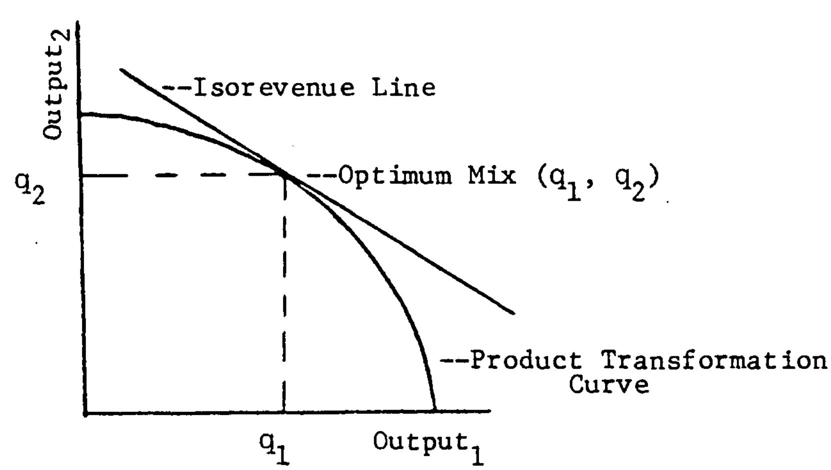


Figure 1. Product Transformation Curve

Constrained Revenue Maximization: One Input Two Output Case

Let:

$R \equiv$ Revenue

Q_1 , Q_2 $\equiv$ Quantity of Outputs 1 and 2, respectively;

P_1 , P_2 $\equiv$ Price of 1 and 2 respectively; and

$R \equiv P_1Q_1 + P_2Q_2$.

To solve the constrained maximization problem, maximize:

$$W = P_1Q_1 + P_2Q_2 + \mu\,[x - h(Q_1,Q_2)],$$

where μ is an undetermined Lagrangian multiplier, x is the level of input, and $x = h(Q_1,Q_2)$. Partial derivatives of W are set equal to zero, giving:

$$\frac{P_1}{P_2} = \frac{\frac{\delta x}{\delta Q_1}}{\frac{\delta x}{\delta Q_2}} = -\frac{\delta Q_2}{\delta Q_1} = \text{RPT}.$$

The RPT (rate of product transformation) must be equated to the price ratio, leading to the equation:

$$\mu = P_1 \frac{\delta Q_1}{\delta x} = P_2 \frac{\delta Q_2}{\delta x}\ .$$

The value of the marginal product of x in the production of each output must equal μ and hence equal one another. The second order conditions require the relevant bordered Hessian determinant be positive, where h_{ij} is the second derivative of h(.) with respect to Q_i and Q_j,

$$\begin{vmatrix} -\mu h_{11} & -\mu h_{12} & -h_1 \\ -\mu h_{21} & -\mu h_{22} & -h_3 \\ -h_1 & -h & 0 \end{vmatrix} > 0.$$

Or, stated simply, the product transformation curve must exhibit increasing RPT (i.e., be concave to the origin) (Henderson and Quandt pp. 91-93).

Constrained Revenue Maximization: Multi-Input Multi-Output Case

In the analysis of a real farm the optimization of many inputs and many outputs is usually required. The production function is implicitly stated as follows, where there are s outputs and n inputs:

$$f(Q_1,\ldots, Q_s, X_1,\ldots, X_n) = 0.$$

Profit is the difference between the total revenue from the sale of all outputs and the total cost of all inputs. Where C_j is the price of the jth input,

$$\Pi = \sum_{i=1}^{s} P_i Q_i - \sum_{j=1}^{n} C_j X_j .$$

The manager desires to maximize profits subject to the technical rules given by his production function f(.) (Henderson and Quandt p.95). He does this by maximizing J(.) with respect to each Q_i and X_j.

$$J = \sum_{i=1}^{s} P_i Q_i - \sum_{j=1}^{n} C_j X_j + \lambda f(Q_1,\ldots, X_n).$$

Setting each partial derivative equal to zero leads to the general optimizing condition that the RPT for every pair of outputs (Q_i and Q_m) holding the levels of all other outputs and all inputs constant must equal the ratio of the prices of the outputs.

$$RPT = -\frac{\delta Q_i}{\delta Q_m} = \frac{P_m}{P_i} \qquad i,m = 1,\ldots, s$$

For the ith output and the jth input the value of the marginal product of each input with respect to each output is equated to the input price.

$$\frac{C_j}{P_i} = \frac{\delta Q_i}{\delta X_j} \qquad \text{or} \qquad C_j = P_i \frac{\delta Q_i}{\delta X_j} \qquad \begin{array}{l} i = 1,\ldots,s \\ j = 1,\ldots,n \end{array}$$

Finally to find the optimum levels of two inputs with all other inputs and all outputs held constant, the RTS (rate of technical substitution of one input for another) for every pair of inputs must equal the ratio of their prices.

$$\frac{C_j}{C_k} = -\frac{\delta X_k}{\delta X_j} = RTS \qquad j,k = 1,\ldots,n$$

The second order conditions for the maximization of profit require that the relevant bordered Hessian determinants alter in sign. Stated simply, the production function must form a closed, strictly convex point set in the neighborhood of the solution (Henderson and Quandt, pp. 95-96).

Similar equations can be derived to indicate how the manager should respond to changes in input and output prices and to changes in the productivity of certain inputs as he attempts to maintain the optimum input-output mix in a changing environment.

In summary, there is a well defined economic theory indicating how managers should determine optimal input-output mixes. One of the problems with using tradtional economic theory or production function formulations for farm decision making is that this approach implies that changes in output are directly related to changes in input. Traditional economic theory assumes farmers will operate in Stage II of the production function. In some cases farmers may choose to operate in Stage III. Actual farm level decisions may often be explained by the fact that increased input use beyond Stage II may be related to a reduction in output variance or a reduction in subjective risk. Cases where increased inputs may be used to reduce risk or the feeling of risk are: a) observable management tendencies toward over capitalization in irrigation equipment, frost control equipment, or harvest equipment to reduce the risks associated with adverse weather, and b) tendencies toward overuse of pesticides to reduce risk of crop failure (Just and Pope).

Application of the economic theory appropriate for optimizing multi-product multi-input management decisions is extremely difficult because the necessary simplifying assumptions are so restrictive and can rarely be satisfied in the real world situation. The first assumption is that the manager be a profit maximizer. Lin, Dean and Moore, in their article "An Empirical Test of Utility Versus Profit Maximization in Agricultural Production", empirically tested three management objectives for their accuracy in predicting actual farm management behavior. These three objectives include Bernoullian utility, lexicographic utility, and profit maximization. They concluded:

> ...none of the models predicted actual behavior well, with a strong tendency for all models to predict more risky behavior than was in fact observed. Profit maximization was the worst offender in this regard, consistently predicting cropping plans far more risky than those actually followed. Bernoullian utility maximization explains actual farmer behavior more accurately than profit maximization (p.507).

When empirically tested, profit maximization was found to be a poor predictor of actual farm behavior in making crop selection decisions. Even the relatively sophisticated Bernoullian utility function, which incorporates risk, was not found to predict well. For these reasons, the profit maximization assumption necessary for economic theory may not necessarily reflect the real world situation.

The second simplifying assumption necessary for the application of economic theory that all input and output prices and production function coefficients be known with certainty. This is obviously an unrealistic assumption in the case of the agricultural industry where both input and output prices may change daily and production coefficients are often difficult to estimate.

The third assumption regards the shape of the production function. It is generally agreed by both economists and production agronomists that there are decreasing benefits to increasing amounts of inputs such as fertilizer, pesticides, and labor. The decreasing marginal benefits of these inputs would tend to make the production function curvilinear in shape and concave towards the origin within the relevant range of activity. But, the estimation of the parameters or coefficients of this production function is a very difficult matter. Empirical studies are limited and the conclusions are not very exact. The problem with estimating the marginal response to increasing amounts of fertilizer or other inputs is that this response is dependent upon a number of other uncontrollable factors such as the weather. When enough intensive test plots have been studied to derive a specific production function, these results can only be applied to situations with similar weather and soils. For practical purposes the farm manager does not know his production function coefficients with certainty and in many cases may not even have a crude estimate of what those production coefficients might be.

The fourth assumption is that all inputs and outputs be infinitely divisible. For the bulk of agricultural inputs and outputs this assumption is valid. A wheat crop is virtually infinitely divisible. Fertilizer and pesticides are, for practical purposes, infinitely divisible. Labor, if provided by casual seasonal employees hired on an hourly basis, is also highly divisible. Machinery inputs constitute the major violation of this assumption. Combines and tractors are not infinitely divisible. Custom machine hire can be used or this problem can be overcome by considering the relevant range for one combine and the relative range for two combines on two separate curves. The production function can not be continuous across a range of these lumpy inputs, so each range must be considered individually.

The fifth assumption is that both input and output prices be constant throughout the range of activity. For the most part, the agricultural industry operates in a nearly perfectly competitive market. Although volume discounts for large bulk purchases of inputs may alter the price of the inputs slightly, for most practical purposes the prices of inputs and outputs are constant throughout the relevant range.

The application of economic theory appropriate for optimizing multi-product multi-input management decisions on a marginal basis is extremely difficult because the required assumptions can rarely be satisfied by real world situations. The basic understanding of this theory is vital however for providing the manager with an understanding of the nature of the optimizing process.

Management Science

With the advent of the modern computer, mechanized optimization of complex business situations became possible. Where managers are faced with problems involving a large number of possible activities that can be activated at different levels individually or in combination with other activities the total number of possible outcomes is enormous. Historically, managers used subjective evaluations to determine a few of this huge number of possibilities to evaluate and then selected an optimum solution from this small set. Electronic data processing on the other hand can be used to systematically sort through the entire set of possible combinations while quickly and efficiently searching for the optimal solution. The disciplines of management science and operations research have over the years developed several models which equip the computers to handle such optimizing problems. Linear programming is one of the most common and well known of these optimizing techniques.

All linear optimization problems can be characterized by the existence of two or more activities (enterprises) which compete for limited inputs. The problem is to determine the best allocations of scarce resources to activities. The objective of linear programming is to determine the level of each activity so that a linear objective function is optimized subject to linear resource limitations and perhaps other conditions expressed by linear constraints. Linear programming is an extremely flexible tool and has been successfully used for a wide variety of management problems including crop selection decisions for diversified farms. Usefulness of the technique is limited however by the nature of the assumptions and conditions necessary for using this technique. These are as follows:

1) The model is deterministic, this means that each coefficient is assumed to be fixed and known with a certainty. In reality this would be very unusual. The estimation of coefficients in the L.P. model requires great care. Fortunately the sensitivity of solutions to fluctuations in the coefficients can be evaluated by sensitivity analysis. Advanced programming models such as stochastic linear programming allow the incorporation of risk and uncertainty into the models.

2) The model is proportional, implying that doubling of the amount of inputs would result in an exact doubling of the resulting output. This condition follows directly from the linear assumptions for the objective function and the constraints, and represents constant returns to scale as apposed to economies or diseconomies of scale.

3) The model is additive, the assumption of proportionality guarantees linearity only if joint effects or interactions are nonexistent. This implies that the whole is equal to the sum of the parts and that the level of one activity (i.e.

enterprise) in no way increases or reduces the productivity of another activity. Rotational benefits, complimentary and supplementary crop combinations would be ignored.

4) The model is divisible; this means that fractional levels for all activities are permissible. One variation of simple linear programming will allow only integer solutions when it is necessary to restrict input and output to integer values.

Other management science solution methods include the following:

1) Dynamic programming, which allows for sequential or time-dependent interactions between activities.

2) Stochastic programming, which allows for unknown but probabilistic outcomes for certain activities.

3) Simulation, which is a technique allowing for the estimation of the probability distribution of net income from different crop combinations. This is done by running the simulation a large number of times, using randomly selected values for the prices and yields.

Each of these different methods has advantages for solving certain types of management problems. They involve different assumptions and limiting conditions. They are all however, entirely dependent upon the availability and quality of the information about the input coefficients, which are necessary to quantifiably model the actual management situation (Budnic, Mojena and Volmann).

Beneke and Winterboer, in their book Linear Programming Applications to Agriculture, develop in detail the theory and techniques of linear programming as it applies to agricultural decision making. This book is an excellent example of the dichotomy between development of highly sophisticated analysis techniques and the need for fundamental record keeping and cost information. In their 240 page book Beneke and Winterboer devote a total of eight pages to the discussion of forming price and production coefficient estimates for use in the linear programming models. In their chapter on sensitivity analysis, they failed to mention sensitivity of the model to price and production cost coefficient estimation errors. Quoting from their two paragraphs on sources of data:

> Ideally, production coefficients would be derived from carefully kept input output records on the farms under study but this is rarely possible. Many planning models will seek to test activities which have never been carried out on the farm; hence no record is possible. Furthermore, the detailed accounting records required to develop planning coefficients are too costly in terms of time and effort to be justified on units of size typical on much of todays agriculture. Thus the assumption that all would be easy if only adequate records were available is a useless speculation. Such records simply are not available for farm planning nor will they be in the foreseeable future.
>
> Most production coefficients must be built on the knowledge transferred from another situation and adapted as best one can to the business under study. Two likely sources of data which may be transferred are; 1) experimental data, and 2) cost accounting data (p.105).

Beneke and Winterboer go on to develop a complicated step by step procedure for helping farmers recall production techniques and estimate costs for production on their farms. Without citing any practical experience or empirical data, Beneke and Winterboer propose that farm operators can usually recall a surprising collection of information about their business if relatively recent time period has evolved; however, they indicate that if more than a year has elapsed confusion among years is often evident. After suggesting the only viable sources of information are experiment station studies and cost accounting done by other institutions, the authors propose an elaborate system for helping the farmers recall their steps of production to estimate costs. Then they go on to explain how production coefficients vary significantly from farmer to farmer. "For reasons not easy to define, two operators may achieve quite different results from what appear to be similar activities" (p.106). Thus they propose that productivity from farmer to farmer varies considerably and then conclude that, "All these manifestations of the level of management can and should be expressed in one way or another by the coefficient specified in the planning model" (p.108).

Clearly the value of linear programming, in its application to agriculture, is significantly limited unless methods to gather accurate and reliable information can be developed. The record keeping techniques and budgeting procedures proposed by this study are not intended to replace the use of linear programming or other sophisticated analysis techniques but are seen as a necessary step to be taken prior to the use of these more sophisticated analysis models. It is further proposed that the process of enterprise cost accounting and the procedure of analyzing these historic costs to develop future cost projections is an invaluable educating process for the farm manager. These steps may create an adequate understanding of individual profit centers to allow the managers to make enterprise selection decisions without the use of more sophisticated analysis models such as linear programming.

Scott, in his book The Basics of Linear Programming and Their Use in Farm Management, states in his summary:

> The gigo (garbage in,garbage out) principle can not be over emphasized. The results obtained from linear programming are no better than the assumptions made about the problem being solved and the accuracy of the input data used. This is equally true of any other planning tool including the simplest partial budgets (p.9).

Scott goes on to propose that linear programming may be less susceptible to nonsense results caused by estimation error than partial budgeting because the total farm can be considered at one time, where as partial budgeting allows the operator to consider only one enterprise at a time. The key point is that the value of any decision technique is limited by the accuracy and reliability of the information used.

Risk Management

Probability

In a discussion of risk as it applies to crop selection decisions it is important to differentiate between empirical probability, deductive probability, and subjective probability. A probability is a number that measures the likelihood or chance that a particular event will occur. Probabilities are expressed by a decimal number 0.0 through 1.0 or in percentage terms 0 to 100%. With 0% indicating no likelihood that that event will occur and 100% indicating absolute certainty that that event will occur. Empirical, deductive, and subjective probabilities differ in the way they are estimated or derived. Empirical probabilities are based on the frequencies of empirical observations and are useful when historic data is available and future events will be consistent with past occurrences.

Deductive probabilities are those that can be obtained by logical deduction from a model which describes a stochastic process, for example the 50/50 probability of a coin toss. Deductive probabilities have little application for farm management decisions because the sources of risk important to the farm manager are rarely of this type (Nelson, et al.).

Subjective probability is a measure of the decision makers strength of conviction or confidence about the chance of occurrance of the particular event. These estimates are based primarily on beliefs and gut feelings. It must be acknowledged that a well educated and informed farmer who understands the interactions of the market and stays informed about current price trends and supply and demand figures will have an educated gut feeling about the price of wheat but it is still just a gut feeling. These feelings or beliefs can be quantified into subjective probabilities by associating a level of confidence to different ranges of prices (Nelson, et al.).

Subjective probabilities are very useful for application in farm management decisions. The farm manager must integrate all the market information he studies, his own intuitive judgement and his own past experience to develop a set of subjective probabilities about uncertain future prices or yields. These probabilities must be developed subjectively or informally, but once quantified they can be incorporated into analysis of certain management options.

Risk Vs. Uncertainty

Uncertainty is a term used to describe a situation where the farm manager foresees any number of possible outcomes for a future event. Within the context of this paper uncertainty will be used to describe the situation where the farmer has no information or beliefs which would allow him to be more confident in some of these outcomes than in others. The farmer is truly uncertain as to which of these events will occur and has no real basis for predicting between them.

Risk is a situation where the farmer foresees a number of future possible events and has information or beliefs allowing him to assign probabilities to the different occurrences. The farmer is more confident in some of these occurring than others and can assign subjective probabilities to these different events.

When the farmer has information or past experience giving him a set of beliefs, he is in a situation of risk. When the farmer has little or no information or experience, he is completely uncertain. Relevant information should move him from a situation of uncertainty to a situation of evaluated risk. As more and more relevant information is obtained the farmer should be able to have more and more confidence that the unknown future event will fall within a certain narrow range allowing the farmer to make more accurate predictions.

Risk is also used to describe the financial hazard of a crop or plan. A high risk crop would be one with a high probability of "significant loss". This high risk crop may also have potential for large profits. The expected net incomes of these high risk crops have wider variances due to volatile prices and/or unpredictable yields.

The analysis of risk is important when trying to understand the crop selection decision process, because different crops and different cropping plans may have different risk characteristics. The probability of disastrous losses is an important consideration to farmers when making crop selection decisions. The size of the potential losses and the relative probability of those losses weighs heavy on the farmers mind.

Some crops can be considered low risk crops because their stable prices and fairly consistent yields eliminate the opportunity of unusually high profits and the hazard of unusually large losses.

Some farmers have an "unusual" aversion to losses in the sense that they may select a crop with a lower profit potential just to avoid the hazard of losses, especially when these losses result in a reduction in family living or the loss of investment in the farm.

Farmers can be grouped in three classes as; risk takers, risk neutral individuals, and risk averters. The risk takers may have strong preference for the opportunity of high profits and disregard or seek) the hazard of the associated risk of loss or failure. Risk neutral farmers place equal rating on the opportunity for high profit and the risk of large losses. Risk averters, on the other hand, have a strong aversion to the hazard of loss and would often prefer a crop with a lower potential profit just to avoid the hazard of large losses associated with other crops. The farmer's risk preference may alter his profit maximizing objectives and may affect his crop selection decisions.

There are numerous methods of incorporating risk considerations into crop selection decisions. E-V analysis is a relatively sophisticated method incorporating quadratic programming. Break even probability is a relatively simple method. There is such a variety of other methods ranging from simple to complex that adequate coverage is beyond the scope of this study.

E-V Analysis

The E-V approach uses quadratic programming to sort out cropping plans with an inverse relationship between gross margin variance and mean expected gross margin. The E-V "efficient" combinations form the E-V frontier, indicating those combinations with the least amount of variance for a given level of expected gross margin. The farmer's risk preferences can be expressed in terms of an E-V indifference curve, which quantifies the trade-off in satisfaction between increasing amounts of expected gross margin and variance. The tangency of the E-V and indifference curves indicates the optimum farm plan (see Figure 2).

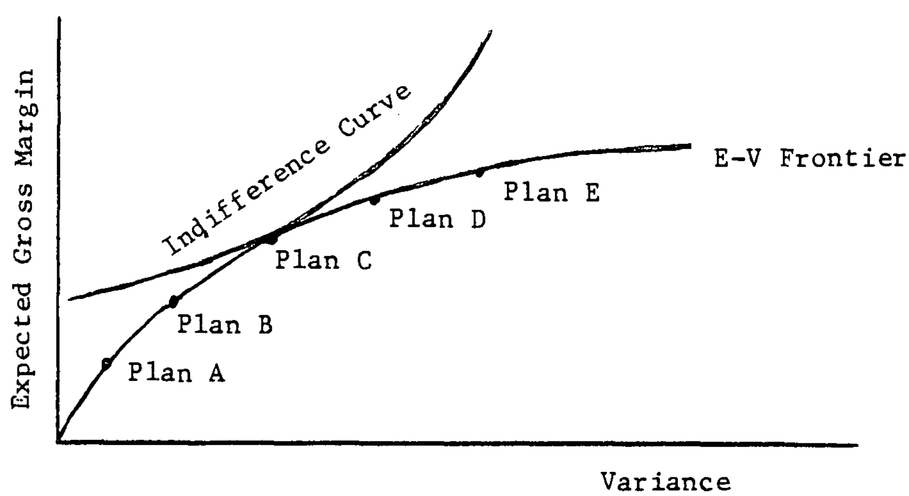


Figure 2. E-V Frontier

The application of E-V analysis to crop selection decisions originated with Markowitz's portfolio analysis and was applied by Freund to farm planning under uncertain revenues (Paris).

> The apparent draw back of such approaches, however, is that they have not been sufficiently tested by means of empirical studies of some realism possibly because the required dimensionality of the associated problems is still regarded as a heavy computational burden (Paris, p.268).

The availability of suitable quadratic programming computer code is one limitation to the use of this approach and is discussed by Thompson and Hazel. The other problem is with the availability of information and the unreliability of the techniques in empirical tests. Paris mentions the unavailability of accurate and suitable cost information.

Halter and Dean, in their book Decisions Under Uncertainty with Research Applications, indicate that one of their objectives for writing the book is that ". . . students would gain a greater appreciation of both the theory and its applications by studying some applications of the theory to real world problems" (p.iii). One of their recommended approaches to crop selection begins with developing an E-V frontier.

The data used for their E-V example comes from a study by Carter and Dean. The variance figures estimated by Dean and Carter are based on net incomes calculated by using county average yields. They note that these estimates probably tend to understate the income variability facing an individual farmer. The standard deviations they use range from 10 to 20% of expected net income (coefficient of variance) for the crops they studied; alfalfa, sugar beets, tomatoes, barley, wheat, and safflower.

The author's personal experience with detailed cost accounting records of over 600 farm enterprise crop years leads him to believe that standard deviations of 100 to 200% of net income (coefficient of variance) are more realistic at least for the crops grown in the Willamette Valley of Oregon. Actual cost and profit data for the following crops was accumulated from Willamette Valley farms using the AgRek computerized enterprise cost accounting system.[3/] Although the sample is small and the data for some years on some farms was unavailable, this information is the best available to those farmers for making crop selection decisions. Detailed tables listing the costs and profits for each farm each year are included in Appendix V.

TABLE 1: ACTUAL MEAN PROFIT AND STANDARD DEVIATION FIGURES

Number of Farms	Crop	Mean Profit/A	St Dev	Coefficient of Variance (%)
12	Wheat	$ 43.62	109.49	251
7	Sweet Corn	82.43	73.31	89
7	Sugar Beet Seed	110.01	210.81	192
6	Bush Beans	131.27	171.30	130

3/ The author's consulting firm, Agri Management Technology, P.O. Box 7, Salem, Oregon markets the AgRek program and associated service in Oregon. The program was developed by Bob Ohling and is owned by AgRek Systems, Inc., Salem, Oregon.

Adams, Menkhause and Woolery found that the efficient crop mixes resulting from E-V analysis display sensitivity to parameter specification. They warned that "If researchers intend to use the E-V approach in providing decision making information to producers, care should be exercised in the choice of income and risk measures used"(p.19).

The sensitivity of the E-V approach to parameters specification is of considerable importance when there are only minor differences in the cumulative risk of significantly different cropping plans. Schurle and Erven concluded that, "Major farm plan changes often are accompanied by relatively small risk changes . . . this indicates that once off the frontier (departing from the "optimum crop plan" developed by E-V analysis) farmers may have many different farm plans to choose from with nearly negligible differences of risk" (p.510). With coefficients of variance of 100-200%, including sampling error and actual variances, it is difficult to place much confidence in the optimum crop plans developed from those figures using E-V analysis. The important question to be considered is whether the E-V approach becomes inconclusive when the individual farmer's variances are that large.

