Role of agricultural innovation in matching the „greening component" of CAP

(Case of site-specific crop production)

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Abstract

It is frequently mentioned, that one of the key elements of strengthening the SMEs is the permanent renewal, the capability for innovation. It is also true in the case of agriculture. From one point of view, innovation in agriculture ensures the widespread use of the most up-to-date technology. Lots of new solutions have been implemented rapidly that are connected to animal health questions, precision technologies, chemical usage, irrigation, etc. in the last decades. These new solutions sometimes are really new inputs of the production, machines, technologies but some of them are new managerial technics as well. Here the role of agricultural extension services, knowledge centres, experimental farms are important. Our opinion is that observing the good practice, adoption and/or adaption – the imitation – should get higher function in everyday life. Site-specific farming is a holistic system, a technology that allows target oriented treatments, thus managing the spatial and temporal variability within an ecosystem, by applying spot treatment applications. It has been shown that the implementation of site-specific crop production can result in savings in the use of pesticides, while savings can also be expected regarding fertiliser use, depending on the objective of production. This technology is the result of a longer innovation process that can be characterised as a technology-push one. Although it is compatible with ecological, economic and social sustainability its real diffusion is not so fast that it can be. The question is whether has any role of precision crop production in meeting the requirements of the "green component" of Pillar 1 of the European Union's (EU's) Common Agricultural Policy (CAP) for the period 2014-2020? Is this technology intended to encourage environmentally friendly farming practice? Precision farming is an abiotic factor, which is the ultimate tool for the reform of agricultural production.

Keywords: pesticide savings, new technology, indirect subsidy

Introduction

Site-specific crop production is an innovation in agriculture. Its history goes back over 25 years, the first appearance of site-specific pesticide use is older than 15 years. Nevertheless the environmental and economic advantages were proved, its spread – as implementation into the every days practice – is not so fast, especially in pesticide use.

Due to agricultural development more and more new ingredients come into practice in the case of plant protection. The use of pesticides in agricultural production, indispensable to the production level, that is needed for the world's population food supply, to produce raw material on the one hand, and mean the risk of human existence on the other hand. All these questions are parts of sustainable agriculture. Due to the limitation of the paper, here we highlight only interpretation of sustainability is extended by Chilinsky and his colleagues in 1998 that the production must be sustainable in economic sense (Chilinsky et al., 1998). The interpretation of sustainable development was extended by the necessity of such level of farming that allows the easy reproduction of assets needed for production not only at business management level, but also at national level management irrespectively of the source of capital necessary for farming. (Jørgensen and Svirezhev, 2004). Bongiovanni and Lowenberg-DeBoer (2004) focused on precision agriculture in the context of sustainable agriculture and underlined that this technology can be a tool for farmers to meet the requirements of environmental, social and economic sustainability at the same time.

Reducing the required quantity of herbicide, combined with a lower environmental burden, also offers more efficient production opportunity for the producer. (Wolf and Buttel, 1996; Timmermann et al., 2003; Swinton, 2005; Takács-György, 2009) Also must be mentioned the fact that precision farming – in connection with yield uncertainty – is a tool of reducing risk (weather, diseases, insects, weeds) and also a tool of reducing environmental damages. (Auernhammer, 2001; Yu and Segarra, (n.a.); Swinton, 2005)

This thoughts appeared in the summary of OECD Workshop on the economics of pesticide risk reduction (Copenhagen, 2001), that both Integrated Pest Management and any technology allowing the site-specific treatments are real tools/ways to assess the economic impacts of pest control and risk reduction at both farm and national level. The economic advantage of introducing site specific crop protection depends on the crops, crop rotation, whether the occurrence of damaging organs is changeable and the proportion of infected area is low. (Barrosso et al., 2004)

Lambert and Lowenberg-DeBoer (2000) examined over 100 literatures on economic studies of precision agriculture. About two thirds of all studies report benefits and another quarter of them report mix results, mainly in the case of fertilizer use, but in the case of site-specific weed management, GPS guidance. The economic advantages were also highlighted in variable rate plant populations when yield potentials vary widely in the field. Some authors were dealing the profitability of site-specific crop production but only small part of them focused on plant protection. Profitability of crop production depends on a lot of technological element, on farming and management skills at the same time when site-specific farming was implemented into practice including plant protection. This is only one strategy for reducing pesticide use but can be achieved advantages. (Knutson, 2009; Rieder at al., 2006; Gutjahr at al., 2008; Takács-György – Takács, 2009; Takács-György, 2012)

