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AGRICULTURAL INNOVATIONS, EXTENSION, FINANCE AND RURAL LOANS IN THE REPUBLIC OF SERBIA: THE CASE OF LOGISTIC REGRESSION

Key words: agricultural innovations, rural financial instruments, agricultural extension, rural loans, credit support, rural development

ABSTRACT. The aim of this article is to examine the impact of the use of agricultural extension, advisory services and agricultural loans on the introduction of agricultural innovations in the Republic of Serbia. Agricultural innovations are incremental changes through which individuals and organizations introduce new or use significantly improved products, services or ways of organizing in order to increase the performance of agriculture. While agricultural extension involves agricultural knowledge, information and skills that are passed on to farmers, their associations and other value chains market actors, agricultural loans are one of the most important financial instruments available to them. In order to investigate the predictive power and influence of these variables, the paper applied the method of binary logistic regression due to the categorical nature of predictors and the dependent variable. Based on the conducted research, the article found that the use of agricultural loans does not have a statistically significant impact on the introduction of agricultural innovations in Serbia, while agricultural extension has. The article concludes that for the further flourishing of agricultural innovations, the development of advisory services, as well as for the development of various fiscal incentives and rural financial instruments, it is necessary to continuously develop the devastated Serbian village and invest more intensively in rural development. This is the only possible way to prevent further waves of rural population emigration to cities, as well as to improve their knowledge, propensity for innovations and livelihoods.

INTRODUCTION

Farmers around the world appear in the role of entrepreneurs, producers, traders, investors and consumers in their effort to use available financial resources with the aim to improve their productivity, business, livelihoods, and consequently their standard of living. Unlike developed countries, where there is an abundance of well-developed, available

and functional rural financial instruments, small farmers from developing countries, especially those from remote rural areas, usually face a lack of advanced rural and market infrastructure, adequate rural financial instruments, the necessary advisory services and, thus, a lack of opportunities for growth and income generation. The 80s and 90s of the last century will remain remembered by attempts to introduce some innovative financial concepts, such as rural banking, group responsibility, micro-insurance, risk management mechanisms, etc. in agricultural finance. However, over time, these initiatives have not yielded the expected results in terms of financing the activities of agricultural micro, small and medium enterprises (MSMEs), primarily due to large business risks to which commercial banks were exposed, as well as a lack of their relevant agricultural knowledge and experience. Namely, along with the prevailing trend of the liberalization, privatization and decentralization of agricultural activities with the aim of solving economic and developmental problems, it was expected that commercial banks would begin to loan funds for agribusiness, as well as provide greater support for further agricultural development. Nevertheless, this did not happen in the expected way, mainly due to the large spatial distance of many agricultural households, exposure of large segments of the agricultural population to identical weather and climate risks, and a lack of relevant knowledge in microfinance institutions (MFIs) about the nature of the agricultural business.

Other reasons of this phenomenon included limited financial knowledge, experience and education of small farmers themselves [Kloeppinger-Todd, Sharma 2010, p. 4]. In addition, in many countries, agricultural decentralization trends have resulted in weakening financial and technical support from central governments, as well as a lack of necessary local government capacity [Davis, Sulaiman 2018, p. 5]. Finally, empirical evidence suggests that the transition to private, market-based systems has been accompanied by difficult, time-consuming and sometimes disruptive market privatization and liberalization processes, leading to the conclusion that some form of state aid and presence in agriculture is still needed [Roseboom 2012, p. 455]. Despite this, the old paragon of agricultural lending, based on centralized and earmarked, i.e. targeted loans, has completely changed and today it supports decentralized access to rural financial markets and services. The new philosophy advocates the decentralization of lending to farmers, encouraging savings by offering more favourable interest rates and flexible savings products, as well as enhancing competition among credit service providers in order to reduce transaction costs and credit risks. The new paradigm also insists on reforming public development banks, privatizing public institutions, encouraging the development of financial markets, flourishing sustainable rural financial institutions and mobilizing the potential of informal financial markets. It also calls for an active role of the government in the promotion of institutional development rather than fostering governmental direct financial intermediation, management and targeted development goals [Smith 2001].

The Food and Agriculture Organization (FAO) of the United Nations defines agricultural innovations as a process in which individuals and organizations introduce new or use improved products, services, processes or ways of organizing, for the first time and in a particular context, in order to increase agricultural performance [FAO 2018]. Agricultural innovations usually occur because of the need to increase the production of food, crops, fodder and agricultural by-products, but also to increase product quality, the quality of production processes, growing conditions and contemporary management practices. Unlike radically new ideas and business practices, agricultural innovations rather have the character of incremental, i.e., small and gradual improvements that involve changing or modifying tools, practices and existing technologies. Qualified farmers, cattle breeders and artisans, rather than inventors, entrepreneurs or scientists themselves, usually carry these gradual improvements out in practice [Van der Veen 2010, p. 1]. Agricultural innovations contribute to agricultural development, the growth of agricultural productivity and efficiency, poverty reduction, coping with environmental and climate challenges, environmental sustainability, increasing the resilience of the agro-food sector, the better management of natural resources and promoting rural equity and, thus, to economic growth and the development of every society. There are numerous classifications of agricultural innovations in contemporary literature. One of them, which is also the most general one, groups agricultural innovations into [OECD 2021]:

– process innovations that improve production techniques (such as more efficient irrigation systems and seeds with higher yields);
– product innovations in the form of new or significantly improved products (such as organic food or new pharmaceutical products);
– marketing and organizational innovations in the form of new or improved ways of organizing and managing agricultural activities.