The empirical studies by Schurle and Erven indicated that there is not necessarily an inverse relationship between risk and expected profitability. The data presented in Table 1 and Appendix V are consistent with their findings. This implies that in some cases it may not be necessary for a farmer to consciously consider the trade off between increased riskiness and increased profitability when formulating a cropping plan. Brink and McCarl, in their exploration of the risk attitudes of individual farmers, concluded that risk aversion is not necessarily an important factor in the selecting of crop acreages. They contend that the efforts by researchers to measure risk and risk aversion appear to be very great compared to gains in ability to predict the actual behavior or produce plans that are consistent with the behavior of farm managers.

For the purpose of on-farm application, E-V analysis may have been developed by agricultural researchers far beyond the level of practical application. In some crop selection decisions, risk may be one of the minor elements worthy of consideration only when crops with similar net incomes are competitive on other criteria. In other words, when several different crops appear to have very similar expected margins then the farm manager's aversion to large losses may be a criteria to select against certain of those crops. In order to accomodate this, a relatively simple indication of the riskiness associated with each of those crops is necessary. Break-even probability is such a technique.

Break Even Probability

Break even probability is a single figure indicating the probability that a particular crop will meet or exceed the level of direct costs or direct cost plus some arbitrary margin for overhead and land charge. This simple risk measurement may provide the farm manager with risk information to make more informed selections between certain crops with very similar expected profitabilities.

In order to calculate the break even probability the probabilities of yields and prices must be subjectively quantified. The triangular probability distribution is a simple technique for quantifying subjective probabilities (Nelson, et al.).

Where very limited information is available describing the nature of uncertain future events and it can not be assumed that those future events will conform strictly to past trends,it is difficult to specify the shape of the probability distribution. The triangular probability distribution is a rather crude but simple and convenient technique for quantifying subjective probabilities and may be adequately sophisticated considering the availability of information and the nature of its application to crop selection decisions.

To quantify a triangular probability distribution only three points are needed; a lowest likely, most likely, and highest likely level.

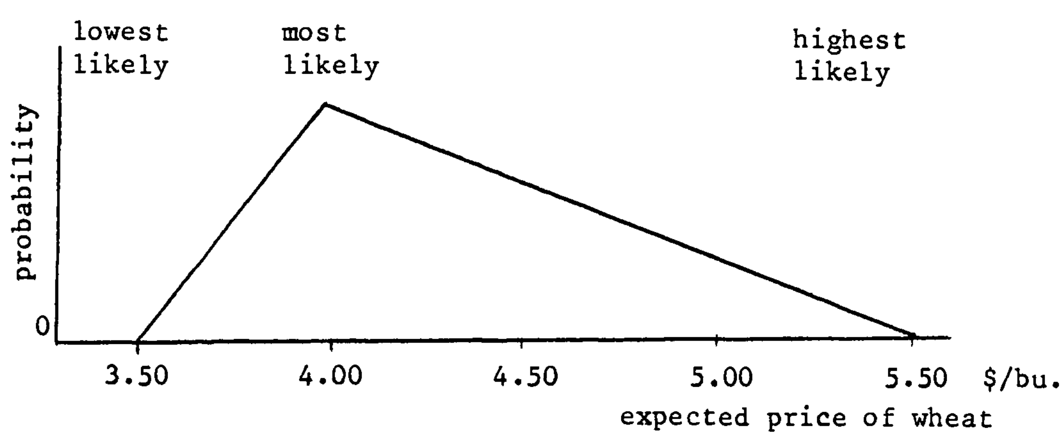


Figure 3. Triangular Probability Distribution

The lowest likely is assigned 0.0 probability with a linearly increasing amount of probability assigned to each level between the lowest likely and the most likely level. The probability peaks at the most likely level and linearly decreases for each level going to 0.0 at the highest likely level. The sum of all probabilities or the area under the triangle must equal 1.0. Once the concept of triangular probability distribution is thoroughly explained, farmers have little trouble specifying the three required values.

The triangular probability distribution need not be equilateral. This allows a long down side or long up side tail to the distribution as seen appropriate to the farm manager. An example of an appropriate use would be when estimating price of wheat. If a government program effectively puts a floor on the price of wheat, there may be a short down side tail but if the farmer believes there are small chances of very high prices, a long up side tail may be appropriate.

Management Information Systems (MIS)

Computers and Management

The study of Management Information Systems (MIS) is dedicated to the important function of providing managers with information they need for making management decisions. One of the managers' primary functions is making decisions. Managers can not make these decisions in a vacuum. Their success depends upon obtaining relevant information and drawing optimum conclusions. Management Information Systems describes a multibillion dollar industry that is a result of the computer revolution. When the computer was first introduced to business uses in the 1950's this remarkable electronic tool revolutionized the speed and convenience of filing, storing, sorting and retrieving large volumes of data. A Management Information System is simply a system, usually computerized, that is designed to sort and store data so that managers can get the information they need, when they need it, in a form they can use. For the system to perform this function, the designers must know ahead of time what information the managers will need so the huge volumes of data stored in the computer can be sorted and sifted down to the items valuable to a given manager in a specific situation.

The word "data" is the plural of "datum" which means fact. Data or facts are unevaluated messages or informational raw materials but they are not information. Information is generally considered to mean data arranged in an ordered and useful form. Thus management information will usually be thought of as relevant knowledge prepared and presented to managers for use in management decision making. To the business manager, however, this data processing is of little value unless it supports meaningful decisions leading to appropriate business actions. The purpose of data processing is to evaluate and bring order to data and place them in proper prospective so that meaningful information will be produced (Sanders).

The outcome of many business activities is, to a large extent, controlled only by chance. This particularly pertains to the agricultural industry; however, a premise for this thesis is that skillful managers with a combination of science and art have the ability to make decisions which tend to make the outcome of their business decisions more profitable more often than the decisions made by poor managers. It follows then that individuals possessing relevant management information are better equipped to make these management decisions. The task of the manager is then to acquire information which will increase his probability of making optimal decisions in the face of uncertain future events.

Information Theory

It is only the future that the manager can influence. He cannot change the past. It is then only information about future events that is relevant to managers. Unfortunately, there are very few sources of absolute information about what will happen in the future. In many cases only predictions can be made. The reliability of these predictions depends largely upon tendencies for future events to follow patterns of similar past events. In this sense only where it can be safely assumed that the outcomes of future situations will be consistent with similar situations in the past, does historical information have relevance to managers for decision making. In spite of the fact that the farm manager operates his business in an environment of ever changing weather, economics, and politics that never exactly repeats itself, accurate records of past costs, yields and prices adjusted to account for current trends and conditions are the farm managers best basis for predicting the future profitability of different management options.

Impediments to the Use of Information

Henry Mintzberg in his book, Impediments to the Use of Management Information, presents a concise and insightful summary of the conclusions of 44 different researchers working on this topic. In answer to the question "Why do managers not use the information specialists think they should?" Mintzberg concludes the following, ". . . the blame lies in these areas: inappropriate information, problems in the function of organizations, and design features of the human brain " (p.1). The use managers make of management information is determined by: (a) the information made available to the manager, (b) the pressures of the organization or situation in which he works, and (c) the way his brain receives and processes the information. Under these three problem areas Mintzberg lists ten specific points of concern.

(A) Problems with the Information

1) The formal information is too limited.

2) The data are aggregated or averaged and therefore too general.

3) Much formal information is too late.

4) Some formal information is unreliable.

(B) Pressures of the Organization or Situation

5) The organization's objectives may favor informal information.

6) The organizational hierarchy and social pressure may cause the manager to ignore or distort information.

7) The nature of his work may drive the manager to favor verbal channels and neglect formal written information.

(C) Psychological Limitations of the Brain

8) Cognitive limitations restrict the amount of information the manager can consider in a complex decision problem.

9) The brain automatically filters new information in line with expectations, personal bias, or previous experience.

10) Risk of failure and emotional threats further impede the brain's openness to information (pp.1-2).

As Russell Ackoff puts it in his article "Management Misinformation Systems",

> Most MIS (Management Information Systems) are designed on the assumption that the critical deficiency under which most managers operate is lack of relevant information . . . it seems to me that they suffer most from an overabundance of irrelevant information. If one sees managers' information problem as one that arises out of an overabundance of irrelevant information then the

> two most important functions of an information system become filtration (or evaluation) and condensation (p.147).

Value of Information

Bedford and Onsi in their article "Measuring the Value of Information - An Information Theory Approach" concisely summarizes some important concepts in the economics of information. In their definition, "Information is accounting data evaluated for a specific use." Information is concerned with the use of evaluated data for a specific problem and for a certain individual at a certain time to achieve a definite goal. The concept of information may be clarified by relating it to the decrease in ignorance that is experienced rather than to the amount of knowledge obtained. Regardless of the matter in which information is viewed, its function is to reduce the amount or range of uncertainty under which decisions are made or at least increase the understanding of that uncertainty range. In this sense the more information there is supporting an accounting estimate of probable cost and revenues of possible plans the more accurate is the estimate and the smaller the range of possible errors. Information is valuable only when it results in gain. It should be gathered only to the point where incremental cost of additional information equals the incremental utility gained by having it. The value of information is measured by comparing the outcome of the actions of the decision maker before and after the receipt of the information (Bedford and Onsi).

> Ackoff suggests three ways in which information may change the actions of a decision maker. A message informs if it changes the probability or chance of a potential course of action of an individual. A message instructs if it indicates a basis of choice from among potential courses of action. A message motivates if it changes the value of the outcome of a course of action (Bedford and Onsi p.17).

If the information does not change the actions of a decision maker or reduce the probability of making a wrong decision, then the information has no value to the manager. The farmer has to know what management information is valuable to him so he can obtain the information he needs at a cost he can justify.

The impacts of risk and uncertainty and the sensitivity of analysis techniques to imperfect information are of particular interest in estimating the value of management information in actual management decisions. This issue is of considerably more importance to private consultants or businesses attempting to provide economic information and analysis services for a fee than for public agencies providing free or substantially free services.

The discussion of the value of information concept is important when considering the effectiveness of information systems and setting priorities for types of information but quantifying the value of information is beyond the scope of this study.

Managerial Accounting

Contribution Margin

Several aspects of managerial accounting are relevant to crop selection decisions. The concept of contribution margin (i.e. gross margin) is crucial to formal analysis of this decision. To calculate contribution margin the different categories of costs must be understood (e.g. variable vs. fixed, direct vs. indirect, enterprise costs vs. overhead costs)(Goldschmidt).

Contribution margin, rather than "absorption" costing, or total costing, is the only relevant accounting method for selecting between enterprises in a multi product business with limited resources. The contribution margin is a measure of how much net revenue each profit center (enterprise) returns or "contributes" back to fixed costs, indirect overhead expenses, and profit. The objective is to maximize total business profits by getting the highest contribution margin per unit of constraining (limiting) factor. This is achieved by increasing the enterprises with high contribution margins and decreasing those with low contribution margins until the optimum enterprise mix is obtained.

The contribution margin is calculated by subtracting all the costs directly traceable to the enterprise (e.g. direct labor and direct materials) from the revenues directly generated by that enterprise. In most cases these directly traceable costs are the same as variable costs because they will vary in proportion to the volume of activity in that enterprise. The contribution margin is particularly helpful for predicting the impact on the profits of the total business from short run volume changes in each enterprise. Those costs that would not be directly affected by short run volume changes in a certain enterprise should not be charged to that enterprise when calculating contribution margins. When it is necessary to calculate the total production costs for each unit of production these indirect overhead costs can be charged but only when allocated by some arbitrary basis. It is the arbitrariness of this allocation basis that makes total costing misleading for making enterprise mix decisions.

Yield X Price	=	Gross Revenues
	-	Enterprise Costs
		Contribution Margin
	-	Allocated Overhead
		Profit

To calculate the contribution margin of each enterprise in a multi product business, the different types or categories of costs must be clearly understood. This is by no means a simple task. Firstly, different authors use different terms when explaining the same concepts. The terms variable versus fixed costs, direct versus indirect costs, and enterprise versus overhead costs are frequently used. The meanings of these terms are very similar and to a great extent overlap but they are not necessarily identical. To make matters worse, these terms are often used interchangeably in the same context. For example, to determine the contribution margin of each enterprise in a multi product business all the enterorise costs (i.e. direct costs, and variable costs) tracible to that enterprise should be subtracted from the gross receipts of that enterprise.

Once the problem of terminology has been hurdled then it is found that in real world application certain costs do not necessarily fit in any of the categories and other costs could just as easily fit in several of the categories. For example, bush bean seed is fairly easy to categorize. The expense of the seed is a variable cost as it varies when the number of acres of bush beans is increased or decreased. It is a direct cost because it is directly traceable to bush beans and it is therefore an enterprise cost of the bush bean enterprise. The seed is only good for the crop year in which it is planted and it is therefore fully chargeable within that year to that year's crop.

On the other hand, consider the cost of a bush bean picker. Machinery costs consist of both variable and fixed portions. The fixed portion of the cost of acquisition of the bush bean picker is not a variable cost. The purchase of the bush bean picker costs the same whether twenty acres of bush beans are planted or forty acres of bush beans are planted. It is therefore a fixed cost within the range and capacity of one bush bean picker. The costs of the bush bean picker is a direct cost to bush beans because it is used for no other crops on the farm but the total acquisition cost of the bush bean picker cannot realistically be charged to one years crop because the harvester has value remaining after one harvest season. The harvester has lost some value so some costs must be charged to that bush bean crop. The amount of cost that must be charged to that years crop is debatable. There are many different theories and many different approaches for calculating the most appropriate amount of cost that should be absorbed by that years crop. Given the same information in the same situation several different managerial accountants could come up with several different conclusions as to the amount that is most appropriate.

Accuracy and Reliability

The purpose of managerial accounting is to generate information on cost patterns or historic costs that can be used to make predictions on future cost patterns to be used for managerial decision making. Even when these historic costs can be reliably traced back to different enterprises, because they are historic costs they are only surrogates for predicting future costs. The accuracy of the initial cost records, the judgement with which the arbitrary cost allocations are made and the degree to which the future will reflect the past, all limit the amount of confidence that a manager can put in information generated by managerial accounting.

It is important to the manager to have some measure to understand the accuracy and reliability of the cost estimates he is given. The value of this information to him as a manager is dependent upon the accuracy and reliability of this information. For example, after all the bookkeeping is done and all the addition and subtraction has been double checked and all the arbitrary cost allocations have been argued and debated, a team of managerial accountants concludes that the variable costs producing each acre of wheat on Farm B in 1980 was $110 per acre. After carefully adjusting the figure for the best estimates on inflation of certain input factors this team concludes that their best estimate of 1981 costs of producing wheat will be $120 per acre. The manager then needs to ask his team of special advisors whether they mean $120 per acre plus or minus two dollars or whether they mean $120 per acre plus or minus $20. If they conclude that with 90% confidence the 1981 actual costs of producing one acre of wheat will fall between $118 and $122 per acre, then the farmer can have good confidence in these figures, and good confidence in the management decisions he makes based on these figures. He can afford to pay more for this information than if his team of advisors conclude with 90% confidence the costs will be between $100 and $140 per acre.

Even with a narrow confidence range there are numerous controllable and un-controllable factors which can result in the actual cost falling outside of this range. There is also the possibility of accounting errors and erroneous assumptions resulting in incorrect estimations. Good predictions are far from a guarantee. An improved understanding of the estimation process, the potential errors and the related uncertainty should help farmers better understand the value of the information available to them.

The practice of associating tolerances or confidence limits with cost estimates is unusual in the accounting profession. These practices are much more common among physicists, chemists, and scientists of other disciplines. The lack of error analysis or sensitivity analysis has contributed to unnecessary misconceptions associated with the computerization of accounting data. Computers can be programmed to print out information to as many places past the decimal point as the programmer desires regardless of the accuracy or reliability of the numbers. The value of that dollar and cents figure for decision making is significantly less if the figure is only reliable to within ten thousand dollars. In most cases the manager has no way of knowing, and therefore, no way of evaluating the management information he gets.

III. SAMPLING PROCEDURE

Willamette Valley Farmers

To survey a random sample of large diversified mid Willamette Valley farmers about crop selection decisions the following procedures were used. The names, addresses, and phone numbers of farmers meeting the specifications of this survey were gathered. These farmers were to be full time, have annual gross sales of approximately $100,000 or more, and were to be growing a variety of irrigated and non-irrigated crops preferably with some vegetable row crops. A total list of 130 names was compiled from county extension agents, agricultural lenders, agricultural field men, and other farmers. A file card was made for each eligible farmer. These file cards were thoroughly shuffled and 40 cards were randomly drawn and numbered in the order of being drawn. From these 40 preliminary selections the final 20 prospects were chosen in order of selection with the extra prospects to allow for elimination of prospects who could not be contacted, were unwilling or unable to be interviewed, or proved to not satisfy the specifications of the survey.

A bias toward diversification may have been introduced by selecting only diversified growers. The intent was to avoid farmers specialized and committed to one crop or restricted to only a few crops by soil conditions, as is the case of many Willamette Valley grass seed growers in the southern parts of the

Valley. The greatest insight into the crop selection decision process was sought by focusing on the farmers who need to annually select from the widest variety of crops.

Specialized, non-diversified farmers with similar soils in the same area as diversified farming operations must have different attitudes toward diversification and enterprise selection. The existence of these farmers and the evidence of their decisions to specialize when others choose to diversify poses intriguing questions in need of further research as they are beyond the scope of this project.

The farmers selected were mailed introductory letters. Several days after mailing the initial contact letter the farmers were contacted by phone to arrange a convenient time for the personal interview. Of those sent letters, approximately one farmer out of three was unwilling to participate in the survey or could not be contacted. The farmers that were contacted and willing were interviewed later that week or in the following week. Farmers who could not be contacted the first week were returned to in subsequent weeks for further attempts. After several consecutive weeks of being unable to contact these farmers their names were abandoned and contact was attempted with the next farmers on the list. Approximately 30 letters were sent out and 30 contacts were attempted to successfully arrange and complete 20 personal interviews.

The interviews were conducted at the farmer's home at a time of his convenience. Many of these interviews were conducted in the evenings. These interviews were conducted by either the author or research assistant who had been specially trained to conduct these interviews. The interviews were of a semistructured format using the developed questionnaire to solicit responses to specific questions as well as lead into a general discussion with the farmer about the crops he grows and the information he uses to decide what crops to grow. The interviewer took notes of pertinent comments the farmers made during these discussions.

The questionnaire consisted of 62 specific questions. Many of these questions solicited groups of responses or explanations in addition to short answers. After completing the 20 interviews all of the short answer questions were tallied for quantified results and the interview comments were summarized and listed in categories. Following each batch of interviews the author and research assistant would share notes and discuss the subjective impressions they received during the interviews. The nature of the interviews was such that some of the information gathered could only be informally summarized and subjectively analyzed to arrive at final conclusions. It is acknowledged that due to the subjectivity of these procedures the personal bias of the author and the research assistant could be introduced into the final conclusions of this study.

The number of farm interviews was limited to 20 by time and resource constraints. Each interview required 45-90 minutes excluding driving time. The emphasis was on conducting an indepth study of a small number of farmers.

Service Person Interviews

To gain further understanding of how farmers decide what crops to grow, and determine the information and services that they use to make these decisions, a number of persons dealing with farmers were interviewed. In this study these people are generally referred to as service persons. These service persons included the following: two community college farm management instructors, two agricultural lenders, and two certified public accountants working with farm clients in the Willamette Valley.

The persons selected to be interviewed for this portion of the study were selected on the basis of their experience with farm managers and the decisions they make in the Willamette Valley. Names of prospective participants were gathered from several sources and those participating were selected on the basis of recommendations as to objectivity, experience, and availability. No attempt was made to systematically sample all the qualified people falling within the service person definition. It is believed that those who were selected to participate provided useful insights but did not necessarily reflect the entire industry.

Questions were asked to determine what services these people provided that specifically helped farmers with crop selection decisions. Their opinions were solicited on how they felt farmers actually made these decisions as well as how they felt farmers should make them. These interviews were personally conducted by the author. Because much of the information is subjective in nature and nonquantifiable, the author's personal bias may have been introduced.

Size and Type of Farm

The following tables indicate the size of the farms studied in terms of total acres, irrigated acres, and the annual gross receipts, and the form of the business.

TABLE 2. SIZE OF FARMS SAMPLED

Size in Acres	% of Sample
Less than 250	5
250 - 499	20
500 - 999	50
1000 - 1999	20
2000 and Over	5

TABLE 3. IRRIGATED ACRES OF FARMS SAMPLED

Irrigated Acres	% of Sample
Less than 250	15
250 - 499	40
500 - 999	30
1000 - 1999	15
2000 and over	0

TABLE 4. ANNUAL GROSS RECEIPTS OF FARMS SAMPLED

Annual Gross Receipts	% of Sample
$ 50,000 - $ 99,999	5
$100,000 - $199,999	30
$200,000 and Over	65

TABLE 5. FORM OF BUSINESS OF FARMS SAMPLED

Form of Business	% of Sample
Sole Proprietorship	40
Family Held Corporation[a/]	40
Partnerships	15
Non-family Held Corporation	5

[a/] Includes Subchapter S Corporations

Forty-five percent of respondents indicated other family members contributed to the crop selection decisions. Fifteen percent indicated that these crop selection decisions were influenced by their peers, brokers or co-op boards.

The subject farms were all diversified and reflected a wide variety of crops. A total of 58 different crops were found on the 20 subject farms. A complete listing of these crops can be found in Appendix I. The number of crops per farm is indicated in Figure 4.

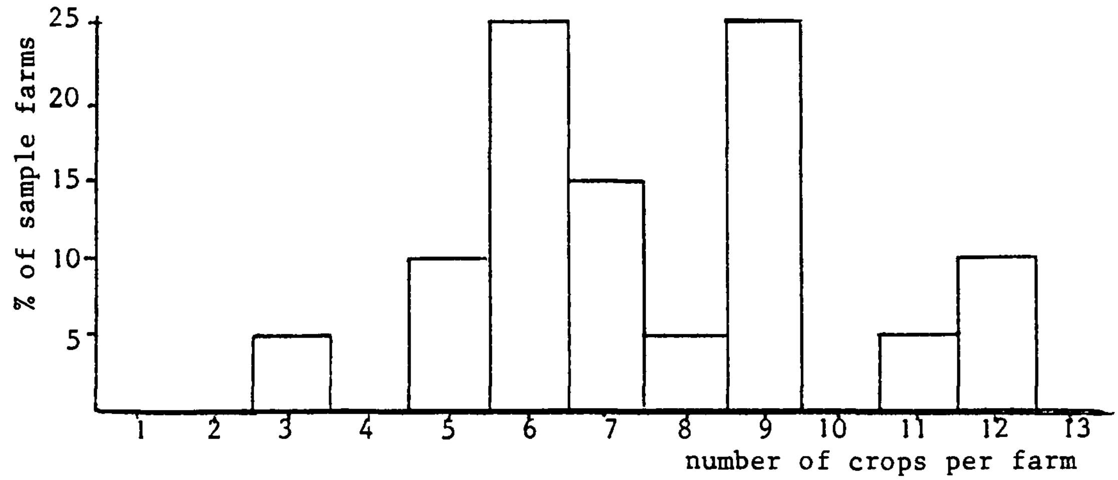


Figure 4. Number of Crops Per Farm on Sample Farms

TABLE 6. COUNTY OF RESIDENCE OF FARMERS SAMPLED

County of Residence	Number in Sample	% of Sample
Marion	9	45
Polk	2	10
Linn	2	10
Benton	1	5
Yamhill	1	5
Washington	5	25

1978 Agricultural Census Data

The data in the following tables were derived from the 1978 Agricultural Census (U.S. Department of Commerce). They indicate the number of farms by size and type in the six Willamette Valley counties of Benton, Linn, Marion, Polk, Washington and Yamhill. Because the size and type divisions used in the census are not the same as those used in this study it was necessary to estimate the approximate population of farms meeting the specifications of the sample group by extrapolation. By this method it could be determined what percentage of this subgroup of farms was sampled.

TABLE 7. NUMBER OF FARMS BY SIZE 1978 AGRICULTURAL CENSUS

	Six County Total
Total All Farms	5847
Less than 180 Acres	4108
180 - 499 Acres	1148
500 - 999 Acres	400
1000 - 1999 Acres	149
2000 + Acres	42

(U.S. Department of Commerce)

TABLE 8. NUMBER OF IRRIGATED FARMS
1978 AGRICULTURAL CENSUS

	Six County Total
Total All Farms	5847
Farms With Irrigated Land	2426
Percent Irrigated	41%

(U.S. Department of Commerce)

TABLE 9. GROSS SALES OF FARMS
1978 AGRICULTURAL CENSUS

Sales Per Year	Six County Total
$100,000 or more	910
$ 40,000 - $99,999	790

(U.S. Department of Commerce)

TABLE 10. FARMS WITH VEGETABLE CROPS
1978 AGRICULTURAL CENSUS

Crops	Six County Total
Sweet Corn, Mellons	778
Snap Beans, Bush & Pole	448

(U.S. Department of Commerce)

The data in Table 10 was used as a measure of the number of diversified farms. Eighty percent of the farms sampled grew either sweet corn and or bush beans in rotation with wheat and other crops.

