

**WHAT CHARACTERIZES FARMERS  
WHO PURCHASE CROP INSURANCE IN POLAND?**

GRZEGORZ STRUPCZEWSKI

**Abstract**

*The purpose of the paper is to compare population of farmers that bought crop insurance with farmers that are uninsured. Based thereon, the author identified features characterizing the insured farmers. These findings were applied to draw more general conclusions concerning factors influencing the insurance awareness and propensity to buy insurance coverage. Demographic, social and economic criteria, individual perception of risk, the loss ratio, and the willingness to pay the insurance premium were taken into consideration. Empirical research is based upon a sample of 150 Polish farmers that were interviewed using the CATI approach. It was found that farms with greater production volume (annual income) and with a larger crop area present higher willingness to buy insurance. Farmers who experienced damage to crops are more inclined to buy insurance coverage. Moreover, higher insurance penetration rate can be found among farmers who are willing to pay a higher price for a crop insurance policy. Surprisingly, despite frequently formulated assumptions, variables such as age of farmer, level of education or individual perception of risk do not determine the decision on insurance purchase.*

**Keywords:** crop insurance, insurance demand, willingness to pay, insurance, economic decisions, risk.

**JEL codes:** G22, Q12, Q50.

## Introduction

The notion of risk management is present in the modern market economy in numerous semantic versions, contexts and practical applications which does not make it easy to develop a consistent concept and structure of *the risk management* process. However, focusing on pure risks only (their outcome can be a loss or no loss/no gain) it may be assumed that “risk management is a scientific approach to handling pure risks by anticipating possible accidental losses and by designing and introducing procedures which minimize the presence of losses or compensate them in financial terms if they do occur” (Vaughan, 1997). The list of possible risk financing techniques, referred to in the final part of the above definition, includes: insurance, risk retention, self-insurance, captive insurance, other non-insurance transfer of risk. Selecting the method of risk financing by a specific entity may depend on factors such as: the frequency of damage, the size of damage, financial resources and the size of an organization, and the cost of insurance (Baranoff, 2000).

Farmers are exposed to many natural perils like heavy rain, flood, drought, snow, low temperatures, storms, etc. Natural perils which seriously threaten agricultural activities are classified as LFHS events (*low frequency – high severity*), namely risks with a low likelihood of occurrence but a high damage potential. Insurance is believed to be the most proper technique of risk financing regarding the catastrophic risk (Rejda, 2008). The purchase of crop insurance seems to be a rational decision. Nevertheless, many farmers do not buy crop insurance despite the high risk exposure in agribusiness (Kunreuther, 1984, 1996; Kunreuther, Meyer and Michel-Kerjan, 2013). This paradox rises an interesting research question about motives and determinants of crop insurance purchase. There is a need for extensive empirical study that could provide policymakers with relevant insights into this issue.

The purpose of the paper is to compare population of farmers that bought crop insurance with farmers that are uninsured. Based thereon, the author identified features characterizing the insured farmers. These findings were applied to draw more general conclusions on factors influencing the insurance awareness and propensity to buy insurance coverage. Demographic, social and economic criteria, individual perception of risk, the loss ratio, and the willingness to pay the insurance premium were taken into consideration.

Numerous studies of crop insurance demand have found that the adoption of crop insurance is positively correlated with having experienced disasters in the past (Cai, Chen, Fang and Zhou, 2009; Fraser, 1992; Garrido and Zilberman, 2008; Sherrick, Barry, Ellinger and Schnitkey, 2004). It was proved that farmers who are more risk averse or perceive greater risk than others are more likely to participate in crop insurance (Sherrick et al., 2004). Moreover, the demand for crop insurance is found to be highly price sensitive, so examining the level of acceptable insurance premium becomes an important issue (Liu, Tang, Ge and Miranda, 2019). Farmers’ education, wealth and risk aversion are all significant factors affecting rural households’ insurance take-up decisions (Hazell et al., 2010).

The research problem formulated above and the purpose of the study addresses one main hypothesis. Empirical verification of the hypothesis is the object of further part of the study.

The main hypothesis is that the population of insured farmers with crop insurance is significantly different (in statistical terms) from the population of uninsured farmers, at least in terms of one of the following features:

- 1) age of a farmer,
- 2) level of education of a farmer,
- 3) area of crop production on a farm,
- 4) annual revenue of a farm,
- 5) historical losses in crops caused by natural perils,
- 6) individual assessment of the perceived risk,
- 7) relative individual risk assessment (risk exposure perceived by a farmer in comparison to general risk exposure in agriculture),
- 8) willingness to pay for crop insurance.

