
Farm Smart 2000

A Decision Support System For Crop Production

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Abstract

Farm Smart 2000 is a decision *support system*¹ (DSS) for managing crop production on the Prairies. Farm Smart 2000 provides “single-window” access to 3 different tiers of decision support utilizing the Internet, *expert systems*² and integrated multiple *agents*³. Farm Smart 2000 provides support for most management aspects of crop production including variety selection, machinery selection, planting, crop rotations, fertility, all facets of weed management, disease management, residue management, harvesting, soil conservation, and economics for the crops of wheat, canola, barley, peas, and flax.

In its most sophisticated tier of decision support, Farm Smart 2000 utilizes multiple agents, integrating them such that they cooperate together to solve complex interrelated crop production problems. A global structure is used for achieving the required communication and coordination among the agents resulting in an “open system”, enabling Farm Smart 2000 to easily extend its problem-solving capabilities by integrating additional agents. Farm Smart 2000 has been developed using a *bottom-up*⁴ problem-solving approach, where underlying on-farm data and agronomic knowledge are the driving forces behind farm-specific problem and planning solutions. To accomplish this, a customized global production Record Keeping System has also been developed.

Introduction

In the past 25 years, farming has progressed from what can be considered elementary cropping systems of fallow and cereal crops, to sophisticated and complex conservation farming and direct seeding systems. In addition, in an effort to adapt to changing markets and farm conditions, Prairie producers are adopting new crops and new cropping systems. Changing farming systems can be a complex issue, involving many decisions which affect the viability of the farm. Furthermore, this progression of cropping systems has necessitated increased levels of decision support because of their ever increasing complexity. The requirement for information is often satisfied through collection from many sources including Internet sites, government publications, farm management specialists and agronomists. In order to effectively utilize this information, it must be integrated into an overall farm management plan. Often the expertise to assist in this process is limited, due to the time constraints of farm management specialists.

¹A *decision support system* is broad in scope, solving problems which span over several knowledge or problem areas.

²An *expert system* is a computer program that solves complicated problems, within a specific knowledge or problem area, that would otherwise require extensive human expertise.

³An expert system which is integrated with other expert systems within a DSS is called an *agent*.

⁴A *bottom-up* problem-solving approach is developed by determining solutions to simpler problems (i.e. sub-problems) and extending them to more complex problems in an incremental manner.

Computer assisted decision processes are a method of assisting farm managers in their farm management process. The requirement to substitute knowledge for labour continues to intensify and decision support systems will play a large role. Economics has, and will continue, to play a major role in matching the correct cropping systems to the available land base. Decision support systems to support these complex diversified cropping systems cannot be developed in isolation, but rather must have the collaborative effort of many, in order that knowledge may be integrated.

Farm Smart 2000 is a computerized decision support system for helping manage crop production on the prairies. It was developed under the Parkland Agriculture Research Initiative (PARI) through collaboration with governments, universities, private industry, and producer associations across the prairies. Utilizing software engineering techniques and methodologies, including artificial intelligence, Farm Smart 2000 provides farm and field level decision support. Farm Smart 2000 provides support for farm management aspects such as variety selection, planting, crop rotations, fertility, weeds, disease, residue management, harvesting, soil conservation-and economics, for crops wheat, canola, barley, oats, and flax.

Farm Smart 2000 Features

Although information and knowledge is available from numerous sources in various formats, Farm Smart 2000 employs a multi-tier approach as illustrated in Figure 1. It provides information and knowledge through its Internet site, individual software packages (i.e. expert systems) and with a fully integrated system in which farm management knowledge is interrelated with agronomic information to provide decision support.