TABLE 11. FIVE COUNTY TOTAL AND SAMPLE ANALYSIS

Farms By Size	All Farms	Irrigated Farms Number	%	Sample Farms Number	%
Total	5847	2426	100	20	100
Less Than 180 A	4108	1704[a]	69		
180 - 499 A	1148	476[a]	20	5	25
500 - 999 A	400	166[a]	7	10	50
1000 - 1999 A	149	62[a]	3	4	20
2000+ A	42	17[a]	1	1	5

[a] These figures were extrapolated based on percent of irrigated farms to total farms in the study area. (2426÷5847 = .41) A Constant proportion across farm size was assumed for lack of data indicating otherwise.

Based on extrapolation of the 1978 Census of Agriculture there are approximately 721 irrigated farms of 180 acres or more in size in the five county area and 245 farms of 500 acres or more.

TABLE 12. NUMBER OF FARMS BY GROSS ANNUAL SALES AND TYPE OF FARM

Sales	Irrigated and Non-irrigated	% Irrigated	Estimated Irrigated
$100,000 or more	910	41	378
$ 40,000 - 99,000	790	41	328
Total Both Groups	1700		705

Analysis of Sample

It is estimated that approximately 700 farms in Benton, Linn, Marion, Polk, Washington and Yamhill counties are irrigated, diversified, of greater than 180 acres in size, and have gross sales of $40,000 or more. The target group of irrigated diversified farms of $100,000 gross or more is estimated to be approximately 378 farms in size. A 20 farm sample of this population constitutes a 5% sample. Thirteen of the 20 farmers interviewed had gross annual sales of $200,000 or more. It is difficult to extrapolate how many farms there are of this size in the study area based on the 1978 census data but the author estimates that only 30-40% of those with annual sales of over $100,000 would exceed $200,000. Based on this assumption, approximately 130 farms in the five county area would exceed $200,000 in annual sales from diversified irrigated farm land. The study sample represents a 10% sample of this sub-group.

It is easy to conclude that the interviews were focused at the largest of the diversified irrigated farmers in the Willamette Valley and constituted a reasonable sample of this population. The sample was consicered too small however, to study correlations within the sample.

IV. STATE OF THE ARTS IN CROP SELECTION DECISIONS

Nature of Decision

Significance of Crop Selection Decisions

The following question and three multiple choice responses were read to each of the survey participants. The frequency of the responses is indicated below.

Question: How important is crop selection in the overall management of the farm?

Responses:	One of the most important decisions.	90%
	An important decision.	5%
	Not an important decision.	5%

The follow-up question to the above question was as follows:

Question: What other decisions do you consider more important or as important?

The numerous responses were categorized and the frequency of response for each of these categories is indicated below:

Responses:	Cultural Management (how to grow)	30%
	Financing	15%
	Marketing	15%
	General Management	15%
	Land Acquisition	5%
	No Response	20%

Management Objectives

One of the essential criteria for understanding how farm managers make crop selection decisions is determining what their primary management objectives are. The use of many optimization techniques, including neoclassical analysis, contribution margin by enterprise, and linear programming, all rely on the assumption that the manager is a profit maximizer. To test this assumption, the following question and three multiple choice responses were read to each of the survey participants.

Question: Is profit:	% of Responses
your primary management objective?	55%
one of your primary management objectives.	45%
not a primary management objective?	0%

There was no specific follow-up question to the above question. However, comments were anticipated and 60% of the survey participants indicated other objectives that were significant in their management decision making. These comments were summarized in the following general categories and the frequency that each category was mentioned is indicated. Several farmers gave multiple responses.

Other primary management objectives:	% of Respondents
Life Style	25%
Security	50%
Build-up soil and improve farm	15%
Land appreciation and long range return	15%
Growth and expansion	10%

Through the interviews it became evident that it is not safe to assume that farmers will always behave as strict profit maximizers. The comments from the service person interviews supported the above findings. The service persons generally agreed that many farmers are not profit maximizers and that life style, security and growth ambitions play a major role in their management decisions. Both the agricultural lenders surveyed indicated that many of their clients were not profit maximizers and that their management decisions are often based on other criteria as long as their operating budgets were approved from year to year and there is adequate financing available to achieve their growth ambitions. However, the first time their operating loan is turned down or they are unable to purchase the new combine they want, then these farmers take a serious look at improving the profitability of their operation, either to preserve their farm or to achieve their growth objectives. It, therefore, seems that most farmers, one way or another, consider profitability when making management decisions. However, it is unsafe to conclude that all farmers act strictly as profit maximizers.

Factors

In an attempt to determine what factors are important in the crop selection process, the following question was read to each of the survey participants: "When deciding what crops to grow, what are some of the factors you consider?" The interviewer had a checklist of expected responses to speed recording, but this checklist was not read aloud. The following answers are listed in the order of frequency of response with the first factor mentioned most often. The percent of the respondents mentioning each gives some indication of their relative importance to this group of farmers. Most farmers mentioned several factors, so responses exceed 100%. The factors included both objectives and constraints.

Response:	Profit	75%
	Crop Rotation	55%
	Labor Schedule	55%
	Soil Suitability	55%
	Equipment	50%
	Markets, Price and Contract Availability	35%
	Irrigation Capacity	15%
	Experience	10%
	Preference	5%

The following follow-up question was also read.

Question: Of these factors, which are most important?

Response:	Profit	50%
	Crop Rotation	20%
	Markets, Price and Contract Availability	20%
	Irrigation Capacity	5%
	Management Experience	5%

Regarding the crop the farmer indicated to be his least profitable crop, he was asked, "If you expected it to be your least profitable crop why didn't you grow something else?" Thirty-five percent of the farmers indicated that their least profitable crop was grown because it was important in their crop rotation. Soil conditions limiting the selection of crops for certain fields was indicated by 30% of the farmers as their reason for not growing something besides their least profitable crop. Contract limitations or the unavailability of contracts to grow more profitable crops was indicated by 25% of the farmers. Risk management was indicated by 10% of the farmers and labor schedule by 5%. Ten percent of the farmers indicated that their least profitable crop was a perennial crop with a large initial capital investment such as orchard or caneberries and that although this was their least profitable crop, they could not afford to replace it with something else.

In regards to the crop which he classified as most profitable, each farmer was asked why he didn't plant more of it. Thirty percent of the farmers indicated the contract limitations kept them from growing more of the crops they considered to be the most profitable. Twenty-five percent of the farmers indicated that labor was the factor that kept them from growing more of their most profitable crop. Cost of establishment and rotation were each indicated by 15% of the farmers. The long range market outlook was indicated by 5% of the farmers.

Although profit maximization cannot be assumed for all farmers, profit is still the most important factor considered when making crop selection decisions. Crop rotation and contract availability, (i.e. marketing potential), can be considered the two most significant constraints in the crop selection optimization problem. Irrigation capacity and management experience were also considered important constraints. Equipment, labor schedule and soil suitability are also important factors considered by farm managers. However, these are not necessarily constraints in the crop selection process. The investment required for additional equipment and the expense of additional labor can be adequately reflected as costs in the objective function. Soil suitability can be accounted for by making appropriate adjustments in yield expectations for specific crops on specific soils.

The major constraints in the crop selection decisions were identified and the relative importance of these was indicated but, no attempt was made to quantify these constraints or express them mathematically.

Diversification and Risk Management

To gain a better understanding of each farm manager's personal philosophy about diversification and risk, the following question was asked. "Do you believe it is more important to be diversified or to specialize on a few crops? And why?" Seventy percent of the farmers indicated that diversification was important for reducing risk and stabilizing annual income. Fifteen percent of the farmers indicated that it was more important to specialize on a few crops. The remaining 10% indicated that it depended on the size and financial condition of the farm. Spreading out labor requirements and equipment use were also mentioned as reasons for diversification.

The reasons given for specialization included less capital outlay for the equipment needed and better utilization of that equipment on specialized farms. One farmer believed that long-term profit lies in specialization due to the increased potential for efficiency. Several farmers mentioned that specialization requires a very strong capital base and that farmers with a high debt load could not afford to specialize because equity gives risk bearing capacity.

All the farmers surveyed were diversified so a preference for diversification could be expected. Most farms grew at least five crops and some grew as many as 12 different crops. No specific question was asked to determine what was the optimum number of crops but several farmers offered the opinion that 12 was too many and that six crops was about right. Eighty percent of the farmers surveyed, grew between five and nine crops. (Refer to Fig. 4)

Timing of Crop Selection Decisions

In order to better assess their needs for economic information, 20 Willamette Valley farmers were asked questions about when they decide what crops to grow. As the interviews progressed, it became evident that there is no one specific time when a farmer sits down to decide what to grow. Crop selection is a decision that occurs over time. Fifty percent of the farmers interviewed indicated that they often plan several years in advance and are thinking about the crop selection decision all year long. The other 50% indicated that there are two primary times when crop selection decisions are made: one being in the fall after harvest when ground has to be worked up and fall crops planted, such as, wheat and most seed crops; the second time when many crop selection decisions are made is in the spring when the spring crops are planted, such as, vegetable row crops for local processors.

As a follow-up question to try to determine some more specific information, the following question was asked. "If you were provided with crop budget information or other information used in making crop selection decisions for 1980-81 planting, what is the latest month you would need to have this information?" Responses ranged from June through October and December through March. September and March received the most responses. September was indicated by 30% of the respondents, and March was indicated by 25%. Sixty percent of the responses were grouped in the three months of August, September, and October.

It can be concluded that information used for making crop selection decisions will be most valuable to the farm manager if received in the fall by the end of September or early October.

Additional information useful in selecting between spring planted crops would be valuable to the farm manager if received before the end of March. Information if received after these critical periods may have value to the farm manager in making long range plans. However, the value of that information decreases because the cost estimates would be based on information that is at least one year old by the time it is put into use.

Frequency of Changes in Crop Plan

The frequency of the crop selection decisions is also considered in this study. It may seem obvious that the crop selection decision is an annual decision and to a great extent this is true. All of the farmers contacted in this survey grew at least some annual crops. Fifty-five percent of the farmers interviewed indicated that they had planted approximately the same crops in the same proportions in 1980 as they did in 1979. Although, the crops did not change, a crop selection decision was made. That being; to continue growing the same crops that were grown the year before. The other 45% of farmers had at least changed the proportions of the crops they had grown and in many cases had completely stopped growing a certain crop or started a new crop between 1979 and 1980.

Crops Grown on Sample Farms

Fifty-seven different crops and two livestock enterprises were found on the twenty Willamette Valley farms sampled. Each farmer was asked to list the crops he grew and the acres of each for the 1978-79 season and for the 1979-80 season. He was then asked to indicate the most profitable and least profitable of these crops for each year. The following table lists the crops found on three or more of the sample farms, the number of sample farmers growing that crop, the combined acres of that crop on the sample farms and the number of times the crop was listed as most profitable or least profitable. A complete table of the crop plan information gathered can be found in Appendix I.

TABLE 13 : CROPS GROWN ON THREE OR MORE OF SAMPLE FARMS

Crop	Numbers of Sample Farms Growing		Total Acres on Sample Farms		Times Indicated Most Profitable		Times Indicated Least Profitable	
	1979	1980	1979	1980	1979	1980	1979	1980
Wheat	18	18	3622	4026	2	1	1	2
Sweet Corn	16	16	1549	1464	2	2	3	3
Bush Beans	11	11	2294	2088	1	2	1	1
Strawberries	9	9	292	282	5	4		
Annual Ryegrass	4	5	671	681			2	3
Red Clover	4	4	467	388	1			
Crimson Clover	4	4	160	225			1	3
Sugar Beet Seed	4	4	158	196	1	1	1	
Marion Blackberries	4	4	140	160				1
Peppermint	2	3	240	300				
Peas	4	3	225	185				
Pasture	3	3	105	105				
Alfalfa	3	3	103	98	1	2		
Carrots	3	3	89	89	1	1		
Blue Berries	3	3	32	32	1	1		

When Farmers Drop Crops and Why

To better understand the frequency and extent in which the changes were made in the cropping plans, a number of questions were asked. Ninety percent of the farmers indicated that in the last few years they had entirely stopped growing one or more crops.

Most farmers gave a combination of reasons for stopping the growing of certain crops. These reasons were lumped into seven major groupings. Low profitability was the most common response. Sixty-one percent of the responding farmers listed low profitability as the primary reason or one of the primary reasons for dropping a crop. Labor problems either due to scheduling or availability of adequate labor was the second most indicated reason with 44% of the responding farmers mentioning labor. The fact that the crop was "hard to grow" or that contracts were no longer available were each indicated by 17% of the farmers. Rotation was mentioned by 11% and risk and equipment by 7% each.

The farmers were asked, "Of the crops you are growing this year, which would you drop first?" Ten percent of the farmers indicated that they did not have any crops in mind that they would be willing to drop. Ninety percent indicated that there was at least one crop they had thought about dropping. Low profit was the primary reason, indicated by 67% of the farmers responding. Labor availability, labor cost or labor management requirements was the second most important reason for dropping a crop, and this was indicated by 33%.

High risk and rotation problems were indicated by 11% each. Contract availability was indicated by 6%.

When Farmers Add Crops and Why

Each of the farmers was asked the following question, "Are you growing any crops now that you did not grow a few years ago?" Only 70% of the farmers indicated that they had added a new crop in recent years, where 90% had indicated that they had dropped one or more crops in recent years.

The primary reasons for adding a new crop are as follows: better profitability was indicated by 57% of the farmers indicating they had added a new crop. Rotation and contract availability were the next most important, each indicated by 21% of the farmers who had added new crops. Convenience and labor scheduling were each indicated by 14%, and risk was indicated by 7%.

The following question was asked, "If you were to add a new crop next year, what would be your first choice?" Eighty percent of the farmers indicated they had considered one or more crops they might add to their crop rotation. Twenty percent indicated that there was no crop that they were interested in adding. Higher expected profit was the primary reason for considering a new crop, with 63% of the farmers indicating that this was one of their primary reasons. Thirty-eight percent indicated rotation advantages, 19% indicated labor advantages, and 6% indicated reduced risk would be a reason for growing the crop they were considering adding to their crop rotation.

The Effect of Input Price Changes

To better determine some of the situations which stimulate farmers to change their cropping plans a number of questions were asked. One of these questions was, "Have you ever changed your cropping plan because the price of an input item like seed, special chemicals, or extra labor increased enough that the crop became less profitable than other crops?" Forty-five percent of the farmers indicated that they had. Fifty-five percent of the farmers indicated that they had not changed their cropping plan for this reason. Farmers indicating that the price of an input item had caused them to change their cropping plans usually mentioned several factors. Increased labor cost was the most frequently mentioned reason, indicated by 56% of those who dropped a crop. The crops that had been dropped because of labor cost increases included strawberries, pole beans, and potatoes. Increased fertilizer and chemical costs were mentioned by 45% of those who had dropped a crop and increased seed cost was mentioned by 22% of those who had dropped a crop due to increased input prices. There were some multiple responses.

The Effect of Commodity Price Changes

Farm commodity prices was one of the most important factors stimulating farmers to change their cropping plans. Eighty percent of the farmers interviewed indicated that they had planted less of a crop or stopped growing a crop because the price was expected to be unusually low. Seventy percent of the farmers interviewed indicated that they had planted more of a particular crop or planted a new crop because the price was expected to be unusually high. Commodity price expectations will cause most farmers to plant more of a certain crop or add new crops to their cropping plans. Unusually low price expectations will stimulate farmers to reduce their plantings of certain crops or drop certain crops entirely.

Resistance to Change

During these interviews it was detected that farmers have a great deal of inertia, resisting changes in their cropping plans. A number of farmers indicated that when conditions stimulated a change, they would be more likely to increase or decrease the crops than to add or drop crops entirely. Two questions were designed specifically to measure this resistance to change in cropping plans. One question was, "If you grew a crop that was not very profitable one year, would you be more likely to switch to a new crop or try to improve the way you grew it the next year?" Fifty percent of the farmers indicated that they would be more likely to try to improve the way they grew the crop. Ten percent of the farmers indicated they would be more likely to switch. However, these farmers and the remaining 40% indicated that the decision would depend on several factors. A number of farmers indicated that if other people found the crop profitable, they would try it again, but if their neighbors were also having trouble with this crop and found it unprofitable, they would be more likely to drop the crop entirely. One farmer indicated that he felt it was important to stick with a crop from four to five years before making a decision. Other farmers indicated that they would give most crops at least a second chance and that the long range profit potential would be important.

The following question was also asked, "Do you feel that it is more important for farmers to shift their crop plans as market conditions change or to stick with a good crop rotation and ride out poor market cycles?" One farmer indicated that he would shift, but that this would be all right only if changing did not affect labor and machinery requirements and that changing did not restrict re-entry at a later date. Seventy-five percent of the farmers indicated that they felt it was more important to stick with a good cropping plan and ride out poor market cycles, than to shift their crop plans as market conditions change. The other farmers indicated that the decision would depend on several factors. Many farmers volunteered that it is not a good idea to jump in and out because they felt farmers are consistently poor guessers and jump at the wrong time. A few crops do slump and disappear; however, most farmers felt that crops would recover if they could ride out the poor market period.

Summary of When and Why Farmers Make Crop Plan Changes

To summarize about how and when farmers make crop selection decisions, it was evident that although the crop selection decision must be considered an annual decision approximately half of the farmers did not make significant changes in their cropping plans from one year to the next. There is considerable resistance to change and it is generally considered a poor policy to be jumping in and out of crops. When conditions warrant a change, many farmers would be more apt to increase or reduce crops than they would be to add or drop entirely certain crops. In spite of this inertia and resistance to change, changes do occur over time. Nearly all farmers had both added and dropped certain crops within the last few years. The primary conditions stimulating these more radical changes in order of importance would be as follows: unusually high or unusually low commodity price expectations, and increased input prices or production costs. Farmers usually have more than one reason for adding or dropping a particular crop. Profit expectations is usually always one of the most important reasons. Crop rotation, labor management, contract availability, manager preference, and risk also play an important role in the farm managers crop selection decision process.

Economic Information and Analysis Techniques Currently Used

Enterprise Budgeting

In order to better assess their needs for economic information and business analysis techniques, the 20 Willamette Valley farmers interviewed in this study were asked what economic information they currently use and what analysis techniques they regularly employ in making crop selection decisions on their farms.

Ninety-five percent of the farmers indicated that they tried to estimate the profit per acre they expected from each crop when deciding what crops to grow. When asked how they calculated these estimations, they all had a clear concept that they would multiply expected price times expected yield to get expected gross revenue, costs would then be subtracted to calculate profit. There was a great deal of diversity in the responses about which costs would be subtracted. It is very likely that many of the farmers did not have a clear concept as to which costs should be subtracted, assuming they were trying to estimate profits. Unfortunately, the interviewing conditions and the way the question was asked did not lead to precise and complete answers to this question.

Sixty percent of the farmers indicated that when making these calculations they always wrote them down. The remaining 40% indicated at least part of the time the calculations were made in their heads.

Yield Expectations

Ninety percent of the farmers interviewed grew wheat. Each of these farmers was asked what they expected their 1980 wheat crop to yield. Each farmer responded rapidly and had a fairly clear indication of what his yield expectation of wheat was. The responses are indicated in the following histogram.

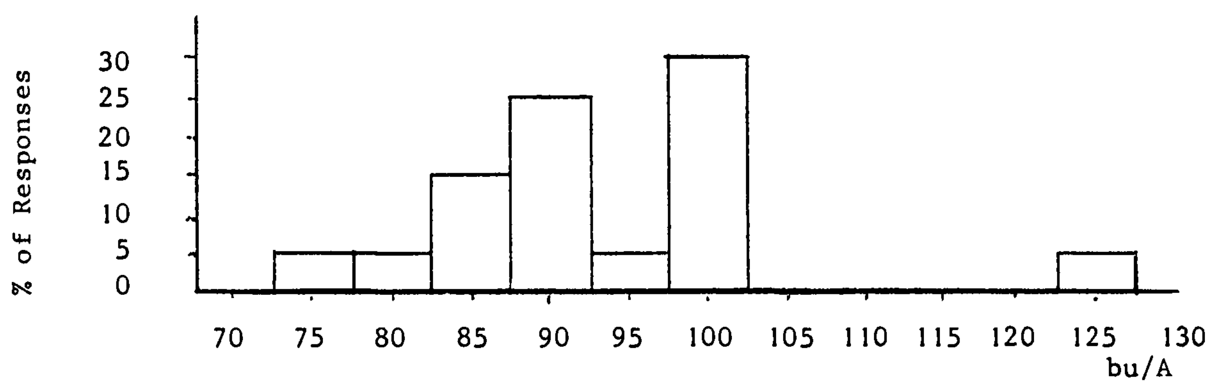


Figure 5. Wheat Yield Expectations 1980 Crop

(Note: 10% of farmers did not grow wheat)

Sources of Yield Information

When asked what sources of information are helpful in making yield estimates, 85% of the farmers felt that their own past yield records were the most valid basis for estimating future yields. Twenty percent of the farmers believed that their neighbor's past yields were important in predicting future yields. County averages were mentioned by 10%, extension bulletins were mentioned by 10%, experiment station tests were mentioned by 5% and the State and Federal Department of Agriculture reports were mentioned by 5%. Several farmers mentioned that they would turn to these other sources of yield information only when they were considering a new crop with which they have had no personal experience.

Price Expectations

Each of the farmers was asked what he expected the price of wheat to be. Most farmers responded quickly, indicating they had a fairly clear expectation of what the price of wheat would be for their 1980 crop. The diversity in price expectations was not nearly as great as the diversity in yield expectations. Thirty-five percent indicated they expected $4.00 and another 35% indicated they expected $4.50 per bushel. Five percent indicated that they expected $4.75 per bushel and 10% indicated they expected $5.50 per bushel.[4/]

4/ These interviews were conducted in August and September of 1980. The actual Portland wheat prices based on monthly averages were as follows: September $4.22, October $4.46, November $4.70 (peaked), December $4.43, January 1981 $4.53, February 1981 $4.52 (#2 SW).

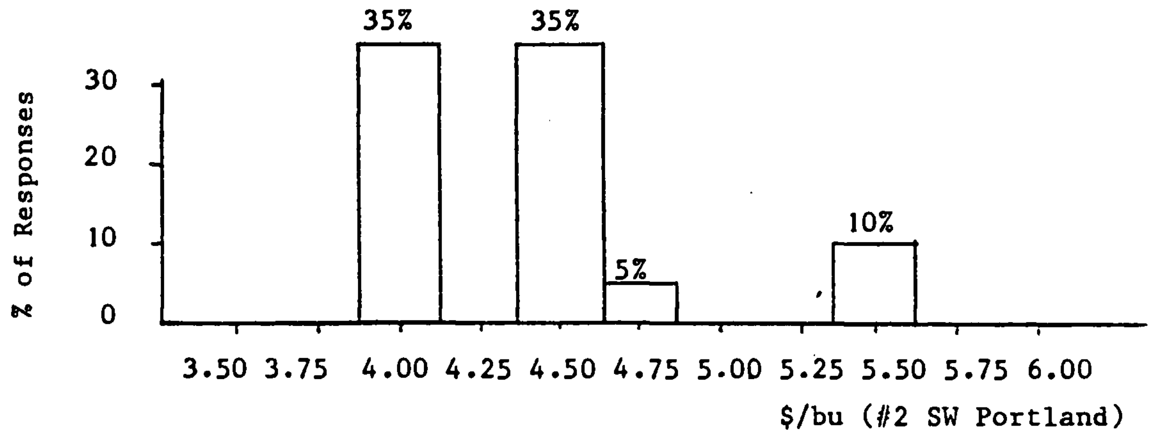


Figure 6. Wheat Price Expectations 1980 Crop

(Note: 10% did not grow wheat)

Sources of Price Information

Farmers were asked what sources of information they found helpful for estimating the price of wheat. A long list of responses was obtained. Most farmers usually indicated several different sources of information. The responses included a diversified list of both sources and types of information farmers found helpful in trying to estimate the price of wheat. Portland cash prices and cash contracts were mentioned by 30% of the farmers as the most valid basis for estimating future prices. Chicago future prices were mentioned by 20% of the farmers. Neighbor's suggestions and expectations were mentioned by 15% of the farmers. All other responses were mentioned by 10% or less of the farmers. These have been listed in no particular order other than types of information have been differentiated from sources of information.

Sources of Information

Neighbors

Brokers

Bankers

Newsletters

- USDA Reports
- ASCS Newsletter
- FmHA Newsletter
- Seed Commission Newsletter
- Kiplinger Agricultural Letter
- Doan's Agricultural Reports
- Pacific Grain Growers Forecasts

Newspapers

- The Oregon Statesman-Journal
- The Capital Press
- The Oregonian
- The Wall Street Journal

Magazines

- Pro Farmer
- Top Farmer
- Farm Features

Magazines (cont.)

