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by

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INTRODUCTION

Numerous factors have increased the importance for commercial grain farmers to explicitly include risk and uncertainty in their marketing and management plans. While yield risk has always been a factor in marketing, a combination of events affecting price and basis instability have accelerated the need for farmers to include risk explicitly in their plans. Price risk increased, for example, with changes in foreign and domestic demands for U.S. grains and oilseeds. Seasonal basis risk increased in the 1980s as storage capacity increased, and weather conditions and agricultural policies modified grain supplies, annually.

In times of predictably rising revenues and widening operating margins, which accurately characterized much of the latter half of the 1970s, market risk demanded less managerial attention than in more recent years. While gross farm revenues leveled off or even declined somewhat during the first half of the 1980s, and while many farmers were facing rising cash flow needs to service recently acquired debt with variable interest rates, financial stress became more pervasive in the farm sector than it had before. This created a situation for many producers that sharply elevated the costs associated with market risk, and for many, unmanaged risk became synonymous with financial failure.

Concurrent with the increased need for improved market risk management skills were three developments that may have made the implementation of risk management programs for individual cash grain producers feasible: (1) a working knowledge of viable grain marketing alternatives, (2) the widespread availability of microcomputers and the development of spreadsheet programs, and (3) the creation of public and private electronic databases. For over 20 years, economists have worked to improve the farmers' understanding of their marketing alternatives [Acker et al, Folker and Rhodes, Knutson et al.].[1] Relatively low cost microcomputers were introduced and adopted by marketing educators, analysts, and many farm operators. These provide the technology for creating sophisticated analytical models for assessing risks and comparative returns for various marketing strategies. The creation of public and private electronic databases allow farmers to access data in an efficient and timely manner.

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Objectives of Educational Program

The authors, in conjunction with colleagues, developed a marketing risk management extension education program for commercial grain producers in Ohio. The authors incorporated risk into the analysis to teach farmers how to identify and integrate marketing alternatives and agricultural policy into a plan that maximizes their probability of financial survival, given actual market conditions. This paper describes a conceptual model of risk and the risk management Lotus based microcomputer model, presents illustrative output for a hypothetical eastern Cornbelt grain farm, and through simulation examines the effects of futures price, basis and crop yield risk on the probability distribution for financial survival (probability that total revenue ≥ total variable cost plus cash flow obligations).

Conceptual Model of Risk

The risk model was designed to illustrate the impact of yield, futures price and basis variability on short and long run survival probabilities for three enterprises: corn, wheat and soybeans and for the commercial grain farm [Baldwin et al.,1986]. Means and standard deviations are calculated for crop yields and basis data. The statistical concepts were based on terminology suggested by Anderson and Ikerd (1985), i.e. the mean +/- one standard deviation were presented as the "expected", "optimistic" and "pessimistic" risk outcomes.[2] The expected outcome is the mean or the most likely outcome. Both optimistic or better than expected outcomes and pessimistic or worse than expected outcomes occur at the one sixth probability level.

Enterprise and Marketing Alternative Probabilities

Following the logic presented by Anderson and Ikerd, the mean gross return for each enterprise and for most marketing alternative is calculated by multiplying the expected cash price (expected futures price plus basis) times the yield. For the forward contract, commodity option or minimum price contract and the federal grain program marketing alternatives, the respective mean returns are calculated by multiplying the forward contract price times the yield, the strike price plus basis times the yield and the loan rate plus expected deficiency payment times the yield. The net mean return per acre was obtained by subtracting the average variable production and marketing cost from the gross return.

Joint yield, price and basis risk determine the variation in net returns, and the normal distribution is used to estimate the probability that total return is greater than total variable cost [Anderson and Ikerd]. Crop yield variance affects all marketing alternatives. The effects of futures price and basis variances change with the selection of the marketing alternatives. Delayed price (DP) contracts and future cash sales (CS) are subject to both futures price and basis risks, for example. At the other extreme, forward contracts (FC), eliminate both futures price and basis risks.

The expected crop yield for each enterprise is derived from the personal production records for each farm operation. To estimate the variation in yields, 1972-84 Ohio yield data were analyzed, the details of which are reported elsewhere [Lee and Djogo]. Based on this analysis, the coefficient of variation for the three crops approximated 0.2. Thus, it was assumed that crop yields would be within $\pm$ 20% of the expected yield in two out of the three years. This coefficient, which was entered into the Lotus model, could not be effectively modified by the inexperienced Lotus user.

