Farmers' adoption behavior:
Stated preferences and perceptions of the innovation

Roussy C.[1], Ridier A.[2], Chaib K.[3]

[1] Corresponding author; croussy@rennes.inra.fr ADEME, UMR SMART, F-35042 Rennes Cedex France

[2] Agrocampus Ouest, UMR SMART, F-35042 Rennes Cedex France

[3] INP Toulouse, Ecole d'Ingénieurs de Purpan, Toulouse Cedex, France

Poster paper prepared for presentation at the EAAE 2014 Congress
'Agri-Food and Rural Innovations for Healthier Societies'

August 26 to 29, 2014
Ljubljana, Slovenia

Abstract

In order to approach farmers' adoption behavior of innovative cropping systems (ICS) on a sample of specialized cereal French farmers, a methodological protocol combining stated preferences and perceptions is designed. An original choice modelling protocol allows analyzing farmers' preferences facing an adoption decision (dichotomous choice) but also the level of adoption (number of hectare adopted). By gathering the data on farmers' preferences, perceptions and characteristics, this experiment allows revealing the determinants of the adoption of ICS.

Key words: adoption, innovative cropping system, stated preferences, perception

Introduction

Cash crop farming represents in France more than 30% of utilized agricultural land. South Western France is one of the biggest French regions for cash crop farming. The short rotation of wheat / sunflower is one of the most widespread dry cropping systems in hillside. This short rotation is strongly questioned and brings yield stagnation due to agronomic stalemates linked to weed and disease resistance or field erosion. The recent CAP changes have set up a wide range of environmental regulation to reduce negative externalities of farming activities, while price volatility has increased. Facing those challenges the agronomic research efforts seek to reconcile the system productivity and the environmental protection by designing innovative cropping systems. Innovative cropping systems (ICSs) are systemic innovations combining technical innovations such as technological advancements on machinery, phytosanitary products or tillage and traditional agricultural tools (i.e. intermediate crops, long rotation). Thus ICSs can be seen as multiproduct innovations designed to provide long run improvements.

The implementation of an ICS implies new investments for farmers (material; machinery, products, but also immaterial; knowledge). Cropping ICSs imply additional uncertainties for farmers since information or experience is lacking on the agronomic potential of ICSs on their own field. Thus, farmers form subjective perceptions about the uncertainties linked to farming innovations. They are assumed to drive their farm by maximizing their income according to the constraints they subjectively perceive thereby relying on the theoretical framework of subjective expected utility (Savage, 1972).

Many determinants of technology adoption have been sought in agricultural economics literature. Farm and farmers' characteristics and the role of policies have been extensively studied (Feder and Umali, 1993; Pannell et al., 2006). Agronomic and climatic factors reduce the adoption by limiting the selection of innovations and by constraining cropping conditions. Farmers' preferences towards technology adoption are linked to the characteristics (or traits) of the technology. Farmers, according to their perceptions and preferences, choose the system for which they obtain the highest expected utility of profit. The components of farmers' profit are subjectively perceived and specific to each production context.

This work presents a methodological proposal to assess farmers' attitude towards the adoption of innovations, by eliciting stated preferences. To analyze the complex behavior of adoption we design a three steps methodology to assess farmers' preferences towards innovation and to understand the factors of farmers' heterogeneity. This methodological paper is composed of two sections. The first section focuses on the adoption decision model required to analyze the adoption behavior. The second section reports the methodology, including the design of the choice modelling protocol and the elicitation of the individual perceptions.

The model of adoption

Theoretical framework

Relying to the subjective expected utility framework, we consider that farmers are maximizing their perceived profit. By integrating the individual evaluations in the profit calculation, the individual expected utility of innovations can be approximated (equation 1, 2).

$$SEU(\pi) = \sum_{i} p'_i \, U(\pi_i)$$

(equation 1)

$$U(\pi) = \frac{\pi^{1-RRA}}{1 - RRA}$$

(equation 2)

With p_i = probability of state of nature *i* for the profit (π_i); $U(\pi)$ = utility function; *RRA* = relative risk aversion coefficient and *SEU* subjective expected utility. Considering an adoption choice, farmers choose the alternative with the highest utility (equation 3). Stated preferences methods allow quantifying individuals' preferences for each characteristic of the innovation. Based on the random utility theory, the global utility of a system is composed by the utility of each characteristic of the cropping system and a stochastic component. Even if the profit is one of the characteristics, farmers maximize their utility considering also other characteristics (agronomic or technical).

$$U_k > U_j$$

$$\text{Where } U = U\left(t_1, t_2, \ \ldots, \ t_r\right) + \varepsilon$$

(equation 3)

With $t_1, t_2, \ \ldots, \ t_r$ corresponding to the r characteristics of the innovation and ε the error term depicting the individual determinants.

A choice modeling approach

Experience design

Choice modelling methods allow analyzing and quantifying individual preferences considering innovation (Hanley et al., 1998). The innovation is described in terms of a set of attributes which allows to assess multidimensional decisions (Alriksson and Öberg, 2008). These methods enable quantifying the value of each attribute normalized marginal utility (Asrat et al., 2010; Useche et al., 2013). Thus, it is possible to rank the weight of each attribute from the most to the less significant in the adoption decision. In choice experiment, a dichotomous choice is generally asked to respondents, adoption of the innovation or conservation of the actual situation (named statu quo). But, considering that farmers can choose to partially adopt an ICS on their cropping area, a dichotomous choice does not allow analyzing the intensity of adoption.

