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Factors affecting the demand for index-based agriculture insurance in Poland[1]

The growing number of catastrophic occurrences is leading more and more insurance companies to refrain from offering traditional insurance products. The purpose of this study is to examine the factors affecting Polish farmers' acceptance of a completely new proposition on the Polish market – index-based insurance against drought. Farmers' acceptance was identified on the basis of a two-stage direct survey, the first covering opinions about the new structure of insurance products, and the next looking at purchasing decisions. A correlation between the area of residence and the level of interest in the new product was detected thanks to a multinomial logit model. On the other hand, the survey indicates hardly any correlation between farmers' decisions and numerous other particular variables – thus suggesting that their approach to drought is very individualistic. Acceptance of the index structure was much higher than willingness to purchase it. The government's engagement in index-based insurance in the form of a premium subsidy seems therefore indispensable.

Key words: drought, insurance in Poland, index-based insurance, contingent valuation, willingness to buy.

Introduction

Recently, the expectations of Polish farmers regarding crop insurance have been rising due to hard-to-accept variability in weather conditions (water shortages on the one hand, excessive humidity on the other). There are more and more common demands for well-structured insurance against drought. At the same time, as insurance companies face these new risks they are asking for higher insurance premiums. Further affecting the raise in premiums are difficulties in claims settlements. The proper calculation of compensation depends on when the drought occurred, whether

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it was drought alone that affected the yield and deciding what the yield for a particular crop to be expected in a given year should be considered[2].

Therefore, due to numerous possible complications, index-based insurance is becoming an increasingly popular option considered in many countries, including Poland[3].

What must be emphasized is that many types of agricultural insurance result in tremendous losses to insurance companies in particular years. The last three years [2009–2012] in Poland are a very good example. The total number of claims made in each of these years on agricultural insurance exceeded 50,000 cases, and the total payout was much higher than the level of collected premiums (in crop insurance). Making things worse was the fact that in Poland loss calculation and payment must occur within 30 days of a claim.

Aligned with the Common Agricultural Policy (CAP), both Polish and other European governments have invented a range of various instruments to support and subsidise farmers[4]. There are direct subsidies based on the number of arable hectares, as well as other instruments allowing farmers to consciously manage risk[5]. Since 2006, the government has been subsidising 50 per cent of the premiums paid by farmers, which has resulted in a significant rise in the number of farmers ready to buy insurance. To illustrate this, it is enough to mention that in 2005 there were 36,000 crop insurance contracts[6], while after the introduction of subsidised insurance in 2006 this number increased to 50,000 [7], 99,500 in 2007[8], at least as many as 1.7 million in 2011[9]. The subsidy is applied, however, only if the premium rate does not exceed 6 per cent of the crop value. In the case of drought insurance, insurers offer as much as 10 per cent of the crop value, which is often far beyond the farmers' budgets[10].

In 2008, there was a catastrophic drought in Poland. According to the estimates of the Institute of Soil Science and Plant Cultivation (IUNG) in Puławy, in one of the six-decade periods for which climatic water balance index is calculated, 58 per cent of spring crops area and 42 per

2. M. Kaczała, K. Łyskawa, "Ubezpieczenia z dopłatami z budżetu państwa jako instrument ochrony gospodarstw rolnych przed skutkami ryzyka," in: *Gospodarka i finanse*, red. W. Przybylska Kapuścińska, Wyd. Uniwersytetu Ekonomicznego w Poznaniu 2008, s. 123–145.

3. J. Preś, "Zarządzanie ryzykiem pogodowym," CeDeWu, Warszawa 2007.

4. E. Berg, J. Kramer, "Policy options for risk management, in: *Income stabilisation in European agriculture. Design and economic impact of risk management tools*," red. M.P. Meuwissen, M.A.P.M. van Asseldonk, R.B.M. Huirne, Wageningen Academic Publishers, 2008.

5. "Managing Risk in Agriculture. Policy assessment and design," OECD, Paris 2011.

6. "Biuletyn roczny. Rynek ubezpieczeń 2005 (dane zweryfikowane)," cz. D: *Sprawozdanie statystyczne*, KNUiFE, Warszawa2005, http://www.knf.gov.pl/opracowania/rynek_ubezpieczen/Dane_o_rynku/Dane_roczne/%20 rocznik3.html.

7. "Biuletyn roczny. Rynek ubezpieczeń 2006," cz. I: *Przegląd rynku*, KNF, Warszawa 2006, http://www.knf.gov.pl/opracow-%20ania/rynek_ubezpieczen/Dane_o_rynku/Dane_roczne/archiwum.html.

8. "Biuletyn roczny. Rynek ubezpieczeń 2007," cz. 5: *Sprawozdanie statystyczne KNF-02*, KNF, Warszawa 2007, http://www.knf.gov.pl/opracowania/rynek_ubezpieczen/Dane_o_rynku/Dane_roczne/archiwum.html.

9. A. Janc, "Trudności w funkcjonowaniu ubezpieczeń upraw i zwierząt gospodarskich w Polsce w latach 2006–2012," referat wygłoszony na konferencji *Trendy w ubezpieczeniach rolnych w Europie. Ubezpieczenia ryzyka suszy w Polsce*, Warszawa 5.11.2012.