As a result of the study, the answer to a simple, but non-trivial question was found: Which farmers buy crop insurance in Poland? Based on our empirical research and the own survey among 150 Polish crop producers, the answer is not surprising: Those who have larger area of farmland, higher income from crop production, those farmers who suffered damage to crops caused by natural risks – and last but not least – those farmers who are ready to pay higher premiums for crop insurance than just a minimum.

The remainder of the paper is organized as follows. At first the research sample and design of the survey were explained. It is followed by the description of variables that are relevant in the study and our methodology. Next section contains in-depth presentation and discussion of results. Finally, we conclude with some general remarks.

### **Research sample**

Not everyone who lives in the countryside is engaged in agriculture. Even if a farmer owns farmland, it is not certain that agriculture is the only source of income. And even if farmer's income comes entirely from agricultural activity, it cannot be assumed that the farmers, form a homogeneous population. Agriculture is such a diversified field of economy that it is necessary to focus on a distinct, clearly defined research sample. In order to reach farmers who are focused on crop production (i.e. crop production is their basic source of revenues), 1,429,006 agricultural farms with the total crop area exceeding 5 ha<sup>1</sup> (including 1,425,386 of individual farmers) was chosen as a target population for the research. These are entities classified into section A of the Polish Business Classification (PKD). The research sample was limited to agricultural farms that grow crops (classes 01.1 to 01.3 of PKD) because 99.9% of all subsidies to the crop and livestock insurance premium is directed

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<sup>1</sup> According to data from the Central Statistical Office of Poland (GUS).

to crop insurance (according to data from the Ministry of Agriculture and Rural Development). Taking into account the above assumptions, the general population is represented by a total of 658,466 crop farmers (GUS, 2014).

Data necessary to conduct the empirical research was collected using computer assisted telephone interviewing (CATI). This method enables to quantify the received results and apply them to statistical analysis. The survey was conducted in December 2017 on a nation-wide sample of Polish farmers with individual agricultural farms with area of farmland at least 5 ha who specialize in crop production. The 150 complete interview questionnaires were obtained out of the address database consisting of 1,000 contacts. In order to obtain the representativeness of the survey, the research sample was selected using the stratified sampling method which consists in the division of the entire community into strata and direct sampling of independent samples within each stratum. Assuming the voivodeships as the sampling strata, a scheme of sampling reflected the geographical distribution of individual agricultural farms in Poland. The sample was picked at confidence level of 95%, and the error of margin at 5%. The stratified sampling method is considered to meet the conditions of randomness (Steczkowski, 1995).

### Description of variables

Information collected from respondents during the survey made it possible to identify variables that are presented in Table 1.

Table 1

<i>Description of variables</i>		
Name of variable	Description of variable	Scope of variability
AGE	Age of respondent	0 – 19-29 years 1 – 30-39 years 2 – 40-49 years 3 – 50-59 years 4 – 60 years and more
AREA	Area of agricultural land (in ha)	0 – 5-20 ha 1 – 21-50 ha 2 – 51-100 ha 3 – above 100 ha
EDUCATION	Level of education	0 – Primary 1 – Vocational 2 – Secondary 3 – Bachelor's degree 4 – Master's degree
INCOME	Annual income of a farm	0 – below PLN 20,000 1 – PLN 20,000-50,000 2 – PLN 50,000-100,000 3 – PLN 100,000-200,000 4 – Over PLN 200,000
INSURANCE	Owing crop insurance (grouping variable)	0 – No 1 – Yes

cont. Table 1

NR_EVENTS	Number of loss events suffered by a respondent, caused by natural perils in the last 15 years	0,1,2,3,4
RISK	Individual assessment of a risk of damage to own crops caused by natural perils	0 – Natural disasters do not threaten me 1 – Very low risk 2 – Small risk 3 – Risk is likely 4 – Risk is highly likely 5 – Something bad will surely happen
RISK_COMP	Relative assessment of a risk of damage to own crops caused by natural perils, in comparison to other agricultural farms in Poland	0 – Less threatened than others 1 – Equally threatened as others 2 – More threatened than others
WTP	Willingness to pay for crop insurance, expressed as % of anticipated annual income from crop production	1,2,3,4,5 (%)

Source: own study.