Successful Farmer

Big Farmer

Farm Journal

Forbes

The following is a list of types of information farmers indicated as helpful when estimating the price of wheat.

Types of Information

Portland cash and cash contract prices

Chicago futures prices

Carry over inventories

Reports on use

Grain surplus

Grain demand

Agricultural situation worldwide

Russian yields

Crop prospects in India

Strength of the US dollar

Crop prospects in Canada, the US, Argentina and Australia

War situations

Stability of competing countries in political situations in world

Foreign markets

Farmers past records

Production Cost Expectations

Seventy-five percent of the farmers indicated that they had estimated the production costs of each crop they planted this year. Twenty-five percent indicated that they had not attempted to estimate the production costs for each crop they planted this year. Each farmer was asked the following question, "Approximately what are your production costs per acre for wheat?" Twenty percent had no idea what their production costs were and gave no answer. Another 10% gave an answer but indicated that they were only guessing. The following histogram indicates the range and frequency of estimated production costs per acre for wheat obtained in this survey.

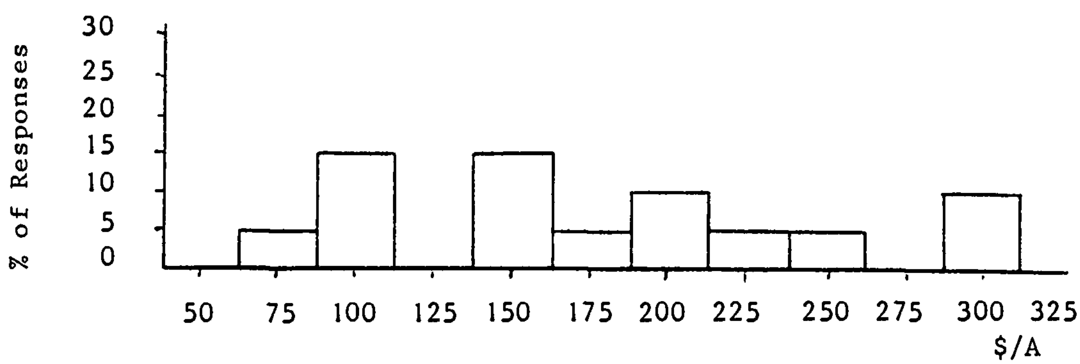


Figure 7. Wheat Production Cost Per Acre 1980 Crop

(Note: 10% did not grow wheat, 20% had no idea what their costs were.)

To gain a better understanding of how farmers consider and calculate production costs, the following question was asked, "When estimating the cost of producing wheat, what costs would you include?" The interviewing conditions and the way the question was asked did not lead to complete and exact answers to this question. The cost categories indicated were not self-exclusive so a farmer's failure to mention certain categories did not necessarily mean that he did not intend to include these costs in his calculations. The list of responses does indicate the categories and types of costs that farmers do consider in making production cost estimations. The frequency with which certain types of costs were mentioned by farmers gives some indication of the relative importance of these categories of costs in the minds of farmers. When making production cost estimates, fertilizer and chemicals were the two categories mentioned most frequently. Eighty percent of the farmers interviewed indicated that they would include the cost of fertilizer and chemicals when estimating the production cost of wheat. Seventy-five percent mentioned that they would include the cost of seed. Sixty percent mentioned that they would include the cost of rent on the land being used. Fifty-five percent mentioned the cost of machinery, 50% mentioned labor. Land preparation and weed control costs were each mentioned by 40%. Harvest costs were mentioned by 25%. Planting, overhead, materials application, and fuel costs were each mentioned by 20%. Interest expense was mentioned by 15%. Taxes and depreciation were mentioned by 10%.

The following list of costs were mentioned by 10% or less of the farmers interviewed: living expenses, land costs, insurance, storage and handling, hauling, custom rates and the amortized cost of lime applications. One farmer indicated that he would include everything but rent. Another farmer indicated that no land or machinery costs should be included. One farmer indicated that he would include cash flow items only. One farmer indicated that he included variable costs, fixed costs, and brokering and marketing costs.

Sources of Production Cost Information

To determine what sources of cost information farmers found useful, the following question was asked, "What sources of information are useful to you in estimating production costs?" Some farmers indicated more than one source of information, so the responses totaled more than 100%. Ninety percent of the farmers indicated that their past cost records were useful in estimating production costs. Twenty-five percent indicated Oregon State University Enterprise Data Sheets were helpful. Ten percent indicated that they found the cost records of their neighbors useful when estimating production costs. The following sources of information were also indicated by 10% or less of the farmers interviewed: Agri Management Technology enterprise cost studies, cannery cost sheets, cost information from fertilizer companies, and cost information from wheat brokers. Fifteen percent of the farmers indicated that they use their past records and then add an adjustment for inflation. When estimating future production costs, one farmer mentioned that there are no good sources; "The Extension cost sheets are no good". One farmer mentioned that chemicals are the biggest expense and that he didn't worry much about the other expenses. Another farmer mentioned that his own costs vary a lot and that it's hard to make estimates.

Anticipating the relative importance of farmers own past cost records in estimating production costs, the following question was asked, "Do you keep records of your production costs for each crop?" Although 90% of the farmers surveyed indicated that their past cost records were important when estimating production costs, only 35% indicated that they kept records of their production costs for each crop. Sixty-five percent of the farmers did not keep records of their production costs for each crop.

The farmers who do keep records of their production costs for each crop were asked why. They gave the following answers. Three farmers indicated that they used these records to help determine the profitability of each crop. One farmer indicated that he was interested in profitability and uses this information to decide what crops to grow. One farmer indicated that he had to know the profitability of each crop before he would even plant the crop. He said,"That is a stupid question because every farmer should have records of production costs to help him estimate the profitability he expects from each crop in order to manage his farm." Another farmer indicated that production cost records were important enough that he cost accounted every field. One farmer indicated that he kept records of his actual costs. These records indicated that his estimates were usually rather close but he keeps records just to check the accuracy of his estimates.

The farmers who indicated that they did not keep records of production costs for each crop, often gave several reasons, so the following responses total more than 100%. Of the farmers who did not keep records of their production costs, 46% said it was because it takes too much time, 39% said that it was too much bother or it was too difficult to sort out cost between crops when they buy inputs in bulk, or buy a variety of inputs from individual suppliers. Twenty-three percent said that they knew their costs well enough without keeping records. Twenty-one percent said that when they need to they can go back and work out what their production costs are. Eight percent said they should, but just never got started.

Thirty-one percent of the farmers who did not keep records indicated that it was probably a good idea and they felt that they should. One wished that he had done more with recordkeeping. Two indicated that they were looking into better methods and one indicated that he had tried it for a while but found it too time consuming to keep up on.

Types of Record Keeping Systems

Seven farmers or thirty-five percent of the farmers surveyed kept enterprise cost records for each crop. Of those seven, two were using the AgRek" computerized system provided by Agri Management Technology. One was using the "Comp and Save" provided by Lippold, Brenner and Bingenheimer an accounting firm in Salem. One was using "Money Minder" provided by U.S. National Bank. The remaining three were keeping records by hand. One was looking into buying a computer, "Probably one of the new Apple computers". His wife had computer training and would have the time and expertise to operate it.

Other Information and Analysis Techniques

To learn more about how farmers think about crop selection decisions and the different analysis techniques used for different types of crops, the following questions were asked, "Do you consider planting a perennial crop more carefully than an annual crop?" Ninety-five percent indicated that they did consider planting a perennial crop more carefully than an annual crop. Ten percent indicated that it was important because there was a greater initial cash outlay for most perennial crops. Ten percent indicated that it was important to consider a perennial crop because you are committed to it for a longer period of time.

To better understand the budgeting and analysis techniques required for perennial crops, the following question was asked, "Do any of the perennial crops you grow require an establishment season with little or no income?" Ninety percent indicated that they did plant perennial crops that required an establishment season with little or no income. The following follow-up question was asked, "When you planted this crop, did you take into account these establishment costs when determining its profitability?" Eighty-five percent of the farmers indicated that they did take into account these establishment costs when determining the crops profitability. When asked how, most farmers indicated that they either averaged out the income over the total life of the crop or they amortized the establishment cost over the productive crop years. Several farmers indicated that these perennial crops were important in their rotation and that profitability was not the primary objective.

The farmers were asked what information they would like to have about a new crop before deciding to plant it. Many farmers gave more than one response, so responses total more than 100%. Fifty-five percent of the farmers indicated that they would like market information before deciding on adding a new crop to their rotation. Forty-five percent asked for cultural information such as timing, sprays and chemical requirements, and soil suitability. Only 25% of the farmers indicated that they would like to have budget information about the expected profitability of this crop before making a decision. Cost information and yield information were specifically requested by only 15% each.

Each of the farmers was asked, "What information is most helpful to you when trying to decide what crops to grow?" The responses were categorized. Many farmers mentioned several different categories or types of information, so the responses total more than 100%. Market information was the most frequently mentioned type of information with 40% of the farmers indicating that market information is the most helpful when trying to decide what crops to grow. Cultural information was mentioned by 30% of the farmers interviewed. Profit and cost information were each specifically mentioned by only 25% of the farmers interviewed. Twenty-five percent of the farmers interviewed indicated they relied on the advice of field men and the recommendations of their peers. Twenty percent felt that their own past experience was most helpful when trying to decide what crops to grow. Yield information was specifically mentioned by only 15% of the farmers interviewed.

Assistance From Lenders

Ninety-five percent of the farmers interviewed, borrowed operating money. Five percent indicated that they did not borrow operating money because they felt it was important to maintain their independence. Sixty-eight percent of those borrowing operating money, were financed by commercial banks. Five different commercial banks in the Willamette Valley were mentioned. The remaining 32% borrowed from the Willamette Production Credit Association. The farmers were asked the following question, "Does your lender help you decide what to grow?" Ninety-five percent of the farmers interviewed, indicated that their lender did not help them decide what to grow. Two farmers indicated that their lenders may not loan on certain crops and this indirectly affected their decisions on what to grow. Only one said his lender helped him decide.

The following question was asked, "Does your lender provide you with assistance in estimating production costs?" Sixty-five percent of the farmers indicated that their lenders did not provide them with assistance in estimating production costs. Thirty-five percent indicated that their lenders did provide them with some assistance in estimating production costs. Twenty percent of the farmers indicated that their bankers probably would provide them with assistance if they were to ask. One farmer whose lender did provide him with assistance said this assistance was of very little value. Another farmer indicated that the banks had their own formulas for yields and prices, but that he had to have his own cost figures. One farmer who is partially financed with the Farmers Home Administration indicated that assistance with budgeting and counseling on management decisions was a necessary part of their loan program.

Ninety percent of the farmers interviewed, prepared operating budgets. Eighty percent of the farmers interviewed, said they compared their actual costs with their budgets.

Assistance From Accountants

One hundred percent of the farmers interviewed, indicated that they used an accountant. A wide variety of accountants in the Willamette Valley area were named, most of them being Certified Public Accountants. When asked, "Does your accountant provide you with information helpful for making crop selection decisions?" 100% of the farmers interviewed, indicated that their accountant did not provide them with information helpful for making crop selection decisions.

Assistance From Other Sources

When asked, "Does anyone else provide you with crop cost information or help you decide what crop to grow?" 60% of the farmers indicated that no one else provided them with crop cost information or helped them decide what crops to grow. The farmers who did rely on other people for information and help in deciding what crops to grow, listed the following sources: 25% found helpful information or assistance from their local OSU Extension Agent. Fifteen percent of the farmers interviewed, found information and assistance from their canneries or their cannery field men helpful. Ten percent mentioned fertilizer and chemical field men provided helpful information and assistance. Ten percent mentioned Agri Management Technology as a source of helpful cost information and consulting advice, and 10% mentioned that they got helpful information from other farmers. The farmers responding listed several sources so the responses total more than 100%.

Summary of Information and Analysis Techniques Used

Enterprise budgeting was the only analysis technique commonly used for making crop selection decisions by the farmers surveyed. Ninety-five percent of the farmers surveyed tried to estimate the profit per acre they expected from each crop when deciding what to grow. Only one farmer mentioned he had tried linear programming using a model available through an Oregon State University Extension Service pilot program several years ago. He found it interesting but not worth repeating. He had since abandon the computerized record keeping which he started as part of the same program. Although four other farmers were currently using computerized record keeping systems no other computerized analysis techniques were being used.

When formulating enterprise budgets it was evident that nearly all of the farmers had a clear understanding of estimating gross revenues per acre by multiplying expected yields times expected prices. Most farmers think in terms of profits or gross margin per acre. It was not evident that many farmers had a clear understanding of the difference between margin and profit. There was no clear consensus on which costs should be subtracted and which costs were not appropriate in the analysis.

Farmers base their yield expectations primarily on their own past yield experiences. County averages, state averages, experiment station tests, and neighbor's experiences were also considered, but usually only when considering a crop that the farmer had no personal experience with.

Price expectations were based on information gathered from a wide variety of sources, including advice from neighbors, brokers and bankers, and information from numerous newletters, newspapers and magazines. Radio was not mentioned as a source of information for any of the farmers contacted in this study. Some farmers also included a wide variety of types of information that they considered in making future price predictions, including supply and demand information, international crop prospects, international politics and worldwide monetary and economic trends.

Making price and yield forecasts is fairly common practice for most farmers. This study indicates that the farmers interviewed readily expressed their price and yield forecasts for the coming year. Going the next step and making cost forecasts so that the gross margin and the expected profit of each crop can be calculated is much less frequently done.

The farmers interviewed expressed less certainty in their cost forecasts than price or yield forecasts. Several indicated that they had no idea what their production costs were. Although 90% of the farmers surveyed indicated that their past records were important when estimating production costs only 35% indicated that they kept records of their production costs for each crop. The wheat production cost estimates given by the survey participants varied from $75 per acre to $300 per acre and were widely dispersed (Figure 7). Mean cost per acre was $176 with a standard deviation of $73. The production cost estimates were much more dispersed than were yield or price expectations given by the same farmers. Although production costs do vary from farm to farm it is believed that the primary reason for this dispersion of cost estimates is the lack of or inadequacy of cost records. Other portions of the survey indicated that farmers did not demonstrate a clear understanding of which costs were appropriate to include in the enterprise cost budgets. The primary reasons given for not keeping production costs were that the record keeping was too time consuming or too much bother and too difficult to segregate the costs between crops. A number of the farmers who did not keep records, indicated that they felt that they should and several were looking into beginning more detailed record keeping.

The OSU Extension Service, cannery field men, fertilizer and chemical field men, management consultants and other farmers were mentioned as providing helpful information for crop selection decisions but it was indicated that accountants and lenders did not provide much helpful information or assistance for this purpose.

New Information Needed

To better determine what farmers needs for information are yet unmet, the following question was asked, "What improvements or new information would make crop selection decisions easier?" Fifteen percent of the farmers interviewed, had no response. Thirty-five percent of the farmers responded that better market and price forecasting information was needed. Twenty-five percent of the farmers indicated that they would like to see better information on new varieties and experiment station test results. Twenty percent of the farmers indicated a need for more reliable and more current enterprise production cost sheets. The following types of information were mentioned by 10% or less of the farmers interviewed: better information on irrigation costs, equipment rate cost information, crop cycle information, profit projections, information on cultural practices, and information on financing and the availability of money.

The following question was asked, "Do you think farmers need better information and assistance in making crop budgets and deciding what crops to grow?" Eighty-five percent of the farmers interviewed indicated that they think farmers need better information and assistance in making crop budgets and deciding what crops to grow. Thirty five percent of the farmers volunteered that there is always room for improvement but one of these said he was not sure that people would be able to use it. Another said, "Some farmers don't want to know how bad things really are," meaning how much they are loosing on some crops.

Factors That Restrict or Discourage Use Of Currently Available Information

To better understand the factors that restrict or discourage, the use farmers make of information that is currently available, the following question was asked, "What would help you make better use of information that is available?" Thirty percent of the farmers interviewed had no response. Fifteen percent of the farmers indicated that they needed more time to read or to analyze the information that was already available. Fifteen percent of the farmers indicated that they needed a better awareness of the information that was available and education on how to use and analyze this information. Ten percent of the farmers indicated that the information available now, needed to be simplified and condensed so it would be easier to use and involve less time to analyze. One farmer mentioned that it was important to get the information in the fall so that he could use it when he was making these decisions. Another farmer indicated that radio broadcasting market information would save him a lot of time and trouble in being aware of the current market situation. One farmer was aware of the OSU Extension Service cost sheets, but said that when they are updated he has to go into the office and request them. If the OSU enterprise cost sheets were mailed out whenever updated it would save him a lot of time and provide him with the most recent information available. Another farmer indicated that more aggressive educational programs and more frequent farm visits by the OSU Extension Service would make him more aware of the information that was available.

Summary of Service Person Interviews

Five out of six of the service persons interviewed felt that profit was one of the primary management objectives of the farmers with whom they worked. One lender believed that profit was the primary management objective for most of the farmers with whom he worked and commented that in the past, way-of-life or life style was the primary objective, but now economic conditions require profit to survive and perpetuate this life style. Another lender interviewed suggested that inflation and appreciation on land may pacify many of the farmers until they get an operating budget turned down or can't buy something that they want, then they start taking a serious look at the profitability of their farms. One accountant suggested that many farmers have four primary objectives; the first, survival or to keep the farm in operation; the second, to minimize debt; third, to satisfy an equipment fetish; and four, to provide something for the kids. The last only applies in a few cases where the kids are interested in coming back to the farm. Several mentioned that self employment, maintaining independence, and perpetuating the farming life style were as important or more important than profit for many of the farmers with whom they worked.

All of the service persons interviewed believe that farmers usually consult with other people when making crop selection decisions. They believe that most of the farmers they work with will usually turn to the Extension Service, their neighbors, farm management consultants, processors, community college farm management instructors, or fertilizer dealers to obtain information when making crop selection decisions.

Four out of six of the service persons interviewed believe that the crop selection decision is one of the most important decisions a farmer makes in the overall management of his farm. The others responded that it was an important decision but not necessarily the most important decision because many farmers don't have that much choice when making a crop selection decision. In this case, marketing, timeliness, cultural practices, cash flow management, financing, tax management, estate planning, and management of labor and machinery are believed to play as important a role in the overall management of the farm as the crop selection decision. Other management decisions believed to be as important or more important than crop selection included marketing, cash flow management, and estate planning.

When deciding what crops to grow all six interviewees believed that profit was the most important factor farmers should consider. Five out of six mentioned that equipment was an important factor to consider. Soil suitability and management experience were each mentioned by three out of six. Labor schedule was mentioned twice, crop rotation, timing, and cash flow were each mentioned once.

Six out of six of the service persons interviewed believe that enterprise cost analysis information is important when deciding what crops to grow. One accountant mentioned that enterprise cost accounting is one of the best management tools available to farmers and wished that more farmers would keep enterprise records and use the information. Agri Management Technology's AgRek System, U.S. Bank's Money Minder System, and the Production Credit Association's Agri Facts, were all mentioned as available computerized record keeping systems providing varying degrees of enterprise cost accounting.

When asked what information or services they provide to assist farmers with crop selection decisions, the two lenders interviewed said that it is important for financing institutions to have qualified personnel to consult with farmers on crops, other management decisions, and on money management particularly during the loan renewal process. Profit and loss statements are often fabricated and budgets are constructed and in some cases general financial problems can be traced back to certain crops or management problems in the farming operation. Both accountants indicated that they did not provide specific information to assist farmers with crop selection decisions. The farm management instructors teach classes in enterprise cost accounting and help the farmers who participate in their classes to construct enterprise cost accounting budgets and use this information for making crop selection decisions.

When asked what new information or improvements would make crop selection decisions easier for farmers, the service persons interviewed had the following recommendations; the SCS soils maps should be updated, better market research could be done and more practical marketing approaches could be taught to farmers, more wide spread use of enterprise cost accounting was highly recommended, and it was suggested that more farmers could make use of the computerized enterprise cost accounting systems already available.

What could farmers do to make better use of the information that is available? One lender responded that farmers just need to understand the information that is available. Some don't use very much information because they have a complex about being "dumb farmers". They need to be willing to learn and to change. The other lender suggested that farmers need to use an enterprise cost accounting system like AgRek or others and to discuss their crop selection decisions with consultants, but that they need to make their own decisions and they can't have a consultant doing their thinking for them. The accountants concurred that farmers just need to keep better records and use the information. The community college farm management instructors suggested that farmers make a point to read the information that they get and ask questions and try to understand it. It takes a time committment to keep records and to analyze their own records and they should use this information before seeking other information.

According to 83% of the service persons interviewed, farmers do not usually budget expected crop profits when deciding which crops to grow. Only one believed that most of the farmers he works with try to estimate the profit per acre they expect from crops. He mentioned that usually their budgets aren't very detailed. Another commented that he did not believe very many farmers could come up with realistic budgets without assistance. All of the service persons interviewed believed that farmers should try to estimate the profit per acre they expect from each crop before deciding what to grow.

It was generally believed among those interviewed that if farmers made profit estimates, they made these estimates in their heads rather than trying to write them down. All of the service persons believed that farmers should make a better attempt to try to write down these estimates when analyzing their crop selection options.

It was generally believed that most farmers prepared operating budgets. The lenders and the community college farm management instructors usually work with farmers when preparing these budgets. Accountants indicated that they usually had very little involvement in preparing operating budgets. Both lenders indicated that many of their clients do at least some of the work in preparing budgets before they come in for loan renewal.

It was generally agreed by those having an opinion that the farmer's own past yield history was the most important factor when trying to make future yield estimates.

It was unanimously agreed that a farmer's own past production cost records were the most important information when estimating future production costs. The lenders and the accountants all believed that very few of the farmers they work with actually keep records of the production costs for each crop. It was indicated that they either don't take the time or that the farmers' record keeping systems are inadequate. The farmers involved in the community college farm management classes usually keep production cost records for each crop as part of their program.

Crop diversification was generally encouraged by all the service persons interviewed. Risk management was the primary reason for encouraging diversification; however, more uniform labor and equipment use were also mentioned. One lender indicated that it takes a banker with a thick skin to ride out the lean years when financing a specialized operation. One lender suggested that three to six crops are about all that many farmers can adequately manage. Another person suggested four to seven crops as an appropriate range for diversification in the Willamette Valley.

When asked if they believed it was more important for farmers to shift to more profitable crops as marketing conditions change or to stick with the crops they grow and ride out poor market cycles, it was generally agreed that farmers should not be jumping in and out. However, change is required over a time and that whenever possible farmers should adjust their management strategy in accordance with crop cycles and market trends. Both of the lenders indicated they encouraged their farmers to change management strategies as market conditions change as long as these changes do not require extensive refinancing for new equipment or tax the farmer's management ability.

The service persons interviewed unanimously agreed that it is important for farmers to check their own production costs, although average production cost figures like those published by the OSU Extension Service and cannery field men may be helpful for comparison purposes, it was generally believed that each farmer's costs are different.

The service persons interviewed generally believed that the crops most profitable for one farmer may not necessarily be the same crops that are the most profitable for another farmer. In situations where the price of a certain commodity is unusually high that crop will be profitable straight across the board; however, management ability, equipment, soil and other factors may vary enough between farms that the crops that are right for one farmer may not be the same crops that are right for another farmer in a different situation.

Generally, the responses gathered from the 20 farmer's interviews indicated a slightly higher level of record keeping and decision making sophistication than was indicated by the service persons expectations. It is likely that because the farm sample concentrated on the largest farmers in the area,a bias toward a higher level of management was introduced. On the other hand, the service persons interviewed may underestimate the record keeping practices and management abilities of their farm clients.

V. PROPOSED INFORMATION AND ANALYSIS SYSTEM

Theory and Technique

The culmination of this study on how farmers decide what crops to grow is to propose a crop selection system based on available or potentially available information and consistent with both economic and management theory and with the management abilities of farmers. The emphasis of this system is on the preparation of accurate, reliable enterprise budgets. The objective is to use these enterprise budget projections to rank the crops being considered in order of desirability considering the expected margin per acre and the break even probability to indicate risk differences between crops.

The use of this system is based on the assumption that once farmers understand the relative expected profitability and associated riskiness of each crop they can informally select a near optimum crop mix that will satisfy the constraints. Some of these constraints may be rather subjective. The advantages of certain crop rotations, management limitations, and labor availability are all constraints that are fairly subjective in nature and may be satisfied subjectively without quantifying them and using a formal model like linear programming.

The enterprise budgets developed by this system can be used as the input for linear programming or other sophisticated optimization techniques if desired. The proposed system is not seen as a substitute for linear programming but as a necessary preliminary step to any form of analysis.

