Computers and Electronics in Agriculture 72 (2010) 37–47

Contents lists available at ScienceDirect

Computers and Electronics in Agriculture

journal homepage: www.elsevier.com/locate/compag

Conceptual model of a future farm management information system

C.G. Sørensen[a,*], S. Fountas[b], E. Nash[f], L. Pesonen[d], D. Bochtis[a], S.M. Pedersen[e], B. Basso[c], S.B. Blackmore[g]

[a] *Århus University, Faculty of Agricultural Sciences, Department of Agricultural Engineering, Research Centre Foulum, Blichers Alle 20, 8830 Tjele, Denmark*
[b] *Center for Research and Technology, Institute of Technology and Management of Agricultural Ecosystems, Technology Park of Thessaly, 1st Industrial Area, GR 385 00, Volos, Greece*
[c] *University of Basilicata (UNIBAS), Via N. Sauro, 85-(85100) Potenza, Italy*
[d] *MTT Agrifood Research Finland, Vakolantie 55, 03400 Vihti, Finland*
[e] *Institute of Food and Resource Economics, University of Copenhagen, Rolighedsvej 25, 1958 Frederiksberg C, Denmark*
[f] *Rostock University, Faculty of Agricultural and Environmental Sciences, Institute for Management of Rural Areas, Justus-von-Liebig-Weg 6, 18059 Rostock, Germany*
[g] *King Saud University, Riyadh 11451, Saudi Arabia*

ARTICLE INFO

Article history:
Received 23 July 2009
Received in revised form 26 December 2009
Accepted 17 February 2010

Keywords:
System boundary
Future farm
ICT
Information systems

ABSTRACT

Future and even current European farmers are experiencing that the managerial tasks for arable farming are shifting to a new paradigm, requiring increased attention to economic viability and the interaction with the surroundings. To this end, an integration of information systems is needed to advise managers of formal instructions, recommended guidelines and documentation requirements for various decision making processes. In the EU funded project FutureFarm, a new model and prototype of a new Farm Information Management System (FMIS) which meets these changing requirements will be developed. The aim of the work presented in this paper is to define and analyse the system boundaries and relevant decision processes for such a novel FMIS as a prerequisite for a dedicated information modelling.

The boundaries and scope of the system are described in terms of actors and functionalities, where actors are entities interfacing with the system (e.g. managers, software, databases). In order to analyse the complex and soft systems situations of how to develop an effective FMIS, which effectively meets farmers' changing needs a conceptual model was developed based on soft systems methodology (SSM) and based on information derived from four pilot farms representing diverse conditions across the EU that are partners of the FutureFarm project. The system components were depicted as part of rich pictures and linked to the subsequent derived conceptual model of the overall system as an outline for the development of the specific FMIS requirements. This research has shown the benefit of using dedicated system analysis methodologies as a preliminary step to the actual design of a novel farm management information system compared with other more rigid and activity oriented system analysis methods.

© 2010 Elsevier B.V. All rights reserved.

1. Introduction

The managerial tasks in agriculture are currently shifting to a new paradigm, requiring more attention on the interaction with the surroundings, namely environmental impact, terms of delivery, and documentation of quality and growing conditions (e.g. Sigrimis et al., 1999; Dalgaard et al., 2006). Among other things, this managerial change is caused by external entities (government, public) applying increasing pressure on the agricultural sector to change production from a focus on quantity to an alternate focus on quality and sustainability (Halberg, 2001). This change has been enforced by provisions and restrictions in the use of production input (e.g. fertilisers, agrochemicals) and with a change of emphasis for subsidies to an incentive for the farmer to engage in a sustainable production rather than based solely on production. In general, this change of conditions for the managerial tasks on the farm has necessitated the introduction of more advanced activities monitoring systems and information systems to secure compliance with the restrictions and standards in terms of specific production guidelines, provisions for environmental compliance and management standards as prerequisites for subsidies. Until now, farmers most often have dealt with this increased managerial load by trying to handle manual a mass of information in order to make correct decisions. The increasing use of computers and the dramatic increase in the use of the internet have to some degree improved and eased the task of handling and processing of internal information as well as acquiring external information. However, the acquisition and analysis of information still proves a demanding task, since information

* Corresponding author. Tel.: +45 89991930.
E-mail address: claus.soerensen@agrsci.dk (C.G. Sørensen).

0168-1699/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.compag.2010.02.003

is produced from many sources and may be located over many sites and is not necessarily interrelated and collaborated. The potential of using these data will reach its full extent when suitable information systems are developed to achieve beneficial management practices (Blackmore et al., 2006). McCown (2002) argued that in designing an information system, the emphasis should be placed less on design and more on learning what the farmers do and how they act, and not only letting researchers design their own views of farm management decisions. Additionally, Alvarez and Nuthall (2006) while realizing that the technology in the farm office was not as extensive as they could expect, and while looking at the potential problems pointed out that software developers should understand the farmers and work closer with them and that the resulting systems should be adaptable to suit a range of farmer characteristics. Specific attempts to improve this situation have included the launch of "web-based collaborative information systems", combining different information components (models, data, text, graphics) from different but collaborating sources (e.g. Jensen et al., 2001). However, such systems still have to be enhanced in terms of collaboration with automated acquisition of operational farm data and integration with the overall Farm Management Information System (FMIS).

