

Expert Systems: Potential Management Aids

Farmers and ranchers are often envious of large businesses that can afford consultants to sift through information and help them make informed management decisions. A new information technology called expert systems (ES), or knowledge-based systems, offers the potential of bringing the consultant to the farm through microcomputers. ES are computer programs (software) that provide expertise to address a specific question and draw conclusions equal in quality to those one would expect from a human expert. ES also provide reasoning behind conclusions based on rules incorporated into the software. By contrast, decision aid and accounting software now produce only numbers, leaving interpretation to the user. ES provide expertise, through use of rules in the software, to interpret the results.

ES can help producers make decisions in an increasingly complex environment that requires a great deal of specialized information. Much of the present information available in agriculture does not tell decisionmakers what they need to know. Sometimes referred to as "information overload," what is provided is simply a great deal of unusable data and information. ES

can help farm managers sort through the multitude of on- and off-farm data and information, determining what is useful. Although no new knowledge is generated by ES, they do provide access to existing knowledge for the decisionmaker who needs expert help.

The use of ES applications in agriculture is best illustrated by three examples of ES presently available to decisionmakers. These three ES are diagnostic systems dealing with crop variety selection, disease diagnosis, and financial analysis.

Wheat Variety Selection

WHEAT WIZ is an expert system developed at Kansas State University for selection of hard red wheat varieties. The data base contains pedigree and release information, disease and insect resistance, maturity and winter hardiness rating, and relative yield on 180 hard red winter wheat varieties. The software can provide information about a certain variety, identify varieties that have the best resistance to specific pests, or provide a list of adapted varieties based on user-specified field location, pest problems, and cultural practices. WHEAT WIZ recommends varieties for

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a particular field using the decision process that would be expected from a wheat specialist. This microcomputer program is available through the Kansas Cooperative Extension Service.

Soybean Disease Diagnosis

Soybean Disease Diagnosis is an expert system developed at the University of Illinois by J. B. Sinclair and Ryszard S. Michalske to diagnose soybean diseases common in Illinois. The system identifies the disease based on a user's answers to specific questions about the diseased soybean plant and its growing environment. The program expresses its final opinion in terms of the degree of confidence that the plant has a specific disease. The degree of confidence is based on the rules that plant pathologists have in the program. The program ends by providing prescriptive information on chemical and natural control for diseases. This expert system is a useful tool for Illinois soybean producers and is distributed to them through the Illinois Cooperative Extension Service.

Agricultural Financial Analysis Expert Systems (AFAES)

AFAES is a set of software designed to facilitate organization and analysis of farm and ranch financial data. I developed these programs with Kedric Karkosh and Clark Osborne. AFAES include software to be used in developing and analyzing data for agricultural financial statements, along with expert systems as it performs diagnostic analysis of the farm or ranch business' financial condition and performance. The analysis is similar to what one would expect from an agricultural financial analysis expert. This software can be used by producers, agricultural lenders, accountants, and educators.

The ES presently evaluate a farm or ranch (1) operating year performance, (2) financial condition, and (3) ability to support operating capital debt. Analysis is based on historical, current, and projected financial data. Additional ES are under development to evaluate the feasibility of long-term capital investment based on financial projections.

Participants in Development. AFAES software was developed by the Texas Agricultural Experiment Station, Texas A & M University. Cooperators in the development and evaluation of AFAES software include the Farm Credit Bank of Texas, producers in Texas, the Texas Agricultural Extension Service, private lenders, and two national task forces. USDA's Federal Extension Service supported the National Task Force with 35 members from 12 States including land-grant professionals, lenders, and software vendors. Development efforts are also closely coordinated with the American Bankers Association's National Farm Financial Standards task force that is developing accounting and financial reporting standards for agriculture. Developing ES for national efforts will help standardize financial reporting and analysis, making agricultural borrowers more competitive with nonagricultural businesses that have standardized reporting procedures.

Diagnostic Financial Analysis and Explanation. AFAES software facilitates the organization of information for current, historical, and projected balance sheets and accrual income statements. These data are then processed to generate specific financial performance ratios and trends. The expert system's rules then use this information to derive diagnostic evaluation of the business and to explain reasons for conclusions.

An example of the kind of information included in the results of an AFAES analysis is shown in the table. This example uses a dairy farm. The financial ratios and measures would be part of the report, along with a graphic presentation and another table (not shown) that defines the ratios and the acceptable range of values for each ratio. For example, the graphic results (not shown) indicated that the dairy farm had a slightly favorable financial performance.

current assets for every dollar of current liabilities. These two factors combine to put the firm in an unfavorable liquidity position. Steps should be taken to get repayment capacity in line with requirements.