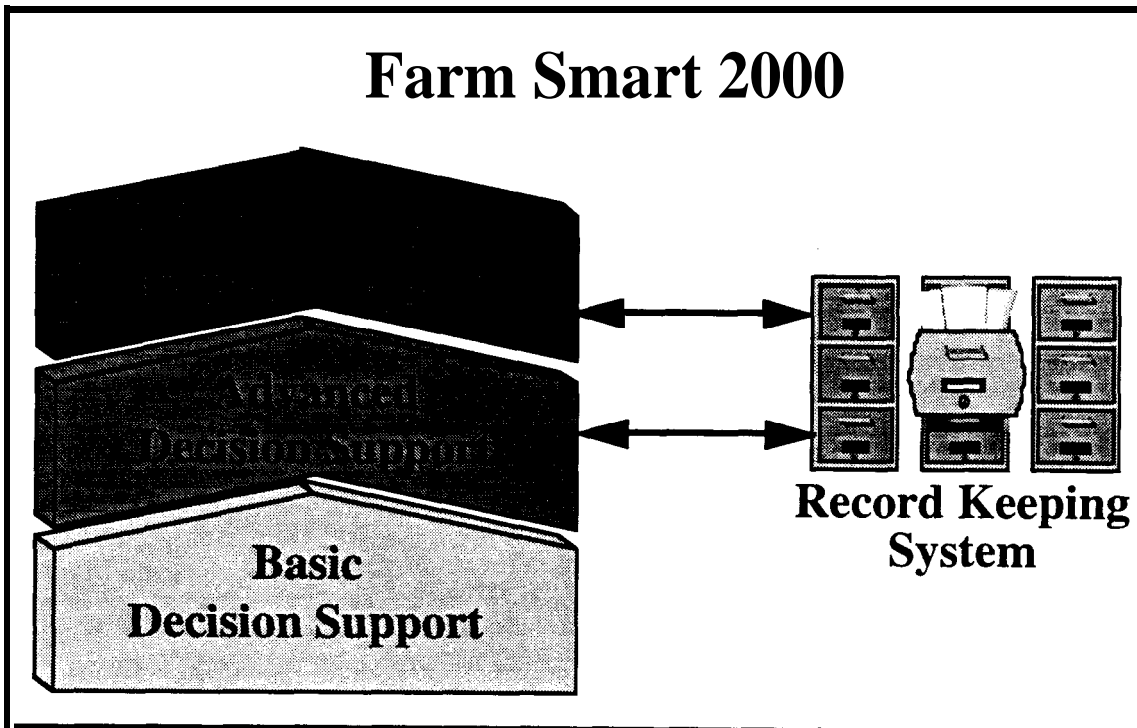


Fig. 1. Farm Smart 2000 Tiers of Decision Support

Basic Decision Support

Tier-1 consists of “Basic Decision Support” based on several types of information, many published, and is accessible through the Prairie Agriculture Research Initiative Decision Support System (PARI DSS) web site at paridss.usask.ca. The PARI DSS web site currently provides various information and knowledge including:

- the PARI FactBook, describing many agricultural systems, techniques and related facts
- a Data Dictionary providing the description and documentation of research databases, datasets, models and reports that are available
- newsletters and bulletins
- notice of regional events
- web pages for partners including Saskatchewan Soil Conservation Association (SSCA), Indian Head Agricultural Research Foundation (IHARF), and Alberta Reduced Tillage Initiative (ARTI)
- a recent addition is the Agri-Food Innovation Fund Specialized Crop Production pages

Advanced Decision Support

Tier-2 provides “Advanced Decision Support” consisting of individual expert systems which provide support and expertise for specific areas of concern. Some of these expert systems have access to a global record keeping system while others have no need for access. The expert systems available are listed below. It is being determined which expert systems will be made accessible in Version 1.0 of Farm Smart 2000.

- SoilCrop: An expert system for Soil Conservation Crop Productivity Relationships
- Crop Variety Select: An expert system for Selecting Canadian Prairie Crops
- PARMS and RTDS: Expert systems for planting and residue management
- AFFIRM: A fertility expert system called the Alberta Farm Fertilizer Information and Recommendation Manager
- WinCPP: Prairie Crop Protection Planner expert system
- Weed Management Planner: An expert system consisting of 6 modules including a Problem Weed Module, Long Term Management Module, Weed Identification, Weed Survey Module, an Economic Threshold module, Weed Density Map module and a link to the Prairie Crop Protection Planner.
- ASK: An Agronomic Soil Conservation Knowledge Base
- STARRT: An expert system; Stepwise Technology Adoption Risk Reduction Tool
- ASSESS: An expert system for salinity problems
- DICTA: An expert system for diagnosing crop diseases
- CCS: An expert system for Climate Classification

