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# Towards a better understanding of operational decision making in agricultural production systems

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## The operational decision making problem

Farming involves the input of resources (seed, fertilizer, pesticides, time, labor, etc.) into natural systems for the purpose of harvesting outputs for sale (biomass, grains, livestock, etc.). In his capacity as a production manager, the farmer makes decisions about the planning and implementation of technical operations (tilling, planting, fertilizing, irrigating, spraying, harvesting, feeding animals, etc.) in the hope of achieving his objectives. Operational decision making is the process of putting the plan into action: (i) finding out which actions are deemed relevant in the actual situation according to the plan; (ii) determining which sets of actions are feasible given the limitations on resources; and (iii) choosing the preferred one among these sets. This paper deals only with the last case. More specifically, the focus of our investigation concerns the kinds of reasoning procedures and knowledge that farmers actually use to arrive at the selected solution. Operational managerial practices vary from individual to individual and need to be understood if a farm manager is to increase his chances of achieving, as well as the level of achievement, of his objectives and, more generally, to develop valuable insights into the relationship between decision making skills and farm performance. The long-term goal is to build a theory of procedural decision making that would be useful to explain and predict the decisions actually reached and to make the decision process (not only the decisions reached) an object of scientific investigation. The study of operational decision making has to be conducted at the overall farm level because a restricted view might indicate improvements that actually induce a deterioration at this level.

## Decision making approaches in farm management

The field of farm management has long been dominated by agricultural economists. They typically approached the problem through decision models that were quantitative, linear–additive and often normative as, for example, linear programming and expected utility models. Usually, these economic models (Chavas *et al*. 2010) do not spell out the procedures by which decisions are made (see Öhlmér *et al*. (1998) for an exception). The branch of behavioral economics, which is more empirically grounded, is better equipped than traditional approaches to explain farmers' behavior. Indeed, the traditional economic models assume an idealized decision situation in which the farm manager knows all the relevant alternatives, their consequences, probabilities and values, making the application of the paradigm of expected utility maximization feasible. Many studies have shown that the farmer's decision making context does not meet these assumptions. In particular, the managers are only partly aware of the possible outcomes of their decisions and not well aware of their likelihood. Moreover, the farmers are also uncertain about their own preferences that are affected by events and emotions. Such models insufficiently encompass all the important aspects of the whole decision problem.

Instead of making assumptions of full rationality in the classical economic sense, other approaches struggle to trade off academic formal modeling with investigations that have more practical relevance for farm managers. Bounded rationality is Simon’s idea (1955). It holds that in decision-making, the rationality of individuals is limited by the information they have, the cognitive limitations of their minds, and the finite amount of time they have to make a decision. Instead of strict rigid optimization procedures, Simon suggests that decision makers use heuristics (Gigerenzer and Gaissmaier 2011), which are

reasoning shortcuts (rules of thumb) making it possible to effectively find good enough solutions when the best ones cannot be obtained. This notion of heuristics corresponds to the notion of decision rules used in many models of agricultural systems (e.g., Cros *et al*. 2003, McCown *et al*. 2012). Within the disciplinary realm of economics, the relatively new field of behavioral economics, which is primarily concerned with the bounds of rationality, appears to provide new investigation potentialities by relying on the actual behavior of farm managers and a more realistic representation of the cognitive and psychological setting in which decisions are made.

## A way forward: some issues

In order to be able to understand differences between management behaviors and their role in performance determination, it is first necessary to identify the type of information invoked, its use in the decision process and the way it is dynamically acquired. In agriculture, operational production management has to deal with: (1) a series of interdependent decisions and/or actions (today's choices have to be made in coherence with those previously made); and (2) constantly changing situations; (3) shifting goals and preferences. The potentially relevant pieces of information that drive the decision process need to be extracted or even constructed for every choice task, i.e., farmers need to be able to obtain preferences and beliefs on the spot when needed, instead of having known, well-defined, and stable ones.

The choice process involves information sources that induce a restriction of the set of candidate solutions (for example, non-urgent candidate solutions can be discarded if others are urgent). In contrast, other factors taken into account in the choice (e.g. cost or expected efficiency) influence the result by modifying the strength of preference of a particular solution over the others. The choice process amounts to a multifactorial evaluation of arguments against or in favor of the candidate solution. Of course, uncertainty about the actual state (due to observation difficulties), future events (especially weather) and their consequences may affect the farmer's choice process that, as usual, involves a trade-off between what ought to be (goals) and what can be (belief). The decision process is also responsible for directing or maintaining the continuous flow of management behavior toward overall production objectives (it is not solely a set of independent episodes involving choice dilemmas).

To be faithful to the reality, the choice process in our model has to involve as little processing as possible in order to be compatible with the paucity of information and the fast pace of decision making observed in farmers' practices. Bounded rationality research aims at developing procedural models of rationality based on psychological processes of reasoning — in order to investigate how managers conduct incomplete searches (Gigerenzer and Gaissmaier 2011) and make trade-offs between heterogeneous aspects. This paper offers some initial thoughts about the issues to be addressed concerning the model-based investigation of operational decision making in agriculture.

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