Understanding Pesticide-Use Decisions

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***Abstract* – An analysis of socio-economic driving forces in crop protection is conducted to facilitate the implementation of innovative strategies. The analysis consists of: the classification of strategies currently implemented in the European Union based on two attributes of pesticide use (i.e. quantity and type of pesticides applied); the explanation of the different strategies by understanding pesticide-use decisions; and the elaboration of policy recommendations. In order to understand pesticide-use decisions, the motivational and knowledge systems relating to crop protection are described, socio-economic factors affecting crop protection strategies are identified, and conclusions are drawn with regard to the driving forces behind pesticide-use decisions.**

INTRODUCTION

Crop protection strategies (CPS) aimed at preventing crop losses generated by the action of pests, diseases and weeds (Struik and Kropff, 2003) are essential for the practice of agriculture, given the increased demand for agricultural produce and the need to maintain levels of productivity (von Witzke et al., 2008). Although pesticide use (PU) is an effective CPS tool, its negative impacts such as human toxicity and environmental contamination make it the subject of much debate.

The evaluation of alternative methods and new technologies of crop protection has demonstrated the viability of innovative strategies which are less reliant on PU (ENDURE, 2009). Besides developing such strategies, however, scientific research should furnish instruments supporting their implementation.

An analysis of the socio-economic driving forces of crop protection therefore becomes relevant. This analysis consists of three parts: (1) Classification of CPS implemented in the European Union as a function of PU attributes; (2) Understanding the dynamics of CPS driving forces (PU causalities); (3) Evaluation of policy options and recommendations.

In order to explain the causality, socio-economic factors affecting CPS were identified and this process was explained within the dynamic context of PU decision-making. Then the causal links between these factors and the PU attributes were determined.

THEORETICAL BACKGROUND

The attributes of CPS are defined by growers' decisions as to when a pesticide treatment is needed, which product should be applied and at what dosage rate. Human behavioural theory states that rational decision-making requires knowledge and a choice between alternatives, and is influenced by motivations (Kasper and Streit, 1998). In order to identify socio-economic factors affecting CPS, the motivational and knowledge systems related to PU decisions were described.

The institutional economics theory, which focuses on understanding the role of institutions and rules in shaping human behaviour (Ostrom, 1998), forms the basis of the analysis for explaining how socio-economic factors affect CPS and elucidating their implications for PU attributes.

MATERIAL AND METHODS

Four European apple-growing regions, each of them representing one CPS, were selected from a classification of agricultural systems implemented for the production of fruit trees. The regions are listed in Table 1. In this classification, CPS are defined by two PU attributes: the quantity and the type of pesticides applied. The quantity of active ingredients applied per hectare was categorised in two intensity levels, whilst innovation levels indicate the high or low safety of the active ingredients applied, according to ratings assigned to their intrinsic properties (e.g. toxicity for humans) (Hernández and Mann, 2008).

Table 1. Case-Study Regions

Pesticide Use	Low Intensity	High Intensity
Low Innovation	Lérida, Spain	Emilia-Romagna, Italy
High Innovation	Kent, England	Lake Constance, Germany

Empirical data was collected via semi-structured interviews with stakeholders influencing PU decisions (i.e. farmers, public and private advisers, pesticide dealers, representatives of certification agencies, growers' associations, fruit retailers, public agencies and agricultural research centers). The interviews, which were recorded, covered the following topics: who makes PU decisions; motivation behind PU; knowledge and perceptions about PU; choosing pesticide products; other farm activities within CPS. In a total of 32 interviews, 38 stakeholders were interviewed: 14 in Spain, nine in England, eight in Italy and seven in Germany. The database was supplemented with statistics, reports on technical fruit-production issues, guidelines for integrated fruit production, and papers.

A qualitative content analysis was then made, in which categories were brought to the empirical material, continuously assessed against the data and modified where necessary (Mayring, 2004). The

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summarising technique was also implemented in order to generalise the empirical material to a higher level of abstraction (Flick, 2006).

Results

Dynamic context of pesticide-use decision-making

- *Motivational* aspects of PU decisions are guided by the economic success of apple production, which depends on the accessibility to the apple-market, where supermarkets share the largest percentage of fruit retail. Private certification of good agricultural practices (GAP) in crop production and compliance with maximum pesticide residue levels (MRL) in fruit determine market accessibility.
- PU decision-making is based on *knowledge* of regional pest and disease problems, and subject to the availability of alternatives, compliance with GAP in production, and attainment of the commercially accepted fruit safety standards. Private GAP certification schemes encourage the use of decision-support systems, operator competence and adviser capability, as well as the maintenance of application equipment. Agricultural policies (e.g. cross compliance and rural development) support apple production whilst addressing the enhancement of grower competitiveness and the implementation of sustainable farming systems. Investment in machinery, financial support for labour and equipment and the advice necessary for dealing with special problems (e.g. pests in quarantine) as well as stimulus to producers' organisations which reinforce the fruit supply and assist growers in employing innovative technology illustrate their instruments, whilst certification of skills to apply pesticides is mandatory.

Causal relationships between socio-economic factors and pesticide-use attributes

- In apple production, technical tools available for crop protection are not always employed (e.g. varieties susceptible to common apple diseases are grown) and PU still necessary. PU is a low-economic-risk tactical strategy owing to its effectiveness and relative low costs within the production costs, which are lower in farming systems with high PU levels. The common perception: controlling pests and preventing diseases governs CPS design; thus, PU is higher where diseases are more likely to occur.
- The aim of reducing risks to consumers from residues in fruits drives the choice of pesticides, with considerations of toxicology or environmental side-effects being limited by the lower availability of authorised products, particularly in the case of insecticides (in regions characterised by low-innovation in PU pest activity is more significant).

Summary and Conclusions

- A homogeneous institutional framework affecting PU decisions in apple production is in force at European level.
- PU decision-making is supported by specific information (e.g. regional thresholds) and performed under internal (e.g. record-keeping) and external (e.g. MRL monitoring) controls.
- Technical advice is supplied by networks of public agencies or marketing organisations with regard to specific conditions in the orchards and adjusted to requirements of private certification schemes on GAP, in significant percentages of the area under fruit production in the different regions (between 65 and 85%).
- Private GAP certification schemes cover larger percentages of area and give priority to achieving fruit safety standards over using all available plant-protection tools and techniques; thus, reducing reportable MRL is enforced, whilst planting apple varieties tolerant to common pests or diseases is not necessarily required.
- Apples are commercially accepted if residues in fruit are below (fractions of) MRL. In regions characterised by high-innovation in PU, restrictions to the maximum number of reportable substances in fruit and the use of certain products are frequently put into operation.
- Technical options exist which may contribute to a reduction in pesticide load (e.g. promotion of natural predators, adjustment of dosage rate) and improve the effectiveness of applications (e.g. enforcing calibration).
- The role of biocidal tools as an alternative to PU depends not only on their availability, but also on their affordability, effectiveness and applicability.

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