The present experience focus on farmers cropping durum wheat on sunflower rotation, one of the most widespread dry cropping system in southwestern France. To limit the hypothetical bias, farmers are directly put in a position of crop rotation choice. Farmers are asked to indicate if they wish to introduce a new crop in their cropping plan before durum wheat. Indeed, farmers are annually required to take such decision thus this experimental approach is credible. The crop proposed is composed of five attributes: i) nitrogen restitution, ii) level of pesticide reduction/increase, iii) level of gross margin per hectare, iv) technical difficulties (in term of labor management) and v) crop season (winter vs summer crop) (Table 1). To ensure the credibility of choice situations, the levels of attributes are selected in consultation with local stakeholders (coops, farmers and researchers opinions confronted during focus groups). An experimental plan has been designed, to avoid over or under representation of the attributes levels. The choice situation is repeated through fifteen independent cards proposed to each farmer. Thus, the originality of the protocol lies in the farmers answer. Farmers have to state, firstly if they adopt the new crop and secondly the number of hectares of their cropping area they will implement with the new crop.

Table 1. Attributes and level of the choice modelling

Attributes of the crop	Levels
Nitrogen restitution for the durum wheat	0, 25 or 50 units
Effect on treatments	0, + or -1 compared to the traditional preceding crop (sunflower)
Gross margin	300, 375, 450, 525 or 600 €/ha
Technical skills required for the cropping management	Not technical, technical, Highly technical
Crop season	Winter or Summer crop

Perception assessment

Risk perceptions are a major break for adoption. Firstly, because the more an innovation is perceived as risky, the less it is adopted by farmers. A recent study on Northern Italian apple farmers shows the linkage between farmers' loss perceptions and their management strategy (Menapace et al., 2013). It may concern yield risk but also market risk on selling prices or production costs. On another hand, perception of the actual system also influences innovation adoption. As farmers adopt ICS in comparison with the actual system, the perception of its own system can affect adoption. But even if the studies show the major role played by perceptions in the choice of adoption, farmers' perceptions are generally included as explanatory variable.

Another specificity of our experience and survey is to directly address farmers' risk perceptions to precisely evaluate, at individual scale, the perceived utility of the conventional system and risk perceptions towards innovations. Thus, risk perceptions on conventional system are assessed through subjective probabilities on yield and market risks using visual impact methods (Norris and Kramer, 1990). Farmers indicate their yield and price distributions concerning durum wheat and sunflower. They also indicate their production costs and the allocation between cost components (fertilization, pesticides…). Concerning the perceptions, they indicate the expected yield, price and production costs for other crops that are generally introduced in this short rotation: sorghum, soft wheat, pea and rapeseed. Farmers also grade on a Likert scale their perception of the profitability, the productivity and the technical skills required for each of those crops.

In addition to the results on perceptions of both actual and innovative cropping systems, socio-economic and agronomic are collected data about farm and farmers' characteristics. This protocol enables to precisely integrate in the analysis of farmers' adoption behavior individual perceptions and preferences as a determinant of adoption

Choice analysis

Choice experiments are generally estimated using dichotomous model such as logit and probit models (Hanley et al., 1998). Random parameters are integrated to take in account the heterogeneity of farmers' behavior within the sample (Asrat et al., 2010; Useche et al., 2013). Those types of models only give an appraisal of the yes/no adoption. The protocol built here permits an assessment of the intensity of adoption. A Tobit model is a more accurate model to deal with this continuous variable (Adesina and Zinnah, 1993). Furthermore, interactions between preferences towards innovation attributes and perceptions and characteristics of the farmers can be tested.

Conclusion

Farmers’ technology adoption behavior is a complex process driven by a large range of determinants already highlighted by the economic literature (individual perceptions and preferences, farming and personal constraints). In the context of climate and regulation changes, farmers are lead to adopt new cropping systems. Facing this adoption decision, preferences toward innovation and individual perceptions need to be addressed. To approach the adoption behavior, stated preferences methods allow ranking and quantifying farmers’ preferences for each characteristic of the ICS. By combining an original choice modelling experience with farmers’ perceptions and characteristics this methodology aim at reaching a more accurate assessment of the determinants of the adoption of ICSs for a better promotion of innovative cropping systems.

References

Adesina, A. A. and Zinnah, M. M. (1993). Technology characteristics, farmers' perceptions and adoption decisions: A Tobit model application in Sierra Leone. *Agricultural Economics,* 9 (4), 297-311.

Alriksson, S. and Öberg, T. (2008). Conjoint analysis for environmental evaluation. *Environmental Science and Pollution Research*, 15 (3), 244-57.

Asrat, S., et al. (2010). Farmers' preferences for crop variety traits: Lessons for on-farm conservation and technology adoption. *Ecological Economics*, 69 (12), 2394-401.

Feder, G. and Umali, D. L. (1993). The adoption of agricultural innovations: A review. *Technological Forecasting and Social Change*, 43 (3–4), 215-39.

Hanley, N., Wright, R.E, and Adamowicz, V. (1998). Using Choice Experiments to Value the Environment. *Environmental and Resource Economics,* 11 (3-4), 413-28.

Menapace, L, Colson, G., and Raffaelli, R. (2013). Risk Aversion, Subjective Beliefs, and Farmer Risk Management Strategies. *American Journal of Agricultural Economics*, 95 (2), 384-89.

Norris, P. E and Kramer, R. A. (1990). The elicitation of subjective probabilities with applications in agricultural economics. *Review of Marketing and Agricultural Economics,* 58 (2-3), 127-47.

Pannell, D.J. et al. (2006). Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture*, 46 (11), 1407-24.

Savage, L. (1972). *The foundations of statistics* (DoverPublications. com).

Useche, P., Barham, B. L. and Foltz, J. D. (2013). Trait-based Adoption Models Using Ex-Ante and Ex-Post Approaches. *American Journal of Agricultural Economics*, 95 (2), 332-38.