Interview based structuring of operational decision-making by farmers

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Charlotte Daydé [*±1], **Stéphane Couture** [1] **& Roger Martin-Clouaire** [1]

[1] UR875 MIAT, INRA, Castanet Tolosan, France

* Speaker
± Corresponding author: charlotte.dayde@toulouse.inra.fr

1 Introduction

Farm management is a dynamic decision problem that requires a series of more or less independent decisions by the farmer about how to operate the farm system to achieve his goals. Such operational decision-making is difficult because it is highly dependent on uncertain factors such as weather, crop and disease development, prices, etc. Other sources of difficulty are the presence of time gaps between decisions and their resulting impacts, as well as the multiple side effects of each decision (e.g., preventing or delaying the execution of other decisions). Unlike in the manufacturing industries, strict production planning in agriculture is therefore not really possible. Operational Decisions (OD) daily decisions about which actions to carry out next and which modifications should be made to activities intended in the future are thus essential in farm management. It is our belief that by analyzing these decisions, we can better understand how farmers perceive operational management and cope with uncertainty, which explains, to a large extent, why performances differ among farmers.

More than only understanding a farmer's reasons for a given choice, we must understand the mental process that leads to this choice, i.e., the decision-making process. Indeed, performance heterogeneity is observed among farmers even if farm systems are similar. This variability can be explained by differences in the mental process leading to the decision. Global knowledge of such a mental process is not available although many structuring features such as beliefs, goals, plans and preferences have long been identified by philosophers and artificial intelligence researchers (Pollock 2006) who have investigated decision-making foundations.

An initial fundamental step that is reported here concerns the use of interviews with farmers about their decision-making practices. The analysis of these interviews makes it possible to highlight the aspects that spontaneously arise from the farmer's discourse and those that are ignored or that remain implicit. On the basis of these outcomes, we plan to develop a refined interview-based survey to explore the decision behavior of a larger panel of farmers and to focus on the aspects that were missing in the first phase.

2 Materials and Methods

Our analysis is based on a systematic examination of interviews to identify the decision-making features that are considered to be determinant by the farmers, which information sources are looked at, and how they are used in the decision process. We conducted six interviews of grain crop producers located in the vicinity of Toulouse (in southwestern France). Each interview lasted from 2 to 5 hours and was recorded and transcribed. Content analysis, using Nvivo software, enabled us to systematically identify main themes and topics that emerged and to make a frequency analysis of the keywords used.

The interviews are divided into three parts. A comprehensive part based on semi-directive interviews allows farmers to talk about their farm, their activities and management decisions, their sources of information, their constraints, and the risks and difficulties experienced in their work. Then, in a more directive part, farmers have to more precisely describe the nature and timing of their farming practices thanks to calendar-based positioning of management operations. The final part aims at investigating the role of events (e.g., incidents) in the dynamics of the decision process.

3 Results – Discussion

The interviews confirmed that regardless of the farm and its location, plan-based management, and actual situation monitoring are vital and usual practices in operating a farm business (Martin-Clouaire and Rellier 2009). Farmers need to adopt plans for the future in order to allow their reasoning about what to do to extend beyond the present moment and to coordinate their activities with each other and with those of other farmers in the case, for example, of equipment sharing. Planning enables rough scheduling of the necessary time, materials and labor, as well as crop allocation to fields. Planning is also a way to anticipate some of the crop needs.

The farmers make operational decisions on the basis of both their beliefs about the current and sometime predicted situations. The belief about the current situation results from direct observations or from indicators formed by making inferences from one or several observations. Most farmers also include the observation (or monitoring) of activities in their plans. The farmers visited rarely mentioned the prediction of situations. The farmer’s decision-making may consist in

selecting the next action to carry out or in formulating or revising a plan and committing to it. Action selection consists of doing the right thing at the right time. It requires resolving conflicts among competing goals, identifying alternative actions that contribute to the goals and that are coherent with the plan involved, and implementing the most appropriate action. Moreover, the actions correspond to the current situation in the sense that they are adjusted to situational requirements.