10. A. Szelągowska, "Financial Provisions and Capabilities of The State and EU Budget as Regards Supporting The Agriculture Insurance System," prezentacja na *Conferencia Internacional Gestión de riesgos y crisis en el seguro agrario*, Madryt 2010, http://www.agroinsurance.com/files//publications/ALEXANDRA%20SZELAGOWSKA.pdf.

cent of winter crops area was threatened with drought. The time between 11 May and 10 July, when plants' demand for water is the highest, was extremely difficult. In many regions, plants did not propagate properly or could not develop spikes. Farms located on weak soil suffered the greatest losses.

This is why it is necessary to look for solutions that will make it possible to establish a kind of insurance enabling farmers to consciously manage risk on their farms. At the same time, the new insurance should allow insurers to function for the long-term in the crop insurance market with suitable profitability.

What makes drought insurance difficult is the fact that, due to climate change, drought occurrence in some regions of Poland is almost a certainty. According to IUNG analyses, in some parts of Poland where the soil quality is poor, drought is due to occur every two years. Therefore, insurance companies will not offer any insurance at all or the premium will be too high for farmers to accept.

Index-based insurance provides a plausible tool to solve the problem of drought insurance or insurance of animal and plant production. Some countries[11], including Austria, Mongolia and Mexico, have already implemented such a system. The first step is always to define the parameters to serve as the basis for compensation payment. These are usually determined by various external bodies, such as administrative bodies or scientific institutes. In the case of drought, the parameters might be, for instance, the actual amount of rainfall over a period of time, air temperature over a given period or, like in Poland, the value of climatic water balance. When the indicator falls below a determined level, it results in crop losses and accordingly leads to a payment of a flat-rate benefit, which unfortunately may not cover the whole of the loss.

Index-based insurance, above all, has quite a few undeniable advantages. Underwriting and administrative costs are lower due to the fact that individual farms do not have to be inspected. Also, there is no need for profit or crop loss adjustment because it is enough to measure the index. Another merit is that interested customers range from farmers to suppliers, banks and consumers; in other words, all parties whose profit is related to the amount of rainfall. As a result, index-based insurance may cover otherwise uninsurable occurrences or minimise the cost of insurance.

The key element for a proper index-based insurance system to be established is to obtain detailed historical data concerning an examined phenomenon. In the course of building the model and calculation of the assumed crop loss, it is crucial to consider both global and local climatic and weather trends, as well as seasonal weather trends.

The main problem connected with the use of index-based insurance is the "basis risk", which denotes the discrepancy between product basis and the genuine risk parameters that a particular entity is to be protected from[12]. In this article, the product basis is the climatic water balance index that has been calculated by IUNG since 2006.

11. P. Hazell, J. Skees, "Insuring against Bad Weather. Recent Thinking," styczeń2005, http://www.spanish.microfinancegateway.org/files/40424_file_34.pdf.
12. L.L. Golden, W. Mulong, C.C. Yang, "Handling Weather Related Risk Throughout the Financial Markets: Considerations of Credit Risk, Basis Risk, and Hedging," *The Journal of Risk and Insurance*, 2007,vol. 74, no.2, s 319–346.

1. The climatic water balance and description of data collection

The Climatic Water Balance (CWB) index is the main drought-monitoring tool in Poland, additionally including soil's water retention qualities. The CWB index meets the requirements of index-based insurance systems because it defines the potential yield losses against the average conditions. Soil conditions must also be considered because Poland is strongly diversified, especially regarding soil water retention qualities. Consequently, identical rainfall deficit and growth of plants can vary dramatically depending on the soil category[13].

CWB expresses the difference between precipitation and potential evapotranspiration.

$$CWB = P - ETP \qquad (1)$$

Where:
CWB – Climatic Water Balance
P – precipitation in a given period (2)
ETP – Penman evapotranspiration in a given period (3)

Meteorological stations measure precipitation while the value of potential evapotranspiration (expressed as approximate capacity of the evaporation of the water from living short grass) is calculated by means of the Penman method. This value can also be precisely evaluated by the use of simplified models, which include meteorological elements that are normally measured by meteorological stations in Poland.

In order to classify agricultural drought, the entire complex of weather and soil conditions is taken into consideration.

According to the definition specified in the Act, drought is defined by damage caused by the occurrence of a climatic water balance (CWB) below a defined value for an individual species or groups of cultivated plants as well as the soil category in any (60 day) period from 1 April to 30 September of that year[14].

The drought index product has been set up on the basis of CWB indications, thus meeting the following requirements:

Threshold = CWB reaches the defined value, which causes damage exceeding 50%, of the 10 year average yield for a given crop in a province (1)

Claim payment per 1 ha = 10 year average price for 1 t of a given crop in a province*claim payment rate (2)

$$\textit{Claim payment rate} = \begin{cases} 1 \text{ for wheat} \\ 10 \text{ for sugar beets} \\ 0{,}75 \text{ for rapeseed} \end{cases} \qquad (3)$$

13. J. Kozyra, et.al. "Agricultural Drought Monitoring Systems (ADMS) – including crop specific requirements and soil map for the detection of areas affected by drought in Poland," *w: Impact of Climate Change and Adaptation in Agriculture. Extended Abstracts of the International Symposium*, red. J. Eitzinger, G. Kubu, University of Natural Resources' and Applied Life Sciences (BOKU), Vienna 2009, s. 37–39, http://www.boku.ac.at/met/report.

