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ESTIMATING THE VALUE OF RESEARCH AND EXTENSION INFORMATION USING A MANAGEMENT GAME

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A laboratory experiment was conducted to measure the value of research and extension information to Indiana corn and soybean producers. A computerized farm management game was constructed incorporating a number of key decisions faced by farm managers when producing corn and soybeans. Students in an advanced undergraduate farm management class at Purdue were asked to "play the game" by making a series of managerial decisions dealing with corn and soybean production practices. One group of students was denied access to research information on corn and soybean production. Another group was denied access to the results (feedback) from the previous decision. Profit was the measure used to quantify the benefits of information and feedback. Results indicated that research information and feedback both had a substantial positive impact on profits.

The Computerized Management Game

The tool used to measure the returns to feedback and research information was the Purdue University Corn-Soybean Production Management Game. 2/ The game simulated (represented) the operation for a 5-year period of a 600-acre corn and soybean farm in Tippecanoe County, Indiana. Research data from the Purdue University Agronomy and Agricultural Economics Departments were the bases for the game construction. Eleven management decisions were included in the game (Table 1). All decisions relevant to corn and soybean production were not included in the game. Each decision was chosen because research (or extension) information useful in making the decision was available from Purdue University.

The game was constructed such that each of the management decisions had an impact

1/ Dr. Debertin is now assistant professor of agricultural economics at the University of Kentucky, formerly post-doctorate research associate at Purdue University. Drs. Harrison and Rades are assistant professors of agricultural economics at Purdue University. This experiment was a result of research done at Purdue under Grant 016-15-21 from the Cooperative State Research Service entitled, "Management Decisions in Soybean Production." This publication is intended for nontechnical readers with special focus upon Extension educators, farmers, legislators and other policy makers.

2/ The construction of the game involved a multidisciplinary team effort by staff in the departments of Agricultural Economics and Agronomy. Individuals who played a role in the construction and/or validation of the game included D. Howard Doster, Paul R. Robbins and John F. Marten of the Department of Agricultural Economics, and W. D. Reiss, M. L. Swearingin and S. A. Barber of the Department of Agronomy.

The management game is explained more fully in a companion publication: A Management Game for Measuring the Return to Information in Corn and Soybean Production, Experiment Station Bulletin No. 57, Department of Agricultural Economics, Purdue University, 1974.

Table 1. Decisions incorporated into the Purdue University Corn-Soybean Production Game

1.	Combination of corn and soybeans to be planted on 600 acres
2.	Soybean variety selection
3.	Row width for soybeans and corn
4.	P_2O_5 and K_2O applied to soybeans
5.	N, P_2O_5 and K_2O applied to corn
6.	Date to begin planting soybeans
7.	Date to begin planting corn
8.	Date to begin harvesting soybeans
9.	Date to begin harvesting corn
10.	Moisture level to which soybeans are to be artificially dried
11.	Moisture level to which corn is to be artificially dried

upon gross returns, cost of production, or both. A variety of techniques were used in constructing the game. (1) Data on corn and soybean response to fertilizer were obtained from research and extension reports of the Purdue agronomy farm. Mathematical equations based upon these data were then incorporated into the computer model. (2) Corn and soybean prices used in the model were historical data on prices received by Indiana farmers over the period 1968-1972 as taken from USDA Reports. (3) The "variety selection" variable was incorporated into the model by adjusting soybean yields by factors based upon yield trial information from the Purdue agronomy farm. Similar adjustments were made in yields to incorporate changes in managerial decisions concerning selection of row widths and planting dates. (4) Cost data used in the model were adapted from survey data by Purdue agricultural economists.

After the game was constructed, a number of computer runs were made in order to study the impacts on costs, yields and profits for selected changes in each of the decisions. Results from each run were evaluated in an effort to determine if the relationships were consistent with what would be expected on an Indiana grain farm. When inconsistencies were found, minor changes in the computer program were made, and the game was rerun. While such a procedure did not prove that the management game was a completely valid representation of an Indiana grain farm, the game approximated a grain farm with a detail sufficient for the subsequent laboratory experiment.