The expected monthly basis for each enterprise is provided by the farm operator, and should be based on past marketing records. To estimate the variation in the basis data, weekly nearby futures data and cash price data for 10 Ohio markets were collected for the 1981-86 time period [Baldwin and Dayton]. A monthly mean and standard deviation were calculated across the ten locations for the six year time period.[3] For corn, basis varied about the mean by 1.5% in July to 4.9% in October. For wheat, basis varied by 1.6% in April to 4.9% in October. For soybeans, basis varied about the mean by 1.0% during the summer months to a high of 2.3% in October. These monthly data, which were entered into the Lotus program, were used as the expected variation in bases for all farmers. These data could not be easily modified by the inexperienced user.

Using today's reported closing prices from the futures market as expected prices for future time periods is based on prior research [Just and Rausser, and Martin]. Log normal futures price distributions are from Anderson and Ikerd. For corn and wheat, discovered futures prices one month into the future are estimated to vary by 10% from expected futures prices. After 12 months into the future, discover futures prices vary from current expected futures prices by 19%. For soybeans, discovered futures prices one and twelve months into the future vary by 10% and 30%, respectively from current expected futures prices. These data were entered into the database, were used as the expected variation in futures prices for all farmers, and could not be effectively modified by inexperienced Lotus users.

Financial Survival Probabilities:

Short-term and long-run survival for the farm is based on the joint expected, optimist and pessimistic net returns for the respective optimum (largest net expected mean return) marketing alternative for the three enterprises. Subtracting short-term and long-run cash flow obligations from the optimistic, pessimistic and expected net returns generates net farm revenue. Using the normal distribution, the probability that the firm will survive in both the short term and the long run is determine (Probability that total revenue is greater than total variable costs plus cash flow obligations).

Risk Management Microcomputer Model

The marketing risk management simulator uses Lotus 1-2-3 software, and runs on an IBM compatible microcomputer which has a MS-DOS operating system and 256 K of RAM memory. The menu driven simulator is comprised of four integrated parts, three enterprise models (corn, soybeans and wheat) and a farm risk model.

The user selects the optimum marketing alternative, elevator and time period for selling grain by examining net expected returns (total per acre revenue minus total variable production and marketing costs). Then, the model sums the expected, optimistic and pessimistic net return for the optimum marketing alternative for each enterprise as input to determine the short-term and long-run expected, optimistic and pessimistic net farm revenue.

Input Screens for One Enterprise

Data are entered by the farmer into elevator, futures and producer input screens (Figure 1). For each elevator, forward contract (FC), minimum price variable basis (MPVB), minimum price fixed basis (MPFB), basis contract (BC), delayed price contract (DP), cash sales (CS) and historic basis (HB) data are collected and are entered via the input screens. For the futures market, futures price (FP) data and commodity option (CO) data are entered.

Each farmer enters total planted acres for the enterprise, average variable cost ($/Bu.) and maintenance on set-aside land ($/planted acre) into the variable cost input screen. To complete the producer input screen, the farmer enters storage cost, annual interest rates, expected yield, selects one of four elevators and enters the corresponding transtation cost, selects two futures contracts to identify the time period for selling grain, forecasts harvest or selling price and related basis, and enters his name as an identifier.