The interviews also showed the need for flexibility and adaptiveness of the plans. Farmers form and commit to partial plans that roughly specify the activities that they intend to perform. Flexibility takes different forms. It may lie in the temporality of the activities declared in the plan. At most, timing is defined with windows of earliest starting time and latest finishing time (especially for sowing activities). The timing of activities may also be limited by temporal relationships of precedence (weeding before fertilization) or parallelism of execution. Plans may be logically complex, including, for example, disjunctions or conditions that provide them with additional flexibility. For instance, a farmer explained that he usually sows rapeseed the first week of September with a given technique, but if weather conditions are bad, he switches to an alternative technique or delays sowing by two weeks. In this example, the flexibility also concerns the resources and means involved in the realization of the intended sowing activity and the fields potentially targeted by the activity. Tuning the execution of an activity to the actual situation is a common practice. Plans are partial because they concern intended activities in the future. Yet, what is going to happen matters and is highly uncertain due to weather, which is a major uncontrollable driving factor. Making a detailed plan would simply be impossible. Having a partial plan makes it necessary to expand and revise it continuously. Expansion is necessary to determine the executable actions that are appropriate in the current situation. Revision is triggered by events recognized as having an importance for management. For example, in the case of a nitrogen fertilization activity that requires repeated applications of fertilizer separated by a time interval, if the first application has been delayed for some reason (e.g., bad weather), then the subsequent ones must also be delayed in the plan.

Another structuring feature of the decision-making process concerns the identification and processing of events. An event is either a significant change in state (e.g., beginning of a new crop stage) or the occurrence of an incident that is external to the farm system (e.g., climatic event) but that affects it. Events are major drivers of change of intentions, including changes that result in actions to be executed immediately. Events constitute hazards as well as opportunities. On the basis of the interviews, we identified six types of events primarily defined with respect to: calendar or management landmarks (e.g., completion of winter wheat sowing), weather (e.g., wind), pest outbreak, crop development (e.g., harvesting stage), resource unavailability (e.g., the farmer is ill, equipment failure, etc.) and legislation (e.g., irrigation ban). These events are observed by farmers or reported to them (e.g., by an adviser) and can be more or less anticipated (e.g., with weather forecasts).

4 Conclusions

By analyzing empirical data from qualitative surveys, we obtained a preliminary view of how grain crop farmers perceive operational decision-making. Using this information, we identified areas that require further investigation through subsequent interviews that we plan to carry out. Goal reasoning and preference characterization and manipulation are our next investigation priorities. The motivational role of goals has long been recognized as a driver of decision-making behavior. Surprisingly, goals often remain implicit in the farmer's discourse, even if the farmer's problem is to frame future actions so as to achieve some desirable outcomes within a relatively short term. Actually, the justifications provided by the farmers indirectly point to goals that can be organizational (avoiding labor bottlenecks later on, having winter crop tillage activities completed by a predetermined date), agronomical (having pests under control), or circumstantial (saving money by having inputs be replenished before a predetermined date). The dynamics of creation and revision of goals is still to be examined.

Farmers often have more tasks to perform than they can do immediately. They have multiple information to consider, numerous goals and wishes to take into consideration, and several ways to move towards the goals. The various goals and wishes may be in conflict with each other (e.g., relaxing and meeting deadlines). The conflict may be between the short-term and long-term consequences that have opposite values in terms of their attractiveness, or because some goals are highly desirable but hardly feasible. Therefore, farmers have to somehow prioritize, which means mobilizing dedicated knowledge about preferences of various types. Such knowledge and the mental processes that can process preferences while taking matters of risks and urgency into account are poorly understood at this stage.

Ultimately, understanding how the various decision features are processed to yield operational decisions will require the exploration of the farmer's bounded rationality (Daydé et al. 2014) that accounts for limitations in the farmer's memory and reasoning powers.

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