A METHOD OF INCORPORATING RISK MANAGEMENT INTO EXTENSION PROGRAMS

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Recent agricultural price variability has produced renewed interest in consideration of risk in extension farm management programs (Walker and Nelson, 1977, 1980). Three, not necessarily mutually exclusive, categories of risk analysis can be delineated in farm management research and extension. The oldest category is the estimation of objective measures of risk for different enterprises and consideration of their implications for diversification (Heady; Carter and Dean) which has recently received renewed attention (Yahua and Adams; Mathia; Walker and Lin; Wible and Saunders). The second category, Markowitz's portfolio analysis, estimates optimal combination of enterprises in reference to tradeoffs in risk and returns (Freund; Hazell; Brink and McCarl). A final category concerns applications of statistical decision theory (Eidman, Dean and Carter; Halter and Dean; Officer, Halter and Dillion) and appears to be advocated in recent considerations of extension programs on risk (Holt and Anderson; Walker and Nelson).

All of these traditional categories have weaknesses for extension applications. The objective risk measurement approach requires an assumption that historical risk measures are appropriate for current individual decisions, which is untenable for modern decision theorists (Anderson, Dillion and Hardaker), and uses risk measures that are not intuitively obvious. The portfolio analysis approach is subject to the same criticisms; however, the confidence interval approach (Scott and Baker; Kliebenstein and Scott) does present the results of portfolio analysis in a more intuitive manner. However, this approach is inconsistent with many extension enterprise programs which emphasize enterprise budgets rather than optimal enterprise combinations. Finally, the statistical decision theory approach usually involves presentation of much detail concerning each alternative and requires an understanding and/or program development of probability theory which is beyond the time allocation available for consideration of risk in many extension programs.

The objective of this paper is to present a method used to incorporate risk considerations into a farm management extension program for which risk is a small component of the overall program. This method includes elements of the three traditional categories identified above: (1) objective, historical risk measures are utilized, (2) the confidence interval approach to risk in portfolio analysis is adapted, and (3) the risk analysis is confined to the narrow concern of enterprise returns. The method is illustrated with data for crop enterprises in Minnesota which were utilized in a recent extension program entitled, "What to Grow in 1980."

Methodological Background

Estimates of profit from various alternatives are presented in many farm management research and extension programs. If variables used to derive these estimates are stochastic, the profit estimates can be considered an estimate of expected profits (E_i). Following Barry and Robison, a lower confidence limit on profits (L_i) can be estimated:

(1) $$L_i = E_i - K\sigma_i$$

where σ_i = standard deviation of profits for alternative i, and K = a constant which measures the probability that E_i is greater than L_i. Assuming the appropriate probability distribution for the profits of the alternative i, K can be chosen to represent any level of desired probability. The usual assumption is that the profits are normally distributed in order to simplify calculations.

Addition of risk estimates based on equation (1) to reports which contain E_i requires specification of values K and σ_i. Scott and Baker utilized values of K associated with 84 percent and 97.5 percent lower confidence limits. Such values are related to standard statistical considerations but, unfortunately, are not readily amenable to intuitive interpretation. If tabled probability distributions are utilized, more intuitive values of K can be utilized. If a payout matrix is desired, multiple levels of K can be selected and used for probability calculations.

Either subjective or objective methods can be used to estimate σ_i. Subjective methods have advantages because economic stochastic events are probably not repeatable and extension program participants are involved in the probability estimation. However, the subjective methods also have methodological and application weaknesses. The time required to elicit probability estimates from extension participants (Holt and Anderson) may not be available in all extension activities. Methodologically, psychologists have found that individuals are not generally very good intuitive statisticians (Tversky and Kahneman), and therefore, the estimates may be unreliable. Roumasset also notes that subjective probabilities restrict normative analysis to information available to the decision maker which appears to be a dubious scientific position.