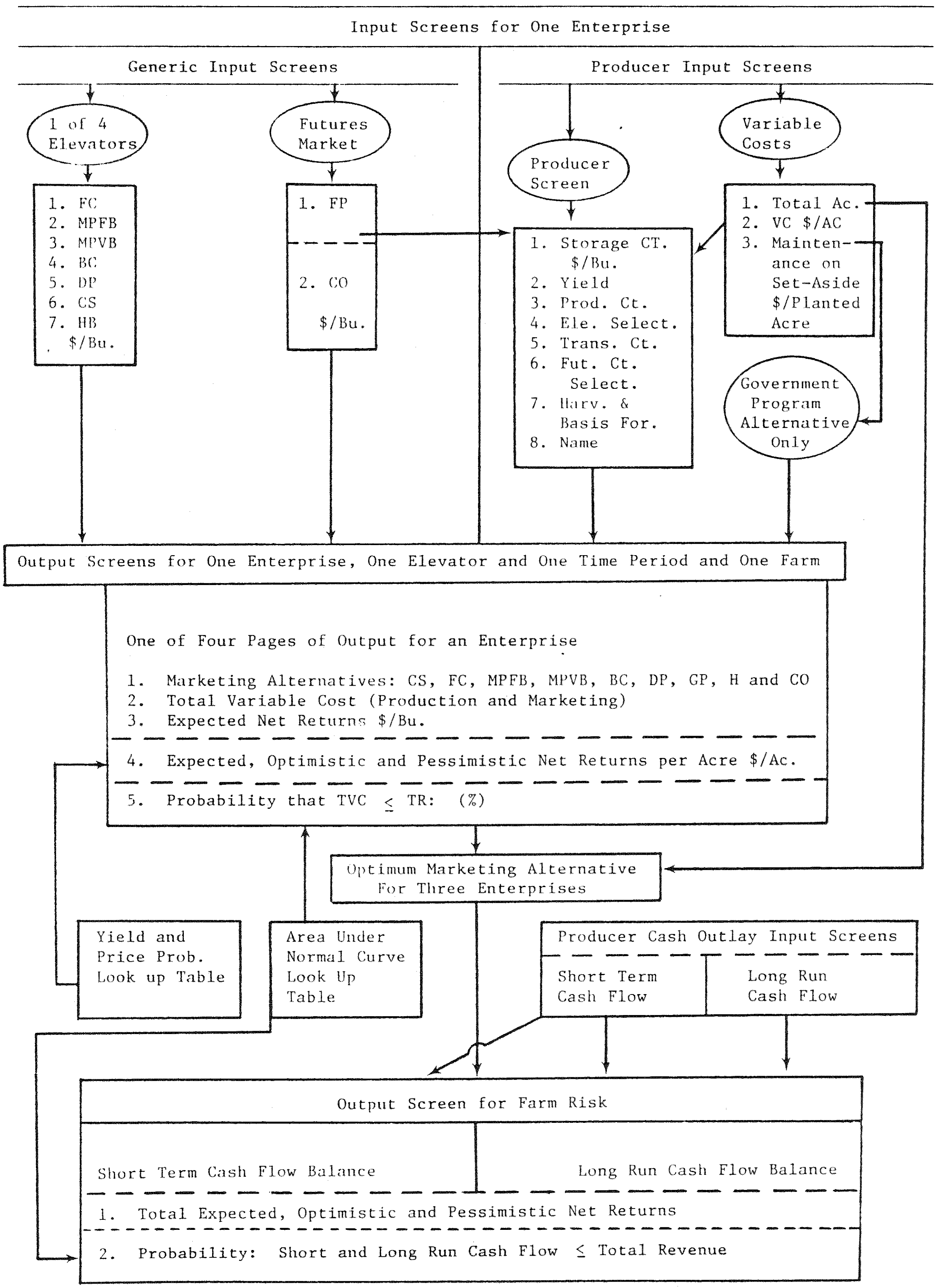
Output for Enterprise Models

For each enterprise, four pages of output are generated for the ten marketing alternatives; expected, optimistic and pessimistic net returns are determined for CS, FC, MPFB or MPVB, BC, DP, CO, government program (GP) without repayment of loan, and government program with loan repayment and market sale (Figure 1). Using the distribution of a normal curve, the probability that total revenue is greater than or equal to total variable cost for each marketing alternative is estimated within the model.

Producer Input and Farm Risk Output Screens

To complete the farm firm analysis, the producer must complete two parts of an additional producer cash outlay input screen. One part includes short-term cash obligations including family living and capital loan payments. The second includes long-run cash obligations including capital replacement long term debt payments and financial growth objectives (Figure 1). Total expected, optimistic and pessimistic net revenues for the short-term and long-run are determined. The probability that total revenue is greater than or equal to total variable costs plus the cash flow is determined for both the short-tern and long-run time periods based on the area under the normal curve.

Figure 1: Flow Diagram of Risk Management Marketing Simulator for One of Three Enterprises (Corn, Wheat or Soybeans), One Elevator and One Time Period, and For Farm Risk



Data for a Hypothetical Eastern Cornbelt Farm

The following example identifies input and output data for the simulator. Since all data are hypothetical, the results do not represent the optimum outcome for a specific grain farmer. Instead the data are used to illustrate the important relationships that the simulator can analyze. One important strength of the model is that it can be run repeatedly to incorporate changes in data, economic conditions and policies for an individual farmer or groups of farmers.

