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Analysis

An economic analysis of the possibility of reducing pesticides in French field crops

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ABSTRACT

The paper aims to study the effects of reducing pesticide use by farmers in the arable sector in France and the feasibility of a policy target of reducing pesticide use by half. The originality of the approach is to combine statistical data and expert knowledge to describe low-input alternative techniques at the national level. These data are used in a mathematical programming model to simulate the effect on land use, production and farmers' income of achieving different levels of pesticide reduction. The results show that reducing pesticide use by 30% could be possible without reducing farmers' income. We also estimate the levels of tax on pesticides necessary to achieve different levels of reduction of pesticide use and the effect of an incentive mechanism combining a pesticide tax with subsidies for low-input techniques.

1. Introduction

The harm caused by pesticides to human health and the environment is a major subject of concern which involves some sensitive issues such as drinking water contamination, the health of users and the harmful effects on wildlife and biodiversity. In France, which ranks third in the world (and first in Europe) for the use of plant protection products, a strong social and political willingness was displayed in 2008, in a large social forum tracing objectives of the environmental policy of the country (known as the "Grenelle de l'environnement"). Ambitious targets were set and different measures and incentives are currently being implemented. The objective of reducing, if possible, the use of pesticides by half by 2018 has been announced.

The issue of reducing pesticide use has also emerged in the environmental policy debates in several other European countries, and therefore in 2009 the European Union (EU) adopted a common framework (directive 2009/128/EC) that requires each member state to submit a 2012 action plan to reduce pesticide use in agriculture. The EU directive gives the policy launched in France a broader perspective.

However the objectives set in 2008 are still under discussion: is the 50% reduction target realistic? What would be the consequences of such a level of reduction on French agricultural production and on farmers' income? What are the economic incentives needed to encourage such a reduction?

Our research was conducted to help answer these questions.[1] The work we present here concerns the French production of field crops. Although the use of pesticides per hectare of crops is not as high as in other crops (fruit, vegetables, and vineyards), the territorial extent of field crop production is such that any global reduction of pesticides in France necessarily involves a reduction in the field crops sector. In 2006, field crops represented 80% of the total cultivated land and accounted for 68% of the pesticides used in agriculture. During the last ten years pesticide use in French agriculture has been quite stable, showing no decrease despite a fall in prices for agricultural products relative to input prices. Most of the French production of field crops is grown using intensive conventional techniques. Although some farmers use less intensive techniques, it is difficult to know exactly what proportion of the total field crop area is concerned. The fraction of organic farming of the total field crop area is around 1% (Butault et al., 2010).

In this context, the evaluation of the effect of a reduction in pesticide use on agricultural production raises the question of how to take account of the possible changes in the production techniques used by farmers. Most of the recent work on analysing the effects on European agriculture of a reduction in pesticide use based on economic simulation models does not consider this aspect. Because of this they lead to the conclusion that reinforcement of the regulation of pesticides would have dramatic consequences on the supply of agricultural products and farmers' income (Nomisma, 2008;

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[1] It is part of a large interdisciplinary study "Ecophyto R&D" carried out by the French "Institut National de la Recherche Agronomique" (INRA) in order to answer specifically the three mentioned questions, this study has been done at the request of the French ministries in charge of agriculture and the environment. All the results can be found on the INRA website.

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Adenauer and Witzke, 2008). However in Europe, particularly Denmark, there have been successes with policies for reducing pesticides allowing significant reduction without harm to the production or to farmers' income (Neumeister, 2007; Nielsen, 2005).

Taking account of farmers' changes of practices in the analysis of the effects of medium- and long-term policies is the main difficulty of approaches based on econometric estimations (Carpentier, 2010). From this point of view, mathematical programming has the advantage of allowing an analysis of modifications in the production decisions of farmers, independently of what has already been observed in the past. A detailed representation of the production technologies can be embodied in the economic models. It thus makes it possible to study the environmental impacts of agricultural production considering the joint production of agricultural outputs and environmental externalities. This explains why this approach has been adopted by many economists analysing the impacts of changes in agriculture practices on the environment (Buysse et al., 2007; Falconer and Hodge, 2001; Havlik et al., 2005; Mosnier et al., 2009; Peerlings and Polman, 2008; Van Calker et al., 2008).

However it is difficult to obtain the data needed for such analysis at an aggregated level. Consequently, the economic studies addressing the issue of pesticide use reduction are generally based on data from observations on a few farms, or data from agronomic experiments (Falconer and Hodge, 2000; Falconer and Hodge, 2001, Kerselaers et al., 2007, Van Calker et al., 2008). Thus, most of them are conducted at the farm level.