If we see the potential political tools of pesticide use reduction, first came the idea of special pesticide taxes. The tax on crop protection chemicals in itself does not reduce chemical use if it is not paired with the compensation of revenues (Falconer – Hodge, 2000). Schmitz and Brockmeier (2001) analyzed the impact of so called „green taxes" on the high level use of chemicals. Due to their outcomes in the first period of implementation the „green taxes" the higher social costs will appear, mainly connected with the income compensation of the farmers (Schmitz – Brockmeier, 2001; Schmitz – Ko, 2001). On the other hand, due to the results of a Danish survey and model, if the farmers give good answers to the fertilizer reduction by one third – from a very high level in the case of Denmark – the income of crop production had not dropped radically. (Ørum et al., 2001; Ørum et al., 2002)

Skevaska et al. (2012) concluded that pesticide taxes as a single instrument can be characterized as ineffective since they result small decreases in pesticide use and environmental spillovers. They stated that the importance of taxes in a pesticide policy relies on their capacity to raise tax revenues that can finance subsidy schemes. So, the increase of social costs will take place. If the policy subsidies the low-toxicity pesticides and technologies, that reduce the "unnecessary" used chemicals, the R&D of more environment-friendly products contribute to considerable hazard reductions. No single tax or levy instrument can lead to a substantial reduction of pesticide use.

Before the new CAP reform there were debates on the alternatives of greening component. Due to the limitation of this paper we do not analyze them we mention some of those who highlighted the risk of the accepted and existing three different practice of greening. Hart and Baldock (2011) focused on less effectiveness from environmental perspective. By their opinion environmentally sensitive agriculture is pursued best by using measures that are tailored and targeted to specific environmental needs and the locations in which action is required, with commitments by farmers covering several years. Westhoek et al. (2012) doubt the effectiveness of crop diversification, especially in the case of smaller farms, as most European farmers already meet this requirement. The EU-wide effects of this measure will be limited and mostly restricted to specialized agricultural areas currently predominantly covered by mono-cultures. We agree with the opinion of Matthews (2013) on flop of greening in the present form of tools. He concluded that greening would add to the costs of production and projected an average decrease in overall farm income per worker between 1.4% and 3.2%. Balzer at el. (2012) underline that the greening component of existing CAP 2013-2020 – notwithstanding the good intention – will not fit its aims (maintain the environment, keep the diversity). It was not successful to lead it into the regulation, practice the principle of "public money for public goods".

We agree with those who call attention to alternative solutions in the discussions of the CAP proposals and do not exclude the acceptance of innovation outputs (technique, technology, organization) in the CAP system (Groupe de Bruges, 2012). Hart and Menadue (2013) highlighted the role of national agricultural policy by developing new certification schemes as the tool through which to deliver greening into wider practice.

Aim, Material and methods

The aim of the paper is to highlight the role of site-specific crop production with special focus on plant protection in meeting the requirements of sustainable agriculture, i.e. the greening component of CAP. Based on Farm Structure Survey (FSS), EUROSTAT and OECD database the savings in chemical ingredients are modeled with scenario analyses on EU-27 level for arable land to year 2006 and year 2012, taking into consideration the available data. The first model was built up in 2008 (Takács-György, 2009; Takács-György – Takács, 2009), in this paper we highlight the changes to year 2012.

Arable and mixed farms would switch to precision farming only if they are above a certain size, owing to the additional equipment required for the technology adoption. The estimations were made for crop production and mixed farms according to countries and groups on the basis of different levels of chemical use.

The following assumptions were taken into consideration:

- Main parts of the chemical savings come from plant protection. The savings of site-specific fertilize use is lower, due to the fact that here more frequently is the so-called optimizing aim. That means the higher yield – depending on soil heterogeneity – is the aim of production.
- Farms above 100 ESU are able to switch to precision crop production by making their own investments based on their farm size and production level, while farms within the 16-40 and 40-100 ESU size classes can convert by using shared machinery and services.
- Farms applying site-specific fertilizer use due to scenarios: 15-25-40 %.
- Fertilizer savings due to scenarios: 5-10-20% of ingredients.
- Farms applying site-specific plant protection due to scenarios: 15-25-40 %.
- Pesticide savings due to scenarios: 25-35-50 % of ingredients.

From total utilized agricultural land cereals, other field crops and forage crops were included into the model calculation. In 2006 the represented farms in the FSS meant 4062.3 thousand farms, operating on 146.43 Million hectares, from which the farms of economic size over 50 000 to 500 000 EUR were 992.6 thousand farms operating on 78.42 Million hectare, while there belonged 56.3 thousand farms to the largest economic size with 16.59 Million hectare. (Table 1) They covered 64.9 percentage of total utilized agricultural land in EU-25.

