

SHORT COMMUNICATION**HOW TO GET A FARMER TO TEST AN INNOVATION, AS A PRECURSOR TO WIDER-SCALE ADOPTION****Jumman A^{1,2}, Bezuidenhout CN^{3,2}**

¹*South African Sugarcane Research Institute,
P/Bag X02, Mount Edgecombe, 4300, South Africa*

²*University of KwaZulu-Natal, College of Agriculture, Engineering and Sciences,
Bioresources Engineering*

³*Massey University, School of Food and Advanced Technology, Palmerston North, New Zealand*

ashiel.jumman@sugar.org.za

Abstract

Many farmers delay their adoption decisions, preferring to wait and watch how early adopters perform with new technologies. In contrast, early adopters test innovations on a small-scale to evaluate on-farm implementation and relative advantage before deciding whether to adopt or not. In this paper, a literature review and system dynamics modelling were used to explore the early adopter's decision-making process in order to understand what triggers on-farm testing. Literature indicated that farmers go through a process of "information acquisition" and "learning-by-doing" to explore the benefits and to reduce the perception of risk. These pertinent concepts were used to construct a system dynamics model, with "motivation to conduct on-farm testing" as the central driver. Initially, motivation is set at zero, signifying that there is no motivation to test the innovation. Motivation accumulates when a farmer acquires knowledge of the relative advantage. However, motivation can be drained simultaneously by risk perception and uncertainty. Risk perception and uncertainty is reduced by acquiring knowledge of the attributes of the innovation (e.g. the ease of use, technical soundness and compatibility). When motivation accumulates to a pre-set tipping point, on-farm testing is initiated. The onset of on-farming testing allows for personal experience with the innovation (learning-by-doing), which allows the farmer to further reduce the perception of risk. Learning-by-doing incrementally increases the scale of on-farm testing, until the farmer is convinced and decides to adopt across the whole farm. The model structure highlights the need to grow knowledge about (1) the relative advantage and (2) the attributes of the innovation, as explicitly independent goals, in order to trigger on-farm testing and learning-by-doing.

Keywords: Adoption, behaviour change, knowledge exchange, on-farm testing, system dynamics modelling

Introduction

Many farmers delay the adoption decision, preferring to watch and wait, in order to see how early adopters perform with new technologies (Rogers, 2003). Late adopters are typically resource-poor and generally need to be assured by their peers that an innovation will not fail, before they adopt. In contrast, early adopters do not have the luxury of confirmation from peers to guide their adoption decisions. Instead, by virtue of their inherent character, early adopters choose to test the innovation on a small-scale, in order to prove that it can work within their context, before deciding whether to adopt it or not (Rogers, 2003; Abadi Ghadim and Pannell, 1999). Rogers (2003) reported that early adopters were typically younger farmers, with a higher level of education, direct access to primary information and higher income or a larger-scale operation. As a result, early adopters have a better capacity to take on, and cope with, the risks and uncertainties associated with on-farm testing.

Early adopters, however, do not automatically test every innovation that crosses their path. A mental appraisal process must still take place to decide if on-farm testing is required. In this paper, a system dynamics modelling approach was used to explore the early adopter's decision-making process in order to understand what triggers on-farm testing.

Materials and Methods

The STELLA® software (iSeeSystems, 2015) was used to build a system dynamics model. Theory was assimilated from literature, to inform model construction.

Results

Abadi Ghadim and Pannell (1999) presented a framework, where adoption was conceptualised as a multi-stage decision process involving information acquisition and learning-by-doing. They reported that the decision to adopt was dynamic in nature. Changes in the perception and attitude of farmers occur over time, as information is progressively collected. The stock and flow language of the system dynamics model, therefore, lends itself to capturing the inner processes of individuals when deciding if on-farm testing is worthwhile (where 'stock' refers to a quantifiable element of a system and 'flow' indicates the rate of change in a stock).

