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## GAMING AS A FARM MANAGEMENT TEACHING DEVICE: A DEVELOPMENT AND ANALYSIS

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I have a colleague at Missouri who says educators in farm management "have failed to deal with the comprehensive problems of farm management comprehensively." I think he is saying that even though we have made great advances (e.g., integrated static firm theory can teach farm organization in a risk world with innovative budgeting and linear programming exercises) our mix does not yet include enough dynamics or management. My colleague contends we rarely attack such managerial problems as imperfect anticipation of future conditions, accumulative effects of decision-condition interaction over time, capital budgeting and the realities of cash flow, time sequencing of decisions, firm-household competition, and firm growth. Such criticisms indicate farm management teaching is ready for new techniques which better communicate functional management processes and the application of farm economics.

Gaming has proven potentially effective in its use in business schools and a few agricultural economics departments. This paper reports the development and use of one such game. Gaming, including the game to be described, is not proposed as the only or best approach in farm management teaching. A single most effective method has not been determined because managerial skills required for effective performance are extremely intangible and difficult to define.

The work reported grew out of a concern that farm management, as sometimes taught, may not prepare students to competently mesh and apply the separate economic and management concepts to which they have been exposed. Particularly discomfoting is the

apparent inadequacy of the lecture method in explaining decision making under an imperfect knowledge and time dynamic environment. Because of these misgivings, objectives selected for the study upon which this paper is based were: (1) To construct a game which portrays the dynamic decision making environment, and (2) To evaluate the problems and potentials of such a game as a technique for teaching economic and management concepts.

Several factors influenced the decision to construct a game rather than use Eisgruber's excellent game [1] or use one from a school of business. Not the least reason was the paucity of farm management games, particularly games amenable to extension or classroom use where a computer was not readily accessible. Second, there was need for a game constructed specifically to provide students an opportunity to use previously learned concepts while struggling with the problems of business coordination and control through time and under imperfect knowledge.

### THE MODEL

The Oklahoma Farm Management Decision Exercise that was developed is a non-competitive, probabilistic model.<sup>1</sup> The hypothetical cash-grain farm chosen as the model is characteristic of many large farms in the high risk plains area. Initial conditions are 1,600 acres cropland and 400 acres pasture valued at \$140,000 against which there is a \$50,000 mortgage. There is no beginning livestock inventory, an average machinery value of \$10,000 and \$2,000 cash on hand. Activities from which a farm organization can be

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<sup>1</sup> Copies of the manual version of the Decision Exercise are available from either K.C. Schneeberger, University of Missouri, or O.L. Walker, Oklahoma State University. A comprehensive discussion of the Decision Exercise can be expected shortly under the title "Gaming with the Oklahoma Farm Management Decision Exercise." Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma.

selected are wheat, grain sorghum, broomcorn, two cow-calf activities and two buy-sell steer activities.

A few salient features were included in the game to give participants a feeling of realism as a means of inducing active involvement. Among these features were the following operating restrictions:

Acres of broomcorn  $\leq$  100 acres.

Avg. acres fallowed  $\geq$  400 acres, can get 800 acres behind.

Wheat acreage  $\leq$  800 acres, allotment restriction.

Native pasture production = .6 AUM per acre.

Cows, once purchased, must be held three years.

Fixed obligations (i.e., taxes, interest on mortgage) must be paid annually.

Avg. family living expense  $\geq$  \$5,000, with a \$3,000 annual minimum.

Avg. machinery expense  $\geq$  \$2,000, with a \$0 annual minimum.

Avg. land payment  $\geq$  \$2,500, one payment in three may be deferred.

Net worth ratio  $\geq$  .35.

The lone, specified objective is net worth maximization at the end of N years.

### SIMULATING THE MANAGERIAL ENVIRONMENT

It was thought the planning-coordination-analysis interaction of the dynamic real world could be best illustrated by constructing a game that emphasized decision making. The major decisions in the Oklahoma Game are (1) the organizational decisions of choosing a plan from among the 7 activities - consistent with fallow, pasture and allotment restrictions, and (2) deciding cash flows once enterprise sales are realized.

The decision environment of the Oklahoma Game is closest to what is generally regarded as a risk situation. In choosing an organizational plan, for example, a participant knows the list of possibilities (the 7 activities). He is also provided data on net revenue<sup>2</sup> per unit of each activity, plus the associated probabilities (see Table 1).

<sup>2</sup> Net revenue refers to gross sales less variable costs.

<sup>3</sup> Development of income equations for another management game is discussed by Walker [6, pp. 41-44].

Decisions on cash flows are discretionary. Each participant decides individual period outlays based on (1) game operating restrictions, and (2) his interpretation of his financial position, past conditions, plans for the future and personal preferences. Transcendent is the goal of net worth maximization.