According to another author, agricultural innovations usually cover one or more of the following areas [Evenson 1974]:

– crop quality;
– the quality of livestock;
– growing conditions;
– the quality and composition of equipment;
– management practices.

Finally, innovations in agriculture can also be seen as [IICA 2014, p. 4]:

– organizational or institutional innovations;
– marketing innovations;
– social innovations relating to the development or substantial improvement of strategies, concepts, ideas, organizational practices, goods or services.

Social agricultural innovations usually have the aim to create positive social changes, meet broader social needs or serve a social purpose and goals. In light of growing demand for

agricultural products, fibre, biofuels, environmental sustainability and greenhouse gas (GHG) emission reduction, as well as biophysical and environmental factors limiting agricultural yields and existing institutional barriers [Sayer, Cassman 2013], the importance of agricultural innovations, regardless of their types and classification criteria, comes to the fore.

The Republic of Serbia (RS) is a country in Southeast Europe, with a population of about 6.9 million, a gross domestic product (GDP) of USD 130.2 billion [HF 2021] and an official unemployment rate of 11.1% [RZS 2021]. According to the Index of Economic Freedom, Serbia belongs to the group of moderately free countries, while its economy largely bases on manufacturing, agriculture, services, foreign direct investments (FDI) and public companies that have retained their significant presence in some sectors. On March 1, 2012, the country officially became a candidate for membership in the European Union (EU). Since then, Serbia has only opened Negotiating cluster 1 and this only happened because this cluster contains negotiating chapters that had already been opened in the previous accession phase (Financial control; Judiciary and fundamental rights; Justice, freedom and security; Public procurement; and Statistics) [EWB 2021]. The country is burdened by numerous political, social and economic problems, such as an insufficiently functioning market economy, necessary public administration reforms, modest reform steps in the rule of law, the legal system and democratic institutions, etc. Serbia has 5.06 million hectares of agricultural land, of which 71% is intensively used in the form of arable land, orchards and vineyards, while 29% of agricultural land consists of meadows and pastures. During the period of its transition, there was no significant change in its economic structure. Since the early 2000s, the share of agriculture in Serbia`s GDP has declined, primarily due to the faster growth of activities in non-productive sectors, such as trade and services. However, due to the Covid-19 coronavirus pandemic, the country still has a relatively smaller decline in GDP than other countries in the region, primarily due to the structure of its economy, a greater share of agriculture and food industry in its GDP and a smaller share of highly sophisticated industries. According to some estimates, the current share of agriculture in the country`s GDP is about 7.5% [Beta 2020]. In addition, compared to the EU-27 average, the share of agriculture in Serbia`s GDP remains high, while the share of services is significantly lower [SGRS 2014]. Today, numerous problems hinder the development of its agriculture, such as low purchase prices, excessive imports of agricultural products, the fragmentation of agricultural farms and their low standard of living, outdated mechanization, underdeveloped cooperatives, low agricultural subsidies and other incentives, declining livestock, and others. The purpose of this article is to investigate the impact of agricultural extension, agricultural loans and credit support on the introduction of agricultural innovations in Serbia. The next section provides a literature overview of these areas, while the third section of the paper provides a detailed overview of the research conducted and the methodology used. The fourth section describes the results of the conducted research, while the last section concludes and gives some specific recommendations to policy makers in Serbia.

A LITERATURE REVIEW

Within the new approach of decentralization of rural financial services, the role of the government is to focus on developing an environment that is conductive to the blossoming of these financial institutions, for example by providing them a credit guarantee scheme. Today, loans are of key importance for financing agriculture, regardless of whether they are used for purchasing inputs (seeds, fertilizers, pesticides, etc.), tools, equipment, or for covering the current operating costs of agricultural households [GPFI 2015, p. 11]. However, small farmers, today, relatively rarely take them because of their economic weakness, their reliance on government subsidies and other incentives, but also due to the high cost of risk assessment and transaction costs of processing and approving loan applications. From the government`s point of view, the use of agricultural loans and the mobilization of savings are far more preferred in relation to state grants and subsidies because they represent a part of the market-based approach to financing agriculture. Today, there are a large number of rural loan types, depending on the government`s agricultural and financial policy, the operating conditions of commercial banks, but also the needs of farmers themselves. Thus, according to their maturity, agricultural loans are divided into [VLLO 2021]:

– short-term (with a repayment period of up to one year);
– medium-term (usually with a repayment period of 2 to 10 years);
– long-term (with a repayment period of up to 20 years).

Rural credits can also be further classified as [GPFIIFC 2012, pp. 27-28]: a) direct agricultural loans; and b) indirect agricultural loans depending on the manner of their approval. Direct loans that are models of retail lending by commercial banks are more efficient than indirect models because they enable the provision of a whole range of financial services and encompass less risks and lending costs. In contrast, indirect loans, i.e., wholesale lending models, are based on the indirect financing of small farmers by commercial banks, usually through farmer-based organizations or agricultural cooperatives. In this model, organizational members appear in the form of collective borrowers, while they guarantee each other when granting loans to some of them. Finally, a special type of rural loans, which is mainly present in the more developed part of the world, is warehouse receipt financing. These credits present a form of financing the owners of non-perishable agricultural goods stored in licenced warehouses, where these goods represent a form of collateral for further short-term lending to their owners [GPFIIFC 2012, p. 30]. In principle, small farmers can use many of these rural loans to finance their innovative agricultural ventures.

