IMPACT OF DIFFERENT FACTORS ON THE FARMERS' DECISION TO INSURE CROP PRODUCTION

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A B S T R A C T

The aim of the paper is to consider and analyze the impact of subsidies levels and other economic and general factors on the farmers' decision to insure their crops. The paper applies the model of logistic regression in order to determine the statistically significant influence of certain factors on the decision of farms. The subject of the research is general and economic data from agricultural holdings in the FADN sample in Serbia for 2018. The sample includes farms that deal with specialist field crops, specialist grazing livestock and mixed crops-livestock production. The survey was conducted on a sample of 819 households, of which 99 households reported insurance costs (12.1%). The results of the research show that with higher subsidy level the probability that farms will insure their production reduces. On the other hand, with an increase of economic size and farm net value added per annual working unit the probability that farms will be insured also increases.

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Introduction

Land performs many key functions that are vital for life (environmental, economic, social and cultural) (Popović et al, 2015). Changing weather conditions, as a consequence of global environmental problems, greatly affect the life of an ordinary person, as well as his work activities. According to research, as much as 80% of the world economy is subject to the influences of the weather factor (Auer, 2003).

Agriculture (especially plant production) is an extremely important branch of the economy that is largely dependent on weather conditions. Considering that it is performed outdoors, ie it has a biological character, the influence of weather on the achieved results in plant production is much more pronounced in relation to other economic branches. It is certain that in the future there will be increasing temperature fluctuations, as well as pronounced oscillations in the amount of precipitation, which will increase production risks in agriculture. In recent years, due to globalization and market liberalization, there has inevitably been an increase in price risks borne by farmers. At the same time, there is an increase in financial risks due to the increase in their indebtedness (Ivanović, Marković, 2018). In this regard, it is necessary to properly manage the risks in agriculture in order to mitigate or completely eliminate their negative effects.

Crops production represents an important activity for land exploitation (Vasilescu et al., 2010). Risks in crop production can be internal and external. Within internal risks, production, financial and personal are dominant. External risks are conditioned by the influence of external factors: market and political conditions. In the case of risk management instruments on the agricultural holding (internal), we distinguish between: risk avoidance, risk diversification and creation of reserves. External instruments include risk transfer and crop and fruit insurance. The most commonly used risk management instruments in agriculture are: insurance, funds for compensation of damages from various weather disasters and joint insurance funds (Marković, 2013).

Insurance, according to the number of risks, can be divided into: insurance against one, several or all types of risks. Crop and fruit insurance systems can also be divided into: insurance related to results on agricultural holdings and insurance based on data related to a specific region or administrative unit. Based on the method of risk compensation, insurance differs from crops and fruits damage to insurance based on time indices (Herbold 2007).

Crop insurance is a very important measure for managing risks in crop production, as it can avoid the possibility of losses due to adverse factors (natural disasters - drought and floods; non-catastrophic weather risks - hail, lightning, storms, frost; then diseases and pests, fire, theft, price variability and quality factors of production, product price volatility, rising interest rates, etc.). In this way, agricultural holdings (AH) that have secured their production have the possibility of compensating for possible losses and enabling the continuation of the production process.

Insurance in agriculture significantly reduces the risk in production and farmers have a greater opportunity to achieve a positive financial result. However, insurance, as a model of risk management, has not largely taken root in domestic farms, since in Serbia only about 12% of the total area under agricultural crops is insured (Poljoprivrednik, 2019; Jokić, 2020). It is certain that the Republic of Serbia (RS) does not have a developed insurance system in agriculture, and the main reasons are: insufficient information of farmers, uncertainty regarding compensation in case of insured event, questionable assessment of damage, relatively long period of time from insured event until the appraiser goes to the field, the attitude of the farmers „it will not happen to me", etc.

Serbian agricultural insurance coverage is more prevalent among legal entities, which annually insure about 50% of cultivated areas. However, for individuals, ie agricultural household, which are dominant in domestic conditions, the level of crop insurance is at a much lower level - only about 3% (Poljoprivrednik, 2019).