14. System monitoring suszy rolniczej 2011. Serwis internetowy prowadzony przez Instytut Uprawy Nawożenia i Gleboznawstwa – Państwowy Instytut Badawczy (IUNG-PIB) na zlecenie Ministerstwa Rolnictwa i Rozwoju Wsi, http://www.susza.iung.pulawy.pl/.

This is what was presented for the farmers to evaluate. Primary data was gathered on the basis of a survey conducted in March 2012 by means of CATI method, using the structured questionnaire schedule, on a focus group of 750 farmers across Poland who cultivate plants. The representative sample was selected on the basis of location and farm size. There were three stages of the level of product acceptance: firstly, overall acceptance of index insurance concept was examined (OA), secondly, the acceptance when the price is given (OAP) and finally, the farmers willingness to buy the product (WTB). The sample product offered to farmers for acceptance was adapted to their primary crop.

The main problem concerning identification of factors affecting respondents' answers as well as relevance of these factors' influence, resulted from their qualitative character. It was due to the fact that both answer variants and respondents' profiles were expressed by means of different qualitative variables: binary variables, polynomial variables – both nominal and also ordinal ones.

2. Methodology

2.1 Dependent variables

According to the purpose of the study, a dependent variable was defined as the level of acceptance of the new product. Acceptance was surveyed as overall acceptance of the index insurance concept, acceptance when the price was given, and finally the farmers' willingness to buy the product at the given price. The measurement of the dependent variables is presented in table 1.

Table 1. Description of dependent variables

Dependent variables	Explanation	Measurement
Overall Acceptance (OA)	Acceptance of a new index-based insurance product concept	0 – I don't like it at all or I like it a little 1 – I quite like it, I like it, I like it very much, I extremely like it
Overall acceptance when the price was given (OAP)	Acceptance of the new concept of index-based crop insurance when the price was given for this insurance	0 – I don't like it at all or I like it a little 1 – I quite like it, I like it, I like it very much, I extremely like it
Willingness to buy (WTB)	Willingness to buy the product for the farmer's dominant crop	1 – I will definitely not buy it or would rather not buy it 2 – I am not sure if I will buy it or not 3 – I might buy it or I will definitely buy it

Source: the authors' own research.

2.2 Explanatory variables

Based on the literature and our own experience, twelve factors influencing OA, OAP and WTB were selected. A detailed list of these variables, their measurement and the hypothesized relationship with the dependent variables are shown in table 2.

Table 2. Description of independent variables and hypothesized relationship

Variables	Explanation	Measurement	Hypothesized Relationship
Geographical location **LOCATION** P_DOLN P_KUJ_P P_LUBEL P_LUBUS P_LODZ P_MALOP P_MAZOW P_OPOL P_ODKARP P_ODLAS P_OMOR P_SLAS P_SWIET P_WAR_MAZ P_WLKP P_ZACHPO	Farm location (16 provinces): Lower Silesia, Kujawy-Pomerania, Lublin, Lubuskie, Łódź, Małopolska, Mazovia, Opole , Podkarpacie, Podlasie, Pomerania, Silesia, Świętokrzyskie, Warmia-Masuria, Wielkopolska, West Pomerania	1 – if a farm is located in a given province 0 – otherwise	Location of a farm in one of the nine provinces: Lower Silesia , Kujawy-Pomerania, Lubuskie, Łódź, Mazovia, Podlasie, Świętokrzyskie, Wielkopolska, West Pomerania increases OA, OAP and WTB levels
Farm size **FARM_SIZE**	Number of hectares owned	<1 ha-7 ha) <7 ha-20 ha) above 20 ha	The larger the farm size, the higher the OA, OAP and WTB levels
Acceptable level of yield loss against the target **ACCEPT_LOSS**	The level of yield loss that the farmer considers as unthreatening to the farm's operations	0 – No loss is acceptable 1 – up to 10% of yield loss 2 – <10%-30%) of yield loss 3 – <30%-50%) of yield loss 4 – over 50% of yield loss	The lower the level of yield loss acceptance, the higher OA, OAP and WTB levels
The level of yield loss leading to bankruptcy **NACCEPT_LOSS**	The level of yield loss that the farmer considers to be the reason for the bankruptcy of the farm	0 – No loss is acceptable 1 – up to 10% of yield loss 2 – <10%-30%) of yield loss 3 – <30%-50%) of yield loss 4 – over 50% of yield loss	The lower the level of loss absorbable by the farm, the higher the OA, OAP and WTB levels
Core productionSPECIALIZ **SPEC_PLANT** **SPEC_MILK SPEC_LIVEST**	Farm specialization: plant, milk or livestock	1 – if a farm is specialized 0 – otherwise	Farm specialization in at least one area increases the OA, OAP and WTB levels
	Core production of the farm: plants, milk, livestock, no dominant production	1 – if a farm is specialized in a given area 0 – otherwise	Plant specialization increases the OA, OAP and WTB levels
Age of farmer AGE	Age of the farmer	≤40 (40–50> (50–60> > 61	The lower the age, the higher OA, OAP and WTB levels
Level of education **EDU_LEV**	Farmer's educational background	1 – secondary or tertiary 2 – vocational 3 – lower secondary or none	Higher education level increases OA, OAP and WTB levels

