

# Decision-making support for Czech farmers

## *Podpora rozhodování pro české zemědělce*

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**Abstract:** The article provides an overview of software applications designed and available for Czech farmers according to two criteria: business function within which the decisions are facilitated, and type of decision-making support the application is built on. The survey shows that most of the applications have a rather narrow focus facilitating only one business function, often only part of it, and that the applications are mostly data-driven, while the vast expertise in the field of agriculture is somewhat neglected.

**Key words:** decision-making, software applications for decision-making

**Abstrakt:** Článek je zaměřen na hodnocení softwareových aplikací na podporu rozhodování, které byly vytvořeny a jsou dostupné českým zemědělci. Tyto aplikace jsou hodnoceny ze dvou hledisek: z hlediska funkcionálního a hlediska typu systému na podporu rozhodování, na kterém je aplikace vybudována. Poznatky ze srovnávání naznačují, že aplikace na podporu rozhodování pro zemědělce jsou většinou úzce zaměřeny na jednu funkcionální oblast podniku nebo dokonce na její pouhou část, a jsou převážně založeny na datech, aniž by byly využity rozsáhlé znalosti v oboru zemědělství.

**Klíčová slova:** rozhodování, softwareové aplikace na podporu rozhodování

## INTRODUCTION

Knowledge and information are the key to correct farm management decisions. Integrated farm management systems that emphasize appropriate decision-making are often information intensive and depend heavily on accurate and timely information for field implementation by practitioners. Additionally, it is critical to strengthen the communication links between researchers and extension professionals and their clientele to expedite multi-way exchange of information and technology transfer. In addition, researchers and extension specialists need the most up-to-date information to design new projects and to set future research goals and directions.

There is already a large volume of useful farming information available on the Internet, however, the information is scattered all across the globe. These resources range from topics such as pest identification, biology, veterinary recommendations, stock market information, tailor-made weather forecasts to complex modelling and systems analysis. As awareness of the Internet increases worldwide, more people are participating not only as users of the information but also as creators of new information; as a consequence, the number of both farmers supporting Internet servers and clients is increasing rapidly, perhaps slightly lagging but generally accompanying the exponential growth of the internet itself.

The transfer of research and extension information to farmers plays the key role in the adoption of modern farm management techniques. Electronic communication provides an effective multidirectional exchange of information. Electronic extension systems provide 24-hour access to an inquirer of specific information to be used in planning and decision support. In fact, it is rapidly changing the way individuals exchange information and make decisions. Now it is possible for extension services and applied researchers to deliver and receive information to and from much larger audiences via fax (both Internet- and telephone-based document delivery systems), multimedia programs, e-mail, and the web. The emphasis is, however, beginning to shift from traditional one-way flow of information from research, then to extension, and finally to end-users of information, to the more egalitarian process where the pool of total experience and knowledge available in the community, from growers, industry, research and extension, is readily exchanged through electronic means, focused learning workshops, and increased on-farm applied research.

The issues described above are dealt with in the research project “Virtual support for farmers decision-making” QF3259 and QF 3200 “Expert Systems to Support Decision-making in Management of Technology and Work processes”, both financed by National Agency for Agricultural Research.

The entry was elaborated as a framework of project “Virtual support for farmers decision-making” QF3259 and QF 3200 “Expert Systems to Support Decision-making in Management of Technology and Work processes” both financed by National Agency for Agricultural Research .

The objectives of the paper are twofold:

- to provide a review of decision support systems and
- to compare decision support systems design specifically for farmers use in the Czech Republic.

### Characteristics of DSS

In the late 1970's a number of companies developed interactive information systems that used data and models to help managers analysed semi-structured problems. These systems were called Decision Support Systems (DSS). DSS can be designed to support decision-makers at any level of an organisation. They can support operations, financial management and strategic decision-making. DSS are both off-the-shelf and tailor-made systems. DSS may support a small group of managers using a single personal computer or a large group of managers in a networked client-server environment. These latter systems are often called Enterprise-Wide DSS.

Although Decision Support Systems have many connotations, based on Steven Alter's (1980) pioneering research the following three major characteristics can be defined:

1. DSS are designed specifically to facilitate decision processes,
2. DSS should support rather than automate decision-making,
3. DSS should be able to respond quickly to decision-makers changing needs.