The state is trying to increase the representation of insurance in agriculture with incentives for legal entities and individuals. Namely, 40-45% of the paid insurance premium reduced by the amount of tax is subsidized. In the area of Moravica, Zlatibor, Kolubara, Podunavlje and Šumadija administrative districts, the recourse can be a maximum of 70% of the paid insurance premium reduced by the amount of tax (Subsidies in agriculture, 2017) However, despite this, many farmers are reluctant to insure their crops, considering it an unnecessary expense.

Taking into account the results of previous research, the aim of the research in this paper is to consider and analyze the impact of subsidy levels and other relevant factors on the decision of farms to insure their crops. The subject of the research is general and economic data from farms in the FADN sample in RS in 2018. These are farms that are primarily engaged in specialist field crops, specialist grazing livestock and mixed crops-livestock production.

The paper is conceived in such a way that it first gives an overview of the research done in the previous period in order to indicate the importance of the topic. The following section describes the procedure for defining the representative sample and model used in the paper. Then the obtained research results are presented, and at the end conclusions and recommendations are given.

Literature review

Coble, Barnett (2013) point out that the level of subsidies is one of the most important factors influencing the decision of farms to insure their crops. However, there are different attitudes in the literature, ie many other factors that influence the decision of agricultural producers. According to available research (Afroz et al., 2017; Ghazanfar et al., 2015; Wang et al., 2015; Falola et al., 2013) the most frequently mentioned are: farm owner experience, farmer training, yield variability, total income, farm size, etc.

Velandia et al. (2009) in their research show that farms that have more of their own utilised agricultural area (UAA) do not often decide to insure their crops. Also, farms that generate significant income from other activities (greater than $ 50,000), or for which agricultural activity is not the primary source of income, generally do not insure their crops.

Enjolras et al. (2012) performed a comparative analysis of two similar insurance systems in France and Italy based on FADN data. The authors point out the size of the farm (expressed as used agricultural land) and the diversification of production (expressed by the number of crops cultivated), as factors that decisively influence the insurance of production. Financial variables, leverage and rates of return on capital, have no statistically significant impact.

Tarasov (2013) observes the influence of the interest rate on the decision to insure agricultural production on the example of Ukraine, as a developing country, and the United States as a developed country. The results of the research showed that in developing countries (Ukraine) there is a need for significant subsidies for the cost of insurance premiums in order to enable the development of the agricultural insurance market due to high interest rates. In the United States, where the agricultural insurance market is at a much higher level, the government allocates significant funds to reimburse insurance premium costs, while interest rates are at a relatively low level.

Di Falco et al. (2014) believe that diversification of plant production can be an adequate substitute for insurance, which is an economic way of protection. This claim stems from research conducted on the basis of FADN data from farms in Italy, where the authors found that diversification of production and insurance can be equally important instruments for managing risk at the farm level. Also, the authors point out that in areas that are more exposed to weather risks, there is an increase in the demand of farmers for crop insurance.

Was, Kobus (2018) found that the decision of farms to insure their crops is largely conditioned by the compensation received in the previous period and significant reductions in the realized yield in previous years. In addition to these factors, the mentioned authors emphasize the significant influence of the value of agricultural production, production intensity and land quality. On the other hand, they found that the impact of subsidy levels was not statistically significant.

Materials and methods

The research in this paper is based primarily on FADN[6] data for RS for the last year for which data exist (2018), as well as for the previous (2017) year, where necessary (financial result of the previous year). The FADN questionnaire, which is used to collect data from agricultural holdings, contains, among other things, data on agricultural insurance on farms that entered the FADN sample.

6 FADN (Farm Accountancy Data Network) is a network for collecting production, economic and financial data from agricultural holdings. In the Republic of Serbia, the establishment of the FADN system began in 2011 and since 2015 the system has become operational and data are relatively reliable. (*www.fadn.rs*).

In 2018, there were a total of 1,647 commercial agricultural holdings in the FADN sample in the Republic of Serbia. Since the aim of the analysis is to determine the influence of various factors on the decision of farms to insure their crops, only those types of farms that have arable production as dominant (external realization) or as a raw material for further production on the farm (internal realization) were considered. In our case, these are farms: specialist field crops (TF 15-16), specialist grazing livestock (TF 45-48), mixed crops-livestock production (TF 83-84).