Variables	Explanation	Measurement	Hypothesized Relationship
Farming loss experience N_PLANT_DIS N_DROUGHT N_FLOOD N_HAIL N_SPRING_FR N_WINTERKILL N_STORM N_FIRE	How many times the following types of crop damage occurred in the farm in the last 10 years: plant diseases, pest, drought, flood, hail, spring frost, winterkill, storm, fire	A discrete quantitative measure	The larger the number of flood-related damages, the lower OA, OAP and WTB levels. The larger the number of other events, the higher OA, OAP and WTB levels
Potential area of drought DROUGHT_AREA	Farm location in a drought prone area in Poland, i.e. in certain municipalities	1 – if a farm is located in a drought area 0 – otherwise	Location of a farm in the drought-prone area increases OA, OAP and WTB levels
Insurance history ANY_INSUR INSUR_DROUGHT INSUR_HAIL INSUR_WK INSUR_SFROST INSUR_FIRE INSUR_FLOOD	Crop insurance in the previous year	1 – if the farmer insured the crops in the previous year 0 – otherwise	Having traditional crop insurance increases OA, OAP and WTB levels
	Types of perils insured: drought, hail, winterkill, spring frost, fire, flood	1 – if insurance covered the peril 0 – otherwise	Having drought and spring frost insurance increases OA, OAP and WTB levels
Type of crop: RAPE WHEAT W_BARLEY TRITICA RYE OATS S_BARLEY MAIZE S_BEETS	Range of cultivated crops, i.e,. rapeseed, winter wheat, winter barley, winter triticale, rye, oats, spring barley, maize, sugar beets in the last two years	1 – if the farmer cultivated a given crop 0 – otherwise	Cultivation of rapeseed, winter wheat or sugar beets increases OA, OAP and WTB levels
Sources of living SOURCELIV	Amount of farming income within the total income of the farm	A continuous quantitative measure of <0, 100> range	The higher the amount of farming income in the total income, the higher OA, OAP and WTB levels

Source: authors' own research.

2.3. Research procedure and methodology

The research was carried out in two stages. The aim of the first phase was to verify the initially proposed hypotheses about existence of factors influencing:

- the respondents' opinions (OA, OAP) regarding the new form of drought insurance
- the decision whether or not to buy it (WTB).

The identification of these factors validates the attempt to create a tool that will enable classification of farmers into those who are likely to become interested in the new product and those who will not show any interest at all. Such an attempt was made during the second stage of research, and its quality was evaluated on the basis of hit ratio and the usability of this tool for insurance companies.

Because the variables analysed were mainly qualitative, the classical measures of correlation could not be used (or applied) in the first stage of the study. The classical matrix of mutual correlations was replaced by a matrix of research results referring to dependence between two particular variables, and methods of testing for independence between these variables were adapted to their character.

As for all the potential qualitative variables measured either on the nominal or ordinal scales, the test of independence was applied, $\chi 2$ z (K1–1)*(K2–1) where K1 and K2 mean the number of possible qualitative variables> variants, whose correlation is examined. Hence, it was possible to show which characteristics of respondents (including their farms) affect their opinion about the insurance product.

Whenever qualitative variables were either nominal or ordinal, the chi-squared test for independence was applied (where test statistic is $\chi 2$ with (K1–1)*(K2–1) degrees of freedom, where K1 and K2 mean the number of possible qualitative variants of variables). Hence, it was possible to show which characteristics of respondents (including their farms) have significant influence on their opinion about the insurance product.

The strength of this correlation was established on the basis of Cramer>s coefficient, which relies on empirical value of $\chi 2$ -statistics[15].

When dependence between the opinion about the product and the quantitative variables (e.g., the number of losses for different reasons, the amount of income obtained from farming) was established, the applied methods depended on the number of possible opinion variants. When there were two variants of opinion (whether they liked the notion or not – in OA and OAP case), the parametric t-test for equality of means was applied to decide about the relevance of the relationship between the opinion about the product and the value of quantitative variable. As the distribution of quantitative variables was unknown (and might not be normal), the nonparametric Mann-Whitney's U-test was additionally applied.

If there were three variants of opinion (won't buy / don't know / will buy - as it was with WTB), an ANOVA analysis based on F statistics was applied to decide about the significance of the influence of a given variable on a customer – ANOVA provides a statistical test of whether or not the means of several groups are all equal, and therefore generalizes a t-test to more than two groups [16]. And similarly, a non-parametric equivalent of ANOVA, the Kruskal-Wallis test, was used as supplementary to parametric tests.

In all cases, the direction of correlation was established either on the basis of empirical numbers against hypothetical numbers (when the chi-squared test was applied) or on basis of the average values of a feature (when one variable was qualitative).

The choice of method in the second stage of research (creating a tool for farmer classification) was strictly related to the fact that explanatory variables were not normally distributed (most of the factors were ultimately described by means of qualitative variables, including dummy and binary ones). Thus the choice of the classifying tool was rather limited. In particular the application of linear discriminant analysis had to be given up, and the selection was made up of classification methods that do not require a specific distribution of variables describing the classified objects. A decision was made to use the probability model, specifically the binomial logit model (for OA and OAP) and the polynomial logit model for ordinal categories (in the case of WTB) – with the awareness that it was also possible to obtain similar results using the probit model. The models were estimated with use of the maximum-likelihood method in GRETL and variable selection was based

15. H. Cramer, "Metody matematyczne w statystyce," PWN, Warszawa1958 oraz Y.M. Bishop, S.E. Fienberg, P.W. Holland, "Discrete Multivariate Analysis: Theory and Practice," M.I.T. Press, Cambridge1975.
16. A.D. Aczel, "Complete Business Statistics," PWN, Warszawa 2000, s. 388–454.

on a backward stepwise variable selection procedure, where a 10 per cent level of significance was assumed. The evaluation of model quality was made on the basis of the hit ratio (HR) in the training set. In each case it was verified whether the calculated hit ratio was higher than what could be achieved by chance – for this purpose the t-statistic was properly calculated and marked as t_{HR}.