The subject of the research was EU-27 in 2012. The represented 4919.4 thousand farms in the database operated on 160.62 Million hectare. The increase in the number of the represented farms (21.1%) was much higher than was the increase in the total utilized agricultural land (9.6%) that came from the fragmented farm structure in Bulgaria and Romania. We think the accession of new members in 2007 do not make relevant effect on our topic, because both countries belong to the group of low level of chemical use. The number of farms of economic size over 50 000 to 500 000 EUR were 1035.2 thousand farms covering 86.22 Million hectare, while there belonged 73.9 thousand farms to the largest economic size with 22.24 Million hectare. (Table 2) We did not examine the potential reasons of the increase in the number of the medium sized and large farms. They covered 64.9 percentage of total utilized agricultural land in EU-27.

We calculated the fertilizer and pesticide cost savings for field crops and mixed types of farms and for country groups differentiated by the level of chemical use, like EU-27; Belgium, the Netherlands and Germany belong to the group with the highest chemical input level; Czech Republic, Denmark, United Kingdom, France, Ireland and Poland to the lower level use group. From the point of chemical usage, Hungary is close to the latest mentioned group. The level of chemical use, especially the use of pesticides alludes to intensity of the production a bit. (The categorization was made on base of Table 1.) When it was available we used data from 2010.

Table 1. Pesticide use in EU-27, 2006 and 2010

Country	pesticide use kg/ha 2006	pesticide use kg/ha 2012	Country	pesticide use kg/ha 2006	pesticide use kg/ha 2012
(BEL) Belgium	11,29	…	(LUX) Luxembourg	…	…
(BGR) Bulgaria	…	…	(LVA) Latvia	0,66	…
(CYP) Cyprus	8,15	…	(MLT) Malta	…	…
(CZE) Czech Republic	1,64	…	(NED) Netherlands	9,32	8,75
(DAN) Denmark	1,39	1,6	(OST) Austria	2.34	2,58
(DEU) Germany	3,01	3,39	(POL) Poland	1,28	1,72
(ELL) Greece	…	…	(POR) Portugal	7,97	6,44
(ESP) Spain	…	…	(ROU) Romania	0,8	0,75
(EST) Estonia	0,64	0,79	(SUO) Finland	0,64	0,78
(FRA) France	3,98	…	(SVE) Sweden	0,79	0,75
(HUN) Hungary	2,01	2,25	(SVK) Slovakia	1,08	1,31
(IRE) Ireland	2,21	2,5	(SVN) Slovenia	6,78	5,75
(ITA) Italy	8,19	7,35	(UKI) United Kingdom	3,68	2,79
(LTU) Lithuania	0,54	0,84			

Source: own construction, based the Dataset: 2013 Edition of the OECD Environmental Database

We used the cost of chemicals instead of the used ingredients per hectare, because there were not available data for pesticide use in each country and the cost changes show general effect on competitiveness.

Our research objective was to estimate the size of arable land on which site specific chemical use can be implemented based on size economic aspects and calculate the changes in cost and cost-structure, due to the question of competitiveness. We made the estimations on year 2006 and 2012. Our hypotheses were the following:

H1: The number of farms shifting to site-specific crop production depends on capital investment needs and/or technical services and a measureable amount of pesticides can be saved at European Union level and cost savings can be tool for strengthening the competitiveness on world market, and thus the objectives of greening can be reached by using precision technology.

H2: Due to the wider dispersion of site-specific plant protection in those countries where the higher chemical use is characteristic – the cost of fertilizer and pesticides is 1/3rd higher in the total cost – the implementation of the site-specific elements causes higher advantage from cost side.

Results

Wide spread of site-specific fertilizer use can cover 67.56 percentage of total utilized agricultural land in 2006 and 67.4 percentage of 2012.

Fertilizer cost reduction

The estimated cost savings in fertilize use was 12226.1 Million EUR from which 7034.0 Million EUR (55.8%) came from 4-5 economic size farms, that represents 53.7% of utilized agricultural area and 24.4% of the farms, while 1716.8 Million EUR (14.0%) came from the farms (13.86%) belonging to the largest category in 2006 and using 11.3% of land. (Table 2)

There was a change for year 2012. The estimated cost savings grew up to by 66.5% (20357.1 Million EUR). The reason of this increase could be not only the general price increase, but the slow increase in fertilize use (per hectare) is the new members states. 57.8% (8673.0 Million EUR) of cost savings came from 4-5 economic size farms representing 53.6% of utilized agricultural area and 21.0% of farms, while 19.0% (3865.0 Million EUR) came from the farms (1.5%) belonging to the largest category in 2012 cultivating 13.8% of utilized agricultural land. (Table 3)

The data show a relative higher cost savings in the largest category of farms while their share in the utilized agricultural land increased by 2.5%-point. Lower was the fertilizer cost savings in the farms belonging to size category 4-5, while their represented area was nearly the same. That can mean a bit lower fertilizer usage, depending on the different fertilizer level in individual countries. As the dispersion of site-specific fertilizer use is different in the countries and we do not have exact data on it, it is hard to say that how it can be changed in the future. Based on the literature the share of farms applying site-specific fertilizer technology is estimated to be 30-60%.

