Integrated Decision Support System: Potential for Horticulture

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Summary. Farming operations must be environmentally sound and economically viable if they are to be sustainable over time. Thus, farmers of the future must balance environmental and economic concerns in making management decisions. An integrated farm decision support system, PLANETOR, has been developed to help farmers balance soil loss, water-quality risks, production efficiency, and profitability in the farm planning process.

PLANETOR is a site-specific, field-level, multi-year, computer-based program that allows farmers to evaluate alternative resource management strategies including cropping sequence, tillage methods, and pest management practices within a whole-farm systems context. The PLANETOR program may be particularly useful for horticultural crop producers who are attempting to use crop rotations and integrated pest management strategies to reduce their reliance on commercial chemical inputs, thus reducing environmental risks and input costs without sacrificing productivity.

United States farmers are being confronted with growing environmental concerns and rising input costs associated with increasingly specialized farming systems. In response, many are searching for farming systems that are more environmentally sound and economically viable than most current systems. These farmers are motivated by concern that production inputs on which they depend today may not be available or effective or may cost even more in the future. Some are motivated by a desire to conserve and protect the long-term productivity of their natural resource base. Others realize the ultimate necessity of responding to societal concerns regarding potential negative impacts of agriculture on the environment.

Emerging technologies, such as genetic engineering, may offer new management alternatives in the future, but farmers must address today's environmental challenges with existing technologies, while the search for tomorrow's solutions continues. The promises of future technological fixes for today's problems may never be fulfilled. Many are searching for ways to reduce their reliance on external inputs, particularly chemical pesticides and commercial fertilizers, while enhancing the profitability of their farming operations. Success in this endeavor will require greater reliance on managing on-farm inputs and internal farm resources, particularly using land, labor, and site-specific knowledge more effectively.

More effective management (timing, placing, and apportioning) of fertilizers and pesticides may improve the economic and environmental performance of specialized farming systems. However, more diversified farming systems may be required for long-term agricultural sustainability. Operators of diversified farms traditionally have rotated crops to control pests, conserve soil, and maintain productivity. Integrated cropping and livestock systems have been used to produce on-farm inputs, use nutrients better, recycle wastes, and stabilize farm incomes. Such strategies may reduce costs and environmental risks simultaneously. Diversified systems depend less on external inputs and, thus, generally are conceded to be more environmentally sound than specialized farming systems. However, diversified systems generally are considered less efficient, at least in terms of short-term productivity and profitability. The challenge is to develop environmentally sound, diversified systems that are commercially competitive with input-dependent, specialized farming systems.

Farm decision support systems

Ultimately, the commodity-based government programs that have supported specialized farming systems may have to be redirected, and new diversification technologies may need to be developed to allow diversified farms in general to compete commercially. However, many farmers may improve the overall sustainability of their farming operations with existing technologies and existing farm programs through more management-intensive, integrated, holistic approaches to farm planning and decisionmaking. Success in achieving this goal may depend at least in part on finding ways to combine the latest technologies, such as microcomputers, with tried and proven farming practices, such as crop rotation and enterprise diversification.

Microcomputers would seem to be the ideal tool to help farmers cope with the complexities of integrated, whole-farm management. Impacts of alternative farming practices on various economic and environmental indicators of farm performance can be estimated quickly and made available to the farm decisionmaker. While the farmerconcentrates on improving economic performance, for example, the computer can track any unintended environmental consequences. A farmer's good judgment can be supported by science-based estimates of a wide range of relationships among economic and environmental alternatives and their consequences. A microcomputer can track economic implications while a farmer concentrates on strategies for meeting environmental rules or regulations.

The primary challenge in developing farm decision support systems is to devise a system complex enough to be realistic—because reality is complex—yet simple enough to be useful. With this objective in mind, a microcomputer-based farm decision support system was developed under a project funded jointly by the Extension Service and USDA Cooperative State Research Service to integrate critical dimensions of sustainability into a single-farm planning process. This system, called SMART, version 1.2, was field-tested in 17 states in all regions of the United States. Significant modifications were made, with additional funding from a variety of sources, and a second generation program, PLANETOR 2, was released in Spring 1995 (Hawkins et al., 1995).[2]

PLANETOR

PLANETOR is a farm decision support system that allows farmers to evaluate the potential impacts of various cropping systems, tillage practices, and input complements on specific fields on their farms. PLANETOR allows farmers to plan their farms field-by-field, year-by-year and assess the economic and environmental implications for each field, each year, for whole farming systems, including livestock and crops.