- The solvency position of the firm is highly favorable as shown by the debt-to-asset ratio of .19. There is \$.19 of debt outstanding against every dollar of assets.

AFAES Operating Year Performance Analysis of Dairy Farm for Year Ending February 1989

Item	Value	Change Percent
Liquidity: Current ratio	.68	49.43
Solvency: Debt to asset ratio	.19	-4.34
Leverage situation: Financial leverage index	.72	-
Profitability: Return on farm assets	.05	-
Repayment capacity: Term debt coverage ratio	.81	-
Net worth: Change in cost basis net worth		(+)
Cash-flow: Annual farm cash income minus cash expenses	\$41,014	

The program explains each one of the factors which were evaluated. Examples of the interpretation of financial factors provided by the program are given below.

- During the operating year analyzed, the firm had a positive cash-flow of \$41,014.

- A return on farm assets of 5 percent puts the firm in an acceptable profitability position. Each dollar of farm assets is generating \$.05 of net income. Profitability should be monitored to insure that it increases.

- Although a positive change provides evidence that the liquidity position of the firm improved, the current ratio of .68 indicates that there are some liquidity problems. There are only \$.68 of

- The term debt repayment capacity indicates that there is only \$.81 of cash for each dollar of term debt repayment capacity required. Immediate action should be taken to get repayment capacity in line with requirements.

AFAES software will greatly enhance the use of farm financial data by farmers and ranchers who often do not have the expertise to fully utilize their accounting and financial data. The software facilitates consistent analysis and borrower comparative analysis using standardized information by type of farm. This software can be integrated into presently available accounting and financial analysis software to add the "human expertise" analysis component. The software is designed for use by

farmers with minimum assistance from Extension Specialists or consultants. AFAES software is available from private software vendors that have licensed the software for sale or through a licensing agreement with the Texas Agricultural Experiment Station.

Research Efforts

There are a large number of research efforts in land-grant institutions to develop ES applications for agriculture. A survey of universities in 1986 identified 28 universities with 128 ongoing activities in research and Extension to develop ES, and a partial survey in 1988 identified 59 applications. Major topics of management applications include crop and livestock production, financial analysis, marketing, and natural resource management. Diagnostic and prescriptive advice on pesticide selection, variety selection, pest management, and financial performance dominate the functional areas of application. Other ES are available for grain marketing, dairy cow reproduction problems, and rice herbicide selection.

Researchers at Texas A & M are developing comprehensive farm level ES for cotton (COTFLEX) and rice (RICEFLEX) to address questions that range from herbicide selection to agriculture policy evaluation. A Mississippi State University-Economic Research Service effort is developing and field testing a cotton management program (GOSSYM-COMAX) that combines a plant growth simulation model (GOSSYM) with a diagnostic expert system (COMAX).

Input Selection Expert System

ES that help with decisions on inputs such as fertilizer, insecticides, and herbicides offer the greatest opportunity for



COMAX tells cotton farmers when the plants are mature enough to harvest. (USDA Photo by Dave Warren, 067-7-36)

ES management aid applications. As agriculture moves toward a more environmentally sound production system, ES will play an increasingly important role. ES can facilitate pesticide selection with rules that address regulatory labels, costs, application method, and safety. ES could even provide information to properly regulate application machinery. Expert system instructions could be combined with field mapping and machinery controllers to regulate planting population and pesticide use as planters and applicators move through the fields.

Success of ES for input selection will depend on how complete the information is to support the decisionmaking rules. A major cooperative effort will be required among input suppliers, researchers, Extension Services, and regulators to insure that ES are comprehensive and information is updated on a timely basis. Users will have to be conscientious to see that ES are properly adapted to their decision environments. Successes in developing ES for agriculture to date have been associated with systems designed to address very specific decisions. The result of successful ES for input selection will be

farm managers who are better informed on the use of inputs, as well as a more cost-effective, sustainable agriculture.

Training and Education

ES have proven to be excellent tools for training decisionmakers. ES should greatly enhance the educational capabilities of professionals such as Extension agents and consultants who must address a wide variety of problems. ES can help extend the capabilities, efficiency, and transfer of knowledge from a limited number of specialists to larger farm and ranch audiences. To make effective use of ES, farm and ranch managers will need good production and financial records.

Future of Expert Systems

Because of an increasingly complex decision environment, managers will use consultants to assist in areas of tax, finance, legal matters, and production input use. ES will be a lower cost and more convenient way to complement and substitute, to some degree, for human experts. ES can add so much to the present management decision aids through explanatory powers that most agricultural software in the future will have some component of expert system technology. ES will be one of the knowledge delivery technologies of the 1990's.

ES will not replace the farm or ranch manager who is required to analyze data and formulate strategies. However, ES tools will greatly facilitate access to information and analysis.

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