About 9% of the farmers used the technology in 2004, generally with 200 hectares, but who used more element of the technology (only 10) cultivated over 200 hectares. The share of Danish farmers using precision technology increased up to 14% by 2010 (Lawson et al., 2010). In Germany only 10% of farmers applied at least one element of the technology in 2009. These farms operated on 200-1000 hectares, they employed a specialist and the decision makers were farmers at age between 30-50 years, with high qualification. (Kutter et al., 2011) Only 11% of Hungarian farmers used more than one element of site-specific crop production, including fertilize usage. (Lencsés – Béres, 2010; Lencsés et al., 2014)

We think real ingredient savings in fertilizer use due to site-specific treatments can be expected in those cases, where it is based on soil mapping, with less than 3 hectares soil sampling system. (On the other hand it must be highlighted that this will increase the costs (mainly fixed cost) in the production.)

Table 2. Represented farm numbers by types and costs of chemicals in EU-25, 2006

Year	Economic size	Type of farm	Farms repre-sented (1000)	Total Utilised Agricultural Area (Million ha)	From this						Fertilisers from total specific costs (Million EUR)	Crop protection from total specific costs (Million EUR)
					cereals (Million ha)	Share (%)	other field crops (Million ha)	Share (%)	forage crops (Million ha)	Share (%)		
2006	(4) 50 000 - < 100 000 EUR	All	478.7	28.23	8.66	30.7	2.31	8.2	14.39	51.0	2174.9	1402.0
2006	(5) 100 000 - < 500 000 EUR	All	513.9	50.20	17.39	34.7	6.05	12.0	21.46	42.8	4859.1	3938.3
2006	All (4) and (5)	All	992.6	78.42	26.05	33.2	8.36	10.7	35.85	45.7	7034.0	5340.3
2006	(6) >= 500 000 EUR	All	56.3	16.59	7.53	45.4	3.21	19.3	4.42	26.6	1716.8	1662.2
2006	All	All	4062.3	146.43	51.66	35.3	14.98	10.2	59.98	41.0	12226.1	9029.6

Source: own calculation

Table 3. Represented farm numbers by types and costs of chemicals in EU-27, 2012

Year	Economic size	Type of farm	Farms repre-sented (1000)	Total Utilised Agricultural Area (Million ha)	From this						Fertilisers from total specific costs (Million EUR)	Crop protection from total specific costs (Million EUR)
					cereals (Million ha)	Share (%)	other field crops (Million ha)	Share (%)	forage crops (Million ha)	Share (%)		
2012	(4) 50 000 - < 100 000 EUR	All	484.0	28.64	8.87	31.0	2.44	8.5	14.74	51.5	3087.7	1597.1
2012	(5) 100 000 - < 500 000 EUR	All	551.1	57.58	21.74	37.8	7.37	12.8	24.05	41.8	8673.0	5381.9
2012	All (4) and (5)	All	1035.2	86.22	30.61	35.5	9.81	11.4	38.79	45.0	11760.6	6979.1
2012	(6) >= 500 000 EUR	All	73.9	22.24	10.78	48.4	4.31	19.4	5.77	26.0	3865.0	2807.3
2012	All	All	4919.4	160.62	59.62	37.1	17.63	11.0	65.71	40.9	20357.1	12152.6

Source: own calculation

Cost savings coming from the site-specific fertilizer usage differs by countries, due to the size of member states and the differences in farm structure.

18.3% of the estimated cost savings is from Germany covering 10.61% of total utilized agricultural land, 28.6% to France 17.21% of total utilized agricultural land and 11.8% to United Kingdom whose share was 10.05% of total utilized agricultural land in 2006. These countries covered nearly 40%, so if more farmers apply site-specific fertilize element of the technology, the positive environmental advantages can be reached besides the cost advantages. (Table 4)

Table 4. Cost savings in fertilizer use due to site-specific crop production, 2006 (Million EUR)