Due to some outliers in primary data, the variables AGE and AREA were coded into ordinal variables.

### Methodology of research

Non-parametric tests were used to identify factors that differentiate the population of insured farmers from uninsured ones. Non-parametric tests for two independent groups, that are used to verify hypotheses on the evenness of averages (medians), have the following formal notation:

$$\begin{cases} H_0 : F_1(x) = F_2(x) \\ H_1 : F_1(x) \neq F_2(x) \end{cases} \quad (1)$$

where  $F_1$  and  $F_2$  are cumulative distribution functions of variable  $X$ .

The set of data should contain an independent variable (grouping variable) with at least two distinct values (binary variable) which unambiguously identify the affiliation of cases to groups in the set of data. As a result of using non-parametric tests, it is no longer necessary to fulfil the assumptions of the equal quantity of each group, the normality of distribution and the homogeneity of variance. Non-parametric equivalents of the Student's t-test for two independent samples are the Mann–Whitney U test and Kolmogorov–Smirnov test (Stanisz, 2006).

The Mann–Whitney U test is used to verify the null hypothesis that two randomly selected samples come from a population with the same median. The test requires the variables to be measured at least on the ordinal scale because its methodology is based on ranks. The verification of hypotheses, for the size of each group of more than 20, is based on Z statistics presented by the formula (Stanisz, 2006):

$$Z = \frac{R_1 - R_2 - (n_1 - n_2)(n + 1)/2}{\sqrt{n_1 n_2 (n + 1)/3}} \tag{2}$$

where  $n$  is the total number of observations ( $n = n_1 + n_2$ ),  $R_1$  is the sum of ranks granted to values of the first sample,  $R_2$  is the sum of ranks granted to values of the second sample. In approximation,  $Z$  statistics have a normal distribution. The test's results take into account the existence of  $w$  given bound ranks.

The Kolmogorov–Smirnov test is a weaker equivalent of the test above. It compares not only the location parameters (median, ranks) but also the shape of the distribution of variables (dispersion, skewness). It may be treated as an extension of the Mann–Whitney U test. It is based on the maximum absolute difference between observed cumulative distribution functions of both samples.

### Discussion of results

The surveyed respondents included farmers in the working age (from 19 to 60+ years old), making the key financial decisions in a household. The sample's age structure may be deemed balanced, without a clear advantage of any age group (Fig. 1).

As far as the level of education is concerned, approximately half of the farmers surveyed has completed secondary level of education, while the second most numerous group are farmers with vocational education. It is worth to mention that holders of a master degree constitute a higher percentage among insured farmers than uninsured ones.

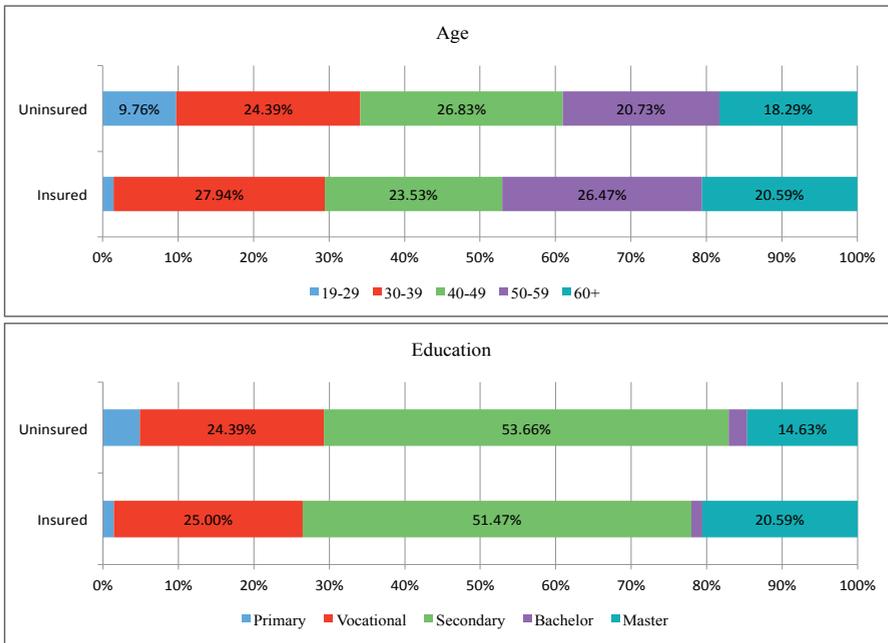


Fig. 1. Structure of age and level of education of the respondents.