Given the hypothetical example, it is assumed that the federal corn loan rate and the deficiency payment for 1988 are estimated at $1.77 and $1.16, respectively. The wheat loan rate is estimated to equal $2.21 with a corresponding deficient payment of $1.53. Variable cost of production for corn equals $139.00/acre or $1.16/bushel [Ohio Crop Enterprise Budgets]. The corresponding variable cost for soybeans equals $108.00/acre or $2.70/bushel, while the variable cost for wheat equals $96.00/acre or $1.60/bushel. It is assumed that for a 1500 acre grain farm, fixed short-term cash obligations equal $212,200, and long-run cash obligations equal an additional $22,500 for a total long-run obligation of $234,700 [Hoorman and Duvick].

For comparative purposes, it is assumed that the farmer producers 500 acres each of corn, wheat and soybeans and is using the model to determine the effects of the feed and food grain programs on short-term and long-run survival probabilities.[4] A partial list of costs, prices, etc. associated with this hypothetical farm are reported in Table 1. Variances for crop yield risk, basis and futures price risk are equal to the coefficients reported in the Enterprise and Marketing Alternative Probabilities section of this paper.

Partial Solution for the Hypothetical Farm:
Non-Participation in Government Grain Programs

The optimum marketing alternative for corn is the March 1989 basis contract (Table 1). By storing corn for nearly five months, the expected net return is $66/acre. Net returns will range between $66 and $127/acre 66 percent of the time, or one standard deviation around the expected return. The probability that total return (TR) is greater that total variable costs (TVC) equals 86 percent.

For soybeans, the optimum marketing alternative is also the March 1989 basis contract. Since the expected net return is nearly $100/acre ($34 more than expected returns for corn), the farmer, who is not participating in the government feed grain program, should consider planting more soybeans and less corn.

For wheat, the optimum marketing alternative is a July 1988 basis contract (Table 1). Therefore, wheat would be sold at harvest time. In this example, the expected net return for wheat is $69/acre. The expected net returns for corn and wheat are nearly equal for this hypothetical example. Since the net return for soybeans are higher than for wheat, the farmer should have planted less wheat in the fall and more soybeans this spring.

Table 1: Selected Input and Output Data for a Hypothetical Cash Grain Farm, A Case Study for the Eastern Cornbelt

Selected Input and Output Data for These Enterprises

	CORN				SOYBEANS				WHEAT			
	INPUT		OUTPUT		INPUT		OUTPUT		INPUT		OUTPUT	
Time Periods	Harv.	Mar.			Harv.	Mar.			Harv.	July		
Government	88	89	Non		88	89	Non		88	88	Non	
Program Decision			Partic	Partic.			Partic.	Partic.			Partic.	Partic.
TVC $/Bu.												
Non Gov't Partic.	1.16	1.16			2.70	2.70			1.60	1.60		
Gov't Participation	1.21	1.21			2.70	2.70			1.71	1.71		
Prices $/Bu.												
Cash Price	1.75	1.84			5.30	5.38			2.90	2.90		
Forward Contract	1.70	1.75			5.05	5.25			2.85	2.85		
Futures	1.74	1 84			5.25	5 38			2.80	2.80		
Basis Contract Bases	-0.07	-0.02			-0.18	-0.04			-0.05	-0.05		
Delayed Price Charges	0.00	0.00			0.21	0.30			0.11	0.11		
Historic Basis	-0.11	-0.02			-0.25	-0.15			-0.06	-0.06		
Mktg. Alternative			BC	GP			BC	BC			BC	BC + GP
Time Period			Mar. 89	July 89			Nov. 88	Jan. 88			July 88	July 88
Price$/Bu.			1.84	2.93			5.38	5.38			2.90	4.92
Net Ret. $/Bu.			0.55	1.99			2.50	2.50			1.14	3.16
Net Ret. $/Ac.												
Optimistic			126.69	308.52			168.86	168.86			110.03	260.14
Expected			65.78	238.20			99.96	99.96			68.53	189.73
Pessimistic			4.87	167.88			31.07	31.07			27.02	119.31
Prob. TV>TVC(%)			86	100			93	93			96	100

Selected Output Data for the Hypothetical Farm Firm

	SHORT TERM		LONG TERM	
Cash Flow Requirements	$212,200		$234,700	
Government Program Decision	Partic.	Non Partic.	Partic.	Non Partic.
Net Returns ($000)				
Optimistic	$160,908	$69,992	$138,408	$47,492
Expected	51,744	-34,457	29,244	-56,957
Pessimistic	-57,419	-138,915	-79,919	-161,415
Prob. TR>TVC+CF (%)	68	37	51	29

The probability that this hypothetical farm firm will break even or will have positive net revenue in the short-term equals 37% (Table 1). The expected net return is -$34,457. For the long-run, the probability that this firm will survive declines to 29%. To survive, this hypothetical grain farmer must reduce costs by refinancing and/or consolidating debt and by reducing family living expenses. Alternatively, additional farm income from outside sources should be sought.

