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PRECISION FARMING TECHNOLOGY AND MOTIVATION FACTORS OF ADAPTATION

TECHNOLOGIE ROLNICTWA PRECYZYJNEGO I MOTYWUJĄCE CZYNNIKI ADAPTACYJNE

Key words: structural interview, site-specific farming elements

Słowa kluczowe: wywiad kwestionariuszowy, elementy rolnictwa Site Specific

Abstract. Thanks to precision farming technology, farmers are able to optimise input in the field with management-zones. Management-zones (the smallest treatment unit in the field) are defined on the basis of knowledge of local conditions, e.g. physical and chemical soil conditions, soil productivity, the presence of weeds and/or pests as well as the incidence of disease. Precision farming technology is able to materialize the requirements of sustainability and increase production. The application of precision farming technology elements go hand in hand with extra costs (the investment costs of new equipment and software; higher operating costs), simultaneously decreasing material costs (the costs of nutrition, herbicides, seeds). The aim of this study is to define motivation factors standing behind the adaptation of precision farming technology. According to 11% of interviewed farmers using precision farming technology on their farms and the research conducted, the main factors of adaptation were field quantity and the age of the farmer.

Introduction

Precision farming technology has numerous alternative names in literature. The expressions most commonly used are: precision plant production, site-specific farming and variable rate application. Precision farming technology concerns the need to identify and save information/data with GPS-coordinates and on the basis of this information a decision is made about treatment. Once the decision has been made, the treatment is carried out precisely on the defined site and in the defined amount [Neményi et al. 2001]. Precision farming technology takes place when the necessary inputs (nutrients, seeds, herbicides and other chemicals) are spread out on field-plots (not on the whole field), therefore the treatment is applied using management-zones. Decisions are made on the basis of management-zones so it is possible to optimize inputs zone by zone (with maximum income). Precision farming technology allows identifying variable field specifications and implementing specific treatments (with time delay – off-line methods or without time delay – on-line method) [Németh et al. 2001, Pedersen et al. 2010]. Precision farming technology decreases risks of agricultural production and increases the controllability of production thanks to the amount and precision of information [LowenbergDeBoer 1997, Swinton, LownbergDeBoer 2001, Sinka 2009, Takács-György 2012].

The prime aims of precision farming technology are income-increase, implementation of sustainable agriculture, higher yield quantity, productive plant-protection and maintenance of natural resource standards [Weiss 1996, Swinton 1997, Batte 1999, Székely et al. 2000, Zhang et al. 2002]. However, precision farming technology is not just a newer plant production technology; it is a kind of management technology, the aim of which is to reduce the consequences of uncertain variables as a result of more valuable and precise information and a better reaction to non-influenced factors [Whelan, McBrateny 2000, Pedersen 2003, Dobermann et al. 2004].

According to international literature, the main motivating factors behind the adaptation of precision farming technology are the following [Daberkow, McBride 2003, Edwards-Jones 2006, Popp, Griffin 2000, Kutter et al. 2011]: field quantity, the number of employees and the age of farmers.

Material and methods

The aim of this study is to define motivation factors standing behind the adaptation of precision farming technology. The main methods was the sturcural interview. Structural interviews were personally conducted, from the summer of 2010 to spring 2011, in order to define the factors influencing the adaptation of precision farming technology. All in all, the data gathered replies from 72 farmers. Such personal interviews prevented any exclusion from the examination due to missing data. The available sample database (n = 72) was divided into three sub-sample databases. The first sub-sample comprised of non-precision farmers ($n_1 = 48$). The second sub-sample constituted precision farmers ($n_2 = 8$). And the third sub-sample were planned precision farmers ($n_3 = 16$). The difference between the sub-samples due to specific features of farms and/or farmers was the focus of this study.