It should be noted that there are numerous examples of research where application of these models has resulted in accurate classifications[17].

3. Empirical results

The results obtained to verify the influence of the first seven factors on the level of product acceptance are presented below (Table 3). In the course of this data analysis, it should be remembered that wherever the p-value level was low (and the trust level equals 1-(p-value)), one could conclude that a given factor did have an influence on the opinion about the insurance product. It was noticed that 46.7 per cent of all farmers in this research accepted this concept of index insurance (OA). After the price information, the acceptance rate fell to 43.7 per cent (OAP). However, willingness to buy the product was declared only by 6.7 per cent of farmers.

Table 3. P-values for the chi-squared test for independence between product acceptance and particular variables

Study variant	Variable													
	LOCATION		FARM_SIZE		ACCEPT_LOSS		NACCEPT_LOSS		SPECIALIZ		AGE		EDU_LEV	
	p-Value	Cramer's coefficient	p-Value	Cramer's coefficient	p-Value	Cramer's coefficient	p-Value	Cramer's coefficient	p-Value	Cramer's coefficient	p-Value	Cramer's coefficient	p-Value	Cramer's coefficient
OA	**0.003**	0.214	0.711	0.030	0.392	0.076	**0.142**	0.085	0.488	0.068	**0.022**	0.123	**0.004**	0.133
OAP	0.152	0.166	0.367	0.052	0.371	0.078	**0.026**	0.111	**0.034**	0.118	0.709	0.054	**0.005**	0.132
WTB	0.217	0.154	0.110	0.070	0.194	0.089	0.993	0.022	**0.186**	0.087	**0.198**	0.086	0.527	0.058

Source: the authors' own research.

First of all, the connection between a farm's location and the opinion about the new construction of insurance product turned out to be statistically relevant, but not highly relevant (based on Cramer's V coefficient). At the same time, the more information was given to the respondents, the less important the studied correlation turned out to be. Ultimately, there was no influence of farm location on the purchase decision. On the basis of the detailed analysis of the number of positive opinions against all opinions (not included in the article due to volume requirements) it could be asserted that the differentiation of opinions in various provinces was mainly due to seven out of the sixteen provinces, six of which were located in the drought area. This is where the evaluation of the concept itself was definitely well above the average.

Secondly, one can state that farm size was of no statistical relevance to the level of product acceptance. A low p-value level was gained only in the case of WTB, which may lead to a conclusion about its

17. A.M. Hackert, J.G. Tokle, "Foregign currency risk management with probit analysis", *Journal of Business Forecasting*, 1993, vol. 12, no. 1, s. 15–18; M.L. DeFond, C.W. Park, "The effect of competition in CEO turnover", *Journal of Accounting and Economics*, 1999, no. 27 (1), s. 35–56; D.G. Blanchflower, D.P. Levine, D.J. Zimmerman, "Discrimination in the Small Business Credit Market," *Review of Economics and Statistics*, 2003 no. 85 (4), s. 930–943.

correlation with the 90 per cent level of trust. It has to be said as well that the percentage of "I'll buy" answers was the highest for the largest farms (18 per cent), and the lowest for the smallest ones (9 per cent).

Thirdly, there was no statistically relevant correlation between the opinion about the product and the level of yield loss considered as safe by the farmer. However, the level of unacceptable crop loss that could lead to a farm's bankruptcy does have an effect on the acceptance of the index-based product. The detailed analysis of the data (also not included) allows the assertion that the highest number of positive opinions about the concept (with and without the price) was noticed for farms where the level of unacceptable loss in yield was 31–50 per cent and not above 50 per cent. A similar correlation could be noticed in willingness to purchase the product.

The further analysis of the table leads to an observation that a large influence on the level of acceptance is exerted by a farm's specialization, which has a smaller influence on willingness to buy the product. Consequently, the detailed analysis (not included in the article) points out that focusing on plant production or milk clearly increases the chance of the product along with acceptance of the given price, while the lack of specialization evidently reduces it. Willingness to buy the product is affected by a similar correlation.

It turns out that the factors characterizing the respondent are also of significant importance (not only the information about the farm). Firstly, the concept of acceptance and (to a smaller extent) the willingness to buy an index-based product is related to the respondent's age. It is the highest with the under 40 group and lowest with people over 61 years of age. Secondly, a higher educational background is clearly conducive to product acceptance. Unfortunately, it does not affect willingness to buy the product, which might be caused by the fact that in general very few respondents expressed the willingness to buy the product in its present form, even though it was accepted by half of them. So, it can be inferred that it is mainly financial factors that are of primary importance here.

Table 4 presents (among other data) the results of examining the correlation between the opinion about the product and the farm's experience in terms of various occurrences. Based on that, it can be said that the opinion about the product is affected by (in the order of strength of the influence): frequency of drought, winterkill, spring frosts, hail and flood. Frequent occurrences of the first four events are conducive to positive opinions, while flood is more likely to entail a negative opinion. If the product price was given, however, it was only drought and flood frequency that mattered.