Table 2. Characteristics of participants in the experiment

1.	Average semesters of college work completed	7.3
2.	Average grade point (6.00=A)	4.78
3.	Percent who were reared on a farm	94.2
4.	Percent not currently farming	26.9
5.	Percent farming alone	5.8
6.	Percent farming with father	57.7
7.	Percent farming with a relative other than father	1.9
8.	Percent farming with a nonrelative	7.7
9.	Percent who intend to return to farm after graduation from college	76.9
10.	Percent who had never grown corn or soybeans	9.6
11.	Percent who had grown corn but not soybeans	15.4
12.	Percent who had grown soybeans but not corn	1.9
13.	Percent who had grown both corn and soybeans	73.1

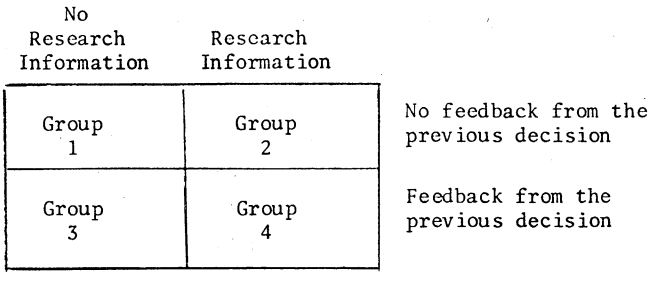

Figure 1. The treatment design.

Table 3. Results provided to participants having access to feedback from the previous decision

1. Bushels corn and soybeans harvested
2. Average moisture content of corn and soybeans sold
3. Price received per bushel
4. Total and per acre revenue on corn and soybeans
5. Hours and cost of hired labor
6. Seed, fuel, repairs, herbicide, machinery, fertilizer, and drying and other charges (total and per acre) for corn and soybeans
7. Fixed charge representing and opportunity cost for owned capital
8. Interest on borrowed money
9. Cost to produce a bushel of corn or soybeans
10. Net returns to management and own labor for each enterprise and for the farm on a total and per acre basis

Table 4. Tables of data available to participants in the experiment having access to research information

1. Purdue University Agronomy Farm soybean test, 2-year average, 1971-72
2. A comparison of per acre variable and fixed costs for 4-row and 6-row corn and soybean production
3. Relation of row width and location to yield of corn grain, 1966-1968
4. Estimated yield advantage for narrow row soybeans, as a percent of yield of soybeans in 40 inch rows
5. Effect of potassium and phosphorous placement and rate on 18-year average per acre yield of corn and soybeans
6. K_20 and P_20_5 recommendations for various yield levels of corn and soybeans at different soil test levels (as recommended by the Purdue University Extension agronomists)
7. Corn response to nitrogen fertilizer, 8-year average, Purdue Agronomy Farm
8. Soybean yields at different planting dates, Purdue Agronomy Farm, 1966-1968
9. The effect of planting date on corn yield, Purdue Agronomy Farm, 1961-1969
10. Returns to drying corn and soybeans at alternative market prices
11. Relationships between corn moisture, harvest date and yield loss

The Laboratory Experiment

Figure 1 illustrates the design used to conduct the experiment with the management game. Participants in the experiment consisted of a group of students in a senior level course in farm management. The majority of the 52 participants in the experiment were quite familiar with corn and soybean production practices. Most were reared on Corn Belt grain farms. Some 73 per cent of the students were farming alone or in partnership. Participants in the experiment could thus be thought of as consisting largely of a select (well-educated) group of beginning farmers. Additional characteristics of participants are summarized in Table 2.

All participants in the experiment received access to characteristics of the 600-acre farm including acreage, soil tests and owned machinery. In addition, all participants were given cash prices of corn and soybeans as of April 1, as well as prices of futures contracts on April 1.

Feedback consisted of the results from the decisions of the previous year. Feedback given to participants approximated a detailed set of farm records. Included in the feedback was information on yields per acre, prices received, harvest moisture, hired labor, machinery, fertilizer, herbicide, and other variable costs, taxes on land and interest on borrowed capital (Table 3).

Information consisted of research data largely obtained from the Purdue Agronomy Farm. As part of the research project, an information retrieval system was developed. Tables of research data were stored on the

Table 5. Average profits generated per year for each of four groups, 5 years of operation

Decision period (year)	Group I No information no feedback	II Information no feedback	III No information feedback	IV Information feedback
1	-3,314	-1,316	-2,292	-504
2	11,978	16,554	14,094	19,316
3	13,814	19,553	17,787	25,267
4	343	5,021	4,099	7,177
5	20,475	24,235	25,990	28,073
Average of 5 years	8,659	12,810	11,935	15,866

computer using a magnetic disk unit. Each of the tables of information was useful in making one or more of the management decisions in the game (Table 4). Participants in the experiment in groups having access to information were allowed to retrieve the tables of information as required by using a system of key words through a remote computer terminal (teletype).

