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Assessing the intensity of pesticide use in agriculture

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Abstract

In order to lower the risks associated to intensive pesticide use, efforts have been made at the European and the national level of several member countries of the European Union. In Germany, a national reduction programme for pesticides had been set up. The programme makes use of the methods elaborated in the context of the NEPTUN-project. The NEPTUN-approach had introduced several indicators to assess the intensity of pesticide use in agriculture. This approach was exemplarily applied to data from a case study region in north-eastern Germany. The aim of the paper is to discuss the strengths and weaknesses of the presented approach as based on results gained in the chosen case study region.

Keywords: Pesticide use; Agriculture; NEPTUN-approach

1. Introduction

According to the Statistical Office of the European Communities (Eurostat), roughly 320,000 t of pesticides with the total value of around € 6 billion (EC, 2002) were sold in the European Union in 1999. Although the use of pesticides in absolute terms is dropping (the sales in the EU decreased about 8% between 1991 and 1996), this is not necessarily linked to a decrease in pesticide intensity, as the application rate of newer pesticides can be very low (Hoyer and Kratz, 2001). In Germany, pesticide sales had remained at high levels for over 10 years now (SRU, 2004). According to the Statistical Yearbook of the German Federal Ministry of Consumer Protection, Food and Agriculture (BMVEL), 34,678 t of pesticides were put on the market in 2002 (UBA, 2004).

Pesticides can pose a risk on the environment and human health (cf. SRU, 2004; Hapeman et al., 2003; Sørensen et al., 2003). A number of pesticides and their metabolites have been found as pollutants in ground and surface waters (e.g. Worrall and Besien, 2005; Fava et al., 2005; Kolpin et al., 2004), in soils (e.g. Sivanesan et al., 2004; Craven and Hoy, 2005) and in the atmosphere (Duyzer, 2003; Dubus et al., 2000). Furthermore, pesticides are held responsible for contributing to the loss in biodiversity and the deterioration of natural habitats (e.g. Pauli et al., 1999; Grue et al., 1982). Despite the fact that pesticides are also applied in other sectors, agriculture is undoubtedly seen as the most important source of this contamination (Hoyer and Kratz, 2001). The growing awareness of the risks related to the intensive use of pesticides have led to a more critical attitude by the society towards agriculture. At the same time, there is a change in consumer concerns that had put more weight on issues such as environmental friendliness in agricultural production and food safety (Saba and Messina, 2003).

As part of the EU's Sixth Environmental Action Programme, the European Commission had formulated a thematic strategy for a more sustainable use of pesticides, in order to reduce the use of pesticides and minimise its risks.

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As a national instrument in Germany, a reduction programme for pesticides had been set up to complement the current legislation (BMVEL, 2004). In doing so, Germany has followed the example set by other European countries, such as Austria, Denmark, Finland, The Netherlands or Sweden, countries that have introduced specific policies to decrease pesticide use (Lucas and Pau Vall, 2005). The programme encompasses altogether 19 measures. Two of these measures are especially important in regard to the focus of this paper:

- the introduction of a so-called standardised treatment index (STI) as an indicator for the intensity of pesticide use in agriculture (measure 1);
- the integration of the STI into the environmental quality assurance systems for agricultural enterprises (measure 10).

The reduction programme for pesticides makes use of the results of the NEPTUN-project for the above purpose of introducing and integrating the STI (cf. Roßberg et al., 2002). NEPTUN stands for 'Network for the Evaluation of the Pesticide Use in different Natural Areas of Germany'. The project is a co-operation between the German Federal Ministry of Consumer Protection, Food and Agriculture (BMVEL), the Federal Biological Research Centre for Agriculture and Forestry (BBA) and the federal counties in Germany. The methodology for the calculation of the STI was worked out in the context of the NEPTUN-project. Additionally, regionally differentiated average values of the STI ($STI_{average}$) and maximum tolerable levels of pesticide intensity (MTP) were determined, that served as a regional reference system, which took into account the differences in pesticide application due to deviant climate conditions and pest probabilities. The $STI_{average}$ and MTP values would serve as yardsticks for the evaluation of farmers' crop-specific chemical pest management within a region with similar conditions. A scheme was suggested by Burth et al. (2003) and Gutsche and Ganzelmeier (2003) for the calculation of the environmental compatibility value (ECV) at the farm level, that is based on the regional $STI_{average}$ and MTP values, which indicates the farm's pesticide intensity in comparison to the average intensity in its respective region. Therefore, the ECV could serve as a measure for the quality of the production process in terms of pesticide intensity. As discussed by Burth et al. (2003) and Gutsche and Ganzelmeier (2003), an agricultural enterprise with a high ECV could be given an environmental label.

The NEPTUN-approach is presented in the following sections in detail, with emphasis on the calculation of the ECV. As an example, the methodology was applied to a set of data on the pesticide use of 13 farms collected from a case study region in north-eastern Germany. The strengths and limitations of the approach are discussed based on the results of the case study region.

2. Methods

2.1. Standardised treatment index (STI)

The STI is calculated using Eq. (1), that takes the number of active substances per application, the actual application rate in relation to the recommended rate as indicated in the technical data sheets of the pesticide products and the percentage of the treated area into account (Roßberg et al., 2002):

$$\mathrm{STI} = \sum \mathrm{AS}\,(n) \times \mathrm{AR}\,(\%) \times \mathrm{TA}(\%) \qquad (1)$$

with STI is the standard treatment index per crop, AS the number (n) of active substances per application, AR the actual applications rate in relation to the recommended one (%), and TA is the treated area (%).

Since pest management usually depends on regional conditions, such as soil properties and climate, the calculated value of the crop-specific STI has to be compared to the average STI per crop ($STI_{average}$, Eq. (2)), calculated for a region with similar conditions. For this purpose, the NEPTUN-approach provided reference values related to so-called major regions in terms of the pest probabilities per crop:

$$\mathrm{STI}_{average} = \mathrm{MV}(\text{all STI per crop and major region}) \qquad (2)$$

with $STI_{average}$ is the average standard treatment index per crop and major region, MV the mean value, STI the standard treatment index per crop (see Eq. (1)).

The definition of the major regions was based on a classification system that divided Germany into 34 different soil climate regions (SCR) (Kaule and Schulzke, 1998). The calculation of the $STI_{average}$ values in the NEPTUN-approach was based on surveys conducted on more than 1000 farms throughout Germany in the vegetation period of 1999/2000. According to Gutsche and Ganzelmeier (2003), the vegetation period of 1999/2000 can be seen as somewhat 'representative' for Germany, due to the 'average' weather conditions during this period, where neither droughts nor long rainy seasons occurred.

2.2. Maximum tolerable level of pesticide intensity (MTP)

The MTP is calculated for each crop by adding the standard deviation of all STI values per crop and major region to the $STI_{average}$ value (Eq. (3)):

$$\mathrm{MTP} = \mathrm{STI}_{average} + \mathrm{S.D.}(\text{all STI per crop and major region}) \qquad (3)$$

with MTP is the maximum tolerable level of pesticide intensity per crop and major region, $STI_{average}$ the average standard treatment index per crop and major region (see