C. Holsapple and A. Whinston (1996) identified five broad characteristics of DSS:

1. A DSS includes a body of knowledge that describes some aspects of the decision-maker's world that specifies how to accomplish various tasks, that indicates what conclusions are valid in various circumstances and so forth.
2. A DSS is able to acquire and maintain descriptive knowledge (i.e. record keeping) and other kind of knowledge as well (i.e. procedure keeping, rule keeping, etc.).
3. A DSS has an ability to present knowledge on an ad hoc basis in various customized ways as well as in standardized reports.
4. A DSS has an ability to select any desired subset of stored knowledge for either presentation or deriving new knowledge in the course of problem recognition and/or problem solving.
5. A DSS can interact directly with a decision-maker or participant in a decision in such a way that the user has a flexible choice and sequence of knowledge management activities.

There is a number of other sources, which might contribute to further explanation of concept of decision support systems, however for the purpose of this paper the following classification have been found useful to introduce practical DSS modifications.

## Decision Support Systems

*Communications-Driven DSS* is a type of DSS that emphasizes communications, collaboration and shared decision-making support. A simple bulletin board or threaded email is the most elementary level of functionality. Groupware is often defined as "software and hardware for shared interactive environments" intended to support and augment group activity. Groupware is a subset of a broader concept called Collaborative Computing. Communications-Driven DSS enable two or more people to communicate with each other, share information and co-ordinate their activities. Group Decision Support Systems or GDSS is a hybrid type of DSS that allows multiple users to work collaboratively in group work using various software tools. Examples of group support tools are: audio conferencing, bulletin boards and web-conferencing, document sharing, electronic mail, computer supported face-to-face meeting software, and interactive video.

Communications-Driven DSS software has at least one of the following characteristics:

- Enables communication between groups of people
- Facilitates the sharing of information
- Supports collaboration and coordination between people
- Supports group decision tasks.

Key research issues for Communications-Driven DSS include impacts on group processes and group awareness, multi-user interfaces, concurrency control, communication and coordination within the group, shared information space and the support of a heterogeneous, open environment, which integrates existing single-user applications. Communications-Driven Decision Support Systems are often categorized according to the time/location matrix using the distinction between same time (synchronous) and different times (asynchronous), and between same place (face-to-face) and different places (distributed).

*Data-driven DSS* is a type of DSS that emphasizes access to and manipulation of a time-series of internal company data and sometimes-external data. Simple file systems accessed by query and retrieval tools provide the most elementary level of functionality. Data warehouse systems that allow the manipulation of data by computerized tools tailored to a specific task and setting or by more general tools and operators provide additional functionality. Data-driven DSS with On-line Analytical Processing (OLAP) provides the highest level of functionality and decision support that is linked to analysis of large collections of historical data. Executive Information Systems (EIS) and Geographic Information Systems (GIS) are special purpose Data-Driven DSS.

A Data Warehouse is a database designed to support decision-making in organizations. It is batch updated and structured for rapid online queries and managerial summaries. Data warehouses contain large amounts of data. A data warehouse is a subject-oriented, integrated, time-

variant, non-volatile collection of data in support of management's decision-making process.

On-line Analytical Processing (OLAP) software is used for manipulating data from a variety of sources that has been stored in a static data warehouse. The software can create various views and representations of the data. For a software product, to be considered an OLAP application it must contain three key features: 1. multidimensional views of data; 2. complex calculations; and 3. time oriented processing capabilities.

Executive Information Systems (EIS) are computerized systems intended to provide current and appropriate information to support executive decision making for managers using a networked workstation. The emphasis is on graphical displays and an easy to use interface that present information from the corporate database. They are tools to provide canned reports or briefing books to top-level executives. EIS offer strong reporting and drill-down capabilities.

A Geographic Information System (GIS) or Spatial DSS is a support system that represents data using maps. It helps people to access, display and analyse data that have geographic content and meaning.

*Document-Driven DSS* is a relatively new field in Decision Support. Document-Driven DSS is focused on the retrieval and management of unstructured documents. Documents can take many forms, but can be broken down into three categories: Oral, written, and video. Examples of oral documents are conversations that are transcribed; video can be news clips, or television commercials; written documents can be written reports, catalogues, and letters from customers, memos, and even e-mail.

It is estimated that American businesses store almost 1.3 trillion documents, which can use up to 50% of their floor space. Yet only 5 to 10 percent of these documents are available to managers for use in decision-making. Unfortunately documents are not standardized in a uniform pattern or structure. Managers and IT/IS staff need a way to transform these documents into usable formats that can be compared and processed to support decision-making. New information technology and software is making this concept into a reality (Fedorowicz 1996).