Table 4. The results of tests for equality of means of different loss experience – OA and OAP case

Frequency of occurrence	Average value of the feature in the case of "I don't like it"		Average value of the feature in the case of "I like it"		t-Student empirical value		p-value		p-value for U-test (Manna-Whitney)	
	OA	OAP	OA	OAP	OA	OAP	OA	OAP	OA	OAP
N_PLANT_DIS	4.108	3.911	3.905	4.093	0.762	–0.680	0.446	0.496	0.775	0.145
N_DROUGHT	2.663	2.723	3.168	3.100	–3.160	–2.349	**0.002**	**0.019**	0.003	0.006
N_FLOOD	0.951	1.019	0.747	0.689	1.764	2.853	**0.078**	**0.004**	0.036	0.000
N_HAIL	0.733	0.806	0.931	0.859	–2.177	–0.575	**0.030**	0.566	0.193	0.988
N_SPRING_FR	3.809	3.244	3.533	3.370	–2.663	–0.741	**0.008**	0.459	0.001	0.075
N_WINTERKILL	2.563	2.720	3.061	2.902	–3.062	–1.114	**0.002**	0.265	0.001	0.042
N_STORM	0.385	0.396	0.317	0.308	0.899	1.144	0.369	0.253	0.742	0.633
N_FIRE	0.026	0.030	0.040	0.036	–0.786	–0.343	0.432	0.731	0.393	0.471

Source: the authors' own research.

Table 5, in turn, presents the results of tests aimed at evaluation of the influence of the frequency of particular occurrences on the willingness to buy the product. Both parametric and non-parametric tests corroborate the high relevance of drought occurring on a farm. ail and hurricanes were also mentioned among the events that present some importance. In all the cases, the higher the frequency of occurrence was, the greater the seeming willingness to buy the product. Interestingly, only in the case of flood was the correlation the reverse: the higher number of positive answers was connected with a lower frequency of flood occurrence and vice versa, which is in fact statistically irrelevant.

Table 5. The results of tests for equality of means of loss experience – WTB case

Frequency of occurrence	ANOVA p-value for F statistic	Kruskal-Wallis test p-value for H statistic
N_PLANT_DIS	0.161	0.137
N_DROUGHT	**0.000**	**0.000**
N_FLOOD	0.285	0.557
N_HAIL	0.044	0.109
N_SPRING_FR	0.497	0.540
N_WINTERKILL	0.487	0.237
N_STORM	**0.723**	**0.046**
N_FIRE	0.078	0.150

Source: authors' own research.

Table 6 presents the correlation of opinion about the product and the willingness to buy it and the farm's location in the drought area, as well as the insurance experience of the farm in terms of various adverse events. It can be concluded that the farm's location has a definite influence on the acceptance and willingness to buy the index-based product. The detailed data analysis (not included here) suggests that the farm's location in the drought area is definitely conducive to the acceptance and willingness to buy the product.

It was also the interdependence between owning traditional crop insurance (regardless of the coverage) and the evaluation of the new insurance concept that was of statistical importance, and even more so, with regard to the willingness to buy the index-based product. Seventeen per cent of those who had purchased some form of crop insurance were ready to buy the product, as opposed to 8 per cent of the farmers who weren't insured. xperience with traditional drought and spring frost insurance was of primary importance here, with 71 per cent of those who had been insured against drought stating that they liked the concept as opposed to 49 per cent of those who had never been insured against this peril.

Table 6. P-values for the chi-squared test for independence between product opinions, drought area and insurance experience

Research variant	DROUGHT_AREA	INSURANCE HISTORY						
		ANY_INSUR	INSUR_DROUGHT	INSUR_HAIL	INSUR_WK	INSUR_FROST	INSUR_FIRE	INSUR_FLOOD
OA	**0.003**	**0.00047**	**0.0024**	0.629	**0.065**	**0.007**	**0.032**	0.1369
OAP	0.00013	**0.0001**	**0.0149**	0.428	0.349	0.288	0.727	0.317
WTB	**0.00002**	**0.0009**	**0.129**	0.209	0.996	**0.0003**	0.972	0.708

Source: the authors' own research .

Table 7 presents p-values for the independence test between product acceptance and the willingness to buy it and the type of crop.

Table 7. P-values for the chi-squared test for independence between product acceptance and crop type

Research variant	Crop								
	RAPE	WHEAT	W_BARLEY	TRITICA	RYE	OATS	S_BARLEY	MAIZE	S_BEETS
OA	**0.273**	0.619	0.406	0.543	0.697	0.844	0.727	0.798	**0.190**
OAP	0.277	0.317	0.535	0.232	0.323	0.363	0.507	**0.088**	0.680
WTB	**0.002**	0.184	0.579	0.206	**0.035**	0.574	**0.089**	0.566	**0.099**

Source: the authors' own research.

The cultivation of rape and sugar beets evidently increases overall acceptance for the idea of index insurance. The cultivation of maize increases the acceptance of the concept when the price is given. The cultivation of rape, beets and barley clearly raises willingness to buy the index-based product, but the cultivation of rye has the opposite effect.

From the data presented in Table 8, one can infer that the acceptance level of the index-based concept, including when the price was given, was not affected by the income structure of the farm. The only result of statistical relevance regarded the willingness to buy the product (WTB). In the ANOVA analysis, the p-value for F statistics amounted to 0.026, while in the case of the Kruskal-Wallis test, the p-value for H statistics was 0.034. The lowest average amount of income from farming in the grand scheme of the farm's income was noticed in the "will not buy" group, while the highest income was found in the "I do not know" group. Thus, the direction of the influence is ambiguous.