Information Gathering

The proposed analysis system emphasizes information gathering. The author's experiences as a farm management consultant, and the results of the interviews collected during the study show that information gathering and budget preparation are weak points in the crop selection decision process. Accurate reliable enterprise budgets are a prerequisite to any form of analysis. Without these, sophisticated analysis techniques are inappropriate. The information gathering efforts can be grouped into three categories; those leading towards price forecasts, those leading to yield forecasts, and those leading toward cost forecasts.

The market news that is gathered and digested by the farm manager would be used to create a subjective probability distribution of predicted prices for each commodity in the coming season. This distribution would be quantified using the triangular probability distribution (Nelson et al.). The farmer would select a lowest likely price, a most likely price, and a highest likely price based on his beliefs and the interpretation of the available market information (Figure 8). In the case of contracted crops, the price may be known with certainty so the probability distribution is single valued (i.e. a vertical line).

A triangular probability distribution with a long upside tail is appropriate for many commodity price forecasts. Commodity reserves or government programs may dampen downside price movements beyond a certain level, for example $3.50 per bushel for wheat, making a short downside tail appropriate.

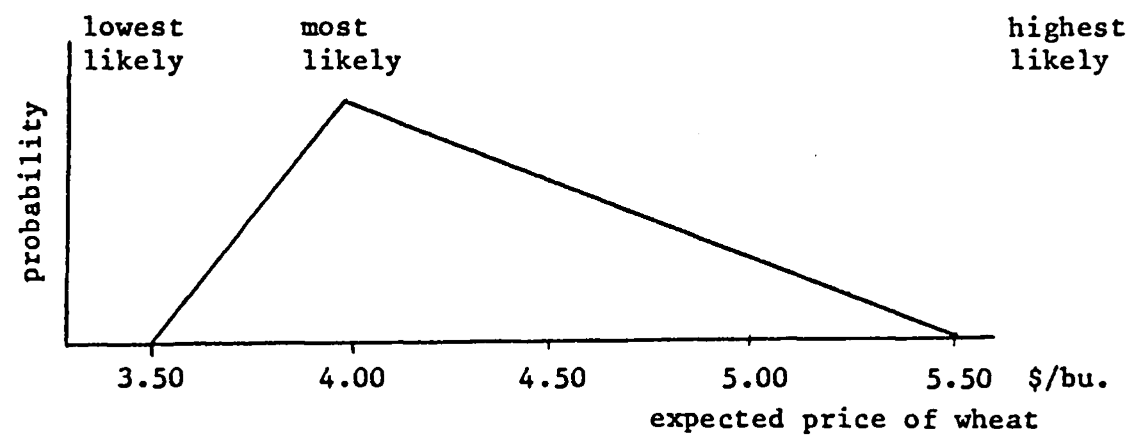


Figure 8. Quantifying Wheat Price Expectations

Small chances of very high prices make a long upside tail appropriate.

Yield forecasts are based primarily on a farmer's personal yield record for that crop. His personal yield experience could be considered in light of neighbors yields or area averages when making yield projections. Yield forecasts would also be expressed as a subjective probability distribution quantified by using the triangular probability distribution. The farmer would indicate the lowest likely yield, the most likely yield, and the highest likely yield he expects to experience in the coming crop season.

A long downside yield is appropriate for quantifying many yield expectations using the triangular probability distribution. The farmers most likely yield may be only slightly less than the maximum potential yield using available varieties and technology. On the other hand, there exists the remote chance of a total crop failure due to some catastrophic weather or other natural disaster like volcano ash. In these situations, a short upside tail and long downside tail is appropriate.

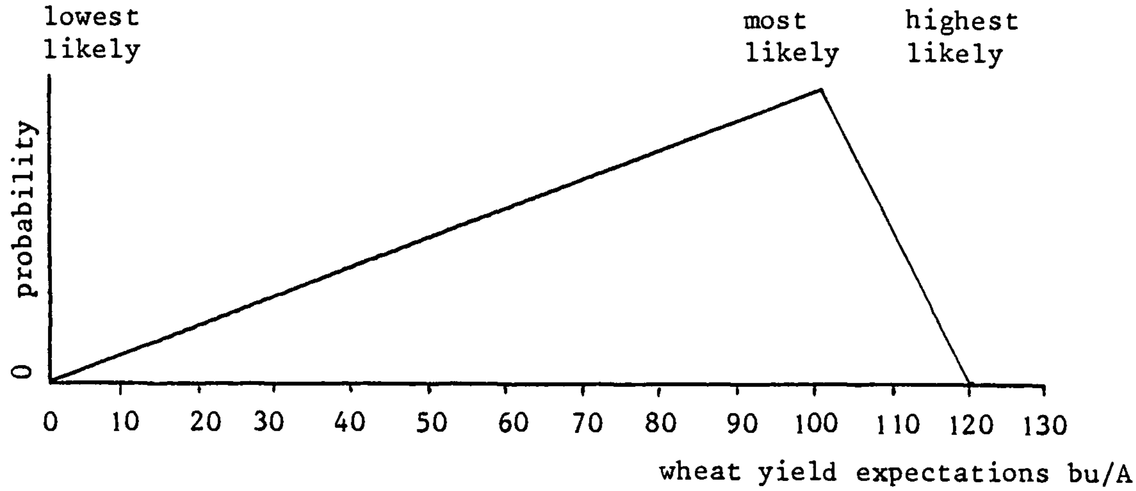


Figure 9. Quantifying Wheat Yield Expectations

Production cost forecasts should be based on accurate and reliable past enterprise cost records. Whether the farm manager accumulates these records using a hand system, his own computer, or one of several computerized cost accounting services, care must be taken to assure both the reliability of these cost records and the appropriateness of the costs charged directly to an enterprise. This requires a clear understanding of theory of enterprise cost accounting and the distinction between direct enterprise costs and overhead costs along with a reliable, accurate record keeping system.[5/]

Once reliable enterprise production cost records have been developed, the farmer's records over the past several years are compared and contrasted with cost records of other farmers growing those crops. Price level changes and changes in technology or efficiency can then be incorporated into the cost projections for the coming year. The proposed system expressed these cost projections in the following format: land preparation costs, planting costs, weed control costs, fertilizer costs, pest control costs, irrigation costs, harvest costs, and marketing costs. Each category includes materials, application, labor and the variable cost of machinery use.

[5/] See Goldschmidt for a detailed presentation of cost accounting theory applied to agriculture.

TABLE 14. WHEAT ENTERPRISE BUDGET 1981

	Lowest Likely	Most Likely	Highest Likely
Yield bu/A	45	90	110
Price $/bu	$3.60	$4.00	$6.00
Expected Gross		$367.49/A	
Land Prep		22	
Planting		17	
Weed Control		12	
Fertilizer		35	
Pest Control		0	
Irrigation		0	
Harvest		40	
Marketing		24	
TOTAL DIRECT		$150/A	
Expected Contribution Margin		$217.49/A	
Land Cost		100	
Overhead		100[a]	
TOTAL COST		$350/A	
Expected Profit		$ 17.49/A	
Break Even Probability		58.46%	

a/ Assumed

Direct enterprise costs are those that are directly traceable to a specific enterprise and vary proportionately as the acres of that crop enterprise are increased or decreased. For the sample wheat crop these costs would include direct labor (hours X rate) plus direct machinery (hours X variable cost), equipment rental or custom charges, all materials such as seed, fertilizer, and sprays, custom application charges if any and hauling storage and marketing charges. The total of these was total direct costs. Gross receipts less direct costs gives contribution margin (see Table 14).

Overhead charges such as interest on operating debt, interest on equipment, equipment depreciation and other indirect costs, are charged as allocated overhead and are not included in direct costs. Land ownership costs such as property taxes, interest on real estate debt, and principal payments are not included; rather, an opportunity cost for land use approximately equal to cash rental rates is charged.

Each of these budgets would be prepared on a per acre basis. It was assumed that within the accuracy of these budgets it was not necessary to account for economies of size or scale within the relevant range of acres for each crop. Land costs and overhead costs were also considered on a per acre basis and added to direct costs to arrive at a projected total cost per acre. Each of these costs was expressed as a single figure and no attempt was made to assign a probability distribution to these costs. This simplification is inconsistent with Paris who proposed that it was as important to consider input price uncertainty as it is to consider output price and yield uncertainty; however, Paris acknowledges lack of available information as a road block to the application of this approach. Input price risk was not mentioned as a serious concern of the farmers interviewed, nor was it a concern of the farmers in the case studies. The crop selection decision analysis system proposed in this paper could easily be expanded to incorporate some measure of cost uncertainty. This may be an appropriate topic for further research.

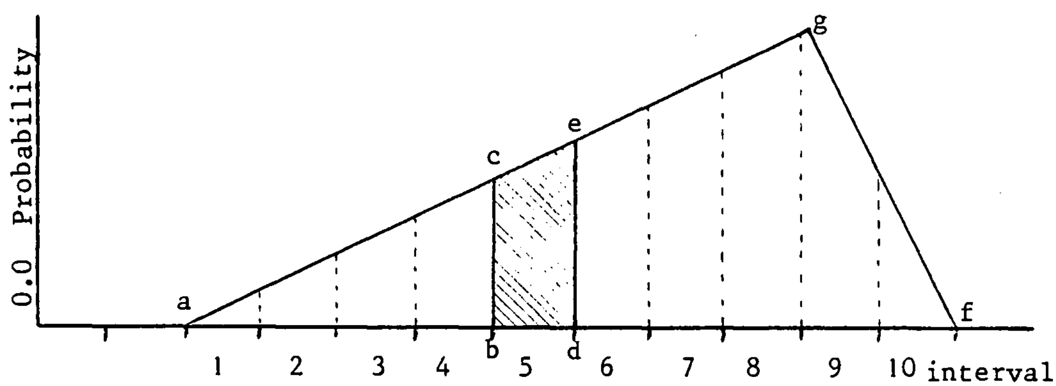
It may be desirable to add an opportunity cost figure to the direct cost to reflect the producer's profit goal per acre. This opportunity cost can be either the expected margin of one crop to be used as an index crop, such as wheat, or a desired profit figure used consistently in analyzing each crop. The farmer could determine that a gross margin per acre of $200 would be required to cover the necessary overhead land charges and give him a reasonable return to management. In this case $200 would be added to the direct costs of each crop. Then the break even probability would indicate the probability that the gross receipts from that crop would at least cover not only the direct costs but the desired $200 per acre return in addition. In the wheat budget example in Table 14, with the prices and yields indicated, the probability of covering the direct costs of $150 per acre is 100%. By adding a $200 per acre land and overhead charge or profit goal, the total cost becomes $350 per acre. Then by rerunning the program we find the break even probability drops to 58.46%. If sweet corn for example, was found to cover its direct costs plus the same $200 per acre profit goal with a higher break even probability, then sweet corn would be considered less risky.

After quantifying the three points expressing the price expectations, the three points expressing yield expectations and the single figure expressing total direct cost these seven inputs are entered into a Hewlett Packard 41C programmed with the "Croplan" analysis program. The calculator evaluates the two distributions for price and yield to calculate mean expected gross income per acre. The mean contribution margin per acre is calculated and a break even probability given. The crops can then be ranked in order of expected profitability and the farmer is left to develop his own crop plan.

The "Croplan" model uses the geometric simplicity of the triangular probability distribution to algebraically solve for the probability of intervals in the price and yield distributions. The model breaks the range between the highest likely points and the lowest likely points into ten equal intervals.[6/]

6/ Some accuracy can be gained by using more than ten intervals; however, more calculator memory is required and the processing time increases rapidly as more intervals are used.

The value indicated for each level is the mid point of that interval. The equation giving the simple probability of each interval is the area under the triangle within that interval. The total area under the triangle and the sum of the simple probabilities are both one.



Probability of interval 5 is the area of ade less the area of abc when total area afg = 1.0

Figure 10. Calculating Probability From a Triangular Distribution

The program calculates the probability for each of the ten price intervals and stores these in ten storage registers. Then the probability of the first yield interval is calculated. This yield is multiplied times the probability of each of the ten price intervals individually before calculating the probability of the next yield interval.

The sum of the products of each yield and price combination and the respective probabilities gives expected gross receipts.

$$\text{Expected Gross} = \sum_{i=1}^{10} \sum_{j=1}^{10} P_i \Pr(P_i) Y_j \Pr(Y_j).$$

Pr(•) signifies probability. P is the price and Y is the yield of the crop being considered. The probability of each price and yield combination that exceeds total direct costs (TDC) is summed to give the break even probability Pr(BE).

$$\Pr(BE) = \sum_{i=1}^{10} \sum_{j=1}^{10} \Pr(P_i) \Pr(Y_j) \qquad \text{for all } P_i Y_j > TDC$$

Prices and yields of a particular crop are assumed to be independent of one another, and it is assumed that the prices and yields of one crop are independent of the prices and yields of another crop.

Case Studies

To test the proposed information system and analysis model two in-depth case studies were conducted. The farmers involved in both of these case studies were well educated and well informed. Both had a thorough background of agricultural economics and business management principles. Also, both of the farmers have been using the AgRek agricultural record keeping system and have excellent enterprise cost accounting records for each of their crops grown over the past three years.[7/]

These case studies were conducted in November and early December 1980. In the future, the optimum time for conducting these analyses would be September or early October before fall planting had been completed. These earlier dates would allow the farmer to immediately incorporate some of the conclusions into his fall planting schedule thus affecting the cropping plan for that year. By conducting the analysis in November and December the opportunity to change the fall cropping plan had been foregone and the only impact the analysis could make would be on spring planted crops or on fall planted crops the following year.

The intent of the analysis was to integrate historic cost data, market and yield expectations for each crop into enterprise budget

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7/ The author is associated with Agri Management Technology a farm management consulting firm which markets the AgRek computerized record keeping service. The author has three years personal experience with these farmers and their records.

projections for the coming year. The budget for each crop would indicate the expected gross margin and expected profit per acre for each crop. The crops would then be ranked in order of expected profitability. This procedure is based on the premise that once an accurate and reliable ranking of crops in order of expected profitability has been completed, the farm manager can convert this ranking into a feasible cropping plan by subjectively satisfying all the necessary constraints. The break even probability is used as a criterion to select between crops with very similar expected gross margins. If the optimum crop plan is not readily apparent, the crop budgets that were developed can be used to formulate a linear programming model. This however, would require using a computer with greater capacity than the HP-41C programmable calculator. The consultant would either need to use a remote terminal, a portable mini-computer, or lose the convenience of developing a cropping plan in one visit to the farm.

This optimization procedure may be less complicated for Willamette Valley farmers than for farmers in other areas. Although there is a wide variety of crops that can be grown in the Willamette Valley many of the more lucrative crops are limited by contract availability. This puts a maximum limit on each of these contracted crops so the optimum mix will contain the maximum amount of each of the more profitable crops. Each crop is added in consecutive order of profitability satisfying the contract maximum or some other constraint such as labor availability or management ability. Some of these constraints may be rather subjective. The manager may subjectively believe that he can only manage a certain number of acres of strawberries, for example, even though it is a very profitable crop under his management. The process is continued until the crop plan uses the total available land.

The proposed analysis system emphasizes the development of reliable future cost expectations. The enterprise costs over the past three years for that farmer were analyzed. Similar cost data developed on other farms in the region were compared and contrasted with the farmer's own personal cost history. Technological changes such as changes in types or amounts of chemicals used, changes in cultural practices, or new equipment and techniques were discussed. Inflation or price level changes of inputs were also discussed and incorporated into the future cost expectations.

This procedure was very time consuming but enlightening as it allowed the farmer to look in detail at the implications of changes in his management techniques and the effect of price level changes on the profitability of different crops. Analyzing three consecutive years of cost data on each crop indicated the effects of past changes in techniques as well as gave an indication of the reliability of the figures and the variability of costs.

It was found that per acre costs often varied as much as 20% from year to year with no intentional changes in management practices. This 20% variance is a total of actual cost variation and record keeping inaccuracies. An example of actual cost variation would be pesticide requirements changing from one year to the next depending on weather conditions and insect populations. An example of record keeping errors would be when land preparation and tillage costs for one crop are inadvertantly added into the land preparation and tillage of another crop. This may happen because at the time the driver was working up the ground he was not certain what crop was to be planted in that field. These costs may then be allocated somewhat arbitrarily between crops thus possibly overcharging one crop and undercharging another crop.

The following table (Table 15) is an example of the enterprise cost records kept by case study Farm A for the past three years 1978-80. These costs were analyzed during the case study to formulate 1981 projections. The highest likely (HL), most likely (ML), and lowest likely (LL) yields and prices are indicated based on the farmer's subjective probability beliefs.

A similar analysis was done for each crop. The crops were then ranked and the 1981 crop plan was devised. Table 17 indicates the ranking and crop plan for Farm A. A complete set of crop budgets can be found in Appendix IV.

TABLE 15. CAULIFLOWER ENTERPRISE RECORDS AND 1981 PROJECTIONS

Crop/Farm	CAULIFLOWER PROCESSED FARM A					
Farm/Crop	1978	1979	1980	1981 Projections		
Acres	35.00	45.00	40.00			
				(LL)	(ML)	(HL)
Yield T/A	10.60	8.50	10.00	4	6	7.5
Price $/T				285	285	285
Income $/A	1983.18	2328.90	2850.00	1666.44 a/		
Land Prep	68.61	59.13	97.08	75.00		
Plant	57.40	88.46	92.64	100.00		
Weed Control	58.70	60.33	40.75	40.00		
Fertilizer	185.48	244.31	257.98	310.00		
Pest Control	48.83	59.92	44.11	70.00		
Irrigate	100.51	55.31	117.15	120.00		
Harvest	528.01	236.58	304.84	250.00		
Market			27.36			
Total Direct $/A	1047.54	804.04	981.90	965.00		
Cont. Margin	935.64	1524.88	1868.10	697.44 a/		
Land Charge	75.00	100.00	100.00	100.00		
Allocated OH	325.40 b/	242.84 b/	510.43 b/	150.00 c/		
Total Cost $/A	1447.94	1146.88	1582.23	1215.00		
Profit/Loss	535.24	1182.04	1257.67	447.44 a/		
Break Even Prob.				98.25%		

a/ Expected (i.e. mean of distribution).
b/ Actual overhead allocated by percent of Total Direct Costs.
c/ For analysis, $150 overhead per acre assumed for all crops.

TABLE 16. CROP RANKING AND 1981 CROP PLAN: FARM A

Rank	Crop	Expected C. Margin $/A	Expected Profit[a] $/A	Break Even Probability %	1981 Crop Plan Acres	Limiting Constraint
1	Processed Cauliflower	$697.44/A	$447.44/A	98.25%	50A	Contract
2	Processed Broccoli	594.74	344.74	90.67	45	Contract
3	Sugar Beet Seed	584.27	334.27	91.67	75	Contract
4	Fresh Cauliflower	533.40	283.40	70.61	45	Management
	Processed Cauliflower (Version B)	507.52	257.52	79.75		
	Fresh Cauliflower (Version B)	388.95	138.95	56.34		
5	Sweet Corn	257.85	7.85	60.00	100	Contract
6	Bush Beans	228.97	(21.03)	40.63	75	Contract
7	Winter Wheat	109.32	(40.68)	26.64	280	Total Acres
				Total Acres	670	

[a] Land rent of $100/A and overhead of $150/A assumed.

TABLE 17. CAULIFLOWER ENTERPRISE 1981 PROJECTIONS REVISED [a]

Crop/Farm	CAULIFLOWER PROCESSED FARM A					
Farm/Crop	Revised 1981 Projection					
Acres						
	(LL)	(ML)	(HL)			
Yield T/A	3	5	7.5			
Price $/T	285	285	285			
Income $/A [b]	1472.52					
Land Prep	75.00					
Plant	100.00					
Weed Control	40.00					
Fertilizer	310.00					
Pest Control	70.00					
Irrigate	120.00					
Harvest	250.00					
Market	0.00					
Total Direct $/A	965.00					
Cont. Margin [b]	507.52					
Land Charge	100.00					
Allocated OH	150.00					
Total Cost $/A	1215.00					
Profit/Loss [b]	257.52					
Break Even Prob.	79.75%					

a/ Yield estimates were revised slightly from those in Table 15.

b/ Expected (i.e. mean of distribution).

After the crops were ranked, the crop plan was developed using the following technique. Starting with the most profitable crop, processed caluiflower, the acreage of this crop was increased until the contract limitation of 50 acres was met. The second most profitable crop, processed broccoli, was then added until a contract constraint of 45 acres was met. Suger beet seed had a 75 acre contract limitation. Fresh cauliflower was added until the farmer felt management ability, labor availability, and the capacity of their packing line would be fully utilized at 45 acres. This subjective constraint may be relaxed in coming years as the farmer gains experience with this crop and gains efficiency in his packing and handling. Sweet corn was added until a contract constraint of 100 acres was met. Bush beans had a 75 acre contract constraint. Wheat had no constraint and was allowed to fill the remaining available acres. This farmer had a total of 670 acres of owned and leased ground available for 1981.

The crop ranking was found to be rather sensitive to price and yield expectations. When the degree of optimism or pessimism about certain crops was questioned, the "Croplan" program was re-run with a modified set of price or yield projections. Table 17 in contrast with Table 15 illustrates the impact on expected gross receipts, margin and profit of processed cauliflower when the yield expectations are slightly modified. Note in Table 16 how the modification of yield expectations on processed cauliflower changes its relative ranking from number one to below number 4.

Due to the nature of the constraints however, the crop plan would have remained the same even had processed cauliflower been ranked number four instead of number one. As all crops except wheat were restricted by contract or some subjective constraints, the maximum amount of each of these crops would be grown unless their ranking fell below wheat. In this case, the wheat acreage would be increased and that crop would be dropped entirely. Additional contract acres of the more lucrative crops will be pursued for future years now that the farmer better understands the relative profitability of his crops.

The farmers involved in both case studies had no trouble indicating their market price estimates. The three points necessary to construct the triangular probability distribution for price and the three points necessary to construct triangular probability distribution for yield were given instantly or after only a few moments of discussion. Even though a farmer may not be an accurate predictor for future commodity prices, the incorporation of the subjective probability distribution for expected prices as used in this model at least allows the farmer to formally incorporate his subjective interpretation of available market information into the crop selection decision. This system allows the farmer to make the best possible use of available information even though that information may be imprecise.

Constructing a cost budget took approximately 20 to 30 minutes per crop. Yields and prices are things that farmers have limited control over; however, costs are a result of a large number of complex management decisions made throughout the growing season. Changes in costs reflect the large number of management options the farmers have in growing a crop and to a large extent indicate the amount of control the farmers have in the profitability of the crop. Discussing the numerous field techniques and chemical applications that go into growing each crop was time consuming but very enlightening. Each cost component was scrutinized and justified in terms of increased yield or the reduction of other costs. This approach stresses the two factors for which farmers do have control. First, the mix of crops they grow and second, decisions on the inputs they will allocate to grow those crops.

In each of the case studies the farmers were very interested in analyzing the relative risk associated with different crops particularly where these crops had similar expected returns per acre but possibly greater risk levels.

A consistent inverse relationship between expected profitability and risk was not found amoung those crops analyzed (See Table 16). Although interested in the risk measures, risk was not a major criterion used by the farmers in the case studies for selecting between crops. Most of the crops ended up being ranked consistent with the farmers' expectations; however, there were a few surprises. The accuracy of these farmers' expectations must be partially attributed to the excellent enterprise cost accounting that they do, their awareness of economic theory and business analysis techniques, and their motovation to keep and analyze crop costs and crop profitability. The author expects that had the case study been conducted with farmers who had not been doing enterprise cost accounting there would have been many more suprises, and farmers without records and without the aptitude for record keeping would probably be less apt to accurately rank the profitability of their crops based on their limited information. Unfortunately, the model can not be tested on farmers who do not have records as these historic cost records are an integral part in the analysis.

The farmers involved in the case study were impressed with the simplicity with which the triangular probability distribution and the crop plan analysis program for the HP 41C can be used for crops being considered both in terms of expected profitability and riskiness. These farmers did not believe the model should automatically tell them how much of each crop to grow but were satisfied with the increased understanding of the relative profitability of different crops and the impacts of management and price level changes on the expected profitability of each of those crops. From the rankings the crop plans were easily developed by hand. In farming areas where the number of crop options is larger or the constraints are less definitive than contract limitations, the optimization process may not be as easy without the aid of linear programming or some other optimization technique.

The proposed crop selection decision analysis system may not determine an exact optimum crop mix as could techniques like the E-V frontier approach, linear programming or marginal analysis.

Based on the discussion with farmers involved in the case studies it was agreed that using the best available information, future production costs per acre can only be estimated within 10% to 20%. Minor changes in optimism and pessimism about prices or yields expected from certain crops were found to change expected margins by as much as 100%. Considering the limited amount of confidence a farmer can place in his data, a near optimum plan informally derived by the proposed system may be all that is appropriate.