Source: own study.

Another factor subject to analysis was the volume of crop production. It was measured with two variables: the area of farmland used for crop production and annual income (in PLN). Data presented in Figure 2 leads to conclusion that farms with smaller farmland area do not buy crop insurance. It may be related to the scale of their risk exposure. Nearly half of uninsured farmers (approx. 43%) owned farmland smaller than 20 ha, and almost 75% of them managed farms that do not exceed 50 ha. On the other hand, approx. 40% of insured agricultural producers had large-area farms that exceed 100 ha. The majority of insured farmers (53%) conducted their crop production on an area of more than 50 ha.

Similar conclusions can be drawn when looking at the structure of annual income from crop production. The highest value of income (more than PLN 200,000 annually) was earned by approx. 40% of farmers that bought crop insurance policy and only by 12% of farmers without such coverage. Looking at farmers with the lowest annual income (below PLN 20,000) it may be noted that this group includes every third of uninsured farmers and every sixth of insured farmer. It might mean that the higher volume of crop production a farmer reaches, the higher is the probability of crop insurance purchase by the farmer.

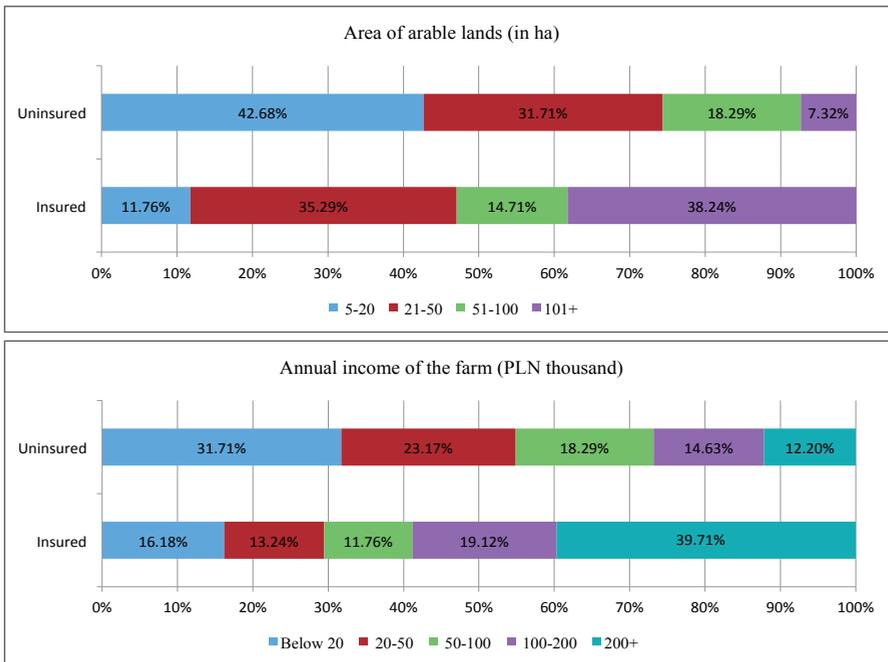


Fig. 2. Economic potential of respondents.

Source: own study.

It is now worth to compare the individual risk perception of insured and uninsured farmers (Fig. 3). Respondents were asked to make a subjective assessment of the risk of suffering losses in own crop production due to natural perils. They

could choose one of six options on the scale describing qualitatively the degree of risk probability. The majority of farmers chose the phrase “hazard is probable” which is the response in the middle of the scale. It proves the farmers awareness of existing natural hazards, but without an excessive concern over the future existence of the farm. The share of insured farmers representing increased risk perception is twice as high as those uninsured (7.35% as compared to 3.66%) – they claim that damage will occur surely or with high probability. The share of farmers who do not perceive the risk or diminish importance of it is at a similar level of approx. 4.5% in both groups.

Relative risk assessment should be understood as a subjective, individual assessment of the probability of suffering damage to own crops due to natural perils in comparison with other agricultural farms in Poland. The conducted research leads to a surprising conclusion that insured farmers declare an almost identical relative risk assessment as uninsured ones. The majority of respondents (approx. 70% in both groups) do not perceive their risk exposure as greater or smaller than a certain “national average” in the individual understanding of this notion by each respondent. At the stage of building the survey questionnaire, it was suspected that farmers purchasing insurance may assess the level of risk to their crop as higher than elsewhere which would be a significant stimulus to purchase insurance cover. However, this intuition has not been confirmed.