As shown in Figure 1, the central stock in the model was the "motivation to test". All action is underpinned by a desire, or a motivating factor. Even inaction is based on some motivating factor. For example, inaction could be based on the desire to avoid the pain associated with change. The balance of positive and negative motivational forces, therefore, explains the resultant action or inaction. Hence, it is logical that to induce behavioural change, enough of the right motivation must be stimulated. Logic suggests that on-farm testing does not take place when the motivation to do so is low. Therefore, motivation is initially set at zero, which signifies that there is no motivation to test the innovation. The motivation stock can be increased by the inflow, which is titled "increasing motivation". Furthermore, motivation must be increased to some trigger point, in order for on-farm testing to be initiated.

Rogers (2003), Pannell *et al.* (2006) and Kuehne *et al.* (2017) emphasised that any innovation had to offer a reasonable relative advantage, in order for it to be considered seriously. Hence, as shown in Figure 1, the "motivation to test" accumulates when a farmer acquires knowledge about the relative advantage. In the early stages, however, farmers are sceptical and uncertain about any innovation (Pannell, 1999; Marra *et al.*, 2003; Pannell *et al.*, 2006). Therefore, the "perception of risk and uncertainty" is introduced as a drainage flow in Figure 1. The "perception of risk and uncertainty" was assumed to be high when the knowledge levels of the innovation were low, i.e. a farmer was expected to become less doubtful of an innovation only when he became more knowledgeable about its attributes; for example, its ease of use, technical soundness and practicality.

The model structure, which is shown in Figure 1, revealed that it is necessary to increase the motivation by promoting the relative advantage, while simultaneously limiting the outflow of motivation by reducing the “perception of risk and uncertainty”. “Learning experiences” must be proportioned to grow two explicitly-different knowledge stocks (“knowledge of the relative advantage” and “knowledge of the attributes”). The intention is to transparently map the causal pathways of the two different types of knowledge. In addition, it is necessary to highlight that the content of a learning experience will dictate to which knowledge stock the acquired information will contribute. A purposeful and focused effort is required to fill up the explicitly-different knowledge stocks. Hence, the model can adequately represent and simulate a bias, equal efforts, or some proportionate splitting of the “learning experiences” towards the different knowledge stocks.

“Learning experiences” by means of “acquiring information” from others, however, is never enough to totally eliminate the “perception of risk and uncertainty”. The model was configured so that the maximum knowledge about the attributes of a certain innovation will only help to eliminate 50% of the “perception of risk and uncertainty”. The explicit assumption was that gaining knowledge from others via “information acquisition 2” is inadequate on its own. A farmer must also experience the innovation for himself. Hence, the model was developed further, so that the remaining 50% of the “perceived risk and uncertainty” can only be eliminated by the knowledge gained from personal experience with the innovation i.e. “learning-by-doing” (Abadi Ghadim and Pannell, 1999; Pannell *et al.*, 2006). Nevertheless, on-farm testing could be initiated when there was still some uncertainty in the mind of the farmer, provided that the motivation stock accumulated to the tipping point.

“On-farm testing” was initiated only when the early-adopter farmer accumulated enough motivation, by increasing the inflow to the motivation stock and reducing the drainage flow. The onset of “on-farm testing” allows a farmer to gain direct personal experience by implementing the innovation. “Learning-by-doing” allows for the accumulation of “knowledge from own experience” (Abadi Ghadim and Pannell, 1999; Pannell *et al.*, 2006), which further increases the “perception of relative advantage” and the flow “increasing motivation”. Furthermore, practical experience helps the early-adopter farmer to develop the necessary skills that are associated with the innovation and to incrementally eliminate the “perception of risk and uncertainty”. Hence, the “scale of on-farm testing” is increased further, until the farmer is convinced and decides to implement the innovation across the whole farm.

