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ECONOMIC ASPECTS OF CHEMICAL REDUCTION ON FARMING – FUTURE ROLE OF PRECISION FARMING

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Abstract. The social need for the decrease in the chemical use of the agriculture and its environmental impacts is growing. The decreased level of chemical use can be resulted by several means from the reduced number and quantity of treatments, the organic production, the sustainable production by integrated chemical plant protection methods to the precision production techniques. The use of these methods will change the whole operation and production system of the farms. With the help of model calculation, the present paper examines the viable size of a crop production farm turned into precision farming (weed management) under Hungarian conditions. The results show that the break-even point is at 205 hectares, in case of which the expected return on investment costs is included as well. In this case precision farming means rational pesticide use. Applying the concepts of integrated crop production to precision farming can help to found the most cost-efficient and economically viable crop production system.

Key words: alternative strategies, precision weed management, viable size

INTRODUCTION

Parallel with the social and economic development in Hungary, it is more and more desired to reduce the chemical use and environmental load in agriculture. The present paper – based on international experiences – aims to explore what methods can model and measure the reduction of pesticide use and risks, examining each technology on farm level, sector level and macroeconomic level. The paper includes those tasks at government and sector level which should be faced following the EU integration.

Regarding the tendency in the developed countries that it is necessary to reduce the use of pesticides, the farmers have to make new strategies. The following trends can characterize the alternatives for the application of technologies with reduced chemical use:

- the application of integrated crop production systems,
- organic farming,

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- an outright ban for chemical use,
- reduction of the application of any chemicals,
- the implementation of precisional farming to promote the rational application of chemicals.

In the past few years in the developed countries there was an increasing need for reducing the risks of chemical application. One of the schools of the research examined that how the economic consequences of the reduction of pesticide use can be considered both from the point of view of the potential methods and the application. The necessity of examining the economic effects of this type of programs were drawn up at 3 former OECD events [Uppsala 1995: „Pesticide Risk Reduction"; Neushatel 1998: „Integrated Pest Management and Pesticide Risk Reduction", Coppenhagen 2001: „Workshop on the Economics of Pesticide Risk Reduction in Agriculture"].

In my opinion, the most important is to determine the procedures which can be applied and supported in the countries at different development levels. Eventually, the application of chemicals cannot be totally banned in areas where it is difficult to produce even the basic crops. However, in areas where the agricultural excess production is usual, dead stock is accumulated, the dose of fertilizers per hectare is high (450–500 kgs per hectare), the average number of plant protection treatments is high (8–9 for autumn wheat), it is necessary to investigate the impact of radical reduction of chemical application. Certainly, these investigations should cover not only the change in cost and yield due to chemical reduction but also the extra expenses on its implementation (costs of transformation, necessary investment, quality assurance). The investigations must be carried out not just on farm level, but we also have to deal with its impact on the sector and on the national economy. An analysis, based on years of data collecting, carried out in Denmark, stated that on the level of national economy the 33% decrease of of chemical application level in the past decade did not reduce significantly the income level of farmers. Income supplements for producers were not necessary.

Precision farming can meet both requirements: it can be a tool of reducing chemical use and a way of profitable farming at the same time. It is necessary to examine the economic aspects of this new technology, regarding the consequences of turning to a new farming strategy that could reduce chemical use and environmental pollution at the same time [Ørum et al. 2001; Swinton 2005; Wiles 2004; Kis 2006].

Defining what precision farming means from the point of view of herbicide use, we can state that precision weed control has two meanings:

- first we can reduce the doze of herbicide depending on the humus content and the adherence of soil (in one land unit it could be differed 3.2–4.5 kg/ha from the same chemical);
- and we can save 30–40% of costs by not treating plots based on the data of weed-collection during the vegetation period.