Table 8. Collective test results for equality of means of SOURCELIV variable - OA and OAP case

Frequency of occurrence	Average feature value in the case of "I do not like it" opinion		Average feature value in the case of "I like it" opinion		t-Student empirical value		p-value		p-value for U-test (Manna-Whitney)	
	OA	OAP	OA	OAP	OA	OAP	OA	OAP	OA	OAP
SOURCE_LIV	68.663	66.584	67.219	69.185	0.615	–1.107	0.539	0.269	0.401	0.344

Source: the authors' own research .

Summing up, one can say that a number of factors with a statistically relevant influence on the acceptance level and willingness to buy the product have been identified. In the OA case, hypotheses regarding the influence and its direction of the following variables were corroborated: LOCATION, P_DOLN, P_KUJ_P, P_LUBUS, P_LODZ, P_PODLAS, P_ZACHPO, AGE, EDU_LEV, N_DROUGHT, N_FLOOD, N_HAIL, N_SPRING_FR, N_WINTERKILL, DROUGHT_AREA, ANY_INSUR, INSUR_DROUGHT, INSUR_SFROST, RAPE, S_BEETS) and NACCEPT_LOSS (lacking a single direction). Regarding OAP, the hypotheses were corroborated as for the influence and its direction of the following variables: SPECIALIZ, SPEC_PLANTS, EDU_LEV, N_DROUGHT, N_FLOOD, DROUGHT_AREA, ANY_INSUR, INSUR_DROUGHT, as well as NACCEPT_LOSS (lacking a single direction). As for WTB, the influence and its direction were corroborated regarding the following variables: SPECIALIZ, SPEC_PLANTS, AGE, N_DROUGHT, N_HAIL, N_STORM, DROUGHT_AREA, ANY_INSUR, INSUR_DROUGHT, INSUR_SFROST, RAPE, S_BEETS, and SOURCE_LIV (lacking a single direction). It has to be made clear, though, that despite its statistical relevance, Cramer's coefficients were not very high (as much as 0.2), so it makes it possible to infer that accurate predictions concerning a farmer's opinion about the product and his willingness to buy couldn't be made based on one variable alone. The information collected in particular variables in a single model would have to be aggregated, which would make it possible to forecast a qualitative variable, such as the customer's opinion.

In order to establish the character of the customer's opinion about the product, the qualitative variable should be expressed as a Bernoulli variable within a probability model: Yi=1 if the i-respondent's opinion is positive, Yi=0 if otherwise. The relevant independent variables and their parameters for the probability model regarding overall acceptance of the product are presented in Table 9.

Table 9. The estimates of Logit model parameters – OA case

LP	Variable	Coeff.	Std. Dev.	LP	Variable	Coeff.	Std. Dev.
1	Const.	−0.744	0.583	11	INSUR_HAIL	−0.637	0.305
2	DROUGHT_AREA	0.777	0.227	12	AGE	−0.149	0.084
3	ACCEPT_LOSS	0.345	0.136	13	EDU_LEV	0.349	0.112
4	NACCEPT_LOSS	−0.21	0.121	14	SOURCE_LIV	−0.006	0.003
5	N_PLANT_DIS	−0.057	0.023	15	P_LUBEL	0.652	0.361
6	N_DROUGHT	0.123	0.048	16	P_LODZ	−0.968	0.242
7	N_WINTERKILL	0.090	0.038	17	P_PODLAS	0.864	0.422
8	N_STORM	−0.155	0.079	18	P_WAR_MAZ	1.308	0.697
9	ANY_INSUR	0.542	0.279	19	P_WLKP	−0.526	0.250
10	INSUR_DROUGHT	0.782	0.329				
Chi-square(18) = 95,2046 [0,0000]							

Source: the authors' own research.

If the acceptance probability was above 0.5 the farmer was assigned to the accepting group, the hit rate was assumed to be about 65 per cent. However, from a practical point of view, the cost of misclassification could be rather high. Therefore, it was decided to set the level of acceptance probability as a minimum of 0.75, and if the probability was 0.25 or below, the farmer was classified as "not accepting" the product. Hence, assuming the range between 0.25 and 0.75 as uncertain, the following classification matrix was obtained: (Table 10)

Table 10. OA classification table

Actual affiliation	Classification		WT (%)
	Like it	Don't like it	
Like it	56	8	88%
Don't like it	14	40	74%
t-$Stud_{WT}$	6.98 (0,000)	WT>>50%	**81%**

Source: authors' own research.

In the logit model, the relevant descriptive variables regarding the probability of acceptance of a product if the price is given (OAP) are presented in table 11 along with the evaluation of these parameters.

Table 11. The estimates of Logit model parameters – OAP case

LP	Variable	Coeff.	Std. Dev.	LP	Variable	Coeff.	Std. Dev.
1	Const.	−1.1636	0.3140	7	INSUR_SFROST	0.4580	0.2597
2	DROUGHT_AREA	0.9801	0.1958	8	EDU_LEV	0.3758	0.1061
3	OATS	0.3577	0.1596	9	P_LODZ	−0.6546	0.2282
4	N_FLOOD	−0.1221	0.0495	10	P_WLKP	−0.7622	0.2389
5	INSUR_DROUGHT	0.6152	0.2951	11	SPECIALIZ	−0.3723	0.1805
6	INSUR_HAIL	−0.7154	0.2565				
Chi-square(10) = 66,9775 [0,0000]							

Source: authors' own research.