Crosstab analysis was applied to explore the relationship between nonmetric variables. In the crosstab analysis, the value of the chi-squared (χ^2), Cramer V, the uncertainty coefficient as well as significance levels were used to explore the relations. The validation of the crosstab was a 5% level of significance. The examined null hypothesis was a lack of relationship between the two variables. If the significance level was found to be lower than 5%, it would mean that there was a significant relationship between the two variables [Sajtos, Mitev 2007].

Results and discussions

All of the interviewed farmers produced plants (having a plant production farm or mixed farm). Some farmers had been using precision farming technology for ages, some farmers planned to adopt the technology and some carried out conventional plant production. There was no territorial demarcation of the interviews conducted in Hungary. The interviews were mostly carried out during agricultural shows where the young were the main age group represented. The rate of farmers who were younger than 35 years of age was 28%, which was higher than the national average (7%) in 2010 [Valkó et al. 2011].

The proportion of large farms in the sample was 44%; medium-sized farms constituted 38% and small-sized farms equalled 18%, based on cultivated land. Taking the European Size Unit into consideration, the rate of very small farms (below 4 ESU) was 25% and 13% of small farms (between 4 to 8 ESU). Basing on the same European Size Unit, all small farms (below 8 ESU) constituted twice the share of small farms based on cultivated land. In the total sample, the rate of the medium-sized category, according to ESU (8 to 16 ESU), was 33%. This rate was almost the same as the rate of medium-sized farms based on cultivated land. The rate of big-sized farms was 30% based on ESU. Most farms (49%) employed less than 10 individuals.

Precision farming technology was used by 11% of the interviewed farmers, while the rate of nonprecision farms was 89% (16 of which planned to adopt the technology in the future). Some non-precision farmers used GPS based soil-sampling or line-guards which are part of precision farming technology, but did not use any other elements which would lead to site-specific production.

Out of all precision farming technology elements used, precision fertilization won first place (75% of precision farmers). In second place was precision plant protection (62.5% of precision farmers). According to precision farmers, GPS-based soil sampling and line guards were not popular elements, but when including the examination of non-precision farmers, the total number of line guards used was the same as the number using precision fertilization. According to the number of elements utilized, the results are as follows: line guards and precision fertilization, GPS-based soil sampling and precision plant production (Tab. 1). The 63% of farmers who used precision farming technology used more than one element of precision farming technology. Farmers who used three of four elements of precision farming technology (50% of users of precision farming technology) adopted the elements at once. In this group of farmers the most popular elements were precision fertilization and precision plant production followed by precision tillage and precision sowing.

Table 1. Adaptation of precision farming technology elements
Tabela 1. Adaptacja elementów technologii rolnictwa precyzyjnego

Precision farming technology elements/*Elementy technologii rolnictwa precyzyjnego*	Adaptation frequency/ *Częstość adaptacji*	
	share/*udział [%] (n = 8)*	number of farms/*liczba gospodarstw*
Line guards /*Bufor ochronny*	12.5	1 (+5*)
GPS based soil sampling/*Pobieranie próbek gleby oparte na GPS*	25	2 (+3*)
Precision fertilization/ *Użyźnianie* precyzyjne	75	6
precision plant protection/ *Precyzyjna ochrona roślin*	62.5	5
precision cultivation/ *Uprawa precyzyjna*	37.5	3
precision weed management/*precyzyjne Zwalczanie chwastów*	12.5	1
Precision sowing/ *precyzyjne sianie*	12.5	1
Air photos/*Zdjęcia lotnicze*	-	- (+1*)
Yield mapping/*Sporządzanie mapy plonów*	-	- (+1*)

* number of conventional farms, where technology elements were used/ *liczba konwencjonalnych gospodarstw rolnych, w których użyto elementów technologii*
Source: own study based on structural interviews
Źródło: opracowanie własne na podstawie wywiadów kwestionariuszowych

Table 2. Relationship between the adaptation of precision farming technology and some important details about farms/farmers
Tabela 2. Zależność między adaptacją technologii rolnictwa precyzyjnego a niektórymi, ważnymi charakterystykami gospodarstw rolnych/ rolników

