WHOLE FARM RISK-RATING MICROCOMPUTER MODEL

Kim B. Anderson and John E. Ikerd

Abstract

The Risk-Rating Model is designed to give extension specialists, teachers, and producers a method to analyze production, marketing, and financial risks. These risks may be analyzed either individually or simultaneously. The risk associated with each enterprise, for all combinations of enterprises, and for any combination of marketing strategies is estimated. Optimistic, expected, and pessimistic returns above variable cost and/or total cost are presented in the results. The probability that total return will be equal to or greater than variable cost and/or total cost is also estimated.

Key words: risk, production, marketing, finance, enterprise, whole-farm analysis.

Risks associated with an enterprise, combinations of enterprises, and combinations of marketing strategies are treated by a Risk-Rating Model. Optimistic, expected, and pessimistic returns above variable cost and/or total cost are presented in the results. The probability that the total return will be equal to or greater than variable cost and/or total cost is also estimated. The model also facilitates the comparison of the outcomes from alternate production, marketing, and financial decisions.

THEORETICAL FOUNDATION

Each situation is described, and results are presented in risk rated terms. These terms are optimistic, expected, and pessimistic (Ikerd and Anderson, 1983). Better-than-expected outcomes are titled optimistic. An optimistic rating may be assigned to a favorable outcome at the one-sixth probability level. Thus, one time out of six the actual yield, price, or net return will be higher than the optimistic estimate. In a normal distribution, the optimistic value is the mean plus one standard deviation.

An expected rating may be assigned to the most likely outcome. There is a 50 percent probability that the outcome will be less than the expected value, and there is a 50 percent probability that the outcome will be greater than the expected value.

Worse-than-expected outcomes are labeled pessimistic. A pessimistic rating may be assigned to an unfavorable outcome at the one-sixth probability level. Thus, one time out of six the actual yield, price, or net return will be less than the pessimistic estimate. The pessimistic value is the mean minus one standard deviation.

The assumption that the expected net return is distributed normally facilitates combining the expected total returns for a marketing strategy containing cash sales, hedging, forward contracts, and/or basis contracts and interpreting the results as optimistic, expected, and pessimistic. Assuming that yields and net returns are normally distributed simplifies the calculation process. The optimistic, expected and pessimistic values are used to calculate the means and standard deviations for the prices and yields.

Prices are assumed to have a log normal distribution.[1] The mean return is calculated by multiplying expected price times expected yield. The variance of the product of a log normal and a normal distribution can be calculated using the following equation

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Microcomputer software articles are approved by the SAEA microcomputer software committee and the *SJAE* editorial council, as per Executive Committee action February 5, 1984.

This model was developed by the Southern Extension Joint Farm Management and Marketing Risk Task Force. Partial funding was provided by the Farm Foundation.

[1]A review of the literature indicated no fundamental justification for selecting a distribution for expected price. The log-normal distribution was recommended by Dr. Richard Anderson, statistician and author. The normal distribution could have been used.

(Anderson et al., pp. 32-38):[2]

$$(1)\quad Vpy = (Up)^2 \times ((Vy) + (Uy^2 \times Vp) \times 2COVpy),$$

where:

Vpy = variance of log price times yield = return variance,
Up = mean price,
Vp = variance of log price,
Vy = variance of yield, and
Uy = mean yield.

The mean and variance for the sum of normal distributions are calculated using the following equations:

$$(2)\quad Ur = \Sigma Uri,$$

where:

Ur = expected return
Uri = return from decision i.

$$(3)\quad Vr = \Sigma Vi + 2(\Sigma\Sigma COVij),\ i \neq j,$$

where:

Vr = variance of joint returns,
Vi = variance from decision i,
COVij = covariance of decisions i and j, $i \neq j$.

DATA REQUIREMENTS

Data for five crop and one each of cow-calf, stocker, feeder, dairy, farrow-feeder hog, feeder-finish hog, and farrow-finish hog enterprises are permanently stored on disk. In addition, temporary data from the last run are stored. At the beginning of each analysis, the user may permanently change the default values. During the run, the user may temporarily change any value. An example data input screen for a wheat enterprise is presented in Table 1.

Users are required to estimate optimistic, expected, and pessimistic prices and yields.[3] Prices must be estimated for cash prices, and if alternate selling methods are used, the basis and the forward contract price must be estimated. The futures price includes the futures contract price; the optimistic, expected, and pessimistic bases; and the contract cost. If a basis contract is used, the expected basis is required as well as the optimistic, expected, and pessimistic contract price. The user may specify one or a combination including any or all selling options for each commodity.

