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ADVANTAGES AND DISADVANTAGES OF PRECISION FARMING TECHNOLOGY FROM ECONOMIC ASPECT

WADY I ZALETY TECHNOLOGII ROLNICTWA PRECYZYJNEGO W UJĘCIU EKONOMICZNYM

Key words: material cost, operational cost, income change, precision weed management, precision fertilization

Słowa kluczowe: koszty materiałowe, koszty operacyjne, zmiany dochodów, zarządzanie precyzyjnym odchwaszczaniem, precyzyjne nawożenie

Synopsis. In economic examination of the precision farming technology we must attend to the extra cost of applying this technology, the value of the available saving and not least the investment cost of this technology variant. In this paper the precision farming technology was examined from economic aspect. The research was made on a case of model-farm. In the model-calculation applying precision farming technology means decrease of sprayed-out chemical amount and material cost, which due to site-specific spraying (which makes increase in operational cost). The main aim of the model is to determine the extra income of precision farming technology

Introduction

In our days we hear a lot about the **environmental protection**, environment friendly agriculture and sustainable growth. The precision agriculture is a farming method which takes part in sustainable development [Swinton 1997] This is the reason why I took up issue about the precision agriculture.

In the technical literature of agricultural production there are lot of studies which handle with the **sustainable development**. This is a growing or developing process (in field, society, economy, and farm) which gives satisfaction to present demand without depressing ability of future generation to satisfy their demand.

The main task of nowadays agriculture to efficiency utilize resources, integrate the biological processes and regulating mechanisms of the production where is possible, and through this confirm the profitability of the agricultural manipulation and save the human resources of the agricultural and the living-standard of provincial society [Barkaszi et al. 2006, Csiba et al. 2009, Sándor et al. 2009].

In the same time the agriculture meet with the challenge that it should produce the food for greater population on more smaller field all over the world. The site-specific (precision farming) technology which optimalise inputs (fertilizer, herbicide, pesticide, etc.) on parcel-level might make solution for this problem. Thanks to the site-specific optimalisation this technology makes increase of yield and makes decrease of environmental-damage effect [Swinton 1997, Batte 1999, Székely et al. 2000, Takácsné 2003, Takács-György-Barkaszi 2006, Kis-Takácsné 2006, Barkaszi et. al 2006, Pecze 2008, Csiba et al. 2009].

In spite of numerous advantages of site-specific plant production, the spread of this technology is in the beginning. Although in the practice farmers have more and more resorts to precision farming technology. Complex precision technology supplies appeared at the Hungarian market. We can discover rapid growth on this market. In 2006 the size of the land cultivated by precision agriculture was ten times bigger as it was in 2001 [Pecze 2006].

When we apply precision farming technology, the first task is the site-specific soil-sampling and the site-specific data of yield collection. Being familiar with this it is possible to the site-specific, differential fertilization are made, which make true the environmental-friendly plant production.

The environmental debit of the production can be decreased for example with the precision weed-management technology, which result cost saving, because of those parcel are treated which conation weeds. Amount of the saving which thank to the site-specific treatment is different in scientific researches. For example Leive et al and Luschei et al. said that this cost-saving is only 20%, in opinion of Barkaszi and Takács-György it is 60%, the others (for example: Reisinger, Batte) defined the cost saving with precision farming technology between 40 and 50% [Leive et al. 1997, Batte 1999, Luschei et al. 2001, Takács-György et al. 2002, Reisinger 2004, Barkaszi-Takács-György 2007].

Two different ways of site-specific spraying are known (both in the fertilization, both in the weed-management). One methods based on a data-base and beforehand define the treating-map which helps to change the sprayed quantity on parcel-level (one parcel is 3-5 hectares). The special literature call this kind of application **off-line** method. The essence of this methods that collection, converting of data and execution separate in time and in space. In this case the short time between the weed-mapping and the weed-killing is the problem. The other possibility when the data collection, converting and execution happen in the same time with help of real-time sensors. The name of this kind of application is **online** or real time method. This way is mostly applied in fields where the weed-pattern is not wide spread, weeds grow only on little part of the field. The advantage of this technology that it is not demanding human intervention and the treatment is made immediately. The online technology is not wide spread in the practice opposite of the off-line method. The reason of this that the weed-recognize in the on-line technology is 70-80%, and this technology is more expensive than the off-line, and the field capacity is relatively low [Reisinger-Nagy 2002, Reisinger 2004, Takács-Barkaszi 2006, Barkaszi et. al. 2006].