The evolution of precision farming and precision weed management goes back to the beginning of the 1990s when development of global positioning, geographic information systems and hardware and software technologies has speeded up. This has opened the gate for a new production strategy trying to offer solutions to the problems of uneven distribution of pests on a given field, while treatments across the fields are usually homogenous. This is especially true in the case of perennial weeds [Maxwell, Luschei 2005].

There are three basic elements of precision farming that is continuous, high precision positioning, geographic information tools and automated work processes on the field. At different points of the field the infestation of the varying factors has to be measured before and during the vegetation period; authenticated on the soil-maps, based on soil examinations (humus content, nutritive ingredients, adherency), and, of course, use of the new technology – called GPS. Herbicide can be applied by an automated sprayer equipped with GPS and controlled with a computer. The sprayer is constantly monitoring its position on the field, and according to sensors or the weed map it will spray only in those places and amounts or doses of herbicides that were determined in advance by a specialist [Reisinger et al. 2004; Neményi, Milics 2006]. Recently, it was discovered that in most cases only 10–20 weed species can be found in a field, and only a few dangerous species mean big threat to production. Therefore, when choosing the weed management strategy, the main attention has to be paid to them. If these species are mainly perennials for which the uneven, patchy distribution is more characteristic, the possibility of the application of a precision weed management strategy will receive high priority [Reisinger 2001].

The economic consequences of precision farming have not got such attention among scientists yet. The costs of precision farming – including costs of weed control – are higher by 10–20% than costs of conventional production, but in some cases they are lower by 10–15% due to cost saving in chemical use. On the other hand, the need of extra investment must be taken into consideration. It is about 5–6 million HUF (20.000–24.000 EUR) per farm.

During the last few years, the investment need and return on investment when changing into precision farming technology was examined under Hungarian conditions. Based on the data of earlier model calculations, the viable size of a crop production farm with own machinery is 100–140 ha (60 kW power) and 160–215 ha (120 kW power) under Hungarian conditions [Takács-György 1998].

It was calculated that the purchase of all the required technical equipment is worth only when a crop producing farm operates on more than 250–270 hectare [Székely, Kovács 2006; Csete et al. 2002] The farm must have more than 500 hectares (plant production) to built up this technology from the first step. In some cases – if there is a real machinery service background available for the farmer – this technology can be built up in smaller farms, too, but the risk of technology will increase. At the same time precision weed management can also be seen as an alternative farming strategy that is the most sophisticated variant of the integrated crop production requiring high level professional skills [Takăcs-György 2003; Kis, Takăcs-György 2005].

MATERIALS AND METHODS

During the research I have updated the former model calculations and made cost-margin analysis in order to show how the viable size – covering the simple capital replacement, too – is modified by the introduction of precision farming with average crop production structure. Upon the calculation of investment costs I presumed that the required machinery is developed parallel with the introduction of the technology and the purchase of basic instruments is not delayed, therefore only the extra investment costs were defined on the basis of Hungarian distributors' data of 2006. Thus the extra investment need of a 250–300 ha farm is 22.000 EUR.

Production costs include costs corrected with income expectations from the invested assets. The produced crops are as follows: 30% winter wheat (5.15 t/ha) – where precision crop protection is not significant – 15% sunflower (2.49 t/ha), 35% maize (7.35 t/ha) – in case of these latter ones, significant cost savings can be calculated due to precision crop protecion – and 20% alfalfa which is utilised within the farm so it was not taken into account upon calculating the viable farm size. The crop yield was calculated on the basis of average Hungarian yield data of test farms in 2004. In the calculations, the material cost saving of precision farming was 10%, the cultivation cost was more by 5%, the yield was more by 10%. The model was built under Hungarian conditions, calculating the costs on price level of 2006.

RESULTS

In case of applying precision crop protection, the calculations help to determine the income per unit in connection with production size compared to the income of conventional farming (it was integrated crop production in this model).