Country	(4) and (5) group of economic size			(6)			Share from the EU-25 cost savings
	5%	15%	20%	5%	15%	20%	
(BEL) Belgium	9.09	18.18	36.37	0.95	1.90	3.80	2.3%
(BGR) Bulgaria	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
(CYP) Cyprus	0.37	0.75	1.49	0.00	0.00	0.00	0.1%
(CZE) Czech Republic	2.49	4.98	9.96	7.65	15.30	30.60	2.3%
(DAN) Denmark	5.59	11.19	22.38	2.84	5.69	11.37	1.9%
(DEU) Germany	51.30	102.60	205.21	28.56	57.12	114.25	18.3%
(ELL) Greece	3.00	6.00	12.00	0.00	0.00	0.00	0.7%
(ESP) Spain	25.24	50.47	100.95	2.54	5.08	10.16	6.4%
(EST) Estonia	0.70	1.40	2.81	0.58	1.17	2.34	0.3%
(FRA) France	118.87	237.73	475.47	6.09	12.17	24.35	28.6%
(HUN) Hungary	4.48	8.95	17.90	5.04	10.08	20.15	2.2%
(IRE) Ireland	12.54	25.08	50.15	0.00	0.00	0.00	2.9%
(ITA) Italy	26.65	53.29	106.59	5.81	11.61	23.23	7.4%
(LTU) Lithuania	1.98	3.96	7.92	1.27	2.54	5.09	0.7%
(LUX) Luxembourg	0.47	0.93	1.87	0.00	0.00	0.00	0.1%
(LVA) Latvia	1.06	2.11	4.23	0.55	1.10	2.20	0.4%
(MLT) Malta	0.03	0.06	0.11	0.00	0.00	0.00	0.0%
(NED) Netherlands	8.05	16.09	32.18	3.68	7.37	14.73	2.7%
(OST) Austria	3.72	7.44	14.88	0.00	0.00	0.00	0.9%
(POL) Poland	16.26	32.51	65.02	7.22	14.44	28.88	5.4%
(POR) Portugal	2.63	5.26	10.52	0.00	0.00	0.00	0.6%
(ROU) Romania	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
(SUO) Finland	5.59	11.18	22.37	0.00	0.00	0.00	1.3%
(SVE) Sweden	6.61	13.22	26.43	1.36	2.72	5.43	1.8%
(SVK) Slovakia	1.16	2.32	4.65	3.00	6.00	12.01	1.0%
(SVN) Slovenia	0.50	0.99	1.99	0.00	0.00	0.00	0.1%
(UKI) United Kingdom	43.36	86.73	173.45	8.36	16.72	33.43	11.8%
All	351.74	703.42	1406.9	85.5	171.01	342.02	100.0%

Source: own calculation

Examining the savings in fertilizer costs by country groups and size categories can be stated that in Belgium, the Netherlands and Germany – can be characterized with a high fertilizer and pesticide use – higher is the fertilizer cost (15.0%) and pesticide cost (15.7) in the largest category than in size category 4 and 5 (13.1 and 13.7%) in 2006. Cost savings in chemical use will result relatively higher competitiveness for the larger farms, not depending on their production type (field crops or mixed). (Table 5 and 6)

Depending on the percentage of fertilizer savings (per ha) the estimated fertilizer cost saving is 437.32 Million EUR if 5 per cent of the farms convert to precision crop production 874.43 Million EUR if 15 per cent convert, while in the best case scenario, the savings can be between 1748.92 Million EUR.

These estimating cost savings are different based on the data 2012. At EU-27 level the cost savings due to the reduced fertilizer use is expected 780.64 Million EUR if 5 per cent 1561.27

Million EUR if 15 per cent of the farms convert to precision crop production. In the best case scenario, when the savings reach 20%, the savings can be 2352.17 Million EUR which is lower than was the expectation for the 2006 data. Among the potential reasons the changes in the farm structure can be mentioned. Both in Romania and in Bulgaria the smaller categories are typical, and the missing data, too.

Table 5. Fertilizer cost savings due to site-specific crop production, by country groups, 2006 (Million EUR)

Country	Year	(4) and (5) group of economic size			(6)		
		5%	15%	20%	5%	15%	20%
All farms							
EU27	2006	351.72	703.44	1406.87	85.51	171.02	342.03
HU	2006	4.48	8.95	17.90	5.04	10.08	20.15
B+NL+D	2006	68.44	136.88	273.76	33.20	66.39	132.78
CZ+DK+UK+F+IRL+PL	2006	199.11	398.22	796.43	32.16	64.32	128.63
(1) field crops							
Country	Year	(4) and (5) group of economic size			(6)		
		5%	15%	20%	5%	15%	20%
EU27	2006	138.28	276.56	553.11	28.28	56.57	113.13
HU	2006	3.65	7.30	14.61	2.71	5.42	10.85
B+NL+D	2006	21.16	42.31	84.63	10.85	21.70	43.40
CZ+DK+UK+F+IRL+PL	2006	81.21	162.42	324.84	11.86	23.71	47.43
(8) mixed							
Country	Year	(4) and (5) group of economic size			(6)		
		5%	15%	20%	5%	15%	20%
EU27	2006	50.01	100.02	200.05	25.48	50.96	101.92
HU	2006	0.34	0.67	1.34	1.56	3.11	6.22
B+NL+D	2006	12.96	25.92	51.84	11.65	23.29	46.59
CZ+DK+UK+F+IRL+PL	2006	31.42	62.84	125.67	10.25	20.50	41.00