A special form of incentives for agricultural development is the government`s credit support, which arose as a consequence of inconsistency in the rural financial sector reform and the needs of small farmers as well as their consequent insufficient access to

financial resources. Credit support usually occurs in the form of loans with below-market interest rates, provided by the government in its arrangements with commercial banks. In rare cases, credit support can also appear as a segment of government partner institution donor programmes. The use of subsidies is often justified as a temporary measure for infrastructural investments and agricultural capacity building and, thus, for improving economic efficiency and achieving long-term redistribution goals. Today, there are also several types of subsidies used to encourage the development of agricultural markets [Meyer 2011, p. 24]:

– direct subsidies (subsidized interest rate);
– indirect subsidies (tax exemptions, tax credits and other fiscal incentives to financial institutions);
– subsidies aimed at the development of the economic environment, rules, regulations and supporting institutions;
– subsidies for innovations and business performance improvement of financial institutions.

Regardless of the kind of subsidy, today they present a part of the old agricultural finance paradigm and are generally not desirable because they affect production and consumption decisions and, thus, the uneven distribution of agricultural income, namely, subsidies and other agricultural incentives lead to possible market distortions, the excessive use or underuse of some products and services and favouring some agricultural groups, while, at the same time, putting some farmer categories in a worse market position. In addition to the fact that subsidies can be subject to policy manipulation and corruption, they can also create dependence among their beneficiaries, which is why it is necessary to implement the subsidy policy in a careful manner. Therefore, the use of agricultural subsidies is only justified in cases of agricultural and financial capacity building to increase competition, develop staff competencies and managerial skills in financial institutions, as well as in cases of encouraging institutional development [Smith 2001] and other factors that can lead to a level playing field and better coping with financial market failures.

On the other hand, many definitions, paradigms and approaches to agricultural extension and advisory services have changed over time. The FAO defines agricultural extension as a part of a broader knowledge system that encompasses agricultural research and education. This term relies on three basic pillars – a) research, b) extension and advisory services, and c) higher agricultural education – in its intention to deliver the necessary knowledge and skills to farmers [Rivera et al. 2001]. Agricultural extension also includes a set of systems that facilitate the access of farmers, their organizations and other market actors to necessary agricultural knowledge, information and technologies [Davis, Heemskerk 2012, p. 180]. These systems facilitate interactions among farmers and their partners in research, education, agricultural business and other relevant institutions, helping them

to develop their own technological, organizational and managerial skills and practices [UG NRS 2014, p. 3]. As was the case with rural finance, the paradigm of agricultural extension has also undergone its radical change. While these activities, during the 70s of the last century, were aimed at increasing production, improving yields, training farmers and transferring agricultural technologies, today they represent a broader system that is key to the flourishing of agricultural innovations. Today, they rather insist on active interaction and deeper learning, but not only on the mere training of agricultural producers [Davis, Heemskerk 2012, p. 180]. The contemporary understanding of extension goes beyond mere technology transfer and advocates reducing the level of forgery, as well as educating and assisting farmers in their businesses, marketing activities and forming partnerships [Davis, Sulaiman 2018, p. 3]. Today, agricultural extension is a critical factor of rural development, implying a broad function that, in addition to rural agricultural enterprises, includes the development of rural non-agricultural enterprises, technical and marketing extension, the active involvement of farmer associations, etc., spreading its purpose and goals to the urban and suburban population. Finally, new approaches to agricultural extension include a commodity-specific approach, training and visit approach, farmer participation in advisory services, a project approach, an agricultural system development approach, and a cost-sharing and agricultural educational institution approach [Rivera et al. 2001]. Within the approach of educational institutions, newer and popular methods, such as business agricultural schools, agricultural field schools, agricultural science centres, electronic agricultural extension, self-help groups and training and visiting models [Dwyer, Maredia 2021, pp. 1-2] gained a special role in implementing the extension.

RESEARCH MATERIAL AND METHODS

The survey of agricultural producers in Serbia was conducted in the period from the end of June to the beginning of August 2021. A Google form survey was created and sent to over 400 e-mail addresses of registered agricultural holdings. Just 55 persons responded to this questionnaire. The survey covered agricultural farms, agricultural entrepreneurs, registered vegetable cooperatives, fruit growers and fisheries, private wineries, registered beekeepers and beekeeper associations, as well as registered producers of organic products, mostly from the territory of the Republic of Serbia. The aim of the survey was to determine, on the collected sample of Serbian agricultural producers, whether and to what extent farmers introduce agricultural innovations in their practice, what their motives for it are as well as what the concrete results and effects of implemented agricultural innovations in their business are. Their answers were evaluated in categorical form (Yes/No/I don`t know). After that, they were subsequently recoded for the purpose of this study, depending on the context of other answers.