Soil parameters, features of ground, water- and nutrient supply, injuries, and yield shows heterogeneity in one filed. The precision farming technology handles the soil like a heterogenic unit, and influences positively the success of farming by means of site-specific treatment. If we have more precise information about the heterogeneity we make sure that able to make site-specific treatment [Weiss 1996, Pecze-Horváth 2004, Reisinger 2004, Csathó et al. 2007, Taskács-György et al. 2008].

In the practice the basic tasks of application of the precision farming technology is the precise determination of position (0,5-1 m accuracy is suitable for precision plant production, nowadays it is reachable), correct data collection and process and the automatic work [Reisinger-Nagy 2002, Reisinger 2004, Neményi-Milics 2007, Csiba et al. 2009].

Table 1. Applicability of the precision plant production elements in different plant culture

Detailed list	Precision soil-sampling	Yield mapping	Differential fertilization	Precision weed management
Winter wheat	+	+	+	+
Maize	+	+	+	+
Sunflower	+	-	-	+
Alfalfa	+	-	-	-
Potato	+	-	-	-
Green bean	+	+	+	+
Soya	+	+	+	+

Source: own construction based on Pecze 2006.

The precision farming technology could not be used complexly in every crop. For example in the sunflower production not solved the problem of the yield-measure, however in the maize production every technology elements are applicable by site-specific methods (table 1).

The farmers should perform numerous technical, technological, informatical and economical conditions for adopting precision farming technology. The investment cost of adaptation is between 17 000 and 34 000 EUR, which depends on the farm-size, this is the reason why is so important a well-think-out economical analysis before decision making. It is important to examine the technical and capital-effectiveness of agricultural assets [Takács 2003] Not allowed to forget about the ecological aspects too, because with this technology the plant production becomes more environmental friendly and it will be sustainable for a long-time.

Important to make knowledge of input change, extra cost, and yield change, economic and environmental impacts of precision farming technology. Extra inputs are for example the following:

purchase of equipments, application of new technology, reduction the yield uncertainty and material cost reduction (fertilizer, chemicals, pesticides, herbicides, etc.) [Weiss 1996].

In the international special literature numerous authors deal with economical analysis of the precision farming technology. Questions of micro economics are in the centre of the research by Weiss. Lowenberg-DeBoer and Boehlje focused on the classic production economic analysis. In side of size-economic definable that smaller and smaller minimal size can make profit with precision farming technology. Kalmár et al. wrote in a study of 2004 that this technology is viable on more than 1000 hectares area. Instead of this in 2006 Kovács and Székely found that the application is viable above 250 hectares. Takács-György in 2007 defined that the minimal size is 206 which is depend on the sowing structure using own equipment [Kalmár et al. 2004, Kovács-Székely 2006, Takács-György 2007]. When the farmers cooperate for example in machinery rings, this size of farm is not a limiting factor [Takács 2000].

Material and methods

Present study examines the extra investment cost, and variable cost of an model-farm which have 250 hectares and apply precision farming technology. In the first step the value of the investment is determined. To make the calculation simpler I stated that not necessary to change the whole machinery, it is enough some small changes. The necessary equipments are the followings: yield sensor, line-driver, field measurer, software. The exception is the spraying machine (for fertilization and weed-management). Based on these the investment cost of the precision farming technology is 28 625 EUR (based on the data of IKR company in 2007)

In the economical model the sowing structure, different cost-structure of different plant production are not calculated, because of make simple the model calculation. The average value of the model farm was calculated. The farm produces winter wheat (30%), maize (20%), sunflower (20%) and alfalfa (20%), the average material cost per hectare is 123 EUR (amount to 57% of the total variable cost of plant production), the average operational cost is 91 EUR per hectare (amount to 43% of the total variable cost of plant production) and the average production value is 577 EUR per hectare. Based on these, the average income of the model farm is 363 EUR on one hectare.