Most farmers assess their current system before evaluating new alternatives. An agricultural specialist or consultant working with the farmer should have determined the basic crop rotations and livestock enterprises used by the farmer and have those available in the PLANETOR database at the time of the first planning session. Otherwise, the farmer will have to develop those budgets from scratch before the planning process can begin.

Budgets used in the PLANETOR program include detailed information on cropping sequence, tillage practices (including timing and equipment used), fertilization, pesticide use, other production costs, stocking rates and feed requirements for livestock, manure management strategies, irrigation and conservation practices, and a variety of other practices that can affect the economic and

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environmental performance of the overall farming operation. Items of equipment are selected from a menu, which brings default values into the program for fuel use, labor, operating costs, and key data needed to calculate soil loss (Fuller et al., 1992). Estimates of production or yield and market prices, including expected values and ranges, are entered by the user. Once basic data have been entered for a given crop, crop rotation, or livestock enterprise, most modifications can be made quickly and easily. However, initial budget data entry can be time consuming, particularly in cases in which the farmer has several different crops in different rotations.

All site-specific information and associated yield and environmental impact estimates are calculated from databases provided with the PLANETOR program. PLANETOR uses the revised universal soil loss equation (RUSLE) to estimate soil loss (See Renard et al., 1993). Soil texture (K), average slope (S), pesticide leachability, and pesticide surface loss potential are identified in NRCS databases of United States soils. These data are used routinely by the Natural Resource Conservation Service (NRCS) in USDA conservation compliance programs. Soil data are available for each state as a part of the PLANETOR package and include all soils that have been classified by NRCS, sorted by county. Slope length values (LS) must be added at the state or local level.

The most appropriate weather (rainfall) factor (R) for a specific farm location is selected by choosing the nearest NRCS weather reporting station included in the PLANETOR weather database. The farmer will be asked to identify predominant soil types by field, to check LS values, to indicate any planned conservation practices (P), such as contour farming or terracing, and to verify soil characteristics and environmental impact estimates for each field. Soil erosion, estimated using the RUSLE, is compared with soil loss tolerance (T) levels for predominant soil types.

Water-quality risks associated with pesticide use are assessed using soil–pesticide interaction values developed by a national team of specialists representing the Natural Resource Conservation Service, Agricultural Research Service, and Extension Service (Goss and Wauchope, 1990, Wauchope, et al, 1992). This procedure compares specific chemical properties of most commonly used pesticides with structural properties of soils, by type, to estimate the water pollution risks associated with using specific pesticides on specific soil types. Pesticide pollution risk indices are estimated by comparing estimated chemical concentration levels in surface and groundwater with U.S.Environmental Protection Agency health advisory concentration levels for each pesticide on each soil type (Hornsby, 1992).

Water-quality risks associated with nitrogen use are derived using a process model, NLEAP, that compares nitrogen application with expected nitrogen uptake of various crops and projected volatilization to estimate net nitrogen available for leaching and runoff (Follett et al., 1991). Potential pollution of streams and lakes from phosphorus runoff is estimated using a procedure developed by the NRCS Phosphorus Index Core Team (Lemunyon and Gilbert, 1993). Economic and environmental impacts of alternative manure management strategies, including nutrient balance estimates for livestock–crop farms, are addressed in a specific module of the PLANETOR program (Livestock waste facilities handbook, 1985). Pesticide handling and residue risks are assessed using toxicity values, oral and dermal, included on pesticide warning label information (Crop protection chemicals handbook, 1994).