Three respondents in the age range of 18-25 (5.5%) responded to this survey, together with 13 respondents aged 26-35 (23.6%), 16 respondents aged 36-45 (29.1%), 9 respondents ranging from 46-55 (16.4%), 5 respondents aged 56-65 (9.1%), and as many as 9 respondents aged 66+ (16.4%). While 51 respondents (92.7%) were male, only four respondents (7.3%) were female. Of all respondents, most were owners of agricultural holdings (81.8%), followed by members of agricultural holdings (12.7%), agricultural entrepreneurs (3.6%) and owners of larger agricultural enterprises (1.18%). Regarding the acquired level of education, 23 respondents (41.8%) completed high school, 11 respondents (20%) had a higher education and completed vocational studies, while 21 respondents (38.2%) graduated college. When it comes to the structure of the agricultural activity of respondents, the most surveyed were beekeepers, farmers and fruit growers. In addition, 16 respondents (29.1%) answered that they were engaged in the production of organic products, while 39 of them (70.9%) were not engaged in organic production.

When asked whether they had introduced one or more agricultural innovations in their practice, 29 respondents (52.7%) gave a positive answer, 19 persons (34.5%) answered no, while 7 individuals (12.7%) did not know the answer to this question. While 35.8% of the surveyed farmers used state subsidies and incentives for the introduction and implementation of agricultural innovation, as many as 64.2% did not. When asked whether they used bank loans to implement and develop this agricultural innovation, only 13.7% of them answered that they did, while even 86.3% of them answered that they did not use them. Finally, when asked whether they used formal and informal agricultural advisory services in introducing and developing their innovation, as many as 88.5% of farmers answered positively, 5.8% answered negatively, while 5.8% did not know the answer to this question. When it comes to the role of the state in encouraging innovative activities, 61.1% of farmers believed that the state can help them to develop innovation, 16.7% of respondents were not convinced, while 22.2% did not know the answer to this question. The aim of this article is to examine the impact of the use of agricultural extension, training services and agricultural loans on the decision of farmers from Serbia to introduce agricultural innovation.

Thus, the purpose of this article is to examine the impact of two independent variables: a) the use of agricultural loans (X_1), and b) the use of advisory services and training (X_2) on the dependent variable, the Introduction of agricultural innovations (Y). In other words, the aim is to determine whether, basing on the use of agricultural bank loans and agricultural extension services, it is possible to predict the introduction of agricultural innovations by farmers from Serbia. In the case of this analysis, the binary logistic regression model was applied due to the categorical nature of the predictors, i.e., independent variables and the dependent variable. More precisely, the paper uses a binary logistic regression model because the discrete nature of the dependent variable (the introduction of agricultural innovations) and since the estimated outcome variables are binary, taking values 0 or 1. Besides, this model is relatively free of restrictions [Tabachnick, Fidell 2013, p.

443-444] because it does not require the normal distribution of the dependent variable, i.e., the residuals around the predicted values of the dependent variable. This model is very popular as it can analyze diverse and complex data sets, especially discrete and dichotomous predictors. Besides, it was also chosen since it starts from the assumption that the dependent variable is qualitative, which fits into the requirements of this analysis. In order to be able to apply this model, all received answers were recoded as follows: 1 – positive answer (event success) and 0 – negative answer (event failure). The first important prerequisite for conducting logistic regression relates to the required sample size. Although there are many methods for determining the allowable sample size, the simplest of them is based on a smaller number of binary outcomes, that is on a smaller share of positive or negative outcomes (in this case on introducers or non-introducers of agricultural innovation) in the observed sample [Peduzzi et al. 1996, p. 1373]. According to this methodology, the smallest possible sample size is obtained based on the following formula [Park 2013, p. 157]:

$$N = 10\,k / \rho \tag{1}$$

where ρ is the smallest of the proportion of negative cases in the sample, while k is the number of independent variables.

After recoding the received answers and applying this formula, it was concluded that, in this analysis, given the sample size $n = 55$ and smaller proportion of $\rho = 0.45$, it was possible to observe the influence of only two independent variables ($k = 2.47$) on the decision of Serbian farmers to introduce agricultural innovations, which fulfilled the first important precondition for the implementation of logistic regression. Another important precondition for the use of logistic regression requires the absence of multicollinearity between predictors, i.e., that there is no collinear relationship between the observed independent variables. Given that there was a very weak positive correlation between them, since Pearson`s correlation coefficient only amounted to $r = 0.20$ and it was not statistically significant ($Sig. = 0.15 > 0.05$), it followed that there was most likely no multicollinearity between these predictors. This finding was also confirmed by the value of Kendall's correlation coefficient, which was also $r = 0.20$, indicating a weak relationship between them. Values of the Tolerance and Variance Inflation Factor (VIF) indicators also confirmed this finding, which were within their permitted limits ($Tolerance = 0.96 > 0.10$ and $VIF = 1.04 > 0.10$) [Pallant 2010, p. 158]. Based on this, it could be assumed that, with the probability of $\alpha = 0.95$, there was no multicollinearity between these independent variables. The results of the Durbin-Watson test also confirmed these findings, that amounted to *Durbin-Watson* = 2.29, indicating that they were within their acceptable limits.