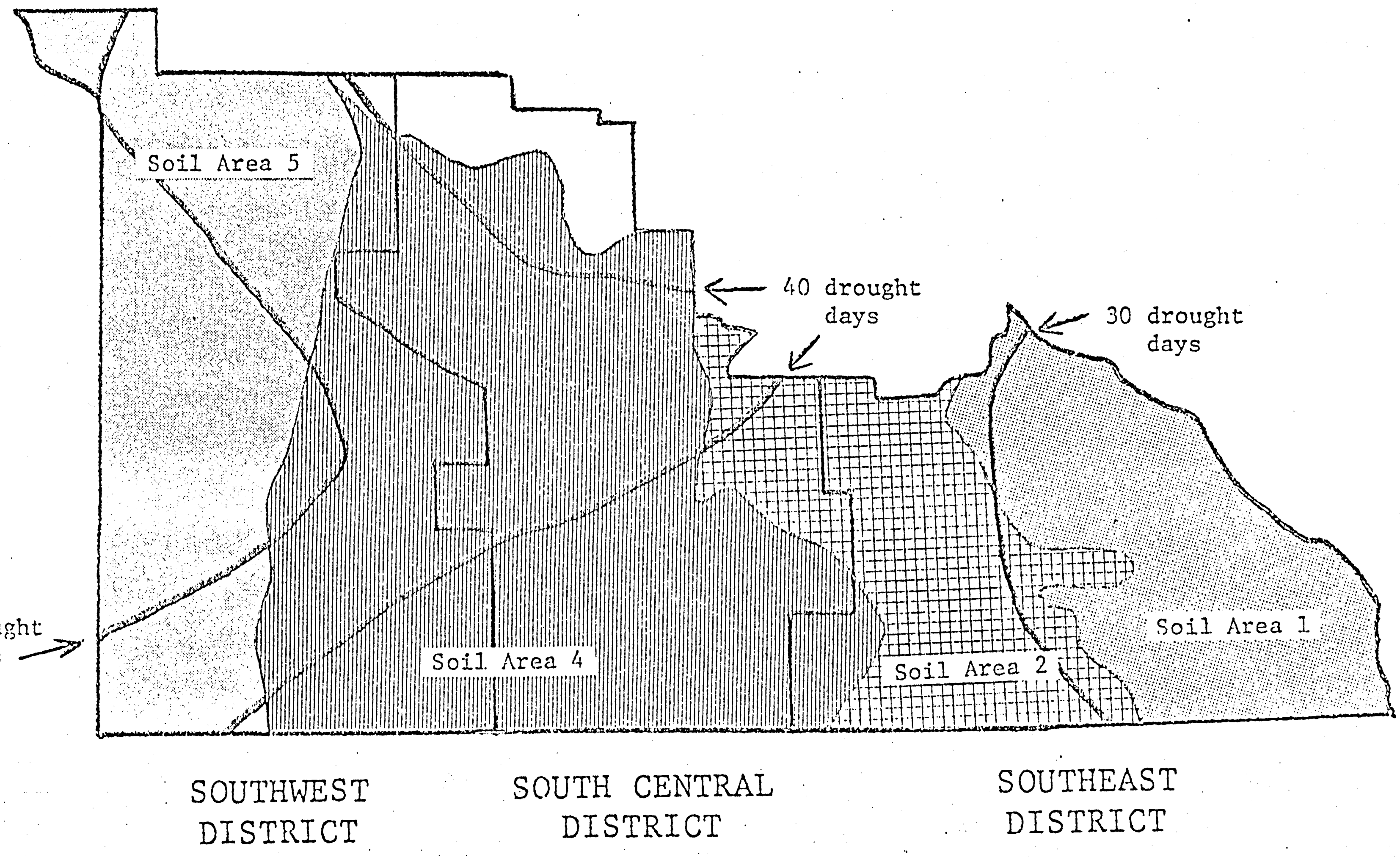
All of these considerations have resulted in renewed interest in the use of objective probabilities estimated from historical data (Young) which are used in this study.

Empirical Situation

This general method was utilized in the "What to Grow" extension program in Minnesota. This program has been conducted for six years and involves both marketing and farm management specialists. The purpose of the program is to provide current production and marketing information to agribusiness professionals to assist their farmer clients in decisions on optimal crop mix for the next year based on the relative profitability of alternative crop enterprises. A specific publication is prepared for each of the production regions in Minnesota. The production regions in Southern Minnesota are illustrated in Figure 1. A separate publication is prepared for the Southeast, South Central and Southwest Districts, in reflection of the climatic differences among these areas. Within each District, a production region is defined for each major soils classification; for example, soils 1 and 2 in Southeast Minnesota are separate production regions for the presentation of production data.

This annual extension series includes materials on crop production costs, pricing information, crop outlook, government programs and marketing management for the coming growing season. The focal points of the "What to Grow" series are current crop production budgets and price outlook which become available during the last two weeks of January. The production costs are updated each year with the use of the Minnesota Budget Generator and annual surveys of land, machinery and other pro-

Figure 1. Production Regions And Minimum Drought Days For Southern Minnesota



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duction input costs (Anthony, et. al., 1980a, 1980b, 1980c).