Interrelated Decision Support

Tier-3 is unique among current decision support systems, providing an interrelated approach and utilizing the latest artificial intelligence methodologies. Farm Smart 2000 integrates multiple software packages in such a manner that they cooperate to solve complex interrelated crop production problems. This cooperation is achieved through an open architecture allowing individual software to interact with a controlling software. This controlling software manages the transfer of data between software, and allows for the integration of new software to enhance problem solving of complex issues. Both user-directed and data-directed control factors have been incorporated to provide the effective coordination of the problem-solving software allowing Farm Smart 2000 to dynamically alter the problem-solving process when necessary. There are five agents and knowledge sources currently integrated in tier-3 including the Weed Management Planner, Crop Protection Planner, PARMS, Crop Variety Select, and Crop Rotation.

The On-Farm Record Keeping System

On-farm data and basic agronomic knowledge are the driving forces behind the problem-solving approach and planning solutions. A customized crop production Record Keeping System has been developed as an important component of Farm Smart 2000. Briefly, the on-farm record keeping system provides:

- the capability to store and manipulate data by fields or groups of fields
- creation and control of management units for precision or landscape farming systems
- inventory control for crop inputs, production, assets and liabilities
- report generation by farm, field, groups of fields, crop, or field practices

Strengths of Farm Smart 2000

Farm Smart 2000 provides “single-window” access to information and knowledge at any time. Farm Smart 2000 is accurate because it is farm specific, utilizing the producer’s own data in combination with knowledge from scientists and extension specialists when analyzing solutions and making recommendations. A major strength of Farm Smart 2000 is diversity, with its many various knowledge sources, not just one, resulting in a holistic system. Farm Smart 2000 is designed as an “open system” to facilitate technology transfer from the research lab and plots to the producer. It transforms research data and results into information and knowledge and delivers it to the end-user. The open architecture design makes it “open” to other issues by adding, deleting and/or updating knowledge sources and agents without re-engineering the entire system, thereby increasing its decision-support capabilities and credibility. Although the PARI DSS has a set of expert system development guidelines, there are no stringent standards that must be followed. Hence, collaborators have the freedom to develop expert systems that fulfill their own needs first and then can be incorporated into the PARI DSS for transfer to the end-user with usually only a few modifications. Farm Smart 2000’s integration of computer software and agronomic knowledge enhances overall decision support capabilities, while simplifying producer’s access to information, knowledge and decision support.

Conclusions

Farm Smart 2000 avails of credible knowledge and information from human experts and published material. By adding value to the producer’s data, Farm Smart 2000 helps the producer make decisions or provides a choice that is specific to the producer’s own farming operation. Through the integration of data, expert systems, and intelligent knowledge bases and databases, Farm Smart 2000 provides interrelated decision support.

The PARI DSS Web site continues to be enhanced and updated as is the case with most successful sites. The development of all the expert systems is complete. The development of the interrelated component is currently underway. A beta version of Farm Smart 2000 is available and is being evaluated and validated this growing season by producers and agricultural specialists.

Future Directions

From the onset of Farm Smart 2000, it has been desirable to incorporate spatially related data with digitized maps to provide easy and more meaningful data management. The database structures within Farm Smart 2000’s Record Keeping System, provide storage of management units which are units of land within various fields that can be grouped together according to a common management practice. Hence, not only does this capability enable specific data to be stored and related to small similar units of land for on-farm management purposes, it also makes Farm Smart 2000 adaptable to precision or landscape farming needs.

Incorporating the integration and interaction with GPS and GIS technologies in Farm Smart 2000 allows the quantification and mapping of spatial variation. GPS and GIS provide the capability to define and manage much smaller units than the current field size. Variable rate application technology provides the capability to automatically adjust nutrient and pesticide inputs to match the requirements of these smaller management units. The incorporation of spatially related data would provide greater flexibility in representing data by allowing data input and output to be graphically implemented.