Source: own calculation

Table 6. Fertilizer cost savings due to site-specific crop production, by country groups, 2012 (Million EUR)

Country	Year	(4) and (5) group of economic size			(6)		
		5%	15%	20%	5%	15%	20%
All farms							
EU27	2012	588.04	1176.08	2352.17	192.60	385.19	770.38
HU	2012	10.42	20.84	41.68	10.18	20.36	40.72
B+NL+D	2012	100.74	201.48	402.97	64.50	128.99	257.98
CZ+DK+UK+F+IRL+PL	2012	309.81	619.62	1239.24	71.03	142.07	284.14
(1) field crops							
Country	Year	(4) and (5) group of economic size			(6)		
		5%	15%	20%	5%	15%	20%
EU27	2012	294.84	589.69	1179.37	81.57	163.13	326.26
HU	2012	9.02	18.04	36.08	5.13	10.25	20.51
B+NL+D	2012	38.00	76.00	152.00	24.40	48.80	97.59
CZ+DK+UK+F+IRL+PL	2012	153.81	307.63	615.26	29.84	59.67	119.35
(8) mixed							
Country	Year	(4) and (5) group of economic size			(6)		
		5%	15%	20%	5%	15%	20%
EU27	2012	71.66	143.33	286.65	41.27	82.55	165.09
HU	2012	0.63	1.25	2.50	3.21	6.43	12.85
B+NL+D	2012	15.96	31.91	63.83	17.53	35.06	70.12
CZ+DK+UK+F+IRL+PL	2012	45.08	90.15	180.30	17.31	34.63	69.26

Source: own calculation

In the countries – can be characterized with a medium level of fertilizer usage – the effect of cost reduction is lower on the total costs due to its lower share in the total costs.

Pesticide cost reduction

The estimated amount of pesticide savings is 5.7-11.4 thousand tonnes if 15 per cent of the farms convert to precision plant protection, 9.5-13.1 thousand tonnes if 25 per cent convert, while in the best case scenario, the savings can be between 15.2 and 30.4 thousand tons. That means 30400000000 kg in optimistic scenario and do not forget, today we use pesticide doze one-two kg per hectare or in some cases we use 20-50 gr ingredients per hectare. In 2010 the total utilized agricultural land was 170 million hectare. In our estimation the covered area is 55.8% that means 94.86 million hectare.

So the ingredient saving of pesticides per one hectare is 0.032 kg in total (13.91 %). If we calculate with this average material savings and count down it by countries, the highest material savings would be in Belgium, the Netherlands and Denmark, where the intensity of crop production is high. Here the countable savings in pesticide use would decrease the production cost by 3-5 %. In the following group – concerning the lower pesticide use – the potential material savings are not so measurable, here the advantage comes rather on macro level and not on farm level (like increase in competitiveness), but in all cases the externalities are important. This goes to the question of sustainability if environment.

In 2006 the average EU-15 pesticide use was 2.3 kg/ha. Because of the lack of the real pesticide use in some countries, we were not able to calculate EU average. If site-specific plant protection were as common in the practice as in the model calculations, the pesticide use could be decreased by 0.32 kg/ha. The decrease in Belgium, in the Netherlands – where the highest pesticide use was – the savings were 1.57 and 1.30 kg/ha. In Germany 0.42 kg/ha would be the saving, in UK 0.51 kg/ha. (Table 7) In the new member states the pesticide usages was below the EU-15 average. The main reason was not connected to environment protective behavior of the farmers, but mainly the lack of financial sources. Due to this the average pesticide use increased a bit in new member states, but remained under the most developed countries with high intensity.

Table 7. Pesticide ingredient savings due to site-specific crop production, 2012 (kg/ha)

Country	2006		2010	
	pesticide use (kg/ha)	saving in pesticides (kg/ha)	pesticide use (kg/ha)	saving in pesticides (kg/ha)
HU	2.01	0.28	2.25	0.31
B	11.29	1.57	…	…
NL	9.32	1.30	8.75	1.22
D	3.01	0.42	3.39	0.47
CZ	1.64	0.23	…	…
DK	1.39	0.19	1.6	0.22
UK	3.68	0.51	2.79	0.39
F	3.98	0.55	…	…
IR	2.21	0.31	2.5	0.35
PL	1.28	0.18	1.72	0.24
EU-15	2.30	0.32	…	…

Source: own calculation

At farm level, beside the savings in material costs, other cost elements, like monitoring, more treatments, etc. can increase at the same time. Based on model calculations between 0.6 and 6.2 per cent of savings in farm-level production costs can be attributed to the site specific use of pesticides. (Takács-György, 2012).