Factors of adaptation/ *Czynniki adaptacyjne*	Uncertainty coefficient/ *Współczynnik niepewności*		Cramer V/ *współczynnik V- Cramera*		Strength of relation/ *Stopień zależności*
	value/ *wartość*	*α*	value/ *wartość*	*α*	
ESU category/*Kategoria ESU*	0.103	0.25	0.28	0.35	no/ *nie zachodzi*
Cultivated land/ *Uprawiana ziemia*	0.135	0.003	0.314	0.01	medium/ *umiarkowany**
Soil heterogenetic/ *Heterogeniczność gleby*	0.005	0.754	0.08	0.8	no/ *nie zachodzi*
Ranging of technologies/ *Zakres technologii*	0.05	0.191	0.19	0.27	no/ *nie zachodzi*
Age of farmer/*Wiek rolnika*	0.09	0.02	0.25	0.46	medium/ *umiarkowany**
Education/*Wykształcenie*	0.08	0.48	0.24	0.61	no/ *nie zachodzi*

* level of significance less than 5% /*poziom istotności mniejszy niż 5%*
Source: own study based on structural interviews
Źródło: opracowanie własne na podstawie wywiadów kwestionariuszowych

The relationship between the adaptation of precision farming technology and certain features of farms or farmers was examined using cross-table analysis. According to this analysis, the adaptation of precision farming technology only depended on the quantity of cultivated land and the age of farmers (Tab. 2). Precision farming technology was mostly adopted by farms with more than 300 hectares of cultivated land and on farms on which the farmer was younger than 40 years-old.

Conclusions

The main aim of this study was to define the motivation factor of adaptation of precision farming technology. In case of this aim the size of cultivated land of farms is significantly correlated with the adaptation of precision farming technology. Precision farming technology is mostly used by middle-aged farmers. These farmers produce plants on more than 300-hectare farms. However, the size of cultivated land does not correlate with the selection of elements of precision farming technology. So according to the structural interviews the two motivation factors of the adaptation of precision farming technology is the age of farmers and the size of cultivated land.

The structural interviews were explored which are the most adopted precision farming elements in the plant production practice. Based on the frequency of applying elements of precision farming technology, the line guard is the most frequently used, followed by precision fertilization, precision soil sampling and finally precision plant protection. The reason for that the line guard is the most frequently used elements of the precision farming technology is that the application of it is very easy, the price of the equipment is no too high and the advantages became true in short time (thanks to the overlapless treatment more than 30% chemical reduction is possible). Precision fertilization is also very popular among the precision farming technology users because of the high price of the fertilizer. In case of fertilization is very important to use the amount of fertilizer which is really needed and save a lot of money from the fertilizer which not used on the field.

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Streszczenie

Celem badań było określenie czynników motywujących do wdrażania technologii rolnictwa precyzyjnego. Technologia rolnictwa precyzyjnego za pomocą stref zarządzania pozwala rolnikom optymalizować poziom ponoszonych nakładów. Podstawą do wyznaczenia stref zarządzania (najmniejszej jednostki pola podlegającej obróbce) jest wiedza na temat lokalnych warunków, np. fizycznych i chemicznych właściwości gleby, zachwaszczenia, występowania szkodników i chorób oraz produktywności gleby. Technologia rolnictwa precyzyjnego jest w stanie urzeczywistnić wymogi ochrony środowiska, zwiększając jednocześnie efektywność produkcji. Stosowanie elementów technologii rolnictwa precyzyjnego wiąże się z dodatkowymi kosztami w inwestowanie w nowy sprzęt i oprogramowanie, a także z wyższymi kosztami operacyjnymi, przy mniejszych wydatkach na materiały (koszt żywienia, herbicydów, nasion). Wśród ankietowanych 11% stosowało technologie rolnictwa precyzyjnego i głównym czynnikiem jej adaptacji była wielkość pola oraz wiek rolnika.

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