In this paper, a binary logistic regression model was used, which belongs to the group of multivariable statistical methods since it investigates the relationship among

two predictors and one outcome, i.e., one dependent variable. In logistic regression, the outcome variable is a dichotomous categorical variable that usually occurs as a binary event, which can be successful (code 1) or unsuccessful (code 0). The odds of an event represent the ratio of the probability that the event will occur and the probability that it will not occur. If we denote the probability of the event occurrence by , then the probability of its non-occurrence is $1 - \rho$. In this case, the corresponding odds are obtained based on the following formula [Park 2013, p. 155]:

$$\textit{odds of an event} = P = \rho / (1 - \rho) \tag{2}$$

Given the fact that, in this analysis, due to the sample size, the impact and predictive power of only two predictors can be observed: a) the use of agricultural loans (X_1) and b) the use of advisory services and training (X_2), as well as that the observed dependent variable Y is binary (denoted by $\rho = P(Y = 1)$), the formula for the odds, after performing a natural logarithm, takes the following general form:

$$\ln(\textit{odds of an event}) = \text{logit}(P) = \ln\left(\frac{\rho}{1-\rho}\right) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \varepsilon \tag{3}$$

where p is the probability of the observed outcome, i.e., the probability of introducing an agricultural innovation, ε is the stochastic term, while X_1 and X_2 are predictors, respectively.

By this model, we have actually transformed the odds using the natural logarithm [Park 2013, p. 155]. By performing an antilogarithmic function on both sides of this equation, it is possible to derive an equation for predicting the outcome probability, in this case of the introduction of agricultural innovation. This mathematical procedure gives the following equation:

$$y = P = \frac{\rho}{1-\rho} = \frac{e^{\alpha + \beta_1 x_1 + \beta_2 x_2 + \varepsilon}}{1 + e^{\alpha + \beta_1 x_1 + \beta_2 x_2 + \varepsilon}} = \frac{1}{1 + e^{-(\alpha + \beta_1 x_1 + \beta_2 x_2 + \varepsilon)}} \tag{4}$$

where P is the probability of 1, e is the bases of the natural logarithm ($e \approx 2.718$), while α, β_1 and β_2 are the parameters of the model. All these equations also give the equation of the logistic curve that links the independent variables x_1 and x_2 with the moving average values of the dependent variable $P(\bar{Y})$.

This article starts from the null hypothesis H_0 that the independent variables x_1 and x_2 do not predict the probability of introducing agricultural innovation in Serbia. This further means that the null hypothesis H_0 claims that the values of coefficients β_1 and β_2 are equal to 0, i.e., that the natural logarithm of the odds is $\ln(odds) = \alpha + \varepsilon$, which is equivalent to

the mathematical expression $odds = e^{\alpha + \varepsilon}$. On the other hand, the alternative hypothesis H_1 assumes that the observed independent variables x_1 and x_2 predict the probability of introducing agricultural innovations in Serbia, which further means that H_1 assumes that the coefficients β_1 and β_2 are different from 0, i.e., that the natural logarithm of odds is $\ln(odds) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \varepsilon$, which is equivalent to the mathematical expression $e^{\alpha+\beta_1 x_1+ \beta_2 x_2+\varepsilon}$. Thus, the null and alternative hypotheses take the following forms:

H_0: $\beta_1 = 0$ and $\beta_2 = 0 \Rightarrow \ln(odds) = \alpha + \varepsilon \Rightarrow odds = e^{\alpha + \varepsilon}$

and

H_0: $\beta_1 \neq 0$ and $\beta_2 \neq 0 \Rightarrow \ln(odds) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \varepsilon \Rightarrow odds = e^{\alpha + \beta_1 x_1 + \beta_2 x_2 + \varepsilon}$

RESEARCH RESULTS AND DISCUSSION

This analysis was performed in the IBM SPSS statistical computer program. This paper used the binary logistic regression model to access the impact of the use of agricultural loans and advisory services and training on the probability that respondents would answer that they had introduced any agricultural innovation. The results of the Goodness of fit test indicated that the whole model, with both predictors, predicted the results well and that it was statistically significant, Chi-square x^2 ($df = 2$, $N = 55$) = 8.02 and $Sig. = 0.02 < 0.05$, suggesting that the model was able to distinguish respondents who did from those who did not answer that they had introduced some agricultural innovation. Also, the results of the Hosmer and Lemeshow test supported the claim that this was a good model, Chi-square x^2 ($df = 1$, $N = 55$) = 0.08 and $Sig. = 0.77 > 0.05$, indicating that, in this model, there was a strong prediction indicator [Pallant 2010, p. 176]. The model, as a whole, explained between 13.6% (Cox's & Snell's R Square) and 18.1% (Nagelkerke's R Square) of variance of the dependent variable and accurately classified 65.5% of cases. The value of McFadden`s pseudo R^2 indicator amounted to $McFadden = 0.11$, while Neglekerke pseudo R^2 was $Neglekerke = 0.18$. At the same time, the value of the Adjusted R^2 amounted to $Adjusted\ R^2 = 0.10$, with a statistical significance of $Sig. = 0{,}02 < 0.05$. While the sensitivity of the model, that is the percentage of really positive cases was $Sensitivity = 63.3\%$, the specificity of the model, i.e., the percentage of really negative cases was $Specificity = 68.0\%$. Besides, while the Area under the curve (AUC) in the case of using banking loans was 58%, the AUC for the use of extension services was 66%, as shown in Figure 1.

