STOWARZYSZENIE EKONOMISTÓW ROLNICTWA I AGROBIZNESU
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TECHNOLOGICAL ANSWERS FOR ENVIRONMENTAL CHALLENGES IN CROP PRODUCTION

TECHNOLOGICZNE ODPOWIEDZI DLA WYZWAŃ EKOLOGICZNYCH W PRODUKCJI ROŚLINNEJ

Key words: environmental burden, chemical use reduction, alternative farming strategies
Słowa kluczowe: obciążenia dla środowiska, ograniczenia stosowania substancji chemicznych, alternatywne strategie gospodarowania

Abstract. In the developed countries it is getting more important to maintain the good conditions of the environment. In sustainable agriculture it is getting more important the need of reducing environmental burden duo to agrochemical use. To carry out environmental protection, the responsible use of natural resources and keep rural development for the future generation is out task. One alternative can be precision farming that fits the ecological, social requirements: to keep the environment, biodiversity for the future and fit the economic requirements. It is examined and forecasted the potential input and cost savings of precision weed management on a sectoral level in the EU countries.

Introduction

The term "sustainable development" includes the current and long-run sustainable production and the controversies of environmental protection that assurance the right quality of life, and hard-preventable, but rather tolerated conflicts. In the realization serious regional, national, social (and of course, political) interests, momentary, short and long-run visions clash, they often confront. [Chilinsky 1998] According to Jørgensen and Svirezhev [2004] sustainability must include the farming that allow for easy reproduction the assets needed for production not only business management level, but also on a national level management irrespectively of the source of capital necessary for farming. It is also important to maintenance of rural areas.

The chemicals used in agricultural production, indispensable to the production level, that is needed for the world's population food supply, needed to produce raw material on the one hand, and mean the risk of human existence on the other hand. Appraising the crop production as a system in the curse of finding the degree of intensity and form of business that eligible for the environment, must take into account the losses of the negative environmental and human consequences that harmful, pathogenic organisms may cause.

It should be noted that the basis of various calculations the yield loss ascribed to the plant pest organisms (biotic stress) can be the 40% of the potential yield. The yield loss is 10-12% brought about by the weeds, 18-20% by pathogenic organisms, while the pests are responsible for 8-10%. This can also comprehensible that producing the yield required, 1.67 times higher area should grow crops, which is not possible due to land limitation. Its effect appears on the increase of production costs. In the case of Hungary, assuming the loss values above, the potential areal equivalent of plant protection is 1.2 to 1.4 million hectares of arable land, if does not happen preventive defense against biotic stress causing organisms [Takácsné 2011].

The results of the agricultural technological development, mechanization, pesticide production, variety breeding, etc. meet the society laid claim the reduction of pesticide use (both the sent quantity and frequency relation.

The use of weed, disease and insect-resistance varieties, as one of the indirect tools is applied in practice, the right combination of additional agro-technical tools may be one basis for resolving the contradiction mentioned above.

The potential development directions of crop production include those forms of farming which separately formed in time and space that is jointly referred as organic – ecological – farming. These trends' common characteristics are the prohibiting synthetic chemicals (fertilizers, pesticides, yield-enhancing) usage, and prohibiting the application of all technology components and procedures that reduce the harmful effects of plant antagonists, but also help to maximize the maintenance of biodiversity [Padel 2001, Schou et al. 2002, Maciejczak, Zakharov 2011]. These directions assume that the sale of products that were produced in this way are provided in a market at a price that will cover a different kind of technology's higher – cost [Takács 2006]. The use of integrated crop production systems means the rational management, that reduce the environmental load with a use of reasonable amount of pesticide (Integrated Pest Management IPM) The precision farming through the spot treatments allows targeted agent application, result rational use of chemical beside the reduction of chemicals. According to Moore and his colleagues [1993], the aim of the „Site Specific Crop Management" is to define, analyze, and „handle" the soil, space and time variability within an agricultural field for the optimal return, sustainability of agricultural production and environmental protection. Precision farming means a new management strategy for the plant production, which allows for the producer the realization of the micro-regions matching technology. This, beside the less environmental load, can provide a more economical production for the farmer.

The aim of the research is the economic evaluation of plant production impact on environmental load reduction in a broader interpretation of sustainability.

Materials and methods

In the research based on content analysis of literature based on the literature, will be evaluated the technological responses that characterize the different management strategies.

Examined alternatives of reducing chemical use in plant production are the following:

– chemical free production (like ecological farming),
– reduced crop protection chemical use (like integrated plant production (IPP)),
– precision farming (PF).

Results

Applying technologies that based on the reduced chemical use, reported the formation of different tendencies besides the conventional farming, that its main economical features are summarized in table 1.