Assuming the uncertainty range as 0.3–0.7, the following matrix was built:

Table 12. OAP classification table

Actual affiliation	Classification		WT (%)
	Like it	Don't like it	
Like it	73	3	96%
Don't like it	22	44	67%
t-Stud$_{WT}$	7,72 (p = 0,000)	WT>>50%	**82%**

Source: the authors' own research.

After the estimation of the polynomial logit model along with ordinal categories, it turned out that one of the cut points was irrelevant. Therefore, the number of classes was reduced. Two classes remained: "will not buy" (1) and "I'm not sure / I'll buy"(2). The relevant descriptive variables and their parameters can be seen in Table 13.

Table 13. The estimates of Logit model parameters - WTB case

LP	Variable	Coeff.	Std. Dev.	LP	Variable	Coeff.	Std. Dev.
1	Const.	−0.0955	0.3781	5	N_DROUGHT	0.1923	0.0368
2	SPECIALIZ	−0.3126	0.1778	6	N_FIRE	1.0601	0.4679
3	ACCEPT_LOSS	0.3060	0.1304	7	S_BEETS	0.7243	0.3392
4	NACCEPT_LOSS	−0.2541	0.1169				
Chi-square(6) = 48.4784 [0.0000]							

Source: authors' own research.

Assuming the uncertainty range as 0.3–0.7, the following matrix was built:

Table 14. WTB classification table

Actual affiliation	Classification		WT (%)
	Like it	Don't like it	
Like it	37	3	93%
Don't like it	14	7	33%
t-Stud$_{WT}$	5,27 (p = 0,000)	WT>>50%	**72%**

Source: authors' own research.

The verification of the hypothesis that the resulting hit ratio is equal to the random classification ratio (against the alternative hypothesis that it is much higher) was carried out by means of t- Student statistics[18].

Conclusions

Solving the drought problem in Poland is a crucial issue for three groups of entities: the government, insurance companies and farmers. This article focuses on the results of research looking into factors affecting the levels of new product acceptance – index-based drought insurance.

According to the research findings, rather high interest in the new product was noticed (OA, OAP) as well as the willingness to buy the product (WTB) in particular areas – either those having suffered from drought in the past years or particular districts (overlapping the drought areas or neighbouring them). What might be surprising is the lack of correlation between the type of crop and the willingness to buy the product (WTB), despite the fact that some types of plants are particularly susceptible to drought in Poland (wheat, beets).

It would make sense to explain why farmers differentiate between the overall acceptance for the product and the acceptance when the price has been given. This might mean that the way in which they perceive the peril of drought is very individualistic[19] (Arnoldi 2009). Other reasons may be the lack of acceptance for the offered price or possibly a varied approach to the problem of financing the consequences (it is unnecessary to purchase the index-based product because the farmer expects a different form of assistance – e.g., a compensation from the state budget).

The fact that more than half of the respondents rejected the concept of index-based insurance means that the "principle of completeness" still plays a key role. In the former socialist countries, expectations for agricultural insurance are historically established. Since full compensation in the area of agriculture was, in fact, a common practice, farmers are still used to being fully compensated for any incurred loss (e.g. expecting that compensation for hail damaged corn should correspond to the values for which the seed could be sold by the farmer).

However, one can say that a prevailing acceptance of the concept has been seen, which might open the door to its possible implementation within a government-based catastrophe-assistance programme. This research also enables us to mark any farmer as possibly or certainly interested in the index concept with 80 per cent accuracy. The main task for insurance companies would be to arrive at the final product shape depending on various factors (price, level of compensation, CWB level activating the payment). To do this, another conjoint method research[20] will have to be conducted, and indeed this is what the authors intend to do in the weeks to come.

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Czynniki wpływające na popyt na indeksowe ubezpieczenia rolne w Polsce

Rosnąca liczba zdarzeń katastroficznych sprawia, że coraz więcej zakładów ubezpieczeń powstrzymuje się od oferowania tradycyjnych produktów ubezpieczeniowych. Celem niniejszej pracy jest analiza czynników wpływających na akceptację przez polskich rolników zupełnie nowej propozycji na polskim rynku – indeksowych ubezpieczeń suszy. Dokonano jej na podstawie dwuetapowego bezpośredniego badania: pierwszy etap obejmował opinie na temat nowej struktury produktu ubezpieczeniowego, natomiast drugi decyzję dotyczącą zakupu. Dzięki zastosowaniu logitowego modelu regresji wielorakiej zidentyfikowano korelację między obszarem zamieszkania a zainteresowaniem nowym produktem. Z drugiej strony, badanie nie wykazało prawie żadnej korelacji między decyzją rolników i licznymi zmiennymi szczegółowymi, co sugeruje, że ich podejście do suszy jest bardzo indywidualne. Akceptacja struktury indeksowej była dużo wyższa od chęci zakupu ubezpieczenia. W związku z tym zaangażowanie rządu w ubezpieczenie indeksowe w formie dopłaty do składki wydaje się niezbędne.

Słowa kluczowe: susza, ubezpieczenia w Polsce, ubezpieczenia indeksowe, wycena warunkowa, chęć zakupu.

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