Partial Solution for Hypothetical Farm: Participation in Government Programs

In contrast to the above scenario, the farmer participates in the corn program by storing and forfeiting the corn to the CCC. The minimum expected net return is $238/acre. The farmer also participates in the wheat program; however, wheat is sold at harvest time via a basis contract. A loan is not secured or a "quick PIK" position is taken.[5] A PIK transaction could increase the net return over that shown in Table 1. Since the expected basis contract price is greater than the soybean loan rate, the farmer elects to not participate in the soybean program (Table 1). Instead, soybeans are stored through March 1989, and are sold via the basis contract. The expected return for soybeans equals $100/acre. The farmer, who is participating in the government feed and food programs, should plant more corn and wheat and less soybeans.

Although set-aside requirements must be met to participate in the feed and food grain programs, the expected farm revenue for this grain farmer increases relative to those non-government participants (Table 1). There is a 68% chance that this hypothetical farm will survive in the short-term and a more than 50% chance for survival in the long-run. The outcome for a specific farm depends upon the historic corn and wheat base.

It also appears that the feed and food grain programs may distort the production mix. Without the programs, the market signals suggest farmers should produce more soybeans and less corn and wheat. Completely opposite signals appear when the farm program is in effect. This is part of the "perversity problem" in U.S. farm policy [Henderson, 1988].

Effects of Crop Yield, Futures Price and Basis Variances on Marketing Alternative and Cash Flow Probabilities

The prior two scenarios or base solutions are predicated on a coefficient of variation for crop yields, and on monthly futures and basis variances. An important question is, "what effect will changes in these variances have on the volatility of net farm revenue (probability TR > (TVC + CF))?" Based on the formulas derived from Anderson and Ikerd, a change in variance for one of the risk factors will not affect the expected revenue but will modify the optimistic and pessimistic returns, the volatility about the mean.

For the base solutions, crop yield and futures price variances are modified separately to examine the individual effect of each on the volatility of net farm revenue (Table 2). Since basis risk is eliminated by participating in the government feed and food grain programs and by selling grain via basis contracts, the effects of a change in basis risk

Table 2: Changing Crop Yield, Futures Price and Basis Variances and Cash Flow Volatilities for Base Models and Cash Sales Model

Base Model Results

	Government Participant		Non-Government Participant	
	Short Term	Long Run	Short Term	Long Run
	- - - Percent - - -		- - - Percent - - -	
Risks Factors				
Yield				
.05	79	68	32	22
.2 (Base)	68	51	37	29
.5	59	55	43	39
Futures Price				
50%	71	62	34	25
100% (Base)	68	61	37	29
200%	63	58	42	36

Cash Grain Marketing Alternative Results[1]

	Short Term	Long Run
	- Percent -	- Percent -
Risks Factors		
Yield		
.05	73	59
.2 (Base)	67	56
.5	59	53
Futures Price		
50%	70	57
100% (Base)	67	56
200%	61	54
Basis		
0%	67	56
100% (Base)	67	56
500%	63	55

[1] Expected net returns [TR-(TVC_S+CP)] are approximately equal to net return for base model.

could not be examined for either solution. The latter is achieved by creating a third solution where the farmer merchandises all grains via cash sale contracts.

Marketing Via Grain Programs
and Basis Contracts (Base Solutions)

Decreasing the crop yield variation coefficient from .2 to .05 (a 75% decrease) for the farm that participates in the government program, increases both the short-term and long-run survival probabilities by 11 and 17 percentage points, respectively (Table 2). This relationship exists because the net expected return is positive ($51,744), and the volatility about the expected revenue is reduced from $218,000 to $124,000. Since the magnitude of the potential pessimistic return is reduced, the probability that this firm will survive increases. Not surprisingly, increasing the crop yield variation coefficient from .2 to .5 decreases the probability that this firm will survive.

Increasing and decreasing the monthly futures price variances also effects the survival probabilities for the farm that is participating in the government program. However, the price variance effect is less than the corresponding yield effect because the farmer is participating in the corn program, and the wheat program establishes a price floor. Selling wheat in July and soybeans in March via basis contracts also minimizes the price effect as price variance increases as the crop year unfolds [Anderson and Ikerd]. That is, price variance is greater 12 months into the future than for one month (July wheat basis contract sale) or four months (March soybean basis contract sale) into the future.

