VII. Looking to the Future

Whole Farm Planning

Chesapeake Bay Preservation Act

Randy Shank

The Chesapeake Bay Preservation Act requires that water quality plans be written for tracts of farm land that are within the “Resource Management Areas” as designated by local governments and as required by the act. It is anticipated that by 1995, over 20,849 agricultural tracts will have need of water quality plans as required by the Chesapeake Bay Preservation Act.

Water Quality Plans have three components; erosion control, nutrient management and pest management. During 1992, there were 306 water quality plans approved by local soil and water conservation districts (SWCD). Each one of these plans had a pest management component that was written by the local extension agent. To date, 19,684 acres of land have water quality plans (and thus pest management plans) written for them.

The program being conducted in response to the Chesapeake Bay Preservation Act involves 45 localities in eastern Virginia. Albemarle County has adopted the program as well. There are ten “water quality specialists” who are employed by the local SWCD’s and who are funded through a grant from the Chesapeake Bay Local Assistance Department. These “water quality specialists” coordinate the program locally and work in a cooperative relationship with the Soil Conservation Service, the Virginia Department of Conservation and Recreation-Division of Soil and Water Conservation (DCR-DSWC), and Extension.

One goal of the IPM program associated with the Chesapeake Bay Program is to get IPM adopted and implemented on the farm. Through funding from the Toxics Subcommittee of the Chesapeake Bay Program (EPA) and from DCR-DSWC, three area IPM agents are employed by Virginia Cooperative Extension to coordinate and implement IPM programs in their region. Currently, the IPM positions are located in Essex County, Nelson County, and Orange County. These IPM agents work with local extension agents and farmers on field demonstrations, scouting programs and pest management planning.

CROPS

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CROPS (Crop ROTation Planning System) is a comprehensive computer decision-aid for farm planning, designed to help farmers who want to move toward more sustainable farming to comply with soil conservation guidelines, to manage nutrients and pesticides safely, or to ensure that their farming operation remains profitable in the long run. CROPS uses knowledge about soils, geography, weather, agronomics, economics, and environmental risks to suggest multi-year, whole-farm crop rotation and tillage plans for specific farms. Inherent in these plans are recommendations for nutrient management, pest management, and soil conservation strategies. In effect, by using CROPS, a farmer can generate a single farm plan that meets farm production and economic goals, the soil conservation standards of the Soil Conservation Service (SCS), the nutrient management recommendations of the Division of Soil and Water Conservation (DSWC), and the pest management goals of the Cooperative Extension Service.

The Need for CROPS

Whether motivated by a desire to farm more in concert with the environment or by recent legislation requiring that farm operations meet environmental standards to receive subsidies, farmers are inexorably moving toward more sustainable agricultural practices to stay in business. With this shift comes more intensive management and more complex planning. At the core of sustainable agriculture is the notion of cycling—taking advantage of natural inputs to agroecosystems (utilizing animal manures for fer-
tilizer, reducing nitrogen demand by adding legumes to crop rotations, managing pests by host elimination) rather than relying on external inputs—and cycling means dynamism. Farmers must rotate crops, tailor tillage methods to specific fields, install and care for grass buffers and waterways, employ integrated pest management and biological controls for pests. All these things make the farm operation more complicated and make planning more difficult.

In spite of the difficulties their actions are imposing on the practical side of farming, legislatures continue to demand that farmers adopt more environmentally sound practices. The end results of this kind of legislation are requirements that farmers file resource management plans if they want to participate in government farm programs or, perhaps, if they want to continue to farm at all. In Virginia, many farmers must file approved soil conservation, nutrient management, and pest management plans if they want to farm environmentally sensitive land. Federal and state agencies have been designated to help farmers formulate such plans and ensure that farmers manage natural resources responsibly by following these plans. In practice, these agencies actually develop the plans for the farmers.

All this leads to an unacceptable situation. Farmers are losing control of their farming operations because they are being told what crops to plant where and how to manage them. Agencies traditionally devoted to helping farmers are now regulating them. All this might be all right if the plans farmers are being given are acceptable—but they are not. Farm resource management plans are being generated by separate agencies dealing with separate resources, and they are being developed at the field level, not the farm level, without provisions for economic analysis. This has occurred by necessity; these plans are being developed by individuals without tools to help them deal with the vast increase in planning complexity inherent in environmentally sound agriculture. Not surprisingly, more and more farmers are realizing that their annual production and economic goals are not being met by the plans they are being told to follow.

**The Solution**

Ideally, farmers would develop a single farm plan that employs environmentally sound farming practices to achieve an acceptable profit. Such a plan should meet the goals of the agencies responsible for protecting individual resources (the soil, ground water, the air), while also being acceptable to the farmer. These are the goals of sustainable agriculture, so the problem can be restated as, how can we help farmers make the transition to sustainable agriculture, with all its complexity, dynamism (due to crop rotation), and intense management?

The CROPS system was designed to do just that. It is based on the implementation of crop rotation, but also employs reduced tillage methods and environmentally sound nutrient and pest management strategies in the farm plans it generates. Relying on estimates of yields, costs, and returns based on soils, topology, and location, CROPS suggests whole-farm plans to the farmer and includes economic and environmental analyses of that farm plan. The farmer concentrates on what crops to grow, how much income the farm must generate, and how much emphasis should be placed on environmental versus economic goals. The system then suggests alternative ways to achieve those goals (if they are possible to achieve).