Problems with the Proposed Information and Analysis System

It was difficult to convey the concept of triangular probability to the farmers and they had a tendancy to be too conservative in their estimates of high yield and high price. In several cases extreme points selected by the farmers were less than prices or yields that they had actually received in the past. An example can be seen in Table 15. Farmer A had processed cauliflower yields of 10.6 tons per acre, 8.5 tons per acre, and 10.0 tons per acre for the past three years but indicated that 4 tons per acre, 6 tons per acre and 7.5 tons per acre fit his expectations of lowest likely yield, most likely yield and highest likely yield. Using 7.5 tons per acre as the highest likely yield point gave no probability of exceeding that yield when he had in fact done so the last three consecutive years. It appeared that the farmers tended to place the three expectations (highest likely, most likely, and lowest likely) too close together thus underestimating the total variability of certain crops.

The analysis system for ranking the crops may not necessarily be invalid as long as the same relative degree of conservatism is expressed throughout all the crops. If a farmer was optimistic with certain crops and pessimistic with other crops this subjective preference would be reflected in the expected profitability of those crops. These tendencies indicate that extreme care must be used when explaining the concept of the triangular probability distribution and in guiding the farmers when estimating the three points to quantify these distributions. Using a diagram of the probability distribution like that in Figure 3 might have been helpful.

One convenient solution to this problem is that if the farmer or the consultant is suspicious that certain distribution is too optimistic or too pessimistic, a revised set of points can be estimated and "re-run" through the programmable calculator to test the sensitivity of that particular crop in the ranking based on the degree of optimism or pessimism about prices or yields. These re-runs were tried several times during the two case studies, and it was found that in several cases the relative profitability of certain crops was quite sensitive to the yield and price expectations. This has two implications, first it reduces the certainty of expected profits on the farm. Second, it reduces the importance of selecting between certain crops when those crops have relatively similar expected profitability and shift in the crop ranking when price or yield estimates are modified slightly.

One shortcoming of the model is that it has no formal technique for incorporating variable costs that are directly related to yield variations. An example would be the expense of harvesting strawberries. The model considers yield variations from highest likely yield to lowest likely expected yield but the cost figure is not allowed to vary proportionately. The way this shortcoming in the model was overcome in the case studies was to subtract costs that vary directly with yields from the expected price giving a price net direct variable cost. For example, strawberries contracted at $.32 per pound with an expected harvest cost of $.10 per pound would be included in the budget at $.22 per pound. The harvest cost would then be ommitted from the production cost budget. Other costs where this would be appropriate would include harvest costs, hauling costs, marketing or processing costs that vary directly with the total quantity of production. This inadequacy in the model could probably be overcome with some simple programming changes.

The proposed system has no formal way of incorporating the time value of money. Considering the time value of money is particularly important for crops grown for co-op canneries. These co-ops may pay out over twelve months or more and may pay a portion of the crop value in non-cash dividends. Considering the discounted present value of delayed crop payments could probably be incorporated as a step in the preparation of the crop budget worksheets for the "Croplan" program.

Some accuracy is lost in calculating expected gross margin when the price and yield distributions are only broken into ten intervals. Increasing the number of additional memory modules in the HP-41C from two to three would give adequate memory space to use more than ten intervals. Total calculation time increases rapidly as the number of intervals is increased beyond ten. The total iterations of that portion of the program is equal to the square of the number of intervals used. As tested the program took approximately four minutes to run. Approximately 20-30 minutes was required to discuss each crop budget so a longer calculation time would not increase the total time required if the farmer and consultant were working on the next budget while the calculation was in process.

The break even probability alone does not give information about range and shape of the gross income distribution. A helpful improvement on the "Croplan" program would be to give the probability of exceeding several levels of income besides the one equal to total direct cost (i.e. break even point). For example if the total direct cost for a crop was $150 per acre, it would be useful to know the probability of gross income exceeding $200 per acre, $250 per acre, $300 per acre and $350 per acre etc. as well as the break even probability. This would be one step toward giving a better indication of the range and shape of the gross income distribution for the crop being considered. Incorporating this feature in the "Croplan" program would be within the capacity of the HP-41C as it was used in this study. These values can be calculated individually for a crop using the program in its present form by increasing the total direct cost value to each desired level and re-running the "Croplan" program. In this same line the next improvement would be to develop the ability to produce a printed diagram of the distribution of each crop.

Time Requirements and Consulting Fees

Although some farmers could probably learn to follow the proposed information gathering process and use the "Croplan" program it was designed to be used by farm management consultants and is better suited to that use. After becoming familiar with the program and the development of the crop budgets, a consultant could work out a crop plan with most farmers in a farm visit of about four hours in length. Such a consultation would probably cost the farmer from $100 to $200 depending on the consultant's hourly fee. The farmer would need to have accurate enterprise cost records completed before this session. The cost of keeping the necessary enterprise records through the year would be significantly more than the cost of the crop planning consultation in terms of the farmer's time, computer services, or bookkeeper's wages.

The computerized record keeping services used by the farmers involved in the two case studies cost more than $200 per month not including the value of the farmer's time for input preparation. If a crop planning session with a consultant using the "Croplan" program enabled the farmer to incorporate his historic cost records, yield expectations, and all the market information he has gathered into a useful set of crop budgets resulting in a cropping plan, then it would probably be well worth the $100 to $200 fee. The farmer probably spends a great deal more than this for all the preliminary information. A session with a management consultant using the "Croplan" program could be the way to analyze this information and make it useful.

VI. SUMMARY AND CONCLUSIONS

Summary of Research

Much of the available farm management information and many of the recently developed computerized tools and analysis techniques theoretically appropriate to assist farmers in making crop selection decisions are not being widely used at the farm level. This is partially because much of the information and/or analysis techniques are not appropriate or practical for use by farmers in making actual crop selection decisions. The information and analysis techniques may have been developed with inadequate understanding of the nature of crop selection decisions, management capabilities farmers have, and the procedures they use.

The business analysis techniques theoretically appropriate for making enterprise mix decisions were reviewed and critiqued in light of the practical limitations of the real world farm management situation. The application of the economic theory appropriate for optimizing multi-product multi-input management decisions on a marginal basis is extremely difficult because the required assumptions can rarely be satisfied in real world situations. The application of linear programming to crop selection decisions may be helpful in some cases but the reliability of this optimization technique is entirely dependent upon the accuracy and reliability of the enterprise budgets used to develop constraints and coefficients. The use of quadratic programming or E-V analysis to incorporate risk management in the crop selection decision process may be helpful in certain situations. These techniques, however, are highly sensitive to parameter specifications and in many cases are inappropriately sophisticated when the availability and reliability of yields, price, and cost information is considered.

Management information is concerned with the use of evaluated data for a specific problem for a certain individual at a certain time to achieve a definite goal. Its function is to reduce the amount or range of uncertainty under which decisions are made. Only future decisions can be affected so it is information about potential outcomes of future actions that is important. Unfortunately, analysis of historic data to determine cost patterns and trends is often the best available information for making future predictions. After adjusting historic data for inflation and technology changes, enterprise budgets can be formulated.

The accuracy of cost records, the judgement with which arbitrary cost allocations are made, and the degree to which the future will reflect the past all limit the amount of confidence that managers can put in information generated by managerial accounting. It is important to the manager to have some measure to understand the accuracy and reliability of cost estimates he is given. Associating tolerances or confidence limits would allow the manager to understand the accuracy and reliability of cost estimates he is given. The value of this information to him as a manager is dependent upon its accuracy and reliability.

To gain a better empirical understanding of the crop selection decisions made by managers of large diversified farms in the Willamette Valley, 20 farmers were randomly selected and personally interviewed. The sample focused on the largest diversified irrigated farms in the northern Willamette Valley and comprised approximately a 10% sample of the largest 5% of the irrigated diversified farms in Marion, Polk, Linn, Benton, Yamhill and Washington counties.

To gain a better understanding of the services available to the farmers pertaining to crop selection decisions two community college farm management instructors, two agricultural lenders, and two certified public accountants, all working with farmers in the Willamette Valley, were interviewed.

Ninety percent of the farmers interviewed and four out of six of the service persons interviewed believed that the crop selection decision is one of the most important decisions in the overall management of the farm. Profit was found to be the primary management objective of most farmers; however, they were not strict profit maximizers. Security, life style, growth and expansion, were also important management objectives. Profit was the most improtant factor farmers considered when making crop selection decisions. Crop rotation, labor schedule, soil suitability and equipment were also considered to be very important factors in the decision.

Enterprise budgeting was the only form of crop mix analysis used on the farms sampled. Only one of the farmers sampled had tried linear programming. This was done as a part of an Oregon State University pilot program one year. He did not feel it was worth repeating and had since dropped the enterprise record keeping that was a part of the same program.

Ninety-five percent of the farmers indicated that they tried to estimate the profit per acre they expected from each crop when deciding what crops to grow. The farmers interviewed did not demonstrate a clear understanding of which costs should be subtracted in making enterprise analysis budgets or that contribution margin was more appropriate for comparisons than profit. Only 60% of the farmers indicated that when making these calculations they always wrote them down. Eighty-five percent of the farmers felt that their own past yield records were the most valid basis for estimating future yields. A wide variety of information sources and types were indicated as helpful when making price predictions.

Seventy-five percent of the farmers indicated that they had tried to estimate the production cost of each crop they planted this year. The estimated production costs for wheat varied widely from $75 per acre to $300 per acre. Although 90% of the farmers interviewed indicated that they had planted less of a crop or stopped growing a crop because prices were expected to be unusually low, seventy percent indicated that they had planted more of a crop or planted new crops because the price was expected to be unusually high. It was detected that farmers have a great deal of inertia resisting change in cropping plans. A number of farmers indicated that when conditions stimulated a change they would be more likely to increase or decrease crops than to add or drop crops entirely. Seventy-five percent of the farmers indicated that they felt it was more important to stick with a good crop plan and ride out poor market cycles than to shift their crop plans as marketing conditions change.

Seventy percent of the farmers indicated that diversification was important for reducing risk and stabilizing annual income. A bias toward diversificaton could be expected as all of the farmers interviewed were diversified.

Fifty percent of the farmers interviewed indicated that they often plan several years in advance and are thinking about crop selection decisions all year long. The other 50% indicated there are two primary times when they make crop selections, in the fall, and in the spring. It was concluded that information used for making crop selection decisions would be most valuable to the farmer if received in the fall by the end of September or early October. Additional information useful in selecting between spring planted crops would be valuable to the farmer if received before the end of March.

Fifty percent of the farmers interviewed indicated that they had planted approximately the same crops in the same proportions as they did the year before. Ninety percent of the farmers indicated in the last few years they had entirely stopped growing one or more crops. Sixty-one percent of responding farmers listed low profitability as the primary reason or one of the primary reasons for dropping the crop. Seventy percent of the farmers indicated that they had added a new crop in recent years. Better profitability was the primary reason for adding a new crop. Forty-five percent of the farmers sampled stopped growing a crop because increased input costs had made that crop unprofitable or less profitable than other crops. Of those indicating that the price of an input item had caused them to change their cropping plan, increased labor costs was the most frequent reason. Farm commodity prices were a much more important factor stimulating farmers to change cropping plans.

Eighty percent of the farmers surveyed indicated that their past cost records were important in estimating costs, but only 35% indicated that they actually kept records of their production costs for each crop. Of the seven farmers who kept enterprise records, four used computerized record keeping services and the remaining three kept records by hand. One of these three was looking into buying his own computer. Many of the farmers recognized the value of production cost records but did not keep them because they felt it takes too much time, or was too much bother to sort out the costs between different crops.

Market information was the most frequently mentioned helpful information for trying to decide what crops to grow. Ninety-five percent of the farmers interviewed indicated that their lender did not help them decide what to grow. All of the farmers interviewed indicated that their accountants did not provide them with information helpful for making crop selection decisions. Eighty-five percent of the farmers interviewed indicated that they think farmers need better information and assistance in making crop budgets and deciding what crops to grow.

An information and analysis system for crop selection decisions was proposed. The emphasis of this system is to prepare the most accurate and reliable enterprise budgets possible using available information. In constructing these budgets it is important to differentiate those costs that are directly traceable to the enterprise, and will vary proportionately with the acres of the crop, from indirect and fixed costs. Gross revenues minus total direct costs gives contribution margin. This amount is the contribution to fixed costs, overhead, and profit from that enterprise and is a more appropriate criterion than profit per acre for selecting between crops because of the arbitrariness of overhead cost allocations.

The objective of this system is to use these enterprise budget projections to rank the crops being considered in order of desirability with the primary criterion being expected contribution margin per acre. Consideration was also given to break even probability to account for risk differences between crops. This system is based on the assumption that once farmers understand the relative expected profitability and associated riskiness of each crop they can informally create a near optimum mix that will satisfy all the other necessary constraints.

A Hewlett Packard 41C programmable calculator and the "Croplan" program written for this calculator by the author were used to simultaneously consider triangular probability distributions of prices and yields. The expected gross income was measured against a cost factor to give an expected margin per acre and a break even probability for each crop. The program was successfully tested in two actual case studies. The proposed information system and analysis program were found time consuming but valuable for three reasons. First, it gave the farmers a better understanding of the relative profitability of each crop to improve crop selection decisions. Second, the detailed analysis of the production costs of each crop should help in understanding and controlling production costs. Third, the historic records and crop budget projections that were developed could be used to help formulate a linear programming model or other sophisticated analysis technique.

Conclusions and Recommendations

Although theoretically appropriate business management techniques are available they are seldom if ever used by farm managers when making actual crop selection decisions. Many of these techniques are over sophisticated when considering the accuracy and reliability of the available cost, price, and yield information. All of these techniques are dependent upon the enterprise budgets developed to formulate the constraints and coefficients for the models. Enterprise budgeting was the only analysis technique found to be in regular use and only thirty-five percent of the farmers sampled were regularly keeping enterprise cost records for this purpose.

There is need for additional record keeping and enterprise cost accounting by farm managers to generate reliable management information specific to each farm. Crop production costs can vary significantly from one farm to the next. Average cost information such as that provided by the OSU Extension Service, canneries, or fertilizer field men may not give managers adequate information of their own situations. Improved record keeping can have a three fold benefit. First, a better understanding of the relative profitability of each crop on a farm will aid crop selection decisions. Second, better cost control can be achieved through detailed analysis of the costs associated with each crop. Third, a reliable personal file of historic cost, price, and yield information will help facilitate valid estimates for the constraints and coefficients necessary for using more sophisticated techniques such as linear programming, quadratic programming, or E-V analysis.

Farmers who are not keeping enterprise records need to become aware of the fundamentals of enterprise cost accounting and consider keeping enterprise cost records even if they are only crude. Farmers should write out their enterprise budget projections and review these projections at the end of the year comparing them with actual results. Once the fundamentals of enterprise cost accounting are understood, farmers can use a hand record keeping system, buy an "in-house" computer, or select one of the several computerized cost accounting record keeping services available in the area. Enterprise cost analysis has two benefits for the farmer. First, a better understanding of the relative profitability of different crops assists in crop selection decisions and second, enterprise budgeting and comparison of actual results with these budgets works as a goal setting technique to aid cost control. Farmers should become aware of enterprise cost information available to them from several sources such as OSU Extension Service cost sheets, cannery cost studies and others to compare these average or standardized budgets with their actual figures. These analysis procedures will help farmers realize the significance of cost control and crop selection decisions and see the results of those decisions in black and white.

The Extension Service should emphasize basic record keeping and cost accounting theory in seminars and publications. A two fold campaign, first, emphasizing the importance of record keeping and enterprise analysis and, second, teaching the fundamental basics of cost accounting and analysis theory would be helpful. The OSU Extension Service "Enterprise Data Sheets" need to be kept up to date and made believable. Several farmers indicated they had little confidence in the cost studies provided because they were out of date and felt there were unrealistically high costs in these budgets.

The problem may be as much that farmers are unwilling to accept what their costs are as it is that the data sheet costs may tend to be on the high side. Cooperation with the community college farm management classes where actual enterprise cost records are being kept would be one way of assuring the reliability of the enterprise cost estimates on the data sheets.

A program to circulate these updated cost studies on a more timely basis would help many farmers. If they could subscribe to the cost studies series and receive updates in the mail whenever available, they would be confident that they had the most recent information. Several farmers commented that they were not aware of when the sheets were updated and had to go into their county extension office to get them.

Community college farm management instructors need to continue emphasizing record keeping and teaching the theory and techniques of cost accounting and enterprise analysis. This is an excellent program providing farmers with training and assistance in enterprise cost accounting. Using comparative cost studies to inform farmers may also get them interested in looking at their own costs.

Lenders need to emphasize enterprise cost accounting and enterprise budgeting for cost control, goal setting and loan monitoring.

Lenders can recommend to borrowers that they keep records and suggest the community college farm management classes or an extension service workshop to learn the fundamentals of cost accounting and the basic principles of setting up record keeping systems. If they need assistance, lenders can suggest one of the computerized systems or private management consulting services in the area.

Consultants should recognize the additional need for information, consulting, training, and record keeping assistance. As only 35% of the large farmers in the sample keep enterprise cost records, there is still a large market potential for record keeping and consulting if the cost can be kept reasonable and the service reliable. A number of farmers have a phobia about computers due to previous bad experiences with unreliability. By emphasizing reliability, consultants can overcome farmers' mistrust of computerized systems and help them develop confidence in the records and information provided. The enterprise accounting systems need to be designed so as much enterprise cost information as possible is available in September and October before fall planting decisions need to be made. Information on spring planted crops needs to be available by April or May. Farmers also mentioned that information needs to be summarized as much as possible and delivered in a simple clear format.

Implications for Further Research

Further research and development are needed in exploring hardware and software combinations to cut the cost and improve the speed, reliability, and availability of computerized record keeping for farmers. Most of the farmers who did not keep enterprise cost records felt that it would be too time consuming. Procedures minimizing input preparation time will be important to any record system. Careful attention needs to be paid to the theoretical appropriatness of these systems and in helping the farmer understand the reliability and associated confidence he can place in the generated information.

Additional research needs to be done to help quantify the cost and benefits of crop rotations. In many cases crop selection decisions are complicated by crop rotations as the decision is not necessarily between crops but is between crop rotations. In other cases crops that are known to be marginally profitable are grown in rotation due to the expected benefit on other subsequent crops. Such complications should not be used as an excuse for disregarding enterprise cost accounting. They need to be seen as a challenge for quantifying rotation benefits or budgeting the entire rotation.

Studies need to be done to help determine the nature of cost, price, and yield variances from year to year and from farmer to farmer. Understanding the magnitude and nature of these variances will help evaluate the accuracy and reliability of sophisticated techniques such as E-V analysis.

The combination of price, yield and cost variances between crops, between years, and between farmers makes crop budgeting difficult and often imprecise. Somewhere in this confusion lies the difference between profit and loss. Success may come from selecting the right crops. It may come from controlling costs, obtaining higher yields, or from better marketing. Enterprise cost accounting can help farmers better understand the reasons for these variances and excercise wise management control over those factors they can control.

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APPENDIX I

FARM QUESTIONNAIRE AND CROP PLAN SUMMARY

Questionnaire Telephone Introduction Statement

HELLO!

My name is ______________

I am helping conduct a survey for the Oregon State University Extension Service about HOW FARMERS DECIDE WHAT CROPS TO GROW.

Have you received the letter we sent about this survey? I am calling to set up an appointment with you to get your responses to our survey questions. The interview will take 45 minutes to an hour. When will be a good time in the next week for me to come out?

Can you give me directions to your house or where I should meet you?

This survey is part of a research project on the economic information Willamette Valley farmers need to make crop selection decisions. The results will be used to guide the extension service and private consulting businesses in supplying the information and consulting services that best meet farmers needs.

This study consists of a small number of intensive interviews, your responses are very important. The survey consists of a questionnaire interview. We are interested in your general comments and opinions about making crop selection decisions as well as the answers to our specific questions. The questions are about the crops you grow and the information you use to make crop selection decisions. Most of these questions require only yes/no or short answers. A few of the questions require specific figures. If you are uncertain about the exact figures, approximations will be adequate. We do not expect you to go look up figures to answer any of these questions.

Your identity and the specific information you provide will be strictly confidential. The summarized results of the survey will be printed in a report and a copy will be mailed to you.

FARM SURVEY QUESTIONNAIRE

SECTION I TYPE OF FARM

1. Do you make the crop selection decisions on this farm? ___ yes ___ no

2. Does anyone else contribute to these decisions? ___ yes ___ no

Who?____

____

3. Is your farm business a:

Sole proprietorship ___ Family held corporation ___
Partnership ___ Non family held corp ___
Sub Chap S Corp ___

4. How many acres do you farm and how much of this land is irrigated?

Total ________ Irrigated ________

5. Is your annual gross income:

___ Less than $50,000
___ Between $50,000 and $100,000
___ Between $100,000 and $200,000
___ Over $200,000

6. How many people work full time on this farm? ________

7. Is profit:

Your primary management objective ___
One of your primary objectives ___
Not a primary management objective ___
Other management objectives, comments ______________________

____

____

8. How important is crop selection in the overall management of your farm?

One of the most important decisions ___
An important decision ___
Not an important decision ___

9. What other decisions do you consider more important or as important?

____

____

____

SECTION II CROP PLANS

10. What crops are you growing this year and approximately how many acres of each?

11. What crops did you grow last year and approximately how many acres of eacb lest year?

Crop	Acres 1979	Profit	Acres 1980	Profit

12. Of the crops you grew in 1979 which were the most profitabla (mark M for most or 1,2,3, etc.) and which were the least profitable? (mark L for least)

13. Of the crops you are growing in 1980 which do you expect to be the most profitable? (mark M for most or 1,2,3, etc.)

14. Which do you expect to be the least profitable? (mark above L for least)

15. Were these your expectations at planting time? ___ yes ___ no

What changes?____

____

____

SECTION II <u>CROP PLANS CONTINUED</u>

16. If you expected ____________________ to be your most profitable crop, why didn't you plant more of it?____________________________________

____.

17. If you expected ______________________ to be your least profitable crop, why didn't you grow something else?___________________________

____.

SECTION III <u>MAKING CROP PLANS</u>

18. When deciding what crops to grow, what are some of tha factors you consider? (Check list, don't raad)

___ Profit ___ Labor Schadule ___ Exparience
___ Crop Rotation ___ Soil Suitability ___ Prefarence
___ Equipment ___ Irrigation Capacity ___

____

____

19. Of these factors which are most important? (Mark above M for most or 1,2,3, etc.)

20. What information is most helpful to you whan trying to decide what crops to grow?

____

____

____

21. What improvements or new information would make crop selection decisions easier? ____

____

____

22. What would help you make better use of the information that is available?

____

____

____

SECTION III MAKING CROP PLANS CONTINUED

23. When deciding what cropa to grow do you eatimata the profit per acre you expect from each crop? ______ yes ______ no
(If no skip to 26)

24. How do you calculate these astimates? ______________________________

____

____

25. Do you make thase calculations:

In your head ________ or write tham down ____________?

26. What did you axpact your wheat (or other crop to yield ?

____________________(bu/A) (T/A)

27. What sources of information are helpful in making yield eatimates?
(Chack list, don't read)

Your paat yields	______	County Average	________
Neighbora past yields	______	Experimental Station teats	______
____________________		____________________	
____________________		____________________	
____________________		____________________	

SECTION III MAKING CROP PLANS CONTINUED

28. What did you expect the price of wheat (other crop) to be?

_______________ ($/bu)($/T)

29. What sources of information are halpful for astimating the price of wheat? (check list don't read)

Portland Prices	Papar ________
Chicago Futures	Radio ________
Doans Forecasts	Magazine ________
Extension Service	Neighbors ________
USDA	Brokar
________	________
________	________

30. Did you astimate production costs for each crop you planted this year?
_____ yes _____ no

31. Approximately what are your production costa per acre for wheat? _____$/A

32. When estimating the cost of producing wheat what costs would you include? (Check list don't read)

Land Preparation	Seed	________
Planting	Chamicals	
Weed Control	Applications	________
Fertilizer	Labor	
Harvest	Machinery	________
Rent	Living	
Overhead	________	________

33. What sources of information are useful to you in astimating production costs?
(Check list do not raad)

Your past cost records	Extension cost sheets
Neighbors cost racords	Doans cost estimates
________	________
________	________

34. Do you keep records of your production costs for each crop? ____ yes ____no

35. Why or why not?____

____

____

SECTION III <u>MAKING CROP PLANS CONTINUED</u>

36. When do you make crop selection decisions?

____

____

____

37. If you were provided with crop budget information or other information useful in making crop selection decisions for 1980-81 planting, what is the latest month you would need to have this information.