Financial and resource implications of alternative farming systems are evaluated using a financial planning format modeled after FINPACK, a widely used program developed by the Center for Farm Financial Management, Univ. of Minnesota (Hawkins et al., 1993). The acreage of each crop, pasture, setaside, or conservation reserve is totaled and can be viewed for each year in the planning horizon. Expected revenues, input costs, gross margins, revenue risks, grains and other feed produced and needed, and hay produced and needed are summarized for each year. Labor requirements, by month, are a part of each enterprise budget and labor availability by month is entered for the whole farm. Any inconsistencies between total labor needed and total labor availability are identified by month of the year. Income or economic risks are indicated by probabilities of returns falling below various budgeted cost levels.

PLANETOR in use

No attempt is made in the PLANETOR program to guide the user toward an optimum farming system. Farmers simply try to develop more environmentally sound and economic viable whole-farm systems by matching alternative resource management strategies with their specific resource base. In some cases, farmers will be able to reduce environmental risks while maintaining or increasing economic performance of their whole-farm system. In many cases, however, farmers may have to deal with tradeoffs between economic and environmental consequences of management alternatives. Some farmers may be willing to settle for a whole-farm plan with higher levels of environmental risks to achieve higher levels of financial performance. Others may be willing to tolerate lower economic returns or higher financial risks to reduce environmental risks. Others may continue to explore alternatives until they have all environmental and economic indicators showing relatively low risk outcomes, or they will not farm. These choices are to be made by the individual farmer.

The PLANETOR program allows farmers, extension workers, private consultants, and others who work with farmers to integrate information from a wide variety of sources using a format that is practical and useful at the farm level. However, PLANETOR will not provide a farmer with a recipe for success. PLANETOR is only a tool to facilitate the planning and management tasks of a good farm manager. Farmers who choose an alternative to their current system should be advised to gather all available information before adopting a new farming enterprise or practice. They should talk to other farmers who have experience with the practice under consideration. They also should visit other farms where the practice is used before they change their own operation, and they should work into any new system slowly so they can learn as they go.

Potential for horticulture

The PLANETOR program is probably more user friendly for farmers on traditional midwestern state grain and livestock farms. However, a great deal of attention has been given to making PLANETOR 2 useful to producers of horticultural crops, cotton, peanuts, and other crops less common in the midwestern states. Some terminology in the program, such as animal units and grain and hay equivalents used to balance feed production and use, may be unfamiliar to those without livestock operations. Some of the budgeting procedures may seem a bit cumbersome to producers of horticultural crops who produce more than two crops a year on one field or have harvesting and marketing costs that depend on yield levels and may exceed all other costs combined. However, a little imagination and creativity should make PLANETOR useful on most any type of agricultural operation. The same field could be entered as two fields with half the acres for the same year, allowing four crops to be budgeted rather than two. Market prices may be entered as prices net of harvesting and marketing costs when such costs are yield dependent.

Menus for enterprise budgets, machinery, fertilizers, and pesticides are more complete for grain and livestock than horticultural crop production. An effort has been made to include most pesticides used on horticultural crops, but the PLANETOR machinery pick list is dominated by equipment used on feed and food-grain operations. Much of the research underlying environmental impact assessment in PLANETOR was carried out under conditions typical oflarge, extensive, row-crop operations. Questions can be raised regarding the transferability of such research to smaller, intensive horticultural operations.

PLANETOR should be particularly useful to horticultural producers in assessing the overall profitability and financial risks in diverse, complex operations that are particularly difficult to assess using traditional planning methods. PLANETOR can track individual performance and complex interactions among a large number of enterprises over relatively long rotation sequences. Environmental indicators may be considered a bonus of the process when using PLANETOR to plan or revise such operations.

The PLANETOR program will not ensure a more profitable or more environmentally sound system for horticultural producers or for any other user. However, it will allow producers to evaluate the potential impacts of alternative technologies and strategies within the context of their particular situation. PLANETOR allows producers to integrate a wide range of research-based information without doing all the research and testing on their own. The PLANETOR program will not ensure success; however, it can be a valuable tool for helping growers move toward more environmentally sound and economically viable production systems that are sustainable in the long run.

For information regarding availability of PLANETOR 2.0, contact the Center for Farm Financial Management, 249 Classroom Office Building, University of Minnesota, St. Paul, MN 55108, phone (800)234-1111.

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