The positive predictive value of the model was 70.37%, while the negative predictive value of the model was 60.71%. In what follows, the regression results will be interpreted

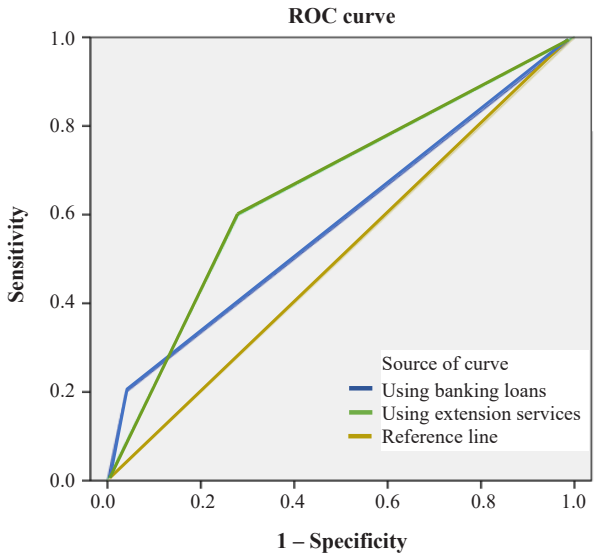

Figure 1. ROC curve
Source: own calculation

in a somewhat unorthodox way. As shown in Table 1, the independent variable the use of advisory services and training showed its statistically significant contribution (*Sig.* = 0.04 < 0.05), while the second predictor the use of agricultural loans did not give a statistically significant contribution to this model (*Sig.* = 0.18 > 0.05) and, thus, most likely to the decision of farmers from Serbia to introduce innovation. At the test significance level of $\alpha = 0.95$, the strongest predictor of the response that a person introduced agricultural innovation was the use of agricultural advisory and training services, with an odds ratio of *Exp*(*B*) = 3.43. This shows that respondents who used these services for each additional unit used, responded 3.43 times more often that they had introduced some innovation so far than those who did not use these services, with all other factors being equal. The odds

Table 1. Coefficients in the equation

Items	*B*	Standard error	Wald	df	*Sig.*	Odds ratio (*Exp*(*B*))	95% C.I. for odds ratio	
							lower	upper
Agricultural loans	1.534	1.150	1.781	1	0.182	4.638	0.487	44.141
Extension and training	1.231*	0.594	4.303	1	0.038*	3.426*	1.070	10.967
Constant	-0.507	0.385	1.737	1	0.188	0.602		

* Denotes statistical significance at a level of $p = 0.05$
Source: own calculation

ratio for the weaker predictor of the use of agricultural loans was higher and amounted to $Exp(B) = 4.64$, indicating that for each additional unit of agricultural loan used, respondents answered 4.64 times more often that they had introduced some innovation so far than those who did not use this type of rural financial instrument, *ceteris paribus*.

The analysis of the independent variables showed that the predictor of using advisory services and training proved to be statistically significant ($Sig. = 0.04 < 0.05$), indicating that it contributed significantly to the model, as well as explained and influenced the decision of Serbian farmers to introduce innovations. On the other hand, although not statistically significant ($Sig. = 0.18 > 0.05$), the second predictor of agricultural loan use was indicative, showing its positive, but far more modest in its contribution to the introduction of agricultural innovations in Serbia. This further means, that the null hypothesis H_0 can be rejected, as well as that the alternative hypothesis H_1 that these predictors predict the probability of introducing innovations cannot be rejected. It also followed, from the analysis, that the coefficient of the predictor the use of agricultural loans was positive and amounted to $\beta_1 = 1.53$, while the coefficient of the predictor the use of advisory services and training was also positive and amounted to $\beta_2 = 1.23$, with a constant value of $\alpha = -0.51$. Based on the obtained results, the logistic curve equation took the following form:

$$logit\,(y) = \ln\left(\frac{\rho}{1-\rho}\right) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \varepsilon = -0.51 + 1.53x_1 + 1.23x_2 + \varepsilon \quad (5)$$

It also followed from the analysis that the values of the dependent variable Y could be obtained based on the following equation:

$$y = \frac{e^{-0.51 + 1.53x_1 + 1.23x_2 + \varepsilon}}{1 + e^{-0.51 + 1.53x_1 + 1.23x_2 + \varepsilon}} = \frac{1}{1 + e^{-(-0.51 + 1.53x_1 + 1.23x_2 + \varepsilon)}} \quad (6)$$

Finally, the following Table (2) shows the results of the calculated Kendall`s tau_b correlation coefficients between the independent variables and the dependent variable, the introduction of agricultural innovations, with corresponding values of their statistical significance. As follows from presented Table 2, Kendall`s coefficient of correlation between the use of banking loans and the introduction of agricultural innovations was expectedly small and positive ($r = 0.24$), while the value of this correlation between the use of extension services and the introduction of innovations was medium and positive ($r = 0.32$), expressing its statistical significance ($Sig. = 0.02 < 0.05$). This could mean that, in the case of agricultural extension services, there is no abuse, as well as that it is still in the initial stages of its more serious application and development. Therefore, it is possible that agricultural extension in Serbia has not yet reached its full extent.