The novelty of our paper is to conduct an economic analysis of the possibility of reducing pesticide use at the national level (i.e. for France) using a mathematical programming model and taking into account alternative technologies. The construction of different production technologies by experts is the solution that we have chosen to provide indicators for techniques ranging from low-input to organic production, for which we lacked data in the farm-based surveys. Those experts used their knowledge combined with data from different sources from statistical surveys, experimental data and farm networks.

We present the method in Section 2; firstly the design of current and alternative production techniques, then the model and the scenarios. In Section 3 we present the results. Section 4 is devoted to a discussion of the results and Section 5 to conclusions.

2. Method

Our methodology relies on a combination of two approaches. Firstly, a group of agronomists studied the feasibility of pesticide reduction in the main French field crops and elaborated for each crop (and several climatic zones) alternative crop management plans to reduce the use of pesticides. Next an economic evaluation of the alternative crop management plans and of economic incentives that may encourage their adoption was carried out. To conduct this economic analysis a mathematical programming model was built for the whole French production, divided into eight main regions.

This approach is similar to the economic modelling approaches that use biophysical or agronomic models to describe production functions. The use of results from biophysical simulation models is often an interesting way of compensating for the lack of data for new techniques that are not in actual use. It thus makes it possible to explore a wide range of alternative, including low-input, techniques, for which observed data on farms or experimental data are insufficient (Flichman and Jacquet, 2003; Janssen and Van Ittersum, 2007). This could have been the approach adopted in our analysis. However, pesticides are not a direct production factor (like water and nitrogen): their effect is to reduce damage levels and hence production losses due to pests, which are imperfectly embodied in the current agronomic models. That is why we decided to use other sources of agronomic knowledge in this research, namely agronomic trial results and expert knowledge.

2.1. Current Situation

France was divided into eight large regions to cover the diversity of soils, climates and pest pressure.

The yields, costs and gross margins for each of the crops and regions were obtained from Farm Accountancy Data Network (FADN) data. This choice was made in order to ensure consistency of our aggregated estimations with national levels of production and areas for each product.

However, the FADN database contains accountancy figures where costs and crops are for the whole farm and are not broken down into the different crops. To obtain costs per hectare for each crop, a standard linear regression model was used (Pollet et al., 1998). This estimate provides results for pesticides, seed, fertiliser and fuel. The crops taken into account were soft wheat, durum wheat, winter and spring barley, maize, other cereals, sugar beet, potatoes, peas, oilseed rape, sunflower, other oilseeds, artificial fodder and other field crops.

Simultaneously, data from a national survey on crop management practices “enquete sur les pratiques culturales” (EPC) (French Ministry of Agriculture, 2008) was used to characterise current agronomic practices in more detail. It covered detailed descriptions of farming practices for 12,900 fields considered to be representative of the French production of field crops. Nine crops are included in this survey (soft wheat, durum wheat, barley, maize, rapeseed, sunflower, sugar beet, potatoes, and peas). These crops represent nearly 90% of the area occupied by French field crops.

This EPC survey was conducted in 2006 (the previous study dating from 2001). Thus, the year 2006 was used for all the work. In 2006, yields and production costs were quite close to the average for the period 2000–2006, and that was also the case for prices of agricultural products (Butault et al., 2010).

Consistency between the two databases is not complete. The FADN database is representative of the total professional farm production and input use, which is not the case for EPC. However the EPC gave additional information in terms of detailed crop management plans.

In order to characterise the current and alternative techniques, indicators were used and calculated using the EPC. The Treatment Frequency Indicator (TFI) was used to measure intensity of pesticide use. This indicator is defined as the number of treatments applied, multiplied by the ratio of the applied dose per hectare to the recommended dose (OECD, 2001; Pingault et al., 2009). It thus took into account the intensity of treatment, which can be applied in reduced doses or on only one part of the area (e.g. chemical weed control in the row only). Using the EPC survey TFI was calculated from records of each treatment applied to plots compared to recommendations, per class of product: herbicides, fungicides, insecticides and “other pesticides[2] ”.

Other indicators were also used, particularly the number of times pesticides were applied (in order to estimate working time), the energy cost and the nitrogen balance. The nitrogen balance (in kg of nitrogen per hectare per year) was defined as the total quantity of nitrogen applied to the field, minus nitrogen exports calculated from the crop yield and nitrogen export coefficients per crop. The energy cost (in gigajoules per hectare per year) took into account the energy directly consumed by agricultural equipment and the indirect energy consumption used to produce fertilisers.

The estimates of costs per hectare of crops from the FADN data provide results in terms of costs per hectare that are not exactly the same but that are consistent with input quantities obtained from the

[2] This latter class covers products used against pests like mollusks, and substances that are not, strictly speaking, pesticides, but which have a controlling effect on crop development (cereal growth regulators).