July ___ Aug ___ Sept ___ Oct ___ Nov ___ Dec ___ Jan ___ Feb ___ March ___

IV CROP SELECTION DECISIONS

38. Have you ever plaoted less of a crop or stopped growing a crop because tbe price was expected to be unusually low? ____ yes ___ oo

What crop ____________________

39. Have you ever planted more of a particular crop or planted a new crop because the price was expectad to be unusually high? ___ yes ___ no

What crop?____________________

40. Have you ever cbanged your cropping plao because the price of an input item like seed, special chemicals, or extra labor iocreased enough that tbe crop became less profitable than other crops? ___yes ___ no

What Crop?____________Why?____________

41a. Are there any crops you have stopped growing in the last few year?

What?____________________

41b. Why did you stop growiog this crop?____________________

____

42a. Are you growing any crops oow that you did not grow a few years ago?

What crop____________________

42b. Why did you start growing this crop?____________________

____

43. Of the crops you are growing this year which would you drop first?

____________ Why?____________

44. If you were to sdd a new crop next yaar what would be your first choice?____________________

Why____________________

45. What information would you like to have about this crop before making a decision?____________________

IV <u>CROP SELECTION DECISIONS CONTINUED</u>

46. Do you consider planting a perennial crop more carefully than an annual crop

_____ yes ___ no

WHY ____

47. Do any of the perennial crops you grow require an establishment season with little or no income? ______________________________

48. When you planted this crop did you take into account these establishment costs when determining its profitability? ___ yes ___ no

If so, how? ____

V MANAGEMENT PHILOSOPHY

49. Do you baliave it is more important to be diversified ____________
or to specialize ____________________ on a few crops

Why?____

50. If you grew a crop that was not very profitable one year would you be more likely to switch to another crop or try to improve the way you grew it the next year?

Switch__________ Not Sure __________

Improve ________ Depends __________

51. Do you feel it is more important for farmera to shift their crop plans as market conditions change or to stick with a good crop rotation and ride out poor market cyclea?

Shift _________ Not Sure ___________

Stick__________ Depends ___________

VI OTHER ASSISTANCE

52. Do you borrow operating money? ____ yes ___ no

53. Where? ____

54. Does your lender help you decide what to grow? ___yes ___ no

55. Does your lender provide you assistance in estimating production costs? ___yes ___ no

56. Do you prepare an operating budget? ___ yes ___ no

57. Do you compare your actual costs with your budget? ___ yes ___ no

58. Do you use an accountant? ____ yes ___ no

59. Who is your accountant? ____

60. Does your accountant provide you with information helpful for making crop selection decisions? ___ yes ___ no

61. Does anyone else provide you with crop cost information or help you decide what crops to grow? ___ yes ___ no

Who? ____

62. Do you think farmers need better information and assistance in making crop budgets and deciding what crops to grow? ___ yes ___ no

Thank you very much for your cooperation. We will send you a summary of the results of this survey.

TABLE 18. 1979 AND 1980 CROP PLANS FOR SAMPLED FARMS

CROP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	No. Growers	Total Acres
Wheat	100M / 165M	440L / 415		275 / 240		60 / 145	255 / 200	200 / 200	20 / 90	250 / 250	150 / 150	50 / 30	60 / 89	100 / 100	345 / 330	600 / 600	67 / 67	100 / 150	600 / 600L	70 / 60L	18 / 18	3626 / 4026
Sweet Corn			25 / 25	80 / 80L	80L / 80L	380 / 400	60 / 60		120M / 150M	15 / 15	25M / 45M	50L / 50L	50 / 33	60 / 60	85 / 75	45 / 45	104 / 104	900L / 810		120 / 72	16 / 14	1399 / 1464
Bush Beans			210 / 210	190 / 160	110 / 110	515 / 286	145 / 145L					100 / 100			170 / 115M	426L / 426	103 / 103	250 / 200		175M / 130M	11 / 11	2264 / 2088
Strawberries			145 / 145			25M / 10M	20 / 20M			30M / 20M	8M / 8	5M / 5M	29M / 34	20 / 20					10 / 10		9 / 9	262 / 282
Annual Ryegrass						125L / 125L		200L / 200L							0 / 10L	300 / 300	46 / 46				4 / 5	671 / 681
Red Clover	160 / 100	170M / 180								100 / 100					37 / 28						4 / 4	467 / 388
Crimson Clover	0 / 40L	60 / 130L								40 / 40								60L / 25L			4 / 4	160 / 235
Sugar Beets															30L / 68	35M / 33M	45 / 45		50 / 50		4 / 4	158 / 196
Marion Blk Berry			62 / 62						53 / 53					10 / 10L	15 / 25						4 / 4	140 / 160
Peppermint		0 / 20															88 / 88			152 / 192	2 / 3	240 / 300
Peas-Green		80 / 25					25 / 25							55 / 35						35 / 0	4 / 3	225 / 185
Pasture									70 / 70	15 / 15	20 / 20										3 / 3	105 / 105
Alfalfa													23 / 18M			20 / 20		60M / 60M			3 / 3	103 / 98
Carrots					20M / 10M							30 / 30					19 / 19				3 / 3	69 / 59
Blue Berries			27M / 27M										3 / 3						2 / 2		3 / 3	32 / 32
Bluegrass	40 / 40	100 / 100																			2 / 2	140 / 140
Field Corn									90 / 185	15 / 15											2 / 2	105 / 200
Onions			95 / 95	15L / 15																	2 / 2	110 / 110
Table Beets												30 / 30							50M / 50M		2 / 2	80 / 80
Evergreen Berry			45 / 45												25 / 25						2 / 2	70 / 70
Boysenberries			58 / 58												8 / 8						2 / 2	66 / 66
Mixed Hay	25 / 25									40 / 70				35M / 35M							2 / 2	65 / 65
Cauliflower							20M / 20														2 / 2	55 / 55
Clover Hay											25 / 25		15 / 12								2 / 2	40 / 37
Cherries							25 / 25									10 / 10L					2 / 2	35 / 35
Filberts							20 / 20				14 / 14										2 / 2	34 / 34
Squash						8 / 8						25 / 25									2 / 2	33 / 33
Oats									0 / 35	100 / 100											1 / 2	100 / 135
Spring Wheat									130 / 56L				0 / 33L								1 / 2	130 / 88
Garlic																	66M / 66M			30L / 0	2 / 1	96 / 66
Oat Hay											15L		17								1 / 2	15 / 32
Perennial RG								2000M / 2000M													1 / 1	2000 / 2000
Gulf Ryegrass								1000 / 1000													1 / 1	1000 / 1000
Tall Fescue								350 / 350													1 / 1	350 / 350
Tetraploid RG								280 / 280													1 / 1	280 / 280
Grass Seed				55 / 100																	1 / 1	55 / 100
Broccoli				92M / 91M																	1 / 1	91 / 92
White Clover								80 / 80													1 / 1	80 / 80
Turnips Forage																		65 / 65			1 / 1	65 / 65
Blk Raspberries			50 / 50																		1 / 1	50 / 50
Fineleaf Fescue																		25 / 25			1 / 1	25 / 25
Barley										20L / 20L											1 / 1	20 / 20
Vetch										20 / 20											1 / 1	20 / 20
Gooseberries			12 / 12																		1 / 1	12 / 12
Red Currants			10 / 10																		1 / 1	10 / 10
Fodder Beets										10 / 10											1 / 1	10 / 10
Timothy Hay													7 / 15								1 / 1	7 / 15
Cabbage Seed																	10L / 10L				1 / 1	10 / 10
Apples																				5 / 5	1 / 1	5 / 5
Rhubarb													13 / 13								1 / 1	13 / 13
Red Raspberries													2 / 2								1 / 1	2 / 2
Pumpkins											2 / 2										1 / 1	2 / 2
Austrian Peas	75L / 0																				1 / 0	75 / 0
Potatoes									60L / 0												1 / 0	60 / 0
Cucumbers									30 / 0												1 / 0	30 / 0
Sudan Grass													0 / 8								0 / 1	0 / 8
Timber & Brush											25 / 25										1 / 1	25 / 25
Cattle (head)																		300 / 300			1 / 1	1600 HD / 1800 HD
Sheep (head)																		1800 / 1800			1 / 1	1800 HD / 1800 HD
Number of Crops	6	6	11	6	3	6	8	7	9	12	9	7	12	6	9	7	9	9	5	7		

1979 Acres / 1980 Acres   L = Least Profitable
M - Most Profitable

APPENDIX II

SERVICE PERSON QUESTIONNAIRE

SERVICE PERSON QUESTIONNAIRE

For the farmers you work with do you believe profit is their primary management objective ____

One of their primary objectives ____

Not a primary objective ____

Comments other objectives ____

____

____

Do you consult with farmers about their crop selection decisions? ____yes ____no

Do the farmers you work with usually consult with anyone else about crop selection decisions? ____yes ____ no

Who?____

____

____

How important is crop selection in the overall managemeot of a farm?

One of the moat important decisions ____

An important decision ____

Not an important decision ____

Whst other farm management decisions do you consider more important or as important as crop selection?

____

____

____

For the farmers you work with what crops were most profitable in 1979?

____

____

____

When deciding what crops to grow do you think most of the farmers you work with try to estimate the profit per acre they expect from each crop?____yes ____no

Do You think they should?____yes ____no

Do you think most of the farmers you work with make these estimates in their heads____ or write them down____?

Do you think they should write them down?____yes ____no

Do most of tbe farmers you work with prepare operating budgets? ____yes ____no

Do You help them prepare these operating budgets? ____yes ____no ________________

____

What information is helpful when making yield estimates?

____Their past yields
____Other farmers past yields
____
____cannery averages
____Extension Service
____

What sources of information are helpful when making price estimates?
(Check list do not read)

____Portland Prices
____Chicago Futures
____Doanes Forecasts
____Extension
____
____
____Paper________________
____Radio________________
____Magazine______________
____Neighbors
____Broker
____

What sources of information are useful when estimating production costs?

Farmers Past Records
Neighbors Records
____
Extension Cost Sheets
Doans Cost Estimates
____

Do most of the farmers you work with keep records of the production costs for each crop? ______Yes ____no

Why or why not?____

____

____

____

Do you think they should keep records of the production costs for each crop?

_____yes ____no

Why____

____

____

When do most of the farmers you work with make crop selection decisions?

____

____

____

If crop budget information or forecasts were provided to farmers what is the latest month they could get this information to use it in planning 1980-81 plantings?

July ___ Aug ___ Sept ___ Oct ___ Nov ___ Dec ___ Jan ___ Feb ___ Mar ___

When deciding what crops to grow what are some of the factors farmers should consider? (Check list do not read)

____Profit	____Labor Schedule	____Experience
____Crop Rotation	____Soil Suitability	____Preference
____Equipment	____Irrigation Capacity	________
________	________	________
________	________	________

Of these factors which is most important? (Mark M for most)

What information do you know of that would be helpful to farmers when deciding what crops to grow?

____

____

What information or services do you provide to assist farmers with crop selection decisions?

____

____

What new information or improvements would make crop selection decisions easier for farmers?

____

____

What could farmers do to make better use of the information that is available?

____

____

____

Do you believe it is more important for farmers to be diversified ______ or to specialize _____ on few crops that they can grow well?

Do you believe the farmers who you work with should use enterprise cost accounting to determine which crops are most profitable for them?____________

Why or why not?____

____

Do you believe it is more important for farmers to shift to more profitable crops as market conditions and production costs change or to stick with the crops they know well and ride out poor market cycles?

Shift _____ Stick _____

Do you believe there is a significant difference between the enterprise production costs of different farmers or that most farmers production costs are about the same?____

____

Do you believe that farmers should rely on average production cost figures like those published by the OSU Extension Service and by cannery field men or is it important that farmers check their own production costs for making management decisions on their own farm?____

____

____

Do you believe that the crops that are most profitable for one farmer are usually also the same crops that are most profitable for other farmers or should each farmer determine those enterprises that are most profitable under his management?

____

____

____

Have some of the farmers you work with ever planted less of a crop or stopped growing a crop because the price was expected to be unusually low?

What crop?____

Have some of the farmers you work with ever planted more of a crop or planted a new crop because the price was expected to be unusually high? ___ yes ___ no

What crop?____

Have some of the farmers you work with ever changed their cropping plans because the price of an input item like seed, special chemicals, or extra labor increased enough that the crop became less profitable than other crops? ___ yes ___ no

What crop?____

____

Are there any crops the farmers you work with have stopped growing or cut down on in the last few years? ___ yes ___ no

What crop?____

Why?____

Have you ever encouraged farmers to get into or out of particular enterprises?
___ yes ___ no

What ?____

Why ?____

Do you know of any new crops that are being grown now that were not a few years ago? ____

What?____

Why have farmers started growing this crop?________________________

____

What information do you think a farmer should consider about a new crop before beginning growing it?____________________________________

____

____

APPENDIX III

CROPLAN PROGRAM FOR HP41C

Croplan

An analysis for crop selection decisions.

Objective

This program is designed to help farmers analyze crop enterprise budgets when crop prices and yields are uncertain. A triangular probability distribution is used to quantify the farmer's subjective expectations about future prices and yields. The farmer indicates the lowest likely, most likely, and highest likely levels for the price and yield of each crop being considered. The total direct production cost is also estimated for each crop. Using these inputs the program calculates the expected gross, the contribution margin, and break even probability for each crop. The crops can then be ranked in order of desirability based on contribution margin per acre and break even probability. From this ranking the farmer's crop plan is developed.

Equipment List

HP41C Programmable Calculator

Two Additional Memory Module for Above

Card Reader HP #82104A

Printer HP #82143A (optional)

Program "Croplan" on both sides of three magnetic program cards (six sides).

INPUTS

Lowest likely price ($ per unit yield)	LLP =
Most likely price ($ per unit yield)	MLP =
Highest likely price ($ per unit yield)	HLP =
Lowest likely yield (per acre)	LLY =
Most likely yield (per acre)	MLY =
Highest likely yield (per acre)	HLY =
Direct costs ($ per acre)	DC =

OUTPUTS

Intermediate:

Midpoint of each of 10 price levels	LEV =
Simple probability of each price	SPROB =
Midpoint of each of 10 yield levels	LEV =
Simple probability of each yield level	SPROB =

Final:

Expected Gross income ($ per acre)	EGROS =
Expected Margin ($ per acre)	MARG =
Breakeven prob (cumulative probability that income will exceed direct costs)	BEPRB =

PROGRAM NOTES

1. Size calculator to 76.

   Turn on [ON] [EXQ]

   [ALPHA] S I Z E [ALPHA]

   0 7 6

2. Load program from magnetic cards.

   Press [GTO] , [.] , [.]

   Load first card.

   Calculator responds RDY 2 of 6.

   Repeat until all sides have been loaded.

   After a period calculator responds with "WORKING".

3. Printer "ON" and "NORMAL" mode (if used).

4. To load input.

   Press [A] in user mode.

   Calculator prompts for input eg. "LLP=?"

   Enter input. Press [R/S]

   Calculator prompts for next input.

   Repeat until all input entered.

   Calculator responds with "END ENTRIES".

5. To review input.

   To review input. Press [B]

   Calculator responds with each input item and the memory register where it is stored. eg. "MR 16 = 4.00"

   To change. Enter corrected value and press [STO] 1 6 or appropriate register.

6. To execute "CROPLAN".

If input does not need reviewing after the "END ENTRIES" message hitting R/S again will cause "CROPLAN" to begin execution.

After all data entries have been reviewed in subprogram B a message "END VAL CHK" will appear hitting [R/S] will begin execution of "CROPLAN" at this point.

Pressing [C] at any point will also begin execution of "CROPLAN".

As "CROPLAN" begins execution, the flag "0" indicator will appear indicating the calculator is executing the price portion of the program. The flag "0" indicator will disappear when the yield portion of the program begins.

Price and yield distributions are broken into ten intervals and the probability of each interval is calculated. The midpoint of the current price or yield interval is temporarily displayed "LEV = XXX". Then the simple probability of this interval is briefly displayed as it is calculated "S PROB =" 0,XXXX"

7. Output

The full calculation will take approximately 4½ minutes. Upon completion the calculator will signal completion with a beep and display the first final answer

"GROSS = $XXX.XX"

To view the next answer press R/S.

Repeat for margin and break-even probability.

Calculator signals end with

"END CROPLAN"

To rerun with new data begin at [A].

To review the final answers of the last run press [D].

LISTING OF CROPLAN PROGRAM

```
PRP "CROPLAN"

01♦LBL "CROPLAN"
02♦LBL A
03 CLRG
04 "LLP=?"
05 PROMPT
06 STO 16
07 "MLP=?"
08 PROMPT
09 STO 17
10 "HLP=?"
11 PROMPT
12 STO 18
13 "LLY=?"
14 PROMPT
15 STO 19
16 "MLY=?"
17 PROMPT
18 STO 20
19 "HLY=?"
20 PROMPT
21 STO 21
22 "P COST=?"
23 PROMPT
24 STO 22
25 10
26 STO 04
27 "END ENTRIES"
28 PROMPT
29 GTO C

30♦LBL B
31 16.02201
32 STO 00
33 CF 29

34♦LBL 03
35 FIX 0
36 "NR"
37 ARCL 00
38 "⊢="
39 FIX 2
40 ARCL IND 00
41 PROMPT
42 ISG 00
43 GTO 03
44 SF 29
45 "END VALCHK"
46 PROMPT

47♦LBL C
48 0
49 STO 23
50 STO 24
51 CLA
52 "Y"
53 ASTO 54
54 SF 00
55 BEEP
56 "PRICE"
57 AVIEW
58 1.01001
59 STO 51
60 1.01101
61 STO 52
62 30.10001
63 STO 28
64 40.10001
65 STO 29
66 54.06501
67 STO 53
68 64.07501
69 STO 54
70 RCL 16
71 STO 01
72 RCL 17
73 STO 02
74 RCL 18
75 STO 03
76 XEQ 01
77 GTO 21

78♦LBL 01
79 RCL 03
80 RCL 01
81 -
82 RCL 04
83 /
84 STO 05
85 1
86 /
87 RCL 01
88 -
89 STO 06
90 RTN

91♦LBL 21
92 RCL 06
93 STO 07
94 RCL 07
95 RCL 01
96 -
97 STO 10
98 RCL 02
99 RCL 01
100 -
101 *
102 STO 09
103 RCL 03
104 RCL 02
105 -
106 ST* 10

107♦LBL 04
108 "LEV="
109 ARCL 07
110 AVIEW
111 RCL 03
112 RCL 07
113 X<=Y?
114 GTO 02

115♦LBL 25
116 FC?C 00
117 GTO 11
118 GTO 17

119♦LBL 02
120 0
121 STO 12
122 RCL 05
123 X≠0?
124 GTO 22
125 RCL 04
126 1/X
127 STO 13
128 FS? 00
129 GTO 24
130 ISG 52
131 GTO 15
132 GTO 11
```

LISTING OF CROPLAN PROGRAM CONTINUED

```
133♦LBL 24
134 ISG 52
135 GTO 10
136 10
137 ST- 52
138 GTO 25

139♦LBL 22
140 2
141 /
142 ST- 12
143 RCL 07
144 ST+ 12
145 +
146 STO 11
147 RCL 03
148 X<=Y?
149 STO 11
150 RCL 12
151 RCL 01
152 X>Y?
153 STO 12
154 RCL 02
155 RCL 11
156 X>Y?
157 GTO 07
158 RCL 11
159 RCL 01
160 -
161 X↑2
162 RCL 09
163 /
164 STO 13
165 GTO 03

166♦LBL 07
167 RCL 07
168 RCL 11
169 -
170 X↑2
171 RCL 10
172 /
173 CHS
174 1
175 -
176 STO 13

177♦LBL 08
178 RCL 02
179 RCL 12
180 X>Y?
181 GTO 09
182 RCL 12
183 RCL 01
184 -
185 X↑2
186 RCL 09
187 /
188 ST- 13
189 FS? 00
190 GTO 10
191 GTO 19

192♦LBL 09
193 RCL 07
194 RCL 12
195 -
196 X↑2
197 RCL 10
198 /
199 CHS
200 1
201 +
202 ST- 13
203 FS? 00
204 GTO 16
205 GTO 19

206♦LBL 16
207 ISG 28
208 ISG 29
209 RCL 07
210 STO IND 28
211 RCL 13
212 STO IND 29

213♦LBL 27
214 FIX 2
215 "YPROB="
216 ARCL 13
217 AVIEW
218 RCL 05
219 ST+ 07
220 GTO 04

221♦LBL 11
222♦LBL D
223 FIX 2
224 "GROS=$"
225 ARCL 23
226 BEEP
227 PROMPT
228 RCL 23
229 RCL 22
230 -
231 STO 25
232 "MARG=$"
233 ARCL 25
234 PROMPT
235 CLA
236 "%"
237 ASTO 54
238 1
239 RCL 24
240 -
241 100
242 *
243 STO 25
244 "PEPRB="
245 ARCL 25
246 ARCL 54
247 PROMPT
248 "END CROPLAN"
249 PROMPT
250 GTO A

251♦LBL 17
252 BEEP
253 "YIELD"
254 AVIEW
255 RCL 19
256 STO 01
257 RCL 20
258 STO 02
259 RCL 21
260 STO 03
261 38.10001
262 STO 28
263 40.10001
264 STO 29
265 XEQ 01
266 GTO 21
267 RTN
```

LISTING

```
268♦LBL 19
269 ISG 29
270 RCL IND 29
271 RCL 13
272 *
273 STO 30
274 ISG 54
275 STO IND 54
276 ISG 28
277 RCL IND 28
278 RCL 07
279 *
280 STO 25
281 ISG 53
282 STO IND 53
283 RCL 22
284 X<=Y?
285 GTO 20
286 RCL 30
287 ST+ 24

288♦LBL 20
289 RCL 25
290 RCL 30
291 *
292 ST+ 23
293 ISG 51
294 GTO 19
295 10
296 ST- 51
297 ST- 28
298 ST- 29
299 GTO 23
300 END
```

INPUTS

```
                 XEQ F
LLP=?
          3.50   RUN
MLP=?
          4.00   RUN
HLP=?
          5.00   RUN
LLY=?
         70.00   RUN
MLY=?
        100.00   RUN
HLY=?
        120.00   RUN
T COST=?
        350.00   RUN
END ENTRIES

                 XEQ E
MR16=3.50
                 RUN
MR17=4.00
                 RUN
MR18=5.00
                 RUN
MR19=70.00
                 RUN
MR20=100.00
                 RUN
MR21=120.00
                 RUN
MR22=350.00
                 RUN
END [illegible]
```

OUTPUTS

```
                RUN
PRICE
LEV=3.50
SPROB=0.0300
LEV=3.7250
SPROB=0.0900
LEV=3.8750
SPROB=0.1500
LEV=4.0250
SPROB=0.1900
LEV=4.1750
SPROB=0.1650
LEV=4.3250
SPROB=0.1350
LEV=4.4750
SPROB=0.1050
LEV=4.6250
SPROB=0.2750
LEV=4.7750
SPROB=0.0450
LEV=4.9250
SPROB=0.0150
LEV=5.0750
YIELD
LEV=72.5000
SPROB=0.0167
LEV=77.5000
SPROB=0.0500
LEV=82.5000
SPROB=0.0833
LEV=87.5000
SPROB=0.1167
LEV=92.5000
SPROB=0.1500
LEV=97.5000
SPROB=0.1833
LEV=102.5000
SPROB=0.1750
LEV=107.5000
SPROB=0.1150
LEV=111.5000
SPROB=0.0750
LEV=117.5000
SPROB=0.0250
LEV=122.5000

GROS=$482.79
                RUN
MARG=$51.79
                RUN
%EPRP=63.33%
```

APPENDIX IV

DATA FROM CASE STUDIES

TABLE 19. CROP RANKING AND 1981 CROP PLAN: FARM A

Rank	Crop	Expected C. Margin $/A	Expected Profit[a] $/A	Break Even Probability %	1981 Crop Plan Acres	Limiting Constraint
1	Processed Cauliflower	$697.44/A	$447.44/A	98.25%	50A	Contract
2	Processed Broccoli	594.74	344.74	90.67	45	Contract
3	Sugar Beet Seed	584.27	334.27	91.67	75	Contract
4	Fresh Cauliflower	533.40	283.40	70.61	45	Management
	Processed Cauliflower (Version B)	507.52	257.52	79.75		
	Fresh Cauliflower (Version B)	388.95	138.95	56.34		
5	Sweet Corn	257.85	7.85	60.00	100	Contract
6	Bush Beans	228.97	(21.03)	40.63	75	Contract
7	Winter Wheat	109.32	(40.68)	26.64	280	Total Acres
				Total Acres	670	

a/ Land rent of $100/A and overhead of $150/A assumed.