Advances in precision agriculture, such as positioning systems and sensors for yield and machinery performance monitoring allows farmers to acquire vast amount of site-specific data which ultimately can be used to enhance decision making (Blackmore, 2000; Fountas et al., 2006). Currently, however, this automatically collected data or data by manual registration is not used due to data logistic problems, leaving a gap between the acquiring of such data and the efficient use of this in agricultural management decisions making (Atherton et al., 1999; Pedersen et al., 2004; Reichardt and Juergens, 2009). Costs of time spent managing the data in many cases outweigh the economical benefits of using the data and it seems that future use of wireless communication is gaining much of interest (Speckman and Munach, 2001; Jensen et al., 2007). In all, a refined and integrated solution to analyse and transform the acquired data is needed to improve decision making in the future (Fountas et al., 2005).

With the current transformation of the agricultural sector and the need for better analysis and transformation of the collected data additional demands on the precision and integration of the planning and control functions have occurred, requiring that the planning considers the dynamic interaction of machine, biological, and meteorological conditions (e.g. Kuhlman and Brodersen, 2001). This resembles the industrial adoption of computer-integrated manufacturing (CIM) and it's embracing of customised production followed by dynamic operations planning and control of operations (Nagalingam and Grier, 2008). The industry has demonstrated how effective an integrated control of work operations can be, based on on-line measurements combined with database and decision support information (McCarthy, 1990; Riezebos et al., 2009). This is especially the case in terms of integrating information technology and information systems in supply chain activities (e.g. Gunasekaran and Ngai, 2004).

In this regard, it has been shown that the enhancement of FMIS is more influenced by common business factors and drivers than specific farming activities (Lewis, 1998). Plan generation and execution of farm operations must be linked with a system monitoring effects of actions, unexpected events and any new information that can contribute to a validation, refinement, or reconsideration of the plan or goal. Plans must be presented in a conditional way, such that supplementary knowledge from observations, databases, sensors and tests can be incorporated and integrated to revise the plan in the light of new information. This involves an extended use of modelling and simulation as opposed to providing a generalised optimal solution (Attonaty et al., 1999; Ohlmer et al., 1998).

A detailed structuring and formalisation of physical entities and the information which surrounds the planning and control of farm operations using efficient mobile working units in automated agricultural plant production systems is a decisive prerequisite for the development of comprehensive and effective ICT-system supporting the task management efforts. An increase in the adoption of new information technologies requires that the functional requirements surrounding the use of such technologies must be explicitly specified (Sørensen et al., 2007). By specifying in detail the information provided and the information required for the information handling processes, the design and functionalities of the individual information system components can be derived. That is the case both for on-board machinery information systems as well as for supporting service information systems. The information flows may be contextualised on different levels and in different details (e.g. Fountas et al., 2006; Sørensen et al., 2007; Nash et al., 2009a).

1.1. Concept of management information systems (MIS)

Management information systems (MIS) are an integral part of the overall management system in an purposeful organisation and form parts of tools such as enterprise resource planning (ERP) and overall information systems (IS). ERP is an industry notion for a wide set of management activities which support all essential business processes within the enterprise. The management systems support management activities on all levels as well as provide for the identification of key performance indicators (KPI's) (Folinas, 2007). Typically, ERP is directly integrated with information systems in the form of databases and will often include applications for the finance and human resources aspects of a business.

MIS differs from regular information systems because the primary objectives of these systems are to analyse other systems dealing with the operational activities in the organisation. In this way, MIS is a subset of the overall planning and control activities covering the application of humans, technologies, and procedures of the organisation. Within the field of scientific management, MIS is most often tailored to the automation or support of human decision making (O'Brien, 1999). Fig. 1 shows the conceptual decomposition of the different management systems in an organisation.

By following this conceptual framework and notation, a FMIS is defined as a planned system for the collecting, processing, storing and disseminating of data in the form of information needed to carry out the operations functions of the farm.

1.2. Diversity of European agriculture

The diversity among European agricultural holdings in terms of farm type, size, geography, cultural differences, etc. has a significant impact on the decision making process of the farmers (e.g. Ohlmer et al., 1998). By structuring the complexity of farms, regions, and technologies for information driven crop production, some indications have been derived which illustrate the issue of FMIS transferability within the EU. Likely issues for worldwide transferability may be extrapolated from this analysis.

The total agricultural area within EU-27 is about 183 million hectares – see Table 1. About 85% of the farm holdings have an area below 20 ha (Danish Agriculture, 2007). The farm area structure varies from an average at about 5 ha per farm holding in Greece to 79 ha on average in the Czech Republic. With the accession of Romania and Bulgaria into the European Union, the number of farm holdings has increased significantly due to numerous small farms in Romania. About 32% of the agricultural area is cultivated with cereals of which wheat is the most common crop. About 40% of the cereals are produced in France and Germany. Farming has been less

Download English Version:

https://daneshyari.com/en/article/84766

Download Persian Version:

https://daneshyari.com/article/84766

Daneshyari.com