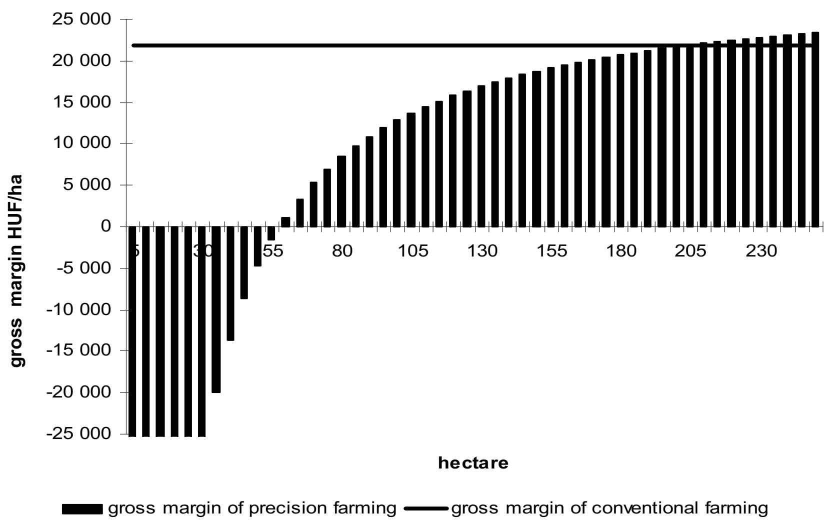

Fig. 1. Viable size determination in case of precision and conventional farming
Rys. 1. Wskaźnik opłacalności w rolnictwie precyzyjnym i tradycyjnym
Source: Own research.
Źródło: Badania własne.

In the examined case, at least 206 hectares – involved in precision farming – is required for crop production in order to realise the same income as in case of production without extra investments, considering also the costs of necessary extra investment for the given year, presuming that the other factors are the same. It means that this type of farming can be viable for medium-size farms. Others should find some ways of co-operation – common machinery use, machine lending, machine leasing – that can help to avoid significant extra investment.

CONCLUSIONS

The results of the research indicate that although the precision plant protection within a farm requires further investigations, it provides the opportunity for rational chemical use. Due to this, it is not the amount of the applied chemicals that can be reduced, but the unnecessary amount of chemicals going into the environment in such way that at the same time the income rises (surplus in the break-even income). At a certain size a farm can operate in a profitable way, and considering the introduction of precision farming, besides the extra costs of the sophisticated equipment and the possible pesticide reduction, farmers should not forget about the additional costs of obtaining the necessary information for the high-tech technology.

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ASPEKTY EKONOMICZNE REDUKCJI ŚRODKÓW CHEMICZNYCH W ROLNICTWIE – PRZYSZŁOŚCIOWA ROLA ROLNICTWA PRECYZYJNEGO

Streszczenie. Potrzeba społeczna ograniczenia zużycia środków chemicznych w rolnictwie i jej znaczenie środowiskowe wzrasta. Niższy poziom zużycia środków chemicznych może być rezultatem wielu czynników, począwszy od zredukowanej liczby i ilości zabiegów, produkcji organicznej, produkcji zrównoważonej poprzez zintegrowane metody chemicznej ochrony roślin, aż po precyzyjne technologie produkcji. Zastosowanie takich metod zmieni cały system produkcji gospodarstw rolnych. Na podstawie modelu kalkulacji w artykule zbadano rentowny rozmiar gospodarstwa prowadzącego produkcję roślinną, przekształconą w uprawę precyzyjną (zwalczanie chwastów) w warunkach węgierskich. Wyniki pokazują, że punktem krytycznym jest 205 ha, w przypadku oczekiwanego zwrotu kosztów inwestycyjnych. W tym przypadku rolnictwo precyzyjne oznacza racjonalne zużycie pestycydów. Zastosowanie koncepcji zintegrowanej uprawy roślin w rolnictwie precyzyjnym może pomóc w znalezieniu najbardziej rentownego systemu produkcji roślinnej.

Słowa kluczowe: strategie alternatywne, precyzyjne zwalczanie chwastów, wielkość rentowna

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