Why Farmers Experiment, and Why Scientists Should Take Note of It

Experimentation is defined as a process of discovery, hypothesis testing or demonstration, and has been part of farming for millennia, as farmers experimented on their land with seeds, breeds, cultivation techniques and the entire gamut of manageable factors. Europe for example, saw between the 17th and 19th centuries multiplication of agricultural productivity. Industry at this time was also growing rapidly.

Scientific principles could not be applied to farming in the same way that they were to industry because of the confounding underlying variability of the natural landscape. This uncontrolled variability was an impediment to scientific experimentation and in the early 20th century, Fisher and co-workers at Rothamsted developed methods of statistical analysis to clarify experimental treatment effects within the field. As a consequence, scientists place more value on information that has to do with the quantifiable effects of factors and discount information about the farming environment in which they occur.

Under this scenario, the effects of factors are known, but the interaction with the farmed landscape less so. This moves agricultural knowledge towards generalizable 'scientific' statements that are true within the bounds of experimentation, and away from the competence that farmers need to manage particular conditions that exist on-farm. In this way, farmer experiments were left behind and knowledge they demonstrated was considered non-scientific (Maat and Glover, 2012). At the same time, the scientific approach leaves a large proportion of variability unexplained, and often farmers find insights from scientific experiments difficult to apply.

Scientists and farmers experiment to reduce uncertainties. Rowe (1994) classifies decision uncertainty into four categories: translational, structural, metric and temporal. Scientists and farmers give different priority to these categories. **Translational uncertainty** (i.e.,the contrast between sets of values and meaning of information) is a serious concern to farmers who must consider all factors relevant to a decision, even if they apply beyond the farm gate. For example, the decision to sow a certain variety of crop depends not only on the expected yield but also on factors such as market price. By contrast, scientists refer less to external values, in order to focus on clarity of result. Translational uncertainty is reduced by knowledge of the desired outcomes of decisions. Farmers can predict outcomes of decisions with reasonable certainty, despite a range of confounding uncertainties. The scientist wants to reduce these to a limited number of generalizable conditions that help define the relevance of experimentation.

Scientists often reduce **structural uncertainty** (i.e., uncertainty caused by variations in the completeness with which people describe systems) by pre-defining part of a system as an object of experimentation, for example by locating experimental plots in sites that avoid variable terrain. Farmers, conversely, are obliged to manage farmland as they find it and modify their practices to fit the variation, rather than ignore it.

Conversely **metric uncertainty** (i.e. uncertainty caused by the difficulty of measuring the state of an attribute) is of great concern to scientists. They seek clear, unambiguous statement of treatment effects far beyond the precision needed by farmers. Virtually all scientists learn statistical analysis to identify improvements that are frequently quite small, and often irrelevant for farmers given the magnitude of other uncertainties. Similarly, farmers handle **temporal variability** through experience of prior events and conservatism when uncertain.

There are two underlying principles as to how farmers experiment. The first principle is heuristic: every time a farmer prepares a field, plants and manages a crop, he observes and experiments a unique set of conditions (Cock et al. 2011). Thus, farmers are continuously experimenting as they manage their crops to cope with the changing circumstances. The second principle is cognitive: farmers frequently try to answer specific questions by consciously experimenting on their farms. In the former case, they let their competence guide them in managing their crops according to the particular social, economic and environmental conditions that occur. In the latter case, they wish to increase their competence by obtaining knowledge, based on deliberate experimentation that can help them manage variation in the future.

The observations of both, conscious experimentation and day-to-day variation in management, are most valid for the farm on which they are produced, but at the same time can be used by others under similar conditions, and may also prompt more conventional experiments. Thus, observations of on-farm experimentation may encourage scientists to bridge the boundaries between ‘formal’ science and farming practice. The closing of this gap and the direct use of the results of on-farm experimentation can reduce management uncertainties and allow farmers to make informed decisions.

This information is derived from an article in Better Crops with Plant Food:

Cook, S., J. Cock, T. Oberthür, and M. Fisher. 2013. On-Farm Experimentation. Better Crops with Plant Food 97 (4): 17-20.

References:

Cock, J., T. Oberthür, C. Isaacs, P. Läderach, A. Palma, J. Carbonell, L. Victoria, G. Watts, A. Amaya, L. Collet, G. Lema, and E. Anderson. 2011. Crop management based on field observations: Case studies in sugarcane and coffee. Ag. Systems 104:755-769.

Maat, H., and D. Glover. 2012. Alternative configurations of agronomic experimentation. In: J. Sumberg and J. Thompson (ed.) Contested agronomy: Agricultural research in a changing world. Routledge, Abingdon.

Rowe, W.D. 1994. Understanding uncertainty. Risk Analysis 14:743-750.