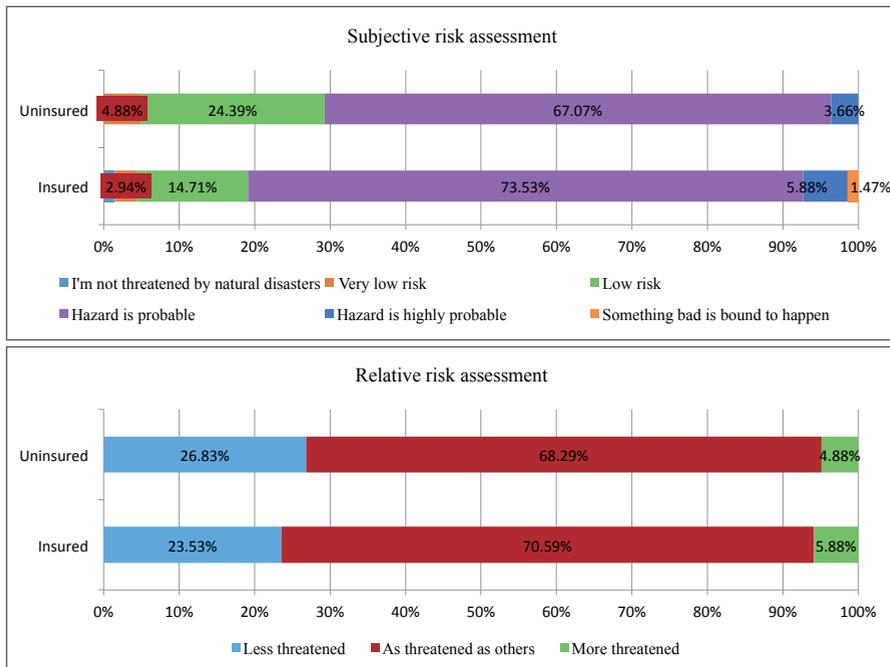


Fig. 3. Subjective and relative perception of risk by respondents.

Source: own study.

When analysing the distribution of the number of loss events in crops over the last 15 years, interesting dependencies may be observed (Fig. 4). The majority of uninsured farmers (58.5%) are those who did not experience more than one loss event caused by natural perils. Every fourth uninsured farmer experienced losses twice over the examined period. The group of insured farmers is characterized by higher average loss ratio, because the weighted average number of loss events is 1.85 (as compared to 1.40 for the uninsured). Every seventh insured farmer had 3 losses in crops over the last 15 years and every eleventh – 4 losses. It may be thus said that the experience of damage to crops in the past increases the willingness to purchase insurance. It is quite an obvious conclusion, but it still needed empirical verification.

According to theory, willingness to pay (WTP) determines the maximum amount an entity is willing to pay for a good instead of resigning from it (Varian, 1992). The conditional valuation method is used to estimate the WTP of respondents. It consists in asking a series of specially selected questions to potential users of a given market or non-market good (Miller, Hofstetter, Krohmer and Zhang, 2011). These questions apply to amounts they would be willing to pay, so that the good is delivered to them (the so-called willingness to pay).

In order to avoid problems with the independent assessment of insurance cost made by people unfamiliar with insurance tariffs, respondents answered a series of dichotomous questions (yes/no response). When they accepted a given price level, the next question with a higher price was read. When this price was accepted as well, the next question with a higher price appeared. An analogous mechanism was planned if the starting price was not accepted. The subsequent questions included lower prices. The insurance price in the survey was defined as the percentage of the insurance sum, similarly to mandatory crop insurance. The levels of prices found in the subsequent questions corresponded to premium rates used on the market, taking into account limits defined in the act on crop and livestock insurance.

The willingness to pay the crop insurance premium of insured farmers is considerably higher than that of uninsured farmers. It turns out that two-thirds of farmers without a crop policy would not be able to pay the minimum premium for it, defined as 1% of the insurance sum, which is a value below market prices. Few farmers would be willing to pay more than 3% for an insurance policy. Farmers who insure their crops are more aware of the real cost of such protection and accept it to a greater extent. Nearly 40% of respondents accept the premium at the level of 3%, 22% would be ready to cover the cost of protection at the rate of 4%. The percentage of farmers looking only for the cheapest insurance (premium rate at 1% of the insurance sum) is lower by half than in the group of uninsured farmers.