### DIGRESSION ON NET REVENUE GENERATION

The information presented in Table 1 is adequate for gaming. A digression on activity net revenue is presented here to explain the conceptual development of net revenue for those who might use a version of the Decision Exercise or for persons interested in constructing their own games.<sup>3</sup> The following example explains the general form of a net revenue equation for wheat:

The net revenue equation of each activity is given on a technical unit (i.e., acre, cow) basis. For wheat, the equation is:  $W_j = [E(W) + S_w X_{ij}] [1 + J \cdot T_w]$

where  $W_j$  = Net revenue from wheat in year j

$E(W)$  = Expected net revenue from wheat

$S_w$  = Standard deviation of wheat revenue

$X_{ij}$  = Normal standard deviate for ith set of conditions in year j

$T_w$  = Production trend for wheat.

The expected net revenue value for wheat,  $E(W)$ , is determined by:

$$E(W) = \sum_{j=1}^n \frac{[Y_j P_j - CC_j]}{n}$$

Where  $Y_j$  = yield in year j

$P_j$  = price in year j

$CC_j$  = cash costs in year j

n = number of years for which j was observed.

The revenue functions for the other 6 activities are of the same form as the one for wheat given here.

In the computer version of the game, the  $X_{ij}$  can be randomly drawn from the appropriate continuous distribution for each activity. The trend, standard

TABLE 1. RETURNS ABOVE CASH COSTS FOR CROP AND LIVESTOCK ACTIVITIES IN THE DECISION EXERCISE

Proba- bility	Crops <sup>a</sup>				Livestock			
					Cow-Calf <sup>b</sup>		Steers	
	Wheat		Grain Sorghum	Broom- corn	Native	Wheat- Native		
	Grain	Pasture					Native	Wheat
	\$	AUM	\$	\$	\$	\$	\$	\$
1/3	5.00				35.00	40.00		
1/3	10.00				50.00	55.00		
1/3	20.00				65.00	70.00		
1/10		0					0	2.00
2/10		.1					5.00	5.00
4/10		.2					20.00	15.00
2/10		.3					30.00	20.00
1/10		.4					40.00	40.00
1/4			3.00					
1/2			11.00					
1/4			22.00					
1/2				0				
1/2				25.00				
E(R)	11.67	.2	11.75	12.50	50.00	55.00	19.00	15.20

<sup>a</sup> Returns from crops are net of cash costs.

<sup>b</sup> Returns from cow-calf enterprises are net of cash costs other than interest. These return figures include the sale of cull cows.

deviation and expected net revenue values can be specified as desired. In the manual version,  $T_w$  is given a value of zero and  $X_{ij}$  is drawn from a discrete distribution. For wheat, the  $X_{ij}$  are drawn from a rectangle distribution from which there are only three possible outcomes. They are  $P(-.88) = .33$ ,  $P(-.22) = .33$ , and  $P(1.1) = .33$ . With an  $E(W)$  of \$11.67 and a standard deviation,  $S_w$  of \$7.60, the discrete distribution of net revenue values for wheat and their probabilities would be:

Probability	Net Revenue/Acre
.33	\$5
.33	10
.33	20

As mentioned above, discrete activity net revenue distributions which have been used are presented in Table 1. The specific  $E(R)$  values used correspond to "Normal" (expected) returns above cash costs developed in a study of farming in the high risk Oklahoma Panhandle area. Net revenue was used because of the desire to limit the amount of computations required in the manual version. This simplification was used since the emphasis is on decision making rather than arithmetic.

#### GAMING MECHANICS ACCOMPLISHED WITH PLANNING FORMS

The Decision Exercise was designed to utilize planning forms as the instrument for making computations. The forms used are profit and loss, pasture balance, credit planning and comparative analysis statements.<sup>4</sup> It was hypothesized that use of forms in game play would (1) improve participant's understanding of those particular forms, and (2) provide the opportunity for participants to discover the usefulness of the forms for analytic purposes. That participants can gain proficiency in use of forms through game play has been verified with the Westinghouse Game [2, p. 150].

The planning forms are designed so total net sales can be immediately determined once an organizational plan is decided and the net revenue events drawn. Once net sales are computed, the participant allocates sales income among overhead expenses, debt repayment, investment, savings and consumption. Use of the planning forms allows participants to record the income and outlays. Thus, the decisions, the resulting income and outlays (both required and discretionary) are available to participants as decision making data in successive periods of game play.

#### PARTICIPANT REACTION AND PERFORMANCE

This section reports general performance and attitudes from the use of the Decision Exercise in two very different learning situations. One was a two-day nonresident (extension) conference with 120 participants, mostly vocational agriculture instructors. The other was a junior-senior level advanced farm management course with students from all disciplines of the agricultural sciences. The conference was a continuous play experience. In the classroom one game play (one year) was simulated each week. In both situations, participants worked in teams of twos.

The analysis of participant performance is based on (1) the results of a questionnaire, and (2) summarization and evaluation of plans used by participants in game play. The participants in either situation were not advised that an evaluation of their activity was planned, nor was any method incorporated to insure participant use of concepts to which they had been previously exposed, or might be exposed to in the conference or course. Game administrators did try to help individual participants bring concepts they discovered (or rediscovered) for themselves into as clear a focus as possible.