1. Trends (kinds of organic farming) are free from chemicals (prohibiting the use of artificial chemicals) and the total prohibition of the use of chemicals from the point of view of environment. Each tendency goes with the decrease of environmental burden, however, the production structure, the resources need, and quality but also the sales opportunities as well of the holdings change. The rate of growth has slowed down because of the limitations of consumer demand for organic products, the market saturation is typical [Takács et al. 2003, Kis 2008, Járási 2009]. The primary condition is the farm technology R&D.
2. Application of the integrated crop management systems meaning rationale production, which is reducing the environmental burden using the appropriate amount of pesticide. Integrated pest management (IPM), reasonable application of biological, biotechnological, chemical, production or plant breeding measures, in the course of pesticide use is strictly limited to the minimum level that will necessary to maintain below in an economically unacceptable level causing injury or loss of harmful population [Smith, Reynolds 1966]. These systems are more important in the horticulture, especially in green houses from the point of view of sustainability [Hágen, Marselek 2010].
3. One special form is the lane spraying, complementing other agro-technical means (lead cultivation) are a process by which the amount of chemical passed can be reduced by 30-70%. However, the energy of the land will increase with this increased because the use of surplus agro-technical element [Blackshaw et al. 2006, Széll et al. 2008]. The primary condition is the farm technology R&D.
4. Use of precision farming that allows rational chemical pass by the spot treatment, result rational chemical use besides reducing chemicals. Precision farming means a new management strategy for the plant production, which allows the implementation of technology for the producers used in the micro-regions, primarily on the relation of chemical use. This, combined with a lower environmental burden, also offers more efficient production opportunity for the producer. [Swinton 2005] Jolánkai and Németh [2007] complete all of this, that the essential element of precision farming is the pursuit for the most accurate adaptation of production technology adjusted to production site. We must not forget that because the technology is primarily based on the achievements of computer technology, therefore the application of IT knowledge is important. The reasons for slow expansion the lack of education and expertise, as impending factors should also be mentioned [Pecze 2008, Takács 2008a, Nábrádi 2010]. The spreading is slow, the reasons include that high-level management skills are needed, high degree of precision is important for the workers, the extra investment costs are relatively high, and

the lack of proof of technology cost efficiency. The possibility of application of machinery in a higher areal unit, as a service or in cooperation, the broadening the forms of cooperation reduce, dissolves these inconsistencies [Takács 2000, Takács, Baranyai 2010a,b]. This also serves the improvement of return on assets, both at operating and at macroeconomic level [Takács 2008b]. Primary conditions are the farm and engineering technology R&D and the R&D of geographic information system.

5. The need of completeness requires, mentioning the coating of commercialized producing of plants that are created with the change of the genetic file hereby the application of can be cancelled or reduced from its technology. Transgenic organism (TGO) developed through the transfer of the genetically modified organization (GMO), or the part of the genome of living organism transferred, have advantageous features by conventional varieties, they are not sensitive to certain technological elements. In an economic sense can talk about the reduction of damage caused by harmful organisms, the avoid of yield reducing impact caused by individual elements applied in farm technology, and the cost reduction from other input savings that for the prevention of the previously mentioned yield's quantity and quality losses. The forthcoming cost savings within the certain elements of this technology is opposed to additional costs, during the production, as the adherence of isolation distance and the surpluses related to sales, besides the high seed cost of GMO's, TGO's varieties. Primary and necessary condition is the variety (biotechnology), R&D, but the operating level of technological R&D is also needed.

Conclusions

Savings of chemicals using precision technology can also be interpreted as not required and not used by the plant, but at the same time chemicals that not allocated, the importance of technology is outstanding in reducing the environmental burden as well. The positive effects of technology are unquestionable, both on the farm and national levels. Previous studies have reported the cost efficiency on farm level, which is not examined because of space limitations [Godwin et al. 2003, Swinton 2005, Chavas 2008, Takács-György 2008, Lencsés 2009].

Among the macro-level effects, the actual decrease in chemical use must be mentioned, that is a potential opportunity. Application of precision farming has an important role the reduction of pesticide use than the reducing of fertilizer. The advantage of precision crop comes from the fact on the one hand that if the proportion of area is high, where the treatment of land protection can be left off, depending on the area infected and the heterogeneity of infection, the spot treatments can result fair material savings. At the EU-25 level, the estimated rate on pesticide savings is from 5.7 to 11.4 thousand tons, if 15% the plant is switched over, from 9.5 to 13.1 thousand tons at the switch over of 25%, while the most optimistic cases the savings are from 15.2 to 30.4 thousand tons. The savings of insecticide cost 1,674.1 to 3,348.1 million EUR (at 2006 prices). If the proportion of the switch over farms is between 30-60% of the total, compared to the quantity used in the surface treatment intensive technology an average savings of 30-60% is estimated of a pesticide's ingredients per holdings. If the 10-35% ingredient reduction carried out by constant yield the environmental burden is reduced by 10-35% at the national level. In this case, the individual utility coincides with the social utility, that serve the sustainability [Takács-György 2009, Takácsné 2011].