One of the main reasons of adopt precision farming technology is to save the amount of the spread fertilizer and herbicide, so the reason is the material cost saving. This saving is thanked to the field is not treated like a homogeneity unit but spread the materials like the micro-plots need, which thanks to the site-specific positioning of parcels. Beside the material cost saving we should/must calculate with operational cost increase. This increase comes from the more precise treating. For example to create treating-maps makes the used time higher, the operation cost of machinery is higher and it needs more attention to the service.

The extra income of the precision farming technology was examined based on the changing of material and operational cost of this technology, but not calculate with the yield increase compare to the traditional production.

Results

Income changes with precision farming technology were defined with different combination of operation cost increase and material cost decrease (fertilizer and herbicide) comparing to the traditional plant production technology (table 2).

Table 2. Income change of precision farming comparing to the traditional technology depending on different operational and material cost change [%]

Operational cost growing \ Material cost saving	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	0	-6	-11	-17	-23	-29	-34	-40	-46	-52	-57
10 %	4	-1	-7	-13	-19	-24	-30	-36	-42	-47	-53
20%	9	3	-3	-9	-14	-20	-26	-32	-37	-43	-49
30%	13	7	1	-4	-10	-16	-22	-27	-33	-39	-45
40%	17	11	6	0	-6	-12	-17	-23	-29	-35	-40
50%	21	16	10	4	-2	-7	-13	-19	-25	-30	-36
60%	26	20	14	8	3	-3	-9	-15	-20	-26	-32
70%	30	24	18	13	7	1	-5	-10	-16	-22	-28
80%	34	28	23	17	11	5	0	-6	-12	-18	-23
90%	38	33	27	21	15	10	4	-2	-8	-13	-19
100%	43	37	31	25	20	14	8	2	-3	-9	-15

Source: own calculation.

The negative values means variable cost saving (in the same time it means income increase also due to the basic condition) and the positive values shows variable cost increase which make decrease in the income. In some combination it is imaginable that the income of the precision farming technology is totally the same like in traditional plant production (the value 0 shows this cases). This case is when the operational cost growth is 40% and the material cost saving is 30% for example. If the operational cost of precision farming technology grow with 60% compare to the traditional technology, we should make at least 50% material cost saving for make extra income.

Conclusions

Very important to say, that the cost surplus can be covered by the dropped of the material cost saving in case of precision plant production compare to the conventional technology. The model-calculation show that if 20% is the increase (the opinion of the special literature is the most possible) we need at least 20% material cost saving to make extra income. If in this case the saving is only 10% the traditional technology make higher profit than the precision farming. Definable that lot of number of cases we need the same percentage of material cost saving like the operation cost growth not calculate with the yield increase. This conclusion thanks to the basic condition which said that the rate of operational cost and material cost is almost the same (43% and 57% of the total variable cost).

In case of material cost saving the increase mainly thanks to the herbicide saving (because of the site-specific optimalize). The reason for this that we treated only that area where the weeds are growing. Earlier examination correlate with maize shows that between 50% and 85% of weed-coverage of autumn the precision weed-management is viable and make higher profit than the conventional technology. In case of fertilization we should calculate much lower level of saving, or the same fertilizer cost like in traditional treating [Lencsés 2009].

The precision fertilization is applicable in most of crops, but the precision weed-management is not wide spread. The adaptation of the precision farming technology can be viable under Hungarian conditions mainly in a medium size (250 hectares) farm, in case when it makes intensive production and the rate of the wide-row culture is at least 40% of the sowing structure.

The advantages of the precision treatment are not only economic, but from ecological and environmental aspects too. Although the precision farming technology is able to reduce the amount of the used fertilizer and herbicide, it makes possibile to decrease environmental burden, makes better conditions of soil, improves better environmental conditions for production. This means grand advantages. In the future we should measure these ecological and environmental advantages too.

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Streszczenie

W artykule podjęto próbę analizy technologii rolnictwa precyzyjnego. Przedstawiono jego rolę i zalety w ujęciu ekonomicznym.

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