*Knowledge-Driven DSS* can suggest or recommend actions to managers. These DSS are person-computer systems with specialized problem-solving expertise. The "expertise" consists of knowledge about a particular domain, understanding of problems within that domain, and "skill" at solving some of these problems. A related concept is Data Mining. It refers to the class of analytical applications that search for hidden patterns in a database. Data mining is the process of sifting through large amounts of data to produce data content relationships. Tools used for building Knowledge-Driven DSS are sometimes called Intelligent Decision Support methods.

*Model-Driven DSS* emphasize access to and manipulation of a model, for example, statistical, financial, opti-

misation and/or simulation models. Simple statistical and analytical tools provide the most elementary level of functionality. Some OLAP systems that allow complex analysis of data may be classified as hybrid DSS systems providing both modelling and data retrieval and data summarization functionality. In general, model-driven DSS use complex financial, simulation, optimisation or multi-criteria models to provide decision support. Model-driven DSS use data and parameters provided by decision makers to aid decision makers in analysing a situation, but they are not usually data intensive, that is very large data bases are usually not need for model-driven DSS. Early versions of Model-Driven DSS were called Computationally Oriented DSS or model-oriented or model-based decision support systems.

Key Terms:

- *Decision Analysis tools* – DA tools help decision makers decompose and structure problems. The aim of these tools is to help a user apply models like decision trees, multi-attribute utility models, bayesian models, Analytical Hierarchy Process (AHP), and related models.
- *Forecasting Support System* – A computer-based system that supports users in making and evaluating forecasts. Users can analyse time series of data.
- *Linear Programming* – A mathematical model for optimal solution of resource allocation problems.
- *Simulation* – A technique for conducting one or more experiments that test various outcomes resulting from a quantitative model of a system.

*Spreadsheet-based DSS Resources* Both Model-Driven and Data-Driven DSS can be built using spreadsheets. Solver add-ins is popular for building Model-Driven DSS based on optimisation models. Small-scale, Data-Driven DSS can be built using Pivot table capabilities.

*Web-Based DSS* deliver decision support information or decision support tools to a manager or business analyst using a "thin-client" Web browser like Netscape Navigator or Internet Explorer that is accessing the Global Internet or a corporate intranet. The computer server that is hosting the DSS application is linked to the user's computer by a network with the TCP/IP protocol. Web-Based DSS can be communications-driven, data-driven, document-driven, knowledge-driven, model-driven or a hybrid. Web technologies can be used to implement any category or type of DSS. Web-based means the entire application is implemented using Web technologies; Web-enabled means key parts of an application like a database remain on a legacy system, but the application can be accessed from a Web-based component and displayed in a browser.

## RESEARCH OUTCOMES

With respect to specific requirements on decision-making in farming, software application designed for the use

Table 1. List of software applications according to business functions facilitated

Software application	Producer	Production		Operations management	Business administration	Property management
		plant	animal			
Evidentiary card	AG info					
Property claim management	AG info					
Shares	AG info					
Land and Building Management	AG info					
S-maps	AG info					
Property Tax	AG info					
Green oil	AG info					
Agronomist	AG info					
Cattle	AG info					
Cattle (meat breeds)	AG info					
Reporting	AG info					
Pigs	AG info					
Pasture Diary	AG info					
Livestock Wholesale	AG info					
AGRO-EVIDENCE	AGRETA Žamberk					
Cattle Nourishment	Agrokonzulta Žamberk					
Optimisation of feeding mixtures	Agrokonzulta Žamberk					
AGROKROM	ZVÚ Kroměříž					
Agrosoft pigs	Agrosoft Tábor					
Agrosoft feeding ratio	Agrosoft Tábor					
MAIS	Alcedo					
Database of businesses	Alcedo					
PC Cattle	Algo Hradec Králové					
ZEMAN	BM servis					
FarmInfo	CompAct Bohemia					
GC Modifications MS Windows	Geocentrum					
Map 3	Gepro					
Katavis	Ivar					
MIKROREP	Konfirm					
PLEMEX	Konfirm					
KRMEX	Konfirm					
Book of plots	Leading farmers					
Reports	Leading farmers					
Green oil	OK data					
Breeding	PLEMO					
Livestock	Profex					
Land book	Profex					
Property share book	Profex					
Livestock – version 9.07	Softteam					
KPÚ 4.0.	Topol Software					
MAPOP, HeleTAX, TAX 2003, ORBIS Mapper 32	Topol Pro					for forestry mgt.
Variex – plant protection	Variex					