For the purposes of this research, all farms of economic size over 250,000 euros SO[7] were classified into one group, due to the relatively small number of such AH in the sample and due to the clarity of the data. Also excluded from the sample are farms of economic size less than 4,000 euros SO, given that this is the lower limit of economic size in RS. After that, seven classes of economic size remained in the sample (tab. 1). 1% of farms were also excluded from the sample due to extreme value indicators, after which a total of 819 farms remained in the sample.

The influence of various factors on the decision of farms to insure their crops was analyzed by applying the binary logistic regression model. Binary logistic regression is a special type of regression model that is applied when the dependent variable (Y) is dichotomous, while the independent variables (X) can be numerical or categorical (Trushaj, Kushta, 2020).

The binary logistic regression model has the following form:

$$\pi(x) = \frac{e^{\alpha+\beta_1 X_1+\beta_2 X_2+...+\beta_k X_k}}{1+e^{\alpha+\beta_1 X_1+\beta_2 X_2+...+\beta_k X_k}} \text{ [1]}$$

Where π(x) represents the expected value of Y for a given value of X, while the parameters α and $ß_{1,2,..k}$ correspond to the parameters α and ß1,2, ... k from the linear regression model, ie α represents the average initial level of the dependent variable, and ß regression direction coefficients that show the average change in logit per unit of change of the independent variable (Kvesić, 2012).

After calculating this expression, a transformation is applied, in order to linearize the given function, after which the function has the following form:

$$\ln\left(\frac{\pi}{1-\pi}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k \text{ [2]}$$

The function is called logit and is linear by the parameters ßi, i = 1 ... k. The π value ranges from 0 to 1, while the logit value ranges from (-∞, + ∞), depending on the value of x (Hosmer et al., 2013).

The maximum reliability method is used to estimate the parameters in the logistic regression model (Tekić et al., 2020). Testing the significance of regression coefficients in the model is performed using the Wald test (Kleinbaum et al., 1998).

7 Standard Output (SO) – the economic size of the farm is expressed by the standard value of production during the accounting year (*www.fadn.rs*).

To assess the agreement of the model with the data, the following were applied: Omnibus test, Hosmer-Lemeshow test and classification matrix. In order to check the quality of the model, Cox and Snell and Nagelkerke pseudo R^2 were also calculated (Walker, Smith, 2016).

The dependent variable in the model is defined as the use of a particular type of crop insurance. The observed dependent variable is categorical, ie it is coded with: NO = 0 or YES = 1, which is the answer to the question: “Does the farm insure its crops?“ The answer to this question was obtained based on whether the farm showed insurance costs or not. Out of the total number of households (819), 99 of them reported insurance costs, which represents a relative share of 12.1%.

Based on the available literature and previous research on this topic, taking into account, of course, the limitations of the database in this particular case, independent variables, ie factors whose influence is observed were defined (tab. 1).

Table 1. Independent variables in the model

No.	Independent variables	Label
1	Region	*(1)* Belgrade region
		(2) Vojvodina region
		(3) Region of Šumadija and Western Serbia
		(4) Region of Southern and Eastern Serbia
2	Economic size (SO)	*(1)* 4,000 – 8,000 €
		(2) 8,000 – 15,000 €
		(3) 15,000 – 25,000 €
		(4) 25,000 – 50,000 €
		(5) 50,000 – 100,000 €
		(6) 100,000 – 250,000 €
		(7) > 250,000 €
3	Subsidy level (%)	Total subsidies - excluding on investments (SE 605)
		Total revenue (SE 131 + SE 605)
4	Farm Net Value Added per annual working unit (SE 425)	Farm Net Value Added (SE 415)
		Total labour input (SE 010)
5	Production intensity	Total inputs (SE 270)
		Total Utilised Agricultural Area (SE 025)
6	Financial result of previous year (2017)	*(1)* Net profit (SE 420)
		(2) Net loss (SE 420)

No.	Independent variables	Label
7	Farmers' experience	*(1)* Not shown
		(2) < 1940
		(3) 1940 - 1949
		(4) 1950 - 1959
		(5) 1960 - 1969
		(6) 1970 - 1979
		(7) > 1979
8	Farmers' education	*(1)* Practical experience
		(2) Basic education
		(3) Full education

Source: Authors'

The paper also uses standard tools of descriptive statistics: arithmetic mean, extreme values (min. and max.), coefficient of variation. Statistical data processing was performed using the SPSS 20 program. Of course, standard methods of business analysis (analysis and comparison) are applied, as well as descriptive, ie the method of logical reasoning.