The valuation of economic impacts of precision agriculture, at farm level, cost-benefit analysis, return and gross margin analysis can be applied. The precision technology has a positive effect on ecological sustainability (reasonable chemical use), profitably can be achieved at farm level, ensuring the rate of return of the developments required for technology (economic efficiency). However, it should be noted in relation in the precision agriculture that it has dual positive effect connection with social sustainability. One is derived from the reduction of environmental burden; the other is contributing the productions of needed food and industrial raw materials, and energy basis.

Need to find a balance between the economy, the environment, and the social expectations. The goal from the perspective of the environment is the conserve and improvement of natural capital, the natural environment, while in terms of the economy is to increase the efficiency of material goods' consumption. In terms of society is needed to ensure the creation and maintenance of equality. This can be done if production factors can take into account in wide range, realizing the causality [Auernhammer 2001, Takács-György 2005]. Satisfying the dual requirement (the pursuit of ecosystem sustainability and the social demand), at the same time, through the technological development, the agro producers have to strive after. The common element of possible responses is the reduction of negative externalities, while focusing the well-groomed, preservative of natural resource productivity, through on remedial solutions the aim is the preservation and value increase of public goods.

In the agriculture at farm level, wide-spread of each technological process, which has positive effects on the preservation, „re-production" of natural resources, and can be achieved by the technology

Table 1. Economical comparison of alternative strategies of chemical reduction
Tabela 1. Porównanie efektów ekonomicznych zastosowania alternatywnych strategii ograniczenia środków chemicznych w ochronie przeciw chwastom

Specification/ ***Wyszczególnienie***	**Reduced crop protection chemical use/** ***Zredukowana ochrona przeciwko chwastom z wykorzystaniem śr. ochr. chem.***	**Chemical-free production/** ***Produkcja bez zastosowania śr. ochr. chem.***	**Precision farming/** ***Rolnictwo precyzyjne***
Obtainable yield/ *Uzyskany plon*	almost same as conventional/ *prawie taka sama jak konwencjonalna*	15-35%	almost same as conventional/ *prawie taka sama jak konwencjonalna*
Production costs/ *Koszty produkcji*		80-110% of conventional/ *konwencjonalnej*	higher due to extra investment/*wyższe w związku z dodatkowymi inwestycjami*
(Extra) Investment Need/*Potrzebne dodatkowe inwestycje*	none/*żadna*	none/*żadna*	significant/*istotna*
Sales price/ *Cena sprzedaży*	same as conventional/ *taka sama jak konwencjonalna*	possible to realize premium (0-30%)/ *możliwość uzyskania premii rynkowej (0-30%)*	same as conventional/*taka sama jak konwencjonalna*
Subsidy/*Dotacje*	same as conventional/ *taka sama jak konwencjonalna*	special target support in addition to conventional/ *dedykowane wsparcie ponad to dla produkcji konwencjonalnej*	special target support in addition to conventional/*dedykowane wsparcie ponad to dla produkcji konwencjonalnej*
Profitability/ *Rentowność*	almost same as conventional/ *prawie taka sama jak konwencjonalna*	higher than conventional in case of premium price and subsidies/*wyższa w wypadku uzyskania premii rynkowej i dotacji*	depending on the size; in smaller farms it is less than conventional due to the big investment need; in middle-size farms it is the same as conventional; in bigger farms it is higher than in case of conventional farming/*uzależniona od wielkości gospodarstwa, mniejsza w małych, porównywalna z konwencjonalnymi w średnich, wyższa w dużych*

Source: own study based on Takács-György, Kis 2010
Źródło: opracowanie własne na podstawie Takács-György, Kis 2010

developments required for returns (economic efficiency) affect towards sustainability. In addition, the spreading of precision agriculture is to promote social sustainability with the reduction of environmental burden and the production of food and industrial raw materials, energetic objective raw materials. Creating the harmony between the individual and social utility, the triplet requirement of sustainability can meet within the plant production, applying this farming strategy in a long-run.

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Streszczenie

W artykule przedstawiono rozważania na temat wyzwań ekologicznych w produkcji roślinnej. Stwierdzono, że odpowiedzią na nie jest stosowanie technologii rolnictwa precyzyjnego. W odniesieniu do tej technologii dokonano diagnozy z elementami prognozowania oszczędności po stronie nakładów i kosztów precyzyjnego zwalczania chwastów na poziomie sektorowym w krajach UE.

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