SHORT COMMUNICATION

AN APPLIED APPROACH TO SUGARCANE HARVEST SCHEDULING DECISION SUPPORT

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Abstract

The authors present an approach to applied decision support research and development for the sugar industry. The approach consists of a series of steps designed to ensure the accuracy, user-friendliness and usefulness of a decision support system for harvest scheduling while keeping development resource demands at a minimum. Brief mention is made of a case used to verify the soundness of the approach, involving actual tactical sugarcane harvest scheduling. The main decision support aim of the study – from a development methodology perspective – is achieving the end-user requirement of complete sensitivity towards multiple complex factors such as the effects of various stalk borers and other pests, lodging, varying degrees of frost, accidental fires and partial harvesting. The stages of the approach are information gathering and initial modelling, first validation and reformulation under end-user cooperation terms, final modelling stage and a final validation stage.

Keywords: sugarcane, harvest scheduling, research approach, decision support systems

Introduction

In developing new computerised decision support systems (DSS) for sugarcane growers and millers, there is potentially some advantage for researchers and developers in general to adopt some purposely designed and universally accepted framework. One advantage may be that researchers could compare different development projects in a more structured fashion, enabling the further improvement of such a framework. Another potential advantage is that a well-formulated framework can aid in identifying the link in the sugarcane supply chain where it will be more/less difficult to conduct decision support system development, thus better motivating additional resource allocation to problematic areas. Thirdly, conducting the development process within such a framework is expected to increase the quality of the resulting decision support systems (Bui and Jintae, 1999).

The findings presented in this short communication are part of a Stellenbosch University, Boras University and University of KwaZulu-Natal collaborative research project, which has had some initial success in developing a decision support system for tactical sugarcane harvest scheduling aimed at grower groups and possibly estate-sized sugarcane producers.

Methods

The assumption was made that some pre-project understanding exists about the project owner's requirements for the system that is to be developed, based on a list of needs, a project proposal or a problem description. Two grower groups consisting of two growers each were approached in mid-2008 and agreed to partake in this development project. The framework consisted of four main phases:

1. A pre-collaborative phase during which the programming language was selected, initial mathematical models were formulated and databases were built.
2. A collaborative phase extending throughout the entire 2009 harvesting season during which the growers commented on and graded the system output on a biweekly basis.
3. A post-collaborative redesign phase during which the system was heavily redesigned and strengthened to address the complaints and suggestions received during the collaborative phase.
4. A collaborative phase during which the redesigned system will be evaluated by the growers (results pending).

These steps make up the development phase of the DSS and emphasise the importance of including end-users from an early stage, as was concluded by Breuer *et al.* (2008).

Phase 1 consisted of programming and designing a scheduling decision support system using Microsoft's *Visual Basic for Applications for Excel* (*VBA for Excel*) and *Excel* itself (http://office.microsoft.com/en-us/excel/default.aspx?ofcresset=1) as the user interface and databases, and Wolfram's *Mathematica* (www.wolfram.com/mathematica) for the scheduling algorithms. The system verification consisted of manual inspections of the system output, while the various inputs (harvesting costs, recoverable value (RV) models, yield models and external events) were manipulated. One particularly important aspect was the calibration of the effect of various events on harvesting costs, yield and RV. Phase 1 extended over a period of six months, ending late in February 2009.

Phase 2 involved the importation of the field records from the four farms participating in the case study, as well as setting up a communications protocol to be utilised during the nine month milling season. The grower-to-researcher side of the protocol consisted of communicating all important opinions and knowledge on predesigned forms, which were sent via email to the researchers on a biweekly basis. The researcher-to-grower protocol consisted of sending a schedule as pdf to the growers on a biweekly basis. In total, 28 schedules were judged throughout the season.

Phase 3 saw the complete reprogramming of the user interface and databases, as well as the replacement of the two scheduling algorithms in *Mathematica* by a single algorithm in *VBA for Excel*. The requirement that the development phase of decision support systems should accommodate major rework (re-programming) is mentioned, for example, by Sprague (1980).

At the time of writing, Phase 4 was still under way.

Results and Discussion

During Phase 1, it became clear that, for the system to become useful, the information on harvest scheduling available in the scientific literature had to be complemented by practical knowledge, which in this case was possessed only by the end-user. This implied that Phase 2 would consist not only of minor changes and parameter calibration, but rather the possibility of, at some stage, having to reconstruct the system. This was also the case when, after five biweekly schedules, a completely new mathematical representation of the scheduling problem was implemented. During Phase 2 the researchers learned how growers prioritise various decisions, such as whether a field should be replanted after harvest, whether or not to use chemical ripeners, whether a particular field is likely to suffer from frost during winter, and which field to harvest first to take full advantage of varietal maturity. This information emanated to some extent from multiple interviews with growers before the development project began, but mostly from several of the feedback forms submitted by the growers in response to the schedules, which implied that some information was possibly withheld by the growers until they realised that it was relevant to the study. This placed a focus on a requirement of Phase 2 that would not have been realised under other circumstances, *viz* retrieving knowledge on a practical level may require more than simply interviewing growers. Even an extensive probe – interview form or other – may not clarify all the requirements and demands that growers may actually place on the system. In fact, for crucial knowledge to become known to the developers, it may be necessary for them to work closely with the growers for an extended period of time.

Another important part of Phase 2 was that the researchers' idea about who the potential end-user was went from being the average grower to larger businesses such as informal grower groups, formal syndicates, contractors, estates and miller-cum-planters. This realisation was due to the number of rigid constraints governing sugarcane harvest scheduling. The two harvesting fronts of approximately 15,000 and 30,000 tons per annum were, the growers argued, so small that very few decisions for the DSS remained. That is after taking into consideration chemical ripening, replanting, frost, drought and variety seasonality. However, the growers also believed that the system could become useful to large-scale growers who produce in excess of 60,000 tons. Table 1 describes the main drivers and requirements (key outcomes and key resources) identified in this project.

Currently, the research project is focused on Phase 4 and is using several harvesting fronts in the Eston area to validate the DSS. The final concession of the project may be that developing a DSS is best conducted under the assumption that several versions will be needed before a highly useful DSS is available to the end-user. In other words, one may be required to repeat Phases 2 and 3 a number of times to successfully design a good DSS.

Table 1. Phases of the Decision Support System development framework listing the key outcomes and inputs that guided the project.

Phase		Key outcomes	Key resources
(1)	Pre-collaboration	A system that can, in principle, provide the necessary requirements.	Project owner, development team, and material and budget to cover Phases 1 and 2.
(2)	Collaboration	Should yield further clarification on possible end-users, stakeholders, their respective demands, and overall system potential.	Development team, stakeholders and a suitable communication protocol.
(3)	Post-collaboration	New resources are allocated according to potential and changes are implemented to meet demands discovered during Phase 2.	Project owner, development team.
(4)	Final validation	Should show that the system satisfies the demands of the intended groups of end-users and stakeholders.	Development team and stakeholders.

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