Table 2. List of software applications according to type of DSS

Software application	Producer	Knowledge-driven DSS	Combined DSS	Data-driven DSS
Evidentiary card	AG info			•
Property claim management	AG info			•
Shares	AG info			•
Land and Building Management	AG info		•	•
S-maps	AG info	•		•
Property Tax	AG info		•	•
Green oil	AG info		•	•
Agronomist	AG info			•
Cattle	AG info	•		•
Cattle (meat breeds)	AG info			•
Reporting	AG info			•
Pigs	AG info	•		•
Pasture Diary	AG info			•
Livestock Wholesale	AG info			•
AGRO-EVIDENCE	AGRETA Žamberk	•	•	•
Cattle Nourishment	Agrokonzulta Žamberk	•	•, S	
Optimisation of feeding mixtures	Agrokonzulta Žamberk	•	•, S	
AGROKROM	ZVÚ Kroměříž	•	•, S	
Agrosoft pigs	Agrosoft Tábor			•
Agrosoft feeding ratio	Agrosoft Tábor		•, S	
MAIS	Alcedo	•	•	•
Database of businesses	Alcedo			•
PC Cattle	Algo Hradec Králové			•
ZEMAN	BM servis	•	S	•
FarmInfo	CompAct Bohemia			•
GC Modifications MS Windows	Geocentrum		•, S	•
Map 3	Gepro			•
Katavis	Ivar			•
MIKROREP	Konfirm		S	•
PLEMEX	Konfirm		S	•
KRMEX	Konfirm		S	•
Book of plots	Leading farmers		S	•
Reports	Leading farmers		S	•
Green oil	OK data		S	•
Breeding	PLEMO		S	•
Livestock	Profex		•, S	•
Land book	Profex		•, S	•
Property share book	Profex			•
Livestock – version 9.07	Softteam			•
KPÚ 4.0.	Topol Software		•, S	
MAPOP, HeleTAX, TAX 2003, ORBIS Mapper 32	Topol Pro			
Variex – plant protection	Variex	•	•, S	

S – DSS is built on specific data (gathered locally), otherwise data available on national level are used

by farmers have been assessed according to the following criteria:

1. Functional criteria – assessment of functional areas in which the application facilitate the process of decision making:
  - a. plant production
  - b. animal production
  - c. operations management
  - d. business administration
  - e. property management (esp. land)
2. Type of DSS – three types of DSS available to Czech farmers among the assessed applications have been identified:
  - a. Knowledge-based DSS
  - b. Data-driven DSS
  - c. Combination of the two focusing on development of tailor made databases working with farm specific data.

Table 1 provides a list of software applications designed to support farmers in their decision-making. It also identifies functional areas facilitated by each of the applications. The research findings have shown the following:

- Most of the applications tend to be function specific (12 supporting plant production decisions, 19 supporting animal production decisions, 11 related to general business operations, 24 support administrative tasks and record keeping, 7 facilitate property management.)
- Only 5 applications cover at least 3 business functions thus providing some user comfort. (Software producer AG Info pursues slightly different strategy: it offers modules with rather narrow focus, however, these can be built into complex system serving all business functions).

Table 2 with the same list of applications identifies types of DSS applied. It is apparent that most of the applications are data-driven, moreover, the applications tend to facilitate record keeping. Their potential to support farmers decision-making is rather low, user comfort is narrowed to technical issues, while the data management is somewhat neglected.

Only 10 of 42 assessed applications or at least have the potential to apply specific knowledge and problem-solving expertise to facilitate decision-making. And

only one third of them support strategic business level decisions.

## CONCLUSIONS

The above rather simple survey has shown that electronic applications to support Czech farmers decision-making tend to be scattered, with a narrow focus on a single business function. The potential of application of vast knowledge available both on farm business level and research/extension level has not been exploited yet. The software applications assessed within the survey are mostly designed for local use, they generally do not allow for the use of multiple sources of data, shared and/or group decision making etc.

The objective of the research project “Virtual support for farmers decision-making”, i.e.

- to enhance competitiveness of farm businesses by development of decision-making skills of managers with the emphasis on quality and effectiveness of decision-making and development of relevant knowledge
  - to support development of decision-making skills in a variety of situations (strategy choice, evaluation of investment, resource allocation, decisions about appropriate technologic, organisational and other processes, evaluation of economic effectiveness of business operations, decisions about suitable personnel policy, etc.)
- is therefore truly justified. The focus on more or less missing knowledge based DSS is the objective of the other research project funded by National Agency for Agricultural Research QF 3200 “Expert Systems to Support Decision-making in Management of Technology and Work processes”.

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