Yields are estimated as optimistic, expected, and pessimistic for crops. With livestock, the standard deviation of yield is calculated based on optimistic, expected, and pessimistic estimates of average daily gain and death loss. Variable cost is assumed to be constant for crops but is variable for livestock.

Itemized production cost per unit must be entered. The interest cost for an operating loan is calculated from a specified percent of operating capital that is borrowed and an interest rate. Fixed cash costs may be entered. Fixed costs are totaled and included in the

TABLE 1. WHEAT ENTERPRISE DATA FILE EXAMPLE, RISK-RATING MICROCOMPUTER MODEL

Crop risk section		Date: April 11, 1983	
Number of acres	80.00	Expected yield/acre	32.00
Percent crop hedged	50.00	Optimistic yield (1 in 6)	40.00
Hedge price	4.05	Pessimistic (1 in 6)	24.00
Expected basis	−0.25	Dollar of nitrogen/acre	18.00
Pessimistic (1 in 6)	−0.35	Dollar of mixed fertilizer/acre	10.00
Optimistic (1 in 6)	−0.10	Dollar of lime/acre	0.00
Hedge cost	0.04	Dollar of seed or plants/acre	6.00
Percent crop sold by basis contract	0.00	Dollar of chemical/acre	5.00
Expected contract price	3.60	Dollar of fuel and oil/acre	15.00
Optimistic (1 in 6)	3.90	Dollar repairs/acre	5.00
Pessimistic (1 in 6)	3.30	Dollar of marketing and harvesting/acre	22.00
Percent crop forward contracted	0.00	Percent operating capital borrowed	80.00
Contract price	3.50	Interest rate	15.00
Average price/unit	3.80	Fixed cash cost	0.00
Optimistic (1 in 6)	4.10	Relationship: yield-price	−0.25
Pessimistic (1 in 6)	3.50	: cash price-basis	0.00
Enter, arrows, tab moves cursor (>)		F1 accepts data	F2 prints screen

[2]Equation (1) is a transformation of the equation presented in Anderson et al.

[3]Symmetric estimates are not required. The model determines and uses the average difference between the optimistic and expected values and the pessimistic and expected values.

whole farm section.

The correlation between price and yield and the cash price and the basis may be accounted for by entering a number between −1 and 1. If the correlation is not known, a zero may be entered.

Enterprise Results

Results for an enterprise include the expected total return, expected variable cost, fixed cost, optimistic, expected, and pessimistic net returns above variable cost, and the probability that total returns will be greater than or equal to variable cost. The probabilities are calculated by using the properties of the normal distribution. An example of a results screen is presented in Table 2.

TABLE 2. RESULT SCREEN FOR WHEAT 1, RISK-RATING MICROCOMPUTER MODEL

Crop risk section		Date: April 11, 1983	
Results for: Wheat 1		Total	Per acre
The expected total returns are		9,344	117
The expected variable costs are.....		7,250	91
The expected fixed cash costs are ..		80	1
Returns above variable cost			
Optimistic =	9,344		
Expected =	2,086		
Pessimistic =	−5,791		
The probability of total returns being >= variable cost is 60 percent			
Press → SPACE BAR next activity	F1 to redo this one		
F2 print screen	ESC to combine activities		

If more than one crop or livestock enterprise is included in the analysis, the user has the option to combine the net returns. The correlation between individual enterprise net returns must be entered. If there is no correlation or if the correlation is not known, a zero may be entered. The combined results are displayed in the same format as a single enterprise.

WHOLE FARM ANALYSIS

The user is asked to enter: (a) total fixed cost, (b) dollar value of all assets, (c) dollar value of whole farm debt, and (d) percent required return to equity. The total fixed cost may be the annual fixed loan payments or a value that includes both cash and non-cash fixed costs.

The dollar value of all assets and of whole-farm debt is used to calculate equity. This value is used to determine the probability of obtaining the specified percent return to equity. Users must provide estimates of the correlation between enterprises.

The results in the Whole Farm section include the expected total return, the expected total variable cost and the expected fixed cost. The whole-farm analysis includes a section to analyze the risk impact of additional loans. Whole-farm results include optimistic, expected, and pessimistic returns above variable cost and also above total cost. The probability that total returns will be greater than or equal to variable and total costs is also estimated.