Depending on the percentage of pesticide savings (per ha) the estimated pesticide cost saving is 1749.79 Million EUR if 5 per cent of the farms convert to precision crop production 2449.7 Million EUR if 15 per cent convert, while in the best case scenario, the savings can be between 3499.58 Million EUR was for the year 2006.

In 2012 at EU-27 level the cost savings due to the reduced pesticide use is expected 2443.32 Million EUR if 5 per cent 3420.63 Million EUR if 15 per cent of the farms convert to precision crop production. In the best case scenario, when the savings reach 20%, the savings can be 4886.62 Million EUR, averagely higher than was the expectation for 2006 data by 40%. As the potential material (ingredient) savings is higher due to the site-specific pesticide treatment, there is a huge potential to reduce the environmental burden by wider application this technology in the practice. (Table 8 and 9) The highest share of pesticide cost reduction goes to those farms that belong to field crop producers.

Table 8. Pesticide cost savings due to site-specific crop production, by country groups, 2006 (Million EUR)

Country	Year	(4) and (5) group of economic size			(6)		
		25%	35%	50%	25%	35%	50%
All farms							
EU27	2006	1335.20	1869.28	2670.40	414.59	580.42	829.18
HU	2006	19.07	26.70	38.14	24.78	34.70	49.57
B+NL+D	2006	299.13	418.78	598.25	165.78	232.09	331.56
CZ+DK+UK+F+IRL+PL	2006	730.46	1022.64	1460.92	160.21	224.29	320.41
(1) field crops							
Country	Year	(4) and (5) group of economic size			(6)		
		25%	35%	50%	25%	35%	50%
EU27	2006	629.20	880.89	1258.41	148.89	208.45	297.79
HU	2006	13.99	19.59	27.99	14.13	19.78	28.26
B+NL+D	2006	122.29	171.20	244.57	54.30	76.02	108.59
CZ+DK+UK+F+IRL+PL	2006	382.04	534.85	764.08	62.94	88.11	125.87
(8) mixed							
Country	Year	(4) and (5) group of economic size			(6)		
		25%	35%	50%	25%	35%	50%
EU27	2006	188.82	264.35	377.64	116.12	162.57	232.24
HU	2006	1.04	1.46	2.09	7.05	9.87	14.11
B+NL+D	2006	60.02	84.02	120.03	51.01	71.42	102.03
CZ+DK+UK+F+IRL+PL	2006	116.15	162.60	232.29	46.53	65.14	93.06

Source: own calculation

Examining the savings in pesticide costs also can be estimated a higher decrease both in the ingredient use and production cost in those countries, where the crop production is very intensive but also have positive effects on the so called “unnecessary” chemical burden on environment in 2012. For the future – in long term – the site-specific use of pesticides conduces to maintain the biodiversity or at least to reduce the risk of production. One of the main questions is that what will happen in the smaller farms. Farms under 50 000 EUR economic size represent 865000 (77.23% of field crop farms), they cultivate 18.53 million hectare (31.14% of total utilized agricultural area in EU-27). The average land in the smallest category (1st) is 8.96 hectare, in the 2nd is 22.77 hectare and in the 3rd it is 45.58 hectare. If we see the three different practice of greening, we can recognize that some hard to comply with these demands in smaller categories:

- maintaining permanent pastures – that is not so easy for those farms that do not deal with animal husbandry
- diversification of the crop production structure (above 10 hectare at least two different crops and at the same time to fit to the requirements not to extend 75% share with the main culture and over 30 hectares at least three different crops not to extend 95% share with the main two crops
- minimum of 5 percent of agricultural land is put into ecological setaside/environmental focus areas and that this option is designed in a way that allows for the delivery of a mix of in-field and field edge management land setting the ecological.

Table 9. Pesticide cost savings due to site-specific crop production, by country groups, 2012 (Million EUR)

Country	Year	(4) and (5) group of economic size			(6)		
		25%	35%	50%	25%	35%	50%
All farms							
EU27	2012	1744.77	2442.68	3489.55	698.53	977.95	1397.07
HU	2012	32.58	45.61	65.16	34.23	47.92	68.46
B+NL+D	2012	341.82	478.55	683.65	248.59	348.02	497.17
CZ+DK+UK+F+IRL+PL	2012	886.10	1240.54	1772.20	264.00	369.60	528.00
(1) field crops							
Country	Year	(4) and (5) group of economic size			(6)		
		25%	35%	50%	25%	35%	50%
EU27	2012	948.09	1327.33	1896.18	299.34	419.08	598.69
HU	2012	24.75	34.65	49.50	16.92	23.69	33.84
B+NL+D	2012	157.69	220.77	315.38	92.78	129.89	185.55
CZ+DK+UK+F+IRL+PL	2012	525.84	736.18	1051.69	121.48	170.07	242.96
(8) mixed							
Country	Year	(4) and (5) group of economic size			(6)		
		25%	35%	50%	25%	35%	50%
EU27	2012	203.93	285.50	407.85	142.33	199.26	284.66
HU	2012	1.56	2.19	3.13	11.38	15.93	22.76
B+NL+D	2012	59.51	83.31	119.02	61.46	86.04	122.91
CZ+DK+UK+F+IRL+PL	2012	120.71	168.99	241.42	56.36	78.91	112.72

Source: own calculation

We agree with Westhoek et al. (2012) who adverts attention to that the positive impacts of the proposals for the Common Agricultural Policy for greening Pillar I on farmland biodiversity and reducing greenhouse gas emissions will probably be small.