#### USE OF PLANNING FORMS

Both the adults and student groups became 95 percent effective in filling out the game forms. It generally took students more plays to attain competence in use of forms than it did adults. There are two reasons. First, learning was slower because of the week interval between plays. Second, students were less experienced in record keeping than were the adults; hence, they were initially more uncertain in handling the forms. Both groups had greater difficulty with the Pasture Balance and Credit Planning forms than with the more familiar Net Worth or Profit and Loss Statements.

The computations of one manual game play can be completed in approximately one hour. This provides feedback on consequences of decision shortly after the decisions are made and before participants forget the reasons for making the decisions. This rapidity of feedback can reinforce correct analysis or cause a participant to re-evaluate faulty reasoning. The actual degree to which information on the planning forms was used for thorough analysis was not measured. That participants displayed a general movement toward higher income and lower variance activities as game play progressed indicated decision making sophistication, part of which may be attributable to the use of the planning forms.

<sup>4</sup> Copies of the planning forms are available from K. C. Schneeberger, University of Missouri.

## STUDENTS LACK EXPERIENCE IN PLANNING FOR FUTURE

It is difficult to assess participants' ability to abstract, organize and plan. There are indications student-participants had greater difficulty adjusting to the dynamics of gaming than did adults.<sup>5</sup> First, student participants experimented more than did adults. During early game plays, students would frequently make complete changes in their plans from one play to the next. Adults tended to select a plan and make slight modifications. Second, students were slow to grasp the flexibility of operation offered by the operating restrictions. Nine of 15 student teams maintained fallowed acres at a constant 400 acres per play, although the opportunity to fall as much as 800 acres behind existed. (One would hypothesize a heavily indebted, low liquidity operator would defer fallow to try to attain a more favorable liquidity position). Third, students initially tended to include wheat up to the maximum although an alternative, grain sorghum, gave equally lucrative returns and had a smaller variance on return. Fourth, over half the students selected a livestock activity in play 1 that tied up what little operating capital (liquidity) they had. This impaired their flexibility in succeeding plays.

Decisions based on incomplete analysis such as the one of allocating all operating capital in an inflexible livestock activity made participants aware of the effects of a decision in  $t_j$  upon conditions in  $t_j \dots t_n$ . One or two faulty decisions generally made participants cognizant of the importance of projecting the possible future consequences of current decisions. As game play progressed, participants learned to adjust capital purchases, land fallow, debt repayment and consumption expenditures consistent with the objective of net worth maximization.

## TWO DECISION MAKING STRATEGIES PREDOMINANT

Both college students and adults relied on a diversification strategy during early game plays. Twenty-eight of 38 adult participants sampled after the conference and 14 of 15 two-man undergraduate teams questioned after two game plays gave diversification as a primary strategy. For the adults, the diversification strategy was highly correlated with "conservative" participants (i.e., selected low variance activities and maintained year-to-year organizational stability).

In the second strategy, a reliance was on expected value,  $E(R)$ . Emphasis placed on this concept during game orientation and its appearance in the game

description (i.e., Table 1) probably influenced the use of this value in decision making. However, reasons given for using  $E(R)$  (1) reflected an initial inability to comprehend and use decisioning data presented in distributional form, and (2) indicated reliance on a single valued expectation model. For example, some participants said they included broomcorn because it had the highest  $E(R)$ . They failed to realize broomcorn had the highest variance of the activities.

Although participants initially used the expected value concept to their possible detriment, by the completion of game play most had developed an understanding of the concept. When questioned after game play, 77 percent of college student-participants were able to relate expected value to "normal" returns used in budgeting and linear programming. They could also give extra-game examples of its use. No cardinal measure was made of adult comprehension of the expected value concept. The conference administrators felt the use of the concept gave adults greater confidence in the coefficients used in farm management publications. If so, this is a significant benefit of the conference. The real test will be observed in increased use of such publications.

In future uses of the game, the  $E(R)$  row in Table 1 will be omitted. This will provide a basis for more accurately assessing participant's ability to use data presented in distribution form for decision making purposes.

## ACTIVE INVOLVEMENT IN LEARNING SITUATIONS

If satisfaction can be at all equated with enthusiasm and involvement, the Decision Exercise qualifies as an intense learning situation. Many conference participants worked through refreshment breaks and as many as half voluntarily cut short their lunch periods to spend additional time in analysis. A sense of competition sparked by the desire to achieve the highest net worth was the catalyst that engendered a high level of interest and analysis among the student-participants.

## SUMMARY

Use of the Decision Exercise as a foci of teaching met with varied degrees of success. Viewed ex post, several observations can be made. First, the continuous play (conference) situation afforded the more intense learning experience. Momentum, once generated, was easier to maintain in the conference experience. Effect was sometimes lost because of the week time lag in the classroom use. Second, while competent use of business instruments was

<sup>5</sup> Similar conclusions are reached by Curtis [3, p. 1031].

accomplished in both situations, it was accomplished sooner in the continuous play situation. Third, participants developed an understanding of normal return and variance of return and were able to use the concepts in decision making. Fourth, participants did

use decision strategies consistent with those observable in the real world. Fifth, game participants almost unanimously preferred gaming to lecture as a farm management teaching method.

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