In the next step of the study, the research hypotheses were empirically verified by statistical tests whether the population of insured farmers is significantly different from the population of uninsured farmers. Various criteria characterizing farmers, such as demographic, social, economic criteria, individual perception of risk, number of losses in crops suffered by a farmer in the past, and willingness to pay for crop insurance, have been taken into consideration.

The Shapiro–Wilk W test of normality of the distribution of variables proved the fact that no variable listed in Table 2 is normally distributed ( $p$ -value <0.05). Based on that, non-parametric tests could be applied.

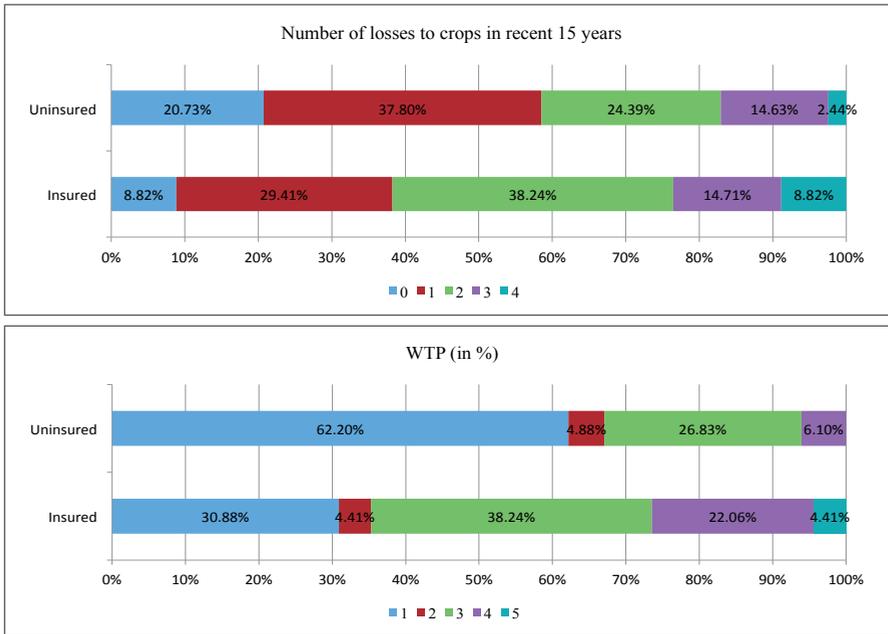


Fig. 4. Number of losses in crops suffered in the last 15 years and willingness to pay for crop insurance. Source: own study.

Table 2

Results of the Shapiro–Wilk W test of the normality of distribution

Name of variable	Grouping variable: INSURANCE			
	Level “0” (Uninsured)		Level “1” (Insured)	
	Stat. W	$p$ -value	Stat. W	$p$ -value
AGE	0.90776	0.00002	0.87891	0.00001
AREA	0.81499	0.00000	0.81984	0.00000
EDUCATION	0.82217	0.00000	0.79663	0.00000
INCOME	0.86410	0.00000	0.81690	0.00000
NR_EVENTS	0.89110	0.00000	0.90545	0.00008
RISK	0.72267	0.00000	0.69403	0.00000
RISK_COMP	0.69100	0.00000	0.68759	0.00000
WTP	0.68897	0.00000	0.84462	0.00000

Source: own study.

Regardless of the purchase of crop insurance, the distribution of the education level of respondents is similar (see Table 3). A similar conclusion relates to the variable describing age. In addition, the willingness to purchase crop insurance is not a feature which would differentiate the distribution of risk perception between the group of insured and uninsured farmers. This applies both to subjective perception (the RISK variable) and relative perception (RISK\_COMP). In other words, population of insured farmers does not differ from population of uninsured farmers if age, level of education, individual risk assessment or relative risk assessment are compared.