The net cash returns from the budgets were used as the values for E_i in equation (1). The values for σ_i were calculated for historical data for 1965-1978. Under the standard assumption that input costs are non-stochastic, the standard deviation of gross income per acre is σ_i. State price data and county yield data were utilized to create the time series of gross incomes (Minnesota Crop and Livestock Reporting Service). A weighted average yield series, for which the weights were total production in the county, were created for each production region. This time series was then multiplied by the price time series to create a gross income time series. The data were detrended with the variate difference method and the values of σ_i estimated for each production area.

Values of K in equation (1) were selected to calculate lower confidence limits of 75% and 90%. While these values were arbitrary, the resulting confidence limits can be interpreted as: three years out of four and nine years out of ten, net cash returns will be greater than these limits. Former applications of the confidence interval concept to portfolio analysis have used the cumulative normal distribution for values of K (Scott and Baker; Barry and Robison; Kliebenstein and Scott). Since the sample size used to calculate σ_i was small, the Student's t distribution seemed more appropriate. With 13 degrees of freedom, the values of K in the analysis were 0.694 and 1.35.

Empirical Results

The results for three production regions of Minnesota, which are delineated in Figure 1, are presented in Table 1. The standard deviations and variability coefficients (VC) were not utilized in the extension program but are presented for interested readers. VC is calculated as:

$$(2) \quad VC_i = \frac{\sigma_i}{E_i}$$

where E_i = the budgeted net cash returns.

The results fulfilled most preconceptions concerning risk in these regions. Except for soybeans, the variability coefficients are larger moving East to West, which reflects lower rain in the West. As illustrated in Figure 1, the minimum number of drought days from May to September ranges from 30 in the Southeast to 50 in the Southwest (Blake, et. al.). Corn was the most risky in all areas and the small grains were the least risky in all areas except the South Central.

Each extension meeting concentrated on one extension district so the amount of data presented at a meeting was minimal. Thirty minutes was adequate for the risk presentation which included some general definitions and background material. Two points related to the methods of estimation of σ_i were emphasized in the presentation: (1) these confidence limits reflected variability as measured historically, and (2) (2) the yield time series were aggregate data (individual farms would likely have more variability). In general, the audience was interested in the results, and no more disagreement concerning the findings was expressed than is normal in extension presentations of representative situations.

Not unexpectedly, the presentation was received with much more

Table 1. Risk-Returns Analysis for Selected Crops by Production Region of Minnesota, 1980

Area and Crop	Price	Yield	Net Cash Returns/Acre				
			Expected Value	Standard Deviation	Variability Coefficient	75% Lower Confidence Limit	90% Lower Confidence Limit
	$	bushels	$	$	%	$	$
Southeast 1							
Corn	2.42	120	138.73	25.15	18.13	121.28	104.78
Soybeans	6.50	27	112.67	16.29	14.46	101.36	90.67
Oats	1.45	90	68.45	5.08	7.43	64.92	61.58
Wheat	4.10	60	174.97	10.60	6.06	167.61	160.66
South Central 4							
Corn	2.44	120	135.00	25.84	19.14	117.06	100.11
Soybeans	6.54	40	186.00	10.14	5.45	178.96	17?.30
Oats	1.45	90	65.43	5.62	8.58	61.53	57.84
Wheat	4.20	60	177.00	17.03	9.62	165.18	154.01
Southwest 5							
Corn	2.32	90	84.42	57.62	57.62	50.66	18.76
Soybeans	6.40	23	94.87	22.94	24.19	78.94	63.89
Oats	1.40	80	54.82	9.98	18.21	47.89	41.34
Wheat	4.06	45	120.79	23.98	19.86	104.14	88.41

interest in a risky production region such as Southwest 5. The comparison of corn and oats in this region was particularly enlightening in reference to risk. Despite the higher expected net returns for corn, the 75% confidence limit is nearly the same, and the 90% confidence limit is over twice as much for oats as corn. This experience supported the view that addition of a risk component to extension meetings is particularly important for regions subject to considerable risk and for topics which involve considerable risk in all regions.

Conclusions

This paper has reported on the use of a lower confidence limit on profits as a means of incorporating risk into an extension program. While the method was used in a crop planning program, it could be adopted for use in any extension program for which profits of alternative decisions are presented. The advantages of the method is that it is simple to implement and more importantly, to explain in the limited time available in many extension programs. Potential users of this method may wish to consider alternative methods of estimating the lower confidence limit. While the normal distribution is convenient, other probability distributions may be more appropriate. Some users may prefer subjective to objective probability distributions, and others may wish to compare subjective and objective distributions. If objective probability estimates are to be used, representative farm yield data could be used, if available. In addition, methods other than the variate difference procedure may be considered for detrending the historical data (Young).

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