In contrast for the non-government program participant, decreasing yield or price variances decrease both the short-term and long-run survival probabilities (Table 2). This relationship exists because the expected net revenue is negative (-$34,457). Decreasing the yield or price variances reduces the volatility about the expected mean, the magnitude of the potential optimistic return, and thus the probability that the firm will survive. A firm that has a negative expected return and little opportunity to reduce costs and/or cash flow obligations improves its changes for survival by selecting more risky marketing or management activities. This phenomena was also observed for horticultural crops [Rhodus].

Marketing Via Cash Grain Sales
Comparison of Risk Factors

To rank the effects of changes in crop yield, futures price and basis risks on survival probabilities, it was assumed that the farmer sold all grains via cash sales. An expected net farm return of $34,900 approximates the net return for participants in the government program base model. A positive net farm return accrues to the cash sale marketing alternative as short-term cash flow obligations are unrealistically decreased. Therefore, as the variance in one of the risk factors increase, the probability that the firm will survive decreases.

The expected relationship between an increase in the variance and a decrease in survival probabilities hold for all three risk factors (Table 2). Increasing the yield and price risk by 250 % (increasing coefficient of variation for yield from .2 to .5, and increasing the price variance from 50% of the base to 200%), causes a 7 to 8 percentage point decrease in the short-term survival probabilities and a 2 to 3 percentage point decrease in long-run probabilities. Although these two risk factors have similar effect on survival probabilities, recognize that the price risk effect increases throughout the crop year. Thus, prices cause more volatility in expected returns when grain is sold at the end of the crop year rather than at harvest.

Changes in basis variance, in contrast, have only a marginal effect on the probability that the firm will survive (Table 2). This ranking for basis is expected and is consistent with basis theory and other empirical findings.

Conclusions and Implications

The above findings are for a hypothetical farm and do not represent the outcome for a specific Eastern Cornbelt farm. The model should be run for an individual farm before making any specific production or marketing decisions. Field personnel and individual farmers in Ohio are currently using the Lotus model to make integrated management marketing financial decisions. The conceptual risk model is readily accepted, and is meaningful for the user.

For this hypothetical example, the question "should I participate in the feed and food grain programs" is answered with a resounding "Yes". Livestock farmers, who do not have an historic corn and/or wheat base should further evaluate whether a base should be established. This would require analyses that are beyond the capability of this model. Such analyses should examine the cost effects for using PIK certificates to purchase feed grain and would require some forecast for the direction of agricultural policy after 1990.

The results from this model suggest that agricultural policy is distorting price signals and thus the allocation of resources for this eastern Cornbelt farm. In the absence of agricultural policy, more resources are allocated to the production of soybeans and less are allocated to corn. This paradox has in part caused an increase in corn inventories and some disequilibrium in the corn market. Policy makers should be cognizant of this fact as they draft policy for the 1990s.

Changing crop yield, futures price and basis variances influence financial survival probabilities for the farm firm. For a firm that has positive (negative) net expected returns, a decrease in yield, price or basis variance increases (decreases) the probability of survival. Thus, well-managed farms or those that have relatively low cash flow obligations should be making marketing and production decisions that reduce net revenue volatility. In contrast, those that have negative expected returns, and cannot effectively reduce their debt load or family and operating expenses, should be making decisions that increase net revenue volatility.

This analysis suggests that the farmer can not significantly affect net revenue volatility through basis risk. Except for the selection of marketing alternatives, the effects of price risk on the volatility of net revenues are also beyond the control of the farmer. Since a farmer can influence production on his specific farm, there may be some opportunity to alter the volatility of net revenue by making management decision that affect yield risks. Thus, production scientist should examine practices that affect both mean production levels and yield variability.

Footnotes

1 Thousands of farm operators have participated in marketing education-programs sponsored by extension services, marketing organizations and private companies.

2 Anderson and Ikerd assumed that futures prices can be analyzed in terms of a log normal distributions. Authors are debating this point [Hall et al., Brenner, or Doukas et al.].

3 All data were acquired from an existing database that is maintained at The Ohio State University [Baldwin and Dayton].

4 In recent years, farm operators have produced more corn and soybeans than wheat. In Ohio, it is not unusual for a farmer to produce 750 acres of corn, 550 acres of beans and 200 acres of wheat.

5 This model does not analyze the effects of the PIK marketing alternatives.

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