IMPLICATIONS FOR EXTENSION, TEACHING AND PRODUCER USES

To analyze each type of risk individually or all risks simultaneously, producers need to understand relatively complex relationships. For example, they must be capable of estimating yield risk, price risk, and interest rate variability. The relationships between price and yield, and between enterprises or activities must also be understood and estimated. This is taught by using the model to concentrate on production, marketing, or financial risks.

The model may be used to teach users to identify data requirements to make risk management decisions. Yield and price outlook accuracy estimates are presented as guidelines. Users are taught that data may be obtained from many levels of sophistication. Producers may use data from farm records to make risk-rated estimates. Even estimates based on a producer's memory may be used. The quality of data is probably less important than teaching the procedure, and results using "best guesses" are better than what has been previously used.

PRODUCTION RISK

Production risk is the probability of low yields or of high cost per unit of production. The risk model has been used to teach farmers or students to predict yields or cost per unit of production as optimistic, expected, and pessimistic rather than predicting just an average yield or cost per unit of production.

After risk has been identified, approaches to reduce production risk have been taught. Risk-reducing production methods have been

taught by using traditional budgeting cost and return methods or by increasing the variable cost in the risk-rating model. Analyses have also been used that show the risk impact of complementary and competitive enterprises.

MARKET RISK

Producers tend to understand production risk and the impact of low yields on net returns. But, marketing risk appears to be different. Producers are shown the results of studies that estimate the accuracy of price predictions. The risk-rating model is then used to demonstrate the potential effect on net return of various marketing strategies and how these decisions fit into whole-farm risk situations.

The effect of risk-reducing strategies is demonstrated by presenting the results as optimistic, expected, and pessimistic returns. For example, to reduce risk, the potential for a large return is usually sacrificed to reduce the probability of a potentially large loss. However, if risk is managed, it is possible to increase production while reducing risk, thus increasing expected returns without increasing risk.

FINANCIAL RISK

Financial risk occurs at two levels: (1) individual enterprise level in the form of an operating loan, and (2) intermediate and long-term loans. Operating loans are included in the partial budget for each enterprise. The user may manipulate both the interest rate and the percentage of operating capital borrowed. Intermediate and long-term debt commitments may be included at the enterprise or whole-farm levels.

The risk-rating model demonstrates how different levels of debt and interest rates affect net return. Once producers understand the impact of debt on returns, they may be taught the importance of reducing or managing debt. The value of records may also be taught.

Combining the returns into a whole-farm net return facilitates teaching the relationships between production, marketing, and financial risks. Moreover, the relationships (competitive or complementary) between enterprises are presented in a manner that producers can understand. Also, producers seem more willing to accept the benefit of production, marketing, and financial strategies if the results are summarized by a few interpretable numbers.

FIELD TESTING

The model has been successfully used to teach risk management and the impact of production, marketing, and finance decisions on net return. The situations included classroom teaching, producer seminars, and paraprofessional workshops. Area extension specialists and county extension agricultural agents in Connecticut, Kansas, Mississippi, Missouri, Oklahoma, and Virginia are using the Whole Farm Risk-Rating Model in educational programs. Professionals and paraprofessionals have been taught to use the model to help answer producers' questions and solve production, marketing, and financially related problems. Producers use the model to assist them in making decisions involving risk. Producers and other users have not had problems using the risk model or the risk-rated management approach.

Producers attending the risk-rating workshops were asked to estimate the probability that the risk-rated approach would help them understand the nature of the decisions they face in agriculture (Ikerd and Anderson, 1984). Results indicated an average probability of 77 percent that this approach would help them make better decisions. Producers indicated an average probability of 80 percent that they would use risk-ratings in making decisions.

The evaluation from county agent in-service training produced a rating of 80 percent that they would use the risk-rated approach to decisionmaking and the whole farm computer program. County agents and producers both responded that the model helped to identify the types of information that are needed to make more efficient decisions.

HARDWARE AND SOFTWARE REQUIREMENTS

This model is programmed and a users manual is available for TRS 80 Model II, Model 12, or Model 16 (Anderson and Ikerd). The model is also programmed for the Apple IIe (configured with 64K and Microsoft CP/M) and computers using MS/DOS. The program is free to all land-grant universities.

There is a $50 charge for producers. The model may be obtained by writing the authors (land-grant universities must supply a formated disk).

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