If those field crops and mixed farms get the greening component that apply or have intent to apply site-specific technology in crop protection instead of the existing third element of the greening requirements.

Why can be site-specific plant production – especially plant protection – a tool of sustainable, competitive agriculture?

Site-specific treatments means that we use the needed chemicals due to the soil parameters, diseases, insecticides and weeds – taking into consideration their disperse and spread in the future, crop rotation, etc. – and the expected yield and production value. From the point of view of economic sustainability that means a decision on farm level: what is the economic advantage, will the gross margin be higher than was before the implementation of the technology. From environmental side it means that we use less harmful chemicals – less will remain in food, soil, water – environment burden will reduce. From social aspect this means that we produce the needed food to feed the word's increasing population in an effective way that will ensure the farmer to reach or exceed the viable farm size, covering the investment at the same time.

So new technologies, innovation on farms – like site-specific plant production – fits the above mentioned requirements of sustainability. Also positive the effects of use of injection syringes, use of GPS supported technologies can help the farmer to reduce pesticide use and not only in farming is a useful tool the weed-eye technology (in railway systems when it is used the recognition technology when spraying along the railway tracks to prevent destabilization due to plant growth, by use of blue, red and infrared light and the spraying is targeted at the elimination of the actual vegetation, etc.) So there are a lot of techniques to explore to make it possible for farmers to take a more resource efficient approach to pesticide use and in this way contributing to stop the decline in biodiversity.

Conclusion

The results from macro-level models support the fact that site-specific crop protection can have an important role in environmental burden reduction, alongside other elements of technological development in agriculture. We think more attention should address to site-specific crop production from the point of view of the greening thought, thou this – potential – tool was not included among the greening measures. The benefit of the transition to precision pest management is proven, since spot treatments will result in real savings in the use of plant protection materials, depending on the area infected by pests. In all cases where there is heterogeneity within the field, and a high number of those spots, plant protection treatments can be omitted without suffering significant economic damage. The yield uncertainty can be reduced during the production of food and industrial raw materials, as it helps traceability in food chains and improves the predictability both at farm and national level. Also cost-advantage the farmer will reach, but there is advantage at EU-27 level as well.

Through the research with model calculations it was proved out the 1st hypotheses. If the farms shifting to site-specific crop production depends on capital investment needs and/or technical services and a measureable amount of pesticides can be saved at European Union level and cost savings can be tool for strengthening the competitiveness on world market, and thus the objectives of greening can be reached by using precision technology, while the production costs are reduced by up to 6%, depending on the applied site-specific elements and tools, but mainly comes from the site-specific pesticide use. Concerning the 2nd hypotheses that due to the wider dispersion of site-specific plant protection in those countries where the higher chemical use is typical – the cost of fertilizer and pesticides is higher 1/3rd in the total cost – the implementation of the site-specific elements causes higher advantage from cost side we carried out that in Belgium, in the Netherlands and in Germany a more forced implementation of site-specific crop production will results higher positive impact of the chemical use reduction. So such directions, like pesticide risk reduction strategy is a detailed plan to reduce the risk to human health and the environment associated with pesticide use in agricultural crops. (PRRP, 2014)

Due to the results of macro-model calculations, it can be stated that site-specific crop production, as an environmentally friendly farming practice meets the requirements of sustainable farming practice. The greening impact – the decreasing substance use measured in agrochemicals – can be greater than the savings reached by leaving the land fallow, because this practice prefers marginal areas where chemical use is originally lower. Farmers who leave their land fallow perform more intensive production on their other land in order to compensate for the yield losses. This process occurred within the United States agriculture before the turn of the millennium. We agree with those who draw attention to alternative new or old innovative solutions, and are worrying about the future of farmers. Several studies are speaking about the slow diffusion of the whole site-specific crop producing technology. It is true, the most important part of the technology – like the site-specific plant protection – are less used than the site-specific seeding or fertilizer use. To force and promote the uptake of precision farming one tool could be – as an indirect subsidy – if the application of precision technology would have been implemented into the tools of the CAP greening component. It must be changed a new paradigm concerning the innovative technologies.

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