Table 2. Kendall`s tau_b correlation coefficients

Specification		Introducing agricultural innovations	Using banking loans	Using extension services
Introducing agricultural innovations	Kendall`s tau_b correlation	1	0.239	0.320*
	Sig. (2-tailed)	-	0.079	0.019
Using banking loans	Kendall`s tau_b correlation	0.239	1	0.199
	S*ig.* (2-tailed)	0.079	-	0.143
Using extension services	Kendall`s tau_b correlation	0.320*	0.199	1
	Sig. (2-tailed)	0.019	0.143	-

* Denotes statistical significance at a level of $p = 0.05$
Source: own calculation

However, possible limitations of the current study relate to the objectively small sample size since only 55 people responded to this survey, as well as the fact that this electronic survey was conducted without direct contact and communication with the respondents, resulting in no possibility of them clarifying the questions asked. Although the respondents were given a detailed explanation of what is meant by the term of agricultural innovation, given all the above, it is possible that they were not sufficiently familiar with some facts, motivated for answering, interested in the results of the survey and focused enough in giving their answers. In addition, having in mind the fact that there was no verification of the respondents' answers, as well as that the values of pseudo indicators and of otherwise a more precise and representative indicator of the adjusted coefficient of determination did not give the desired outcomes, the results of this analysis should be taken with some caution. It is possible that these coefficients of determination arose as a result of insufficiently efficient and successful domestic agricultural policy in terms of encouraging agricultural innovations. If it had been more efficient, fair and comprehensive, the values of these indicators would probably have been higher. It also follows from the research that the general response to the national agricultural subsidy policy is unfavourable and inadequate but, within it, some answers in terms of sensitivity and specificity curves are relatively well obtained.

Numerous problems stifle Serbian agriculture today, such as the gradual reduction of sown areas, the decline of livestock, modest yield rates, production extensification and vulnerability to climate change, inefficient labour force, dependence on imports, as well as a high share of the active agricultural population in the total Serbian population. Other issues burdening the country`s agriculture include low productivity, a wave of rural emigration and deagrarization, declining trade surpluses, a lack of strategic planning, market monopolization, insufficient incentives, the competitiveness of imported products,

agrarian budget cuts, an unfavourable tax policy, and limited knowledge of farmers about agricultural management practices [Gluscevic 2019]. In such circumstances, advisory services in Serbia have, so far, failed to reach their full potential. However, the results of this research still indicate the fact that agricultural extension significantly helps and contributes to innovating by agricultural producers from Serbia. Nevertheless, it is also obvious that there is still plenty of room for improvement in these activities.

Agricultural extension in Serbia is organized and implemented through all levels of a formal educational system, from high schools to doctoral studies, as well as through various forms of organized trainings intended for farmers. The Serbian Strategy of Agricultural and Rural Development for the period from 2014 to 2024 recognised the importance of these activities, classifying them in one of the fourteen areas of agricultural policy, requiring certain government intervention to achieve sustainable development and strategic goals. This document also recognised a number of problems, noting that extension services are not efficient enough, that they do not meet the needs of technological restructuring of agriculture and that they are no incentive for the cooperation and connection of the creators of agricultural knowledge (mainly universities and scientific institutes) with end users. The strategy further emphasizes that there is a lack of functional networks of specialized knowledge centres and limited access to necessary information, as well as a lack of quality equipment and conditions for research that lag considerably behind the European average. Besides, Serbia lacks sufficient financial resources that would support agricultural knowledge creation, although it has relatively high-quality staff in this field. Agricultural extension is mainly organized through group lectures and occasional visits to farms, while this knowledge reaches a relatively small number of users. In addition, farmers often accept the information obtained with scepticism, avoid investing their own funds in acquiring new knowledge and skills, while larger farms in more developed rural areas usually faster and more efficiently accept new technologies [SGRS 2014, pp. 34-35]. Recognising these problems, legislators and decision-makers have adopted the Regulation on the Annual Plan for the Development of Advisory Affairs in Agriculture [VRS 2021]. Although this document regulates many aspects of this activity in detail, the effects of its implementation in practice remain to be seen, although this is certainly a step forward in advisory service professionalization. There is also evidence that the Serbian Agricultural Advisory Service has very effectively adapted to the Covid-19 coronavirus pandemic by using a variety of digital tools [Crnobarac 2021].

On the other hand, the Republic of Serbia allocates incentives for agricultural and rural development on an annual basis, which, in addition to direct payments, rural development measures and special incentives, also include credit support. While, on average, in the period from 2015 to 2017, the funds for agricultural investments accounted for about 5% of the RS budget, so far, up to 2% of these funds have been allocated for credit support. With this measure, the RS Ministry for Agriculture, Forestry and Water

Management provides subsidized loans to farmers in its cooperation with commercial banks. The owners of agricultural holdings, agricultural entrepreneurs, micro and small enterprises and registered agricultural cooperatives, with at least five members, are entitled to this form of assistance. In Serbia, credit support is intended for the development of farming, livestock, viticulture, fruit growing, vegetables and floriculture, investments in agricultural machinery and equipment, as well as the purchase of animal feed. The market of agricultural loans in Serbia is relatively well developed because of its market-based lending opportunities and significant improvements in supply and demand capacities, as well as the gained experience of commercial banks in financing these activities. At the same time, interest rates on agricultural loans are still relatively low, with the steadily growing agricultural loans` portfolio and competition among banks. However, the main obstacles to the better functioning of this market are reflected in the insufficient economic power of farmers, the small share of loans as well as a lack of adequate approaches of Serbian banks to agricultural lending. It should also be emphasized that, traditionally, domestic farmers prefer to rely on some other sources of financing, such as state subsidies and incentives, rather than on commercial and subsidized loans. In addition, the market of Serbian agricultural loans experiences a small share of short-term loans. The most commonly used sources of agricultural financing include:

– a farmer's own income and savings;
– cooperation with input suppliers, directly or through agricultural cooperatives (barter arrangements);
– state, provincial and municipal subsidies and incentives;
– loans from friends, relatives and neighbours [DGIZ, MPZZS 2017, pp. 34-35].