Results

Out of a total of 819 farms in the sample, 99 farms reported insurance costs, which means that 12.1% of farms insure their crops. The average value of insurance costs on farms in the RS is RSD 137,514 (*tab. 2*). There is a large range between the minimum and maximum value, as well as high variability of data, which is explained by the fact that in the sample there are farms of different economic sizes that certainly have significantly different expenses for insurance costs. This is justified having in mind that the economic size of the farm was taken as a criterion when assessing the impact of various factors on the decision of farms to insure their crops.

Table 2. Descriptive statistics

Descriptive statistics	Number of holdings	Mean	Interval of variation		Coefficient of variation (%)
			Minimum	Maximum	
Cost of insurance	99	137,514	10,000	2,909,578	232.3
Subsidy level (%)	819	6.7	0.0	38.7	95.3
FNVA per AWU	819	2,279,970	-564,172	23,819,360	127.9
Production intensity	819	162,024	12,750	3,151,111	114.2

Source: Authors' calculations

The share of subsidies in the total income of households is on average 6.7% on farms in Serbia. The highest level of subsidies is 38.7%, which means that a good part of the total income on the respective farm comes from state taxes. This is not the only case, and it is usually noticeable in farms that deal with milk production and mixed plant and livestock production. The reason is the significant subsidies per head of livestock realized by the mentioned farms.

Farm net value added (FNVA) is an indicator of the economic performance of a farm that is very important when assessing business performance. It is expressed per annual working unit (AWU) in order to take into account the differences in compensation for labor on the farm (*Miljatović et al., 2020*). This indicator can also be negative, which is the case with farms that have made a gross loss (*tab. 2*).

Production intensity, expressed by input costs per UAA, averaged RSD 162,024 per ha of UAA. This intensity is significantly lower in farms engaged in farming compared to farms of predominantly livestock production type.

The logistic regression model was applied to assess the impact of certain factors on the decision of farms to insure their crops. The selection of predictor variables, ie independently variables in the model, was performed using the „stepwise“ method, in order to determine their contribution in each step of the procedure. The selection of variables was performed in six steps, while only the results of the sixth step will be presented in the paper. The omnibus test was applied to test the performance of the model, ie „goodness of fit.“ The Hosmer and Lemeshow test was used to determine the quality of the model prediction (*tab. 3*).

Table 3. Omnibus tests of model coefficients and Hosmer and Lemeshow test results

Test	Step	Chi-square	df	Sig.
Omnibus test	Step 6	37.438	3	0.001
Hosmer and Lemeshow test	Step 6	11.163	8	0.193

Source: SPSS output

The results of the Omnibus test (*tab. 3*) show that there is a statistically significant difference between the model containing the selected variables and the model containing only the constant, ie the model is adequate for predicting the results ($p < 0.05$). The results of the Hosmer and Lemeshow test confirm the results of the Omnibus test (the indicator of good prediction in this test is $p > 0.05$).

By calculating the Cox and Snell's and Nagelkerke Pseudo R^2 coefficient, the fitting of the model was evaluated, i.e. it was assessed how well the model explains the data (*tab. 4*). Based on the value of the Pseudo R^2 coefficient, it can be concluded that the obtained model explains between 17.1% and 31.1% of the variance. Such a low level of explanation of variance shows that there are still many internal and external factors influencing the decision of farms to insure, which could not be included in the model. This is due to the fact that certain influencing factors, such as: distrust of farmers, fear of non-payment of the insured event, attitude „not me“, regression of insurance costs, etc., do not exist in the FADN database or cannot be quantified. However, based on the review of research from the previous period and the considered specifics of the observed area, the paper defines variables that have a significant impact on the decision of farms to insure.