TABLE 20. CAULIFLOWER ENTERPRISE RECORDS AND 1981 PROJECTIONS

Crop/Farm	CAULIFLOWER PROCESSED FARM A			
Farm/Crop	1978	1979	1980	1981 Projections
Acres	35.00	45.00	40.00	
Yield T/A	10.60	8.50	10.00	(LL) (ML) (HL) 4 6 7.5
Price $/T				285 285 285
Income $/A	1983.18	2328.90	2850.00	1666.44
Land Prep	68.61	59.13	97.08	75.00
Plant	57.40	88.46	92.64	100.00
Weed Control	58.70	60.33	40.75	40.00
Fertilizer	185.48	244.31	257.98	310.00
Pest Control	48.83	59.92	44.11	70.00
Irrigate	100.51	55.31	117.15	120.00
Harvest	528.01	236.58	304.84	250.00
Market			27.36	
Total Direct $/A	1047.54	804.04	981.90	965.00
Cont. Margin	935.64	1524.88	1868.10	697.44
Land Charge	75.00	100.00	100.00	100.00
Allocated OH	325.40	242.84	510.43	150.00
Total Cost $/A	1447.94	1146.88	1582.23	1215.00
Profit/Loss	535.24	1182.04	1257.67	447.44
Break Even Prob.				98.25%

TABLE 21. CAULIFLOWER ENTERPRISE 1981 PROJECTIONS REVISED

Crop/Farm	CAULIFLOWER PROCESSED FARM A					
Farm/Crop	Revised 1981 Projection					
Acres						
Yield T/A	(LL) 3	(ML) 5	(HL) 7.5			
Price $/T	285	285	285			
Income $/A	1472.52					
Land Prep	75.00					
Plant	100.00					
Weed Control	40.00					
Fertilizer	310.00					
Pest Control	70.00					
Irrigate	120.00					
Harvest	250.00					
Market	0.00					
Total Direct $/A	965.00					
Cont. Margin	507.52					
Land Charge	100.00					
Allocated OH	150.00					
Total Cost $/A	1215.00					
Profit/Loss	257.52					
Break Even Prob.	79.75%					

TABLE 22. PROCESSED BROCCOLI ENTERPRISE RECORDS AND 1981 PROJECTIONS

Crop/Farm	BROCCOLI PROCESSED FARM A					
Farm/Crop	1978	1979	1980	1981 Projection		
Acres	20.00	29.00	35.00			
				(LL)	(ML)	(HL)
Yield	5.33	6.34	6.38	3.5	5.0	7.0
Price $/T				340	340	340
Income $/A	1535.21	1907.12	2186.15	1756.74		
Land Prep	64.26	50.52	61.66	65.00		
Plant	101.62	53.90	67.63	70.00		
Weed Control	64.62	77.05	79.14	85.00		
Fertilizer	196.73	223.54	266.50	280.00		
Pest Control	87.04	142.46	107.90	132.00		
Irrigate	108.78	65.91	130.16	130.00		
Harvest	301.64	403.25	344.08	400.00		
Market			57.51	0		
Total Direct $/A	924.69	1016.63	1114.58	1162.00		
Cont. Margin	610.52	890.49	1053.57	594.74		
Land Charge	75.00	100.00	100.00	100.00		
Allocated OH	341.14	294.81	469.14	150.00		
Total Cost $/A	1340.83	1411.44	1683.72	1412.00		
Profit/Loss	194.38	495.68	484.43	344.74		
Break Even Prob.				90.67%		

TABLE 23. SUGAR BEET SEED ENTERPRISE RECORDS AND 1981 PROJECTIONS

Crop/Farm	SUGAR BEET SEED FARM A					
Farm/Crop	1978	1979	1980	1981 Projection		
Acres	20.0	27.0	50.0			
				(LL)	(ML)	(HL)
Yield lbs/A	2102	2295	2502	1500	2700	4000
Price				.40	.40	.40
Income $/A	756.85	826.50	950.76	1093.27		
Land Prep	4.00	57.36	34.74	41.00		
Plant	3.78	1.81	2.99	10.00		
Weed Control	64.41	40.70	22.35	65.00		
Fertilizer	164.92	89.04	211.71	162.00		
Pest Control	23.32	18.94	10.65	20.00		
Irrigate	71.50	28.01	36.10	50.00		
Harvest	95.60	133.18	89.94	95.00		
Market	65.87	60.00	65.00	66.00		
Total Direct $/A	493.40	429.04	473.48	509.00		
Cont. Margin	263.45	397.46	477.28	584.27		
Land Charge	75.00	100.00	100.00	100.00		
Allocated OH	102.94	154.26	244.34	150.00		
Total Cost $/A	671.34	683.30	817.82	759.00		
Profit/Loss	85.51	143.20	132.94	334.27		
Break Even Prob.				91.67%		

TABLE 24. FRESH CAULIFLOWER ENTERPRISE RECORDS AND 1981 PROJECTIONS

Crop/Farm	CAULIFLOWER FRESH FARM A			
Farm/Crop	1978	1979	1980	1981 Projected
Acres	34.00	30.00	42.00	
Yield CTN./A		418.47 CTN	514.45 CTN	(LL)(ML)(HL) 300 400 600
Price $/CTN				2 4 6
Income $/A	1776.36	1916.59	2573.12	1733.40
Land Prep	59.14	30.90	73.94	75.00
Plant	57.26	23.05	28.94	35.00
Weed Control	49.65	54.37	92.71	100.00
Fertilizer	162.75	138.23	46.53	280.00
Pest Control	95.58	74.41	58.05	90.00
Irrigate	92.97	44.38	112.98	120.00
Harvest	457.06	627.91	499.70	500.00
Market	174.09	192.42	80.29	
Total Direct $/A	1148.50	1185.67	993.15	1200.00
Cont. Margin	627.86	730.92	1579.97	533.40
Land Charge	75.00	100.00	100.00	100.00
Allocated OH	436.39	325.97	518.08	150.00
Total Cost $/A	1659.89	1611.64	1601.23	1450.00
Profit/Loss	116.47	304.95	961.89	283.40
Break Even Prob.				70.61%

TABLE 25. FRESH CAULIFLOWER ENTERPRISE 1981 PROJECTIONS REVISED

Crop/Farm	FRESH CAULIFOLWER FARM A					
Farm/Crop	Revised 1981 Projection					
Acres						
	(LL)	(ML)	(HL)			
Yield CTN/A	300	400	600			
Price $/CTN	2	3	6			
Income $/A	1588.95					
Land Prep	75.00					
Plant	35.00					
Weed Control	100.00					
Fertilizer	280.00					
Pest Control	90.00					
Irrigate	120.00					
Harvest	500.00					
Market						
Total Direct $/A	1200.00					
Cont. Margin	388.95					
Land Charge	100.00					
Allocated OH	150.00					
Total Cost $/A	1450.00					
Profit/Loss	138.95					
Break Even Prob.	56.34%					

TABLE 26. SWEET CORN ENTERPRISE RECORDS AND 1981 PROJECTIONS

Crop/Farm	SWEET CORN FARM A					
Farm/Crop	1978	1979	1980	1981 Projection		
Acres	110.00	100.00	100.00			
				(LL)	(ML)	(HL)
Yield T/A	9.17 T	10.25 T	9.86 T	7.0	9.5	11.0
price $/T				65	65	65
Income $/A	563.77	612.75	601.46	595.85		
Land Prep	35.98	38.37	50.13	55.00		
Plant	21.18	22.58	14.49	18.00		
Weed Control	15.06	15.47	16.51	15.00		
Fertilizer	85.64	86.76	89.94	100.00		
Pest Control	7.45	1.21				
Irrigate	56.25	35.47	69.26	70.00		
Harvest	110.62	13.29	30.66	80.00		
Market	1.15	10.59				
Total Direct $/A	333.33	223.74	270.99	338.00		
Cont. Margin	230.44	389.01	330.47	257.85		
Land Charge	75.00	100.00	100.00	100.00		
Allocated OH	90.55	99.89	169.28	150.00		
Total Cost $/A	498.88	423.63	540.27	588.00		
Profit/Loss	64.89	189.12	61.19	7.85		
Break Even Prob.				60.00%		

TABLE 27. BUSH BEAN ENTERPRISE RECORDS AND 1981 PROJECTIONS

Crop/Farm	BUSH BEANS FARM A					
Farm/Crop	1978	1979	1980	1981 Projection		
Acres	115.00	72.00	70.00			
				(LL)	(ML)	(HL)
Yield T/A	4.62 T	6.01 T	4.85 T	2.75	4.0	6.0
Price $/T				160	160	160
Income $/A	613.67	862.42	776.00	679.97		
Land Prep	39.56	37.44	52.04	55.00		
Plant	73.94	75.11	68.06	70.00		
Weed Control	31.03	12.94	31.67	33.00		
Fertilizer	60.92	58.64	93.06	70.00		
Pest Control	18.93	4.51	4.88	12.00		
Irrigate	67.04	37.00	71.22	71.00		
Harvest	139.95	149.70	112.86	140.00		
Market	3.32					
Total Direct $/A	434.69	375.34	433.79	451.00		
Cont. Margin	178.98	487.08	342.21	228.97		
Land Charge	75.00	100.00	100.00	100.00		
Allocated OH	114.04	125.07	202.40	150.00		
Total Cost $/A	623.76	600.41	736.19	701.00		
Profit/Loss	(10.06)	262.01	39.81	(21.03)		
Break Even Prob.				40.63%		

TABLE 28. WHEAT ENTERPRISE RECORDS AND 1981 PROJECTIONS

Crop/Farm	WHEAT FARM A			
Farm/Crop	1978	1979	1980	1981 Projection
Acres	175.00	220.00	270.00	
Yield BU/A	49.32	97.77	100.00	(LL)(ML)(HL) 45 90 110
Price $/BU				3.8 4.4 5.0
Income $/A	216.29	429.93	440.00	359.32
Land Prep	21.04	21.01	22.09	22.00
Plant		11.14	5.01	17.00
Weed Control	12.05	8.84	7.04	12.00
Fertilizer	31.21	39.91	29.77	35.00
Pest Control	1.11	4.60		
Irrigate				
Harvest	17.79	26.85	39.99	40.00
Market	6.10	5.81	3.92	24.00
Total Direct $/A	89.30	118.16	107.82	150.00
Cont. Margin	126.99	311.77	332.18	209.32
Land Charge	75.00	100.00	100.00	100.00
Allocated OH	55.95	90.44	125.28	150.00
Total Cost $/A	220.25	308.60	323.10	400.00
Profit/Loss	(3.96)	121.33	116.90	(40.68)
Break Even Prob.				26.64%

TABLE 29. CROP RANKING AND 1981 CROP PLAN: FARM B

RANK	CROP	EXPECTED C. MARGIN $/A	EXPECTED PROFIT[a] $/A	BREAK EVEN PROBABILITY %	1981 CROP PLAN Acres	LIMITING CONSTRAINT
1	Strawberries	848.00	228.00	99.44	70	Management
2	Cabbage Seed	566.00	316.67	100.00	45	Contract
3	Sugar Beet Seed	532.45	302.45	100.00	75	Contract
4	Bush Beans	409.66	159.66	93.20	126	Contract
5	Turnip Seed	364.32	114.32	100.00	25	Contract
6	Sweet Corn	301.01	51.01	90.67	318	Contract
7	Wheat	191.65	(58.35)	7.40	1327	Max. Acres

[a] Land rent of $100/A and overhead of $150/A assumed. The amortized fixed cost of strawberry establishment ($370/A) is added back to contribution margin.

TABLE 30. STRAWBERRY ENTERPRISE RECORDS AND 1981 PROJECTIONS

Crop/Farm STRAWBERRIES FARM B

Farm/Crop		1979	1980	1981 Projections		
Acres		50	50	70		
				(LL)	(ML)	(HL)
Yield lbs/A		8947.00	10,165.00	8000	8500	10,000
Price $/lb				.28	.30	.32
Net Price $/lb[a/]				.16	.18	.20
Income $/A		2837.12	3585.33	1594.00		
Land Prep			.54			
Plant		324.47	357.35	(370) Amort.		
Weed Control		97.69	88.11	90.00		
Fertilizer		45. 1	37.75	40.00		
Pest Control		95.46	173.10	175.00		
Irrigate		112.28	102.84	102.00		
Harvest		1422.69	1754.95	425.00		
Market			5.75	10.00		
Total Direct $/A		2098.00	2519.12	1112.00		
Cont. Margin		739.12	1066.21	478.00		
Land Charge		90.00	90.00	100.00		
Allocated OH		795.12	1260.94	150.00		
Total Cost $/A		2983.12	3870.06	1362.00		
Profit/Loss		(146.00)	(284.73)	228.00		
Break Even Probab				99.44		

[a/] Price net variable picking cost per lb.

TABLE 31. CABBAGE SEED ENTERPRISE RECORDS AND 1981 PROJECTIONS

Crop/Farm: CABBAGE SEED FARM B

Farm/Crop		1979	1980	1981 Projection		
Acres		20.00	64.30			
				(LL)	(ML)	(HL)
Yield LBS/A		400.00	2064.40	1000	1200	1500
Price $/LB				.80	.80	.80
Income $/A		251.79	1548.30	986.67		
Land Prep		8.19	26.71	26.00		
Plant		13.05	37.01	37.00		
Weed Control		328.50	85.87	85.00		
Fertilizer		167.59	52.10	52.00		
Pest Control		78.87	17.31	20.00		
Irrigate		80.39	28.38	60.00		
Harvest		3.90	131.53	140.00		
Market						
Total Direct $/A		680.49	378.91	420.00		
Cont. Margin		428.70	1169.39	566.67		
Land Charge		90.00	90.00	100.00		
Allocated OH		275.70	226.86	150.00		
Total Cost $/A		1046.19	845.02	670.00		
Profit/Loss		(794.40)	703.28	316.67		
Break Even Prob,				100%		

TABLE 32. SUGAR BEET SEED ENTERPRISE RECORDS AND 1981 PROJECTIONS

Crop/Farm	SUGAR BEET SEED FARM B					
Farm/Crop		1979	1980	1981 Projection		
Acres		21.00	53.90			
				(LL)	(ML)	(HL)
Yield lbs/A		4673.62	2148.24	2300	2630	3000
Price $/lb				.38	.38	.38
Income $/A		1682.50	816.33	1004.45		
Land Prep		8.57	95.55	50.00		
Plant		10.87	8.95	10.00		
Weed Control		364.92	72.41	85.00		
Fertilizer		78.33	52.10	52.00		
Pest Control		98.23		15.00		
Irrigate		84.19	58.06	110.00		
Harvest		170.78	126.65	130.00		
Market		141.11				
Total Direct $/A		957.00	413.72	452.00		
Cont. Margin		725.50	402.61	552.45		
Land Charge		90.00	90.00	100.00		
Allocated OH		313.82	247.76	150.00		
Total Cost $/A		1360.82	751.48	702.00		
Profit/Loss		321.68	64.85	302.45		
Break Even Prob.				100%		

TABLE 33. BUSH BEAN ENTERPRISE RECORDS AND 1981 PROJECTIONS

Crop/Farm	BUSH BEANS FARM B			
Farm/Crop	1978	1979	1980	1981 Projection
Acres	135.00		180.00	
Yield T/A	4.14	4.57	5.20	(LL) 4.0 (ML) 4.75 (HL) 5.5
Price $/T				140 190 230
Income $/A	615.16	570.53	831.84	886.66
Land Prep	67.59	43.09	33.59	33.00
Plant	55.08	73.57	3.04	4.00
Weed Control	25.92	32.37	15.68	20.00
Fertilizer	98.10	111.10	37.57	80.00
Pest Control	6.63	58.17		20.00
Irrigate	80.81	84.21	121.63	120.00
Harvest	123.00	106.60	200.53	200.00
Market			32.67	
Total Direct $/A	457.13	509.11	444.71	477.00
Cont. Margin	158.03	61.42	387.13	409.66
Land Charge	90.00	90.00	90.00	100.00
Allocated OH	63.56	169.81	97.93	150.00
Total Cost $/A	610.69	768.92	632.64	727.00
Profit/Loss	4.47	(198.39)	109.20	159.66
Break Even Prob.				93.2%

TABLE 34. SWEET CORN ENTERPRISE RECORDS AND 1981 PROJECTIONS

Crop/Farm	SWEET CORN FARM B			
Farm/Crop	1978	1979	1980	1981 Projection
Acres	150.00	180.00	245.00	
Yield T/A	8.79 T	10.12 T	9.91 T	(LL) 8.5 (ML) 10 (HL) 12
Price $/T				60 60 60
Income $/A	512.28	627.89	601.63	610.00
Land Prep	65.98	12.96	16.66	20.00
Plant	29.13	31.03	4.23	4.00
Weed Control	21.43	12.50	19.77	20.00
Fertilizer	71.83	84.37	85.78	80.00
Pest Control	7.42	15.96	1.81	
Irrigate	48.49	84.72	109.58	100.00
Harvest	106.72	72.07	37.44	85.00
Market				
Total Direct $/A	351.00	313.61	275.27	309.00
Cont. Margin	161.28	314.28	324.73	301.01
Land Charge	90.00	90.00	90.00	100.00
Allocated OH	49.08	117.61	78.35	150.00
Total Cost $/A	490.08	521.22	443.62	559.00
Profit/Loss	22.20	106.67	156.38	51.01
Break Even Prob.				90.67%

TABLE 35. WHEAT ENTERPRISE RECORDS AND 1981 PROJECTIONS

Crop/Farm	WHEAT FARM B			
Farm/Crop	1978	1979	1980	1981 Projection
Acres	500.00	850.00	859.20	
Yield bu/A	34.15	107.50	87.14	(LL) (ML) (HL) 75 95 108
Price $/bu				3.50 4.25 4.80
Income $/A	126.70	451.52	383.41	387.63
Land Prep	15.85	18.78	31.03	25.00
Plant	61.51	15.27	8.70	13.00
Weed Control	.57	17.10	15.37	30.00
Fertilizer	26.00	46.92	53.98	66.00
Pest Control	1.35	1.17		
Irrigate				
Harvest	33.19	44.63	30.71	30.00
Market	11.90	14.28	6.11	32.00
Total Direct $/A	150.37	158.15	145.90	196.00
Cont. Margin	(23.67)	293.37	237.51	191.65
Land Charge	60.00	90.00	90.00	100.00
Allocated OH	36.76	95.40	81.88	150.00
Total Cost $/A	247.13	343.55	317.78	446.00
Profit/Loss	(120.43)	107.97	65.63	(58.35)
Break Even Prob.				7.4%

APPENDIX V

DATA FROM AGRI MANAGEMENT TECHNOLOGY FILES

The following tables of crop cost and profit figures are from the files of Agri Management Technology. These enterprise cost figures are compiled by Willamette Valley farmers using the AgRek Systems computerized enterprise cost accounting system under the supervision of farm management consultants. Although these records may contain some errors or omissions because most of the input is the responsibility of the farmer, they are some of the best actual cost accounting data available in this area. Some of the variance between years and between crops is due to accounting variances such as omission or variances in cost allocations. However, most of the variance is due to variations in cultural practices and resources used in production. Both sources of variance contribute to the uncertainty that needs to be associated with cost and profit estimates.

TABLE 36. VARIANCE OF WHEAT PRODUCTION COSTS AND PROFITS

	A	B	C	D	E	F	G	H	I	J	K	L	MEAN	ST DEV	%
				TOTAL PRODUCTION COST PER ACRE					TOTAL PRODUCTION COST PER ACRE						
1977				223.08	249.27	191.73	201.21			233.18	221.12	131.50	207.30	38.51	19
1978	247.13	217.24		146.67	190.79	262.66		187.96	207.82	290.81		146.46	210.84	49.54	23
1979	343.55	308.60	294.02	350.41	233.35	187.76	157.23	269.72		138.69	232.03	175.09	244.59	74.40	30
1980	265.85	341.81	332.79	271.32	256.63	223.86	217.58	379.57	429.35	327.55	206.30	200.30	287.99	73.79	26
Mean	285.51	289.22	313.41	247.87	232.51	216.50	192.01	279.08	318.59	247.56	219.82	163.34	238.69		
St. Dev.	51.13	64.51		85.48	29.46	34.76	31.21	96.15		82.32	12.91	30.57		72.42	
%	18	22		34	13	16	16	34		33	6	19			30
				PROFIT PER ACRE					PROFIT PER ACRE						
1977				43.30	(67.63)	89.47	107.69	(105.61)		150.62		138.68	50.93	100.80	198
1978	(120.43)	.95		(21.07)	(42.36)		172.55	(50.82)	(141.88)	290.81		36.35	13.79	138.48	1004
1979	(107.97)	121.33	90.55	1.44	184.40	88.00	25.94	(19.34)		166.70		137.82	68.89	92.32	134
1980	(70.23)	116.90	50.21	72.63	244.30	85.96	102.06	(58.59)	(149.35)		6.86		40.08	112.35	280
Mean	(99.54)	79.73	70.38	24.08	79.68	87.81	73.47	43.66	(145.62)	202.71		104.28	43.62		
St. Dev.	26.14	68.26		41.94	157.76	1.76				76.72		58.83		109.49	
%	26	86		174	198	2	72	75		38		56			251

TABLE 37. VARIANCE OF SWEET CORN PRODUCTION COST AND PROFIT

	A	B	C	D	E	F	G	MEAN	ST DEV	%
TOTAL PRODUCTION COSTS PER ACRE										
1977			318.87	368.84	373.04	340.33		350.27	25.48	7
1978	492.06	490.08	319.25	312.01	274.96	326.04		369.07	96.14	26
1979	423.63	521.22	358.72	292.75	393.28	431.44	559.12	429.70	88.89	21
1980	553.31	439.95	487.58			412.23	530.96	484.81	59.39	12
Mean	489.67	483.75	371.11	324.53	347.09	377.51	545.04	412.29		
St Dev	64.87	41.00	79.87	39.56	63.28	52.11			88.73	
%	13	8	22	12	18	14				21
PROFIT PER ACRE										
1977			94.18	104.16	42.21	128.27		92.21	36.27	39
1978	128.99	22.20	172.16	(18.70)	(.67)	36.83		56.80	76.32	134
1979	189.12	106.67	125.16	81.37	(50.04)	22.98	19.72	70.71	79.43	112
1980	61.19	156.38	256.31			73.15	61.80	121.77	85.04	70
Mean	126.43	95.08	161.95	55.61	(2.83)	65.31	40.76	82.43		
St Dev	64.00	67.84	70.60	65.36	46.16	47.00			73.31	
%	51	71	44	118	1631	72				89

TABLE 38. VARIANCE OF SUGAR BEET SEED PRODUCTION COST AND PROFIT

	A	B	C	D	E	F	G	MEAN	ST DEN	%
TOTAL PRODUCTION COSTS PER ACRE										
1977				758.69			990.97	874.83		
1978			706.77	551.00	580.45	741.57		644.95	93.95	14
1979	1360.82	768.40	623.30	382.61	504.83	635.89		712.64	343.29	48
1980	763.04	850.70	622.67	835.59		824.41	959.64	809.34	111.54	14
Mean	1061.93	809.55	650.91	631.97	542.64	733.96		747.85		
St Dev			48.37	205.15		94.49			218.18	
%			7	32		13				29
PROFIT PER ACRE										
1977				59.55				59.55		
1978			49.95	119.32	217.67	(93.57)	(86.01)	41.47	133.85	323
1979	321.46	(129.76)	202.90	821.23	(45.11)	48.47		203.20	344.21	169
1980	107.21	95.23	36.13	68.35		41.99	145.12	82.34	41.68	51
Mean	214.34	(17.27)	96.33	267.11	86.28	(1.04)	29.56	110.01		
St Dev			92.55	307.35		80.20			210.81	
%			96	115		77				192

TABLE 39. VARIANCE OF BUSH BEAN PRODUCTION COST AND PROFIT

	A	B	C	D	E	F	MEAN	ST DEV	%
TOTAL PRODUCTION COSTS PER ACRE									
1977				394.87	418.46	546.62	453.32	81.66	18
1978	610.69		619.34	534.18	485.84	467.32	543.47	69.79	13
1979	768.92	691.21	600.41	582.12	426.49	499.57	594.81	124.24	21
1980	628.14	929.46	736.18	667.56	506.91	560.64	671.48	149.67	22
Mean	669.25	810.34	651.64	544.68	459.68	518.54	583.75		
St Dev	86.76		77.82	114.10	43.65	42.99		131.41	
%	13		12	21	10	8			23
PROFIT PER ACRE									
1977				260.11	106.27	293.06	219.81	99.70	45
1978	4.47		(10.06)	52.75	(22.99)	171.79	39.19	79.47	203
1979	(198.39)	44.32	262.01	421.07	159.82	55.39	96.44	224.01	232
1980	199.20	36.75	23.33	539.70		95.51	178.90	213.28	119
Mean	1.76	40.54	91.76	318.41	81.03	153.94	131.27		
St Dev	198.81		148.38	210.94	93.98	104.56		171.30	
%	112.96		162	66	116	68			130