Finally, when it comes to agricultural loans for the development of innovations in Serbia, the RS Government has provided additional funds for incentives to improve the system of knowledge transfer and creation [PKS 2021, p. 27].

CONCLUSIONS

For the further development of agricultural extension services in Serbia, but also of other assistance mechanisms to agriculture, such as fiscal incentives and various rural financial instruments, it is necessary to work continuously on the development of the devastated Serbian village. In this sense, there is a need to enhance and develop a number of aspects that would prevent the rural population from ongoing emigration to cities. These fields are very broad and include investments in building the infrastructure, education, healthcare, financial services, employment opportunities, agricultural practices and administration and management, i.e., in all activities contributing to the quality of work, life and the livelihoods of the domestic rural population. All these measures should additionally contribute to

meeting broader economic and social goals, such as social inclusion, strengthening the social structure of rural communities, sustainable resource management, environmental protection, increasing agricultural competitiveness and productivity, a more successful adaptation to climate change, and the harmonization of agriculture with the EU`s Common agricultural policy (CAP), encouraging the development of rural tourism, etc.

Given that this research showed that the use of agricultural loans did not make a statistically significant contribution to the introduction of agricultural innovations in Serbia, the state should work more comprehensively on financial and wider computer and ICT literacy of the rural population as a key developmental factor in any society. In the contemporary era of new technologies and financial instruments, farmers should have enough competences for their smooth use. In the educational context, this implies the responsibility of Serbian society in disseminating knowledge and understanding financial concepts, instruments and risks as well as developing appropriate attitudes and skills with the aim of more rational and efficient financial decision-making. Financial education should include a corpus of knowledge on the basics of budgeting, financial accounting, understanding the procedures of lending and interest rates, the functions and roles of savings, the traps of credit default and excessive borrowing cycles, security and the theft of identity issues, online and mobile banking, leasing, insurance, remittance and other available financial instruments, etc. Of course, at the same time, farmer commitment to taking and servicing loans depends on their standard of living and livelihoods, too. Finally, the state should develop the rural financial market, as well as its existing and new instruments and regulations to enable the Serbian rural population to start financing and operating on a market basis.

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INNOWACJE W ROLNICTWIE, UPOWSZECHNIANIE WIEDZY ROLNICZEJ, INSTRUMENTY FINANSOWE ORAZ POŻYCZKI DLA OBSZARÓW WIEJSKICH W REPUBLICE SERBSKIEJ: PRZYPADEK REGRESJI LOGISTYCZNEJ

Słowa kluczowe: innowacje w rolnictwie, instrumenty finansowe na obszarach wiejskich, upowszechnianie wiedzy rolniczej, pożyczki dla obszarów wiejskich, wsparcie kredytowe, rozwój obszarów wiejskich

ABSTRAKT

Celem artykułu jest ocena wpływu korzystania z programów upowszechniania wiedzy rolniczej, usług doradczych i pożyczek dla obszarów wiejskich na wdrażanie innowacji rolniczych w Republice Serbskiej. Innowacje w rolnictwie to przyrostowe zmiany, przez które poszczególne jednostki i organizacje wprowadzają nowe lub wykorzystują znacząco ulepszone produkty, usługi lub sposoby organizacji, w celu zwiększenia wydajności rolnictwa. Podczas gdy upowszechnianie wiedzy rolniczej obejmuje kwestie wiedzy, informacji i umiejętności w dziedzinie rolnictwa, które są przekazywane rolnikom, ich stowarzyszeniom oraz innym podmiotom rynkowym w ramach łańcucha wartości, pożyczki rolnicze stanowią jedne z najważniejszych i dostępnych instrumentów finansowych. W celu zbadania zdolności predykcyjnej i wpływu tych zmiennych, zastosowano metodę binarnej regresji logistycznej ze względu na kategoryczny charakter predyktorów i zmiennej zależnej. Na podstawie badań stwierdzono, że korzystanie z pożyczek rolniczych nie ma statystycznie istotnego wpływu na wprowadzanie innowacji w serbskim rolnictwie, w przeciwieństwie do upowszechniania wiedzy rolniczej. Stwierdzono, że w rolnictwie, rozwoju usług doradczych, a także opracowaniu różnych bodźców podatkowych i instrumentów finansowych przeznaczonych dla obszarów wiejskich, konieczne jest skupienie się na ciągłym rozwijaniu wyniszczonej serbskiej wsi oraz bardziej intensywne inwestowanie w rozwój obszarów wiejskich. Jest to jedyny możliwy sposób zapobiegania dalszej emigracji mieszkańców wsi do miast, a także rozszerzenia ich wiedzy, stymulowania skłonności do wdrażania innowacji oraz poprawy warunków życia.

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