Table 4. Model summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
6	621,375	0.171	0.311

Source: SPSS output

The classification determines the accuracy indicators of the model, ie it evaluates how well the model predicts the categories of dependent variables (*tab. 5*). Based on the obtained results, it can be noticed that the model successfully classified 87.9% of all cases.

Table 5. Classification table

Insurance	Logistic regression	
	Not insured	Insured
Not insured	720	0
Insured	99	0
Total (%)		87.9

Source: SPSS output

The contribution of each predictor variable was tested by the Wald test. It is considered that the variable significantly contributes to the predictive capabilities of the model if $p < 0.05$. Based on the presented results (*tab. 6*), it can be concluded that of all the observed predictor variables, three variables can be distinguished as significant predictors.

Table 6. Variables in the equation

Step	Variables	B	S.E.	Wald	df	Sig.	Exp(B)
Step 6	Economic size	0.511	0.100	26.227	1	0.001	1.668
	Subsidy level	-0.045	0.021	4.678	1	0.031	0.956
	FNVA per AWU	0.001	0.001	4.621		0.032	1.001
	Constant	-3.384	0.404	70.235	1	0.001	0.034

Source: SPSS output

Based on the results of the Wald test, it can be concluded that significant predictor variables are economic size, subsidy level and FNVA per AWU ($p < 0.05$), ie these three variables have the greatest influence on the decision of farms whether to insure or not, while for other variables it can be concluded that they are not significant predictors. Based on the calculated regression coefficients, the equation of the estimated logistic regression model has the following form:

$$\hat{Y} = -3.384 + 0.511\ \textit{Economic size} - 0.045\ \textit{Subsidy level} + 0.001\ \textit{FNVA per AWU}$$

Based on the obtained results, it can be concluded that with the increase of the share of subsidies in the total income, the probability that crops will be insured decreases (Exp (B) <1). This claim can be explained by the fact that subsidies have a high share in the total income of farms that are less profitable, since the structure of income of successful farms is dominated by sales revenues. Therefore, these farms are not willing to use the additional income generated from subsidies to pay the costs of insurance premiums.

The class of economic size and net value added per annual working unit directly influence the decision of farms to insure (Exp (B)> 1). This practically means that as the economic size of the farm increases and the economic performance (FNVA per AWU) increases, the probability that the farms will insure their crops increases.

Conclusion

Given the extremely low percentage of farms that insure their crops (12%) and the need to increase the share of insured farms, the survey identified factors influencing the decision of farms in RS to insure their crops. This is primarily to exclude the possibility of large losses due to weather conditions (production risks), but also personal, market, political and other risks that greatly affect agricultural production.

The biggest problem in the development of the insurance system in domestic conditions is the distrust of farmers, which in many cases is justified. This primarily refers to the too long wait of the appraiser to go out on the field after the insured event occurs, as well as to the questionable assessment of the damage given that the appraisers are not independent of the insurance companies. For these reasons, farmers often consider the cost of insurance premiums an undesirable and unnecessary expense.

Subsidizing insurance costs is also a topic that is given special attention when it comes to crop insurance. The state regresses up to 40% (in extreme cases even up to 70%) of insurance premium costs to farmers who choose to insure their crops. This is certainly a very important factor, which has an impact on the decision of farms to insure their crops. However, the authors believe that there is no significant room for improvement of this measure by the state and that the problem of low rates of agricultural insurance in our country primarily stems from other factors.

The paper shows that subsidy level, economic size and farm net value added per AWU are factors that influence the decision of farms whether to insure their crops or not. Economic size and FNVA per AWU affect directly proportionally, ie with the increase of these indicators, the probability that farms will be insured also increases. On the other hand, the impact of the subsidy level is inversely proportional, which means that with a larger share of subsidies in total income, the probability that farms will decide to insure their production decreases.

In domestic conditions, crop insurance becomes relevant only after the catastrophic damage that plant production suffers, and is a consequence of weather conditions (floods, hail, drought, etc.). The essence is to prevent potential losses that can be realized by farmers, and they are caused primarily by unstable weather conditions, but also by other risks in agriculture. This can be achieved only by increasing the share of insured farms and by emphasizing the importance of risk management in agriculture (primarily crop production) through various seminars, trainings, conferences, etc.

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Conflict of interests

The authors declare no conflict of interest.

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