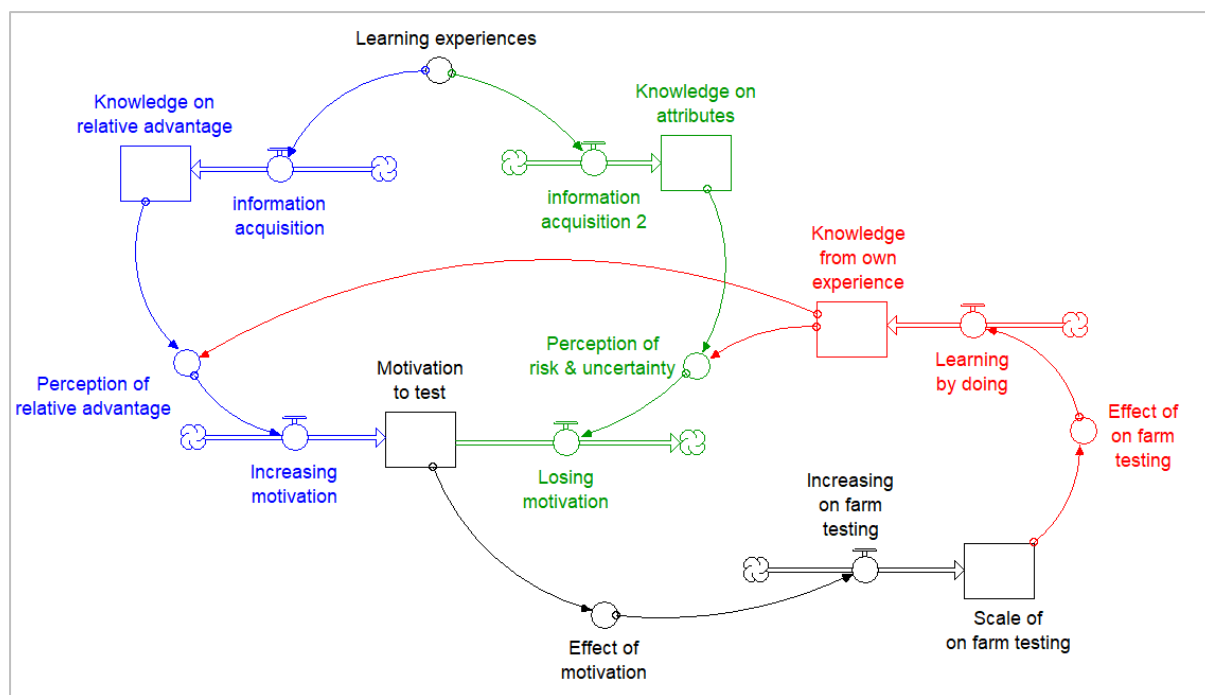


Figure 1. Model map depicting the theoretical framework for initiating on-farm testing

The “motivation” stock is a central puzzle piece of the model, which, when placed structurally, as it has been, helps to explain, or even define, the causal direction and influence of the other model fragments, in the context of behaviour of an individual farmer. In this way, the model and the embedded theoretical framework contribute to the advancement of science by extending beyond the previous practice of listing key variables as important. The “perception and knowledge of relative advantage”, the “perception of risk and uncertainty”, “innovation attributes”, “information acquisition” and “learning-by-doing”, for example, are not new variables. In the on-farm testing model, the central “motivation” stock pulls the other model fragments together, to demonstrate how the variables work together as one system.

Discussion and Conclusions

In this paper, a theoretical framework was proposed to explain how on-farm testing is triggered and used as a mechanism to gain the confidence to adopt an innovation fully. The system dynamics framework allows for the transparent sharing of the causal structure, which enables a peer review and an opportunity for the further refinement and embellishment of the theory. In this case, the explicit hypothesis is that the quality, directional proportion and number of learning experiences can be used to fill up low-knowledge stocks in the minds of early-adopter farmers, in order to simultaneously stimulate the accumulation of “motivation” to implement the innovation, and to limit the drainage of such motivation, until enough “motivation” is acquired to spur on an individual to test the innovation on his/her own farm. No single intervention is likely to achieve the goal on its own. Instead, the combination of variables must be tuned in the correct proportions, in order to work together in the causal system.

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