**What Makes Whole-Farm Planning So Difficult?**

Conceiving of the CROPS system and bringing it to fruition are two separate processes. Developing a planning system that can deal with all the complexity of the whole-farm, multi-year, multi-objective planning problem has been extremely difficult and has stretched the limits of our computing power and knowledge. Consider what is involved on a particular farm. Each time you change a crop, a tillage method, the timing of an operation, the pesticide used to control a pest, the sequence of a rotation, etc., it constitutes a new plan with different risks of environmental pollu-
tion and/or economic profitability. This leads to an enormous combinatorial explosion of potential plans. On even a small farm with just five fields and ten possible two- and four-year crop rotations, there are about two billion different four-year plans from which to choose! At one second per plan evaluation, it would take more than 60 years just to examine each plan, 90 years if you sleep. Clearly, a computer-based solution is needed and even with high-speed computers, the complexity is nearly prohibitive.

**CROPS—An Expert System Approach**

CROPS deals with this complexity by using the same kind of smart technology now used by the Navy to coordinate its Pacific fleet operations and by airports to develop flight schedules. Artificial intelligence techniques allow the system to take advantage of all kinds of information relevant to farm planning, from numerical models of soil erosion to qualitative estimates of the risks of pesticide leaching. The problem is dealt with as a set of constraints that limit the acceptable possible alternatives available for a farmer to achieve his or her goals. CROPS considers:

- **Soil Erosion:** CROPS identifies highly erodible land (HEL) and uses the Universal Soil Loss Equation (USLE) to estimate soil erosion rates. These rates must not exceed the rate of soil formation for highly erodible fields.
- **Crop Rotation:** CROPS includes conventional and alternative crop rotations compiled by consulting with experts in agronomy, sustainable agriculture, soil science, and integrated pest management. When possible, the plans suggested by CROPS tend to promote soil fertility and structure, reduce weed and pest problems, and adopt a lower-input approach.
- **Tillage:** Minimum tillage methods are recommended to promote soil structure and organic content.
- **Reducing Risks from Pesticide Applications:** CROPS tries to avoid suggesting crop rotations and management schemes that would result in pest problems controllable only by using high risk pesticides, i.e., those that would leach or run off into ground and surface waters.
- **Nutrient Management:** CROPS avoids the assignment of rotations and practices that promote nitrate leaching and surface runoff.
- **Integrated Pest Management (IPM) Strategies:** Pest management schemes that rely on crop rotation and cultural practices help reduce the need for pesticide applications.
- **Annual Production Goals:** Farmers can specify target acreages and/or crop yields (e.g., to meet base acreage or livestock feed requirements).
- **Economic Constraints:** CROPS suggests only plans that meet the fixed cost, debt payments, and cash income requirements of the farm enterprise.

**The Output**

CROPS provides many textual and graphical summaries of the farm plan over time. Economic and production summary tables are available, as are color-coded field maps to indicate crops and rotations, environmental risks, and improvements anticipated through adopting the plan suggested. CROPS can also provide a printed soil conservation plan for all highly erodible crop land and will soon provide a printed nutrient management plan as well.
CROPS represents an important planning tool in agriculture whose development and extension should benefit both the farmers and environmental agencies concerned with monitoring the management of our natural resources. CROPS could be used by a farmer to experiment with different planning goals, to develop a soil conservation plan, to monitor environmental risks, or to help make a transition to sustainable agriculture.

The systems now runs on Apple Macintosh computers and includes information needed by most crop and crop/livestock operations in the western parts of Virginia, including the Shenandoah Valley. By the end of 1993, we expect to have versions of CROPS running on Intel-based PC’s and UNIX workstations. CROPS has been developed by the Information Systems & Insect Studies Lab at Virginia Tech, in association with the members of the Departments of Entomology, Agricultural Economics, Crop, Soil & Environmental Sciences, and Computer Science at Virginia Tech, and Virginia & North Carolina Farmers. CROPS development and implementation have been funded by grants and contracts from: the USDA/CSRS Southern Region Sustainable Agriculture Research and Education Program (SARE, formerly LISA); the Soil Conservation Service, through Virginia SCS; the Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation; and the Virginia Corn Board.

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Crop Management Associations

Joe Hunnings

Crop Management Associations (CMA) are non-profit enterprises, organized and directed by farmers and supported by Cooperative Extension. The ultimate goal of a CMA is to promote more economical, efficient and environmentally sound crop production practices.

Farmers require a great deal of technical information to make sound crop management decisions. Due to the size and complexity of present day farms, most operators don’t have time to gather the necessary information. Obtaining the right information at the right time and interpreting it correctly are critical to growing crops efficiently for a profit.

Crop Management Associations employ technicians to provide members an array of year-round information gathering services. Services can include the following:

**Scouting**: Insects, weeds, diseases, stored grain pests, and temperature monitoring.

**Sampling**: Soil, manure, plant tissue, forage and feed, nitrate quick test.

**Crop Management Planning**: Crop rotation plans, nutrient management plans, and pest management plans.

**Crop Management Reports**: Field history of cultural and chemical practices, soil tests, pest infestations.

**Yield Checks**

**Calibration**: Of sprayers, fertilizer and manure spreaders.

CMA staff could work closely with Extension agents and provide information to members based on land grant university based research. CMA producers use crop management information to partially substitute for and optimize the use of crop inputs such as pesticides, purchased fertilizers, labor, and fuel. Thus, producers use crop inputs more efficiently and increase their profitability while protecting the environment.