Table 3

*Test results of statistical comparison of two independent groups  
(insured versus uninsured farmers)*

Name of variable	Mann–Whitney U test		Kolmogorov–Smirnov test		
	Stat. Z	<i>p-value</i>	Maximum negative difference	Maximum positive difference	<i>p-value</i>
<i>AGE</i>	1.077070	0.281450	0.000000	0.082855	$p > .10$
<i>AREA</i>	4.876868	0.000001	0.000000	0.309182	$p < .005$
<i>EDUCATION</i>	0.804189	0.421289	0.000000	0.059541	$p > .10$
<i>INCOME</i>	3.982287	0.000068	0.000000	0.319943	$p < .001$
<i>NR_EVENTS</i>	2.537710	0.011159	0.000000	0.203013	$p < .10$
<i>RISK</i>	1.567691	0.116954	-0.014706	0.101506	$p > .10$
<i>RISK_COMP</i>	0.503250	0.614789	0.000000	0.032999	$p > .10$
<i>WTP</i>	4.331838	0.000015	0.000000	0.317791	$p < .005$

Source: own study.

Test results shown in Table 3 demonstrate that there are four factors that are significantly different when populations of insured and uninsured farmers are compared. These factors are:

- size of farm measured by the area of agricultural land (*AREA*),
- volume of crop production measured by the value of annual income of a farmer (*INCOME*),
- number of losses in crops caused by natural perils in the last 15 years (*NR\_EVENTS*),
- willingness to pay the crop insurance premium expressed as a percentage of sum insured (*WTP*).

To summarize, it has been proved that the research hypothesis is correct. There is at least one factor (in fact, there are four factors), which made the population of insured farmers with crop insurance significantly different (in statistical terms) from the population of uninsured farmers.

## **Conclusions**

The conducted empirical research showed the complexity of the issue of crop insurance purchase decision-making. The most prominent factors determining the crop insurance purchase were identified. The higher propensity to manage natural perils using risk transfer mechanism can be found among farmers with greater crop production potential, both in terms of the area of farmland as well as earned annual income from crop production. Farmers who experienced more losses in crops due to natural perils as well as those who are willing to pay a higher price for the crop insurance policy usually decided to purchase insurance. On the other hand, despite frequently formulated assumptions, factors such as age, education or perception of risk did not determine the final decision on buying crop insurance.

The topic of crop insurance purchase requires further, in-depth research, preferably on a large and representative research sample. The results showed here may be used by policymakers to shape the policy of support for crop insurance market, especially by improving the system of subsidies from the state budget to crop insurance premiums. Such a system already exists in Poland but still requires some adjustments in order to meet expectations of both farmers and insurance industry. The main problem is to find an optimal mix of premium rates and subsidies that would be acceptable for both sides. This study, particularly in the field of WTP, addresses this problem. Moreover, studying key determinants of demand for crop insurance might prove valuable to insurance companies which could address their insurance offer to farmers more effectively.

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## CO CHARAKTERYZUJE PRODUCENTÓW ROLNYCH, KTÓRZY KUPUJĄ UBEZPIECZENIE UPRAW W POLSCE?

### Abstrakt

*Celem artykułu jest porównanie populacji rolników, którzy wykupili ubezpieczenie upraw z populacją rolników nieubezpieczonych. Na tej podstawie zidentyfikowano cechy charakteryzujące rolników, którzy zdecydowali się na zakup ubezpieczenia upraw. Obserwacje te zostały wykorzystane do wyciągnięcia bardziej ogólnych wniosków dotyczących czynników wpływających na skłonność do zakupu ubezpieczenia. W tym celu uwzględniono czynniki demograficzne, społeczne i ekonomiczne, indywidualne postrzeganie ryzyka, liczbę szkód w uprawach doświadczonych przez rolnika w ostatnich 15 latach oraz skłonność do płacenia składki ubezpieczeniowej. Badania empiryczne opierają się na próbie 150 polskich rolników, z którymi przeprowadzono wywiady przy użyciu metody CATI. Stwierdzono, że gospodarstwa o większej wielkości produkcji (roczny dochód) i większym obszarze upraw wykazują większą gotowość do zakupu ubezpieczenia. Rolnicy, którzy doznali szkód w uprawach, są bardziej skłonni do zakupu ubezpieczenia. Co więcej wyższy wskaźnik penetracji ubezpieczeniowej można znaleźć wśród rolników, którzy są gotowi zapłacić wyższą cenę za polisę ubezpieczeniową. Co zaskakujące, pomimo często formułowanych przypuszczeń, czynniki takie jak wiek rolnika, poziom wykształcenia czy indywidualne postrzeganie ryzyka nie determinują decyzji o zakupie ubezpieczenia.*

**Słowa kluczowe:** ubezpieczenie upraw, popyt na ubezpieczenie, skłonność do płacenia, ubezpieczenie, decyzje ekonomiczne, ryzyko.

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