It is important to note that neither the feedback nor the information told the participant which decision to make. In fact, each farm "manager" was required to make a substantial amount of interpretation of both feedback and research information. The information provided to the groups consisted of data no more detailed than that which is readily available from an experiment station of a land grant college.

To insure a willingness on the part of the students to do their best in "managing" the simulated farm, a reward system was used. Each student was paid 10 dollars for participating in the experiment. In addition, prizes of 25 dollars were awarded to the students who were able to generate the largest total profits for the five decision periods in each of the groups. 3/ Students in each of the groups were told not to share feedback or research information with members of the other groups. Each of the groups met to obtain information and feedback and make decisions at separate locations. The authors' subjective conclusion was that little, if any, information was exchanged between groups. Competition for prizes within groups insured that there was minimal trading of feedback information among students within treatment groups. The authors concluded that the students made every effort to do a "good" job at making the managerial decisions consistent with the experiment and did not in any way attempt to sabotage the experiment. Interest in the experiment was

3/ Actually, only students in groups 2, 3, and 4 competed for prizes. Data for cell 1 in the experiments were obtained by asking 15 of the students to complete a second set of decisions under the no feedback-no information condition. These students were then randomly assigned to one of the other groups and made a third set of decisions in competition for prizes. The amount of the cash awards was admittedly quite modest relative to rewards in the real world and may be argued that rewards should have been larger. However, the additional realism would have meant a substantial increase in the cost of running the experiment.

very high among the students, and students were told of the research findings at the conclusion of experiments.

Appraisal of Results

Average profits generated per year for each of the four treatment groups over the 5 years of operation of the game are presented in Table 5. Fluctuations in average profit levels over the 5 years occurred primarily as a result of variation in prices and weather variables incorporated into the game.

Results of the analysis clearly show a positive return to both feedback and information. The group with access to information and feedback was able to generate average profit levels nearly twice as great as the group with access to neither feedback or information. Average profit levels (Table 5) were entirely consistent with expected results for every decision period.

Therefore, from the evidence generated in the laboratory experiment, it is possible to show returns to research information and feedback in a laboratory environment. Results provided encouraging evidence that both feedback and research information are major determinants of profit levels for "managers" of computerized corn and soybean farms.

Under laboratory conditions information appeared to have a more important impact on profits than did feedback. In many cases, individuals confronted with the feedback-no information condition appeared to be groping for an optimal decision. A trial and error approach for the group was very evident. For example, even after several decisions had been made, many members of the group with feedback but without information were applying fertilizer to crops at rates that were far from profit maximizing. Individuals in both groups with access to information "zeroed in" on fertilization levels that resulted in profit levels that were nearly maximum very early in the experiment.

If farm managers in the real world behave similarly to participants in the experiment, the potential benefits to improved information delivery systems may be substantial. A number of participants in the experiment commented on the usefulness of having information on all phases of corn and soybean production readily available in one place. A remote computer terminal may prove to be a more effective means than traditional research and extension bulletins for making large amounts of research information readily available for use by farm managers.

While the preliminary results from the effort to estimate returns to research and extension information in a laboratory setting were encouraging, three warnings apply to the results:

1. Participants were not experienced farm managers but were individuals who may have had relatively little previous experience in actually making managerial decisions. However, the use of novice rather than experienced farm managers for the experiment in no way invalidates the results. On the contrary, novice farm managers provide an excellent group for studying the value of research and extension information. Whether research and extension information would be of equal value for managers who had been producing corn and soybeans for many years remains to be tested in subsequent research.

2. Some, not all novice farmers have college educations. A college education may have better enabled participants in the experiment to interpret and use information in a decision-making framework. Following this reasoning, returns to information for beginning farmers presented in this paper are overstated. However, it might be alternately suggested that the value of research and extension information for beginning farm managers without college educations would be even greater than for the college-trained participants in the experiment. Participants had no doubt been exposed to similar research and extension information in agronomy and agricultural economics courses prior to the experiment. Extension information may substitute for formal schooling. Returns to information for beginning farmers without

college would hence be greater than for those with college educations.

3. Even though a great deal of time and effort was devoted to the development of a managerial game that represented the real world operation of a Corn Belt grain farm, there is no way to prove that the game functioned identically to the real world. Further, there is no way to prove that the participants in the laboratory environment functioned identically to how they would function facing real world risks in a real dollar and real social and political environment. The same criticism can of course be levied against nearly any experiment conducted in a laboratory setting.

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