DEMOGRAPHIC ANALYSIS OF THE AGRICULTURAL POPULATION OF SERBIA

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ABSTRACT

The paper explores employment trends and demographic characteristics within Serbia's agricultural sector. Utilizing data from the Statistical Office of the Republic of Serbia and applying descriptive statistics and Probit regression analysis, the research examines key factors such as gender, age, education, region, and settlement type that influence employment in agriculture. The findings reveal a declining share of agriculture in total employment, accompanied by high rates of informal work and an aging workforce, with minimal participation from younger generations. The study highlights the need for urgent measures to rejuvenate the workforce, promote youth involvement, and formalize employment. Key recommendations include developing educational and financial support programs for young farmers, modernizing agricultural practices, and implementing rural development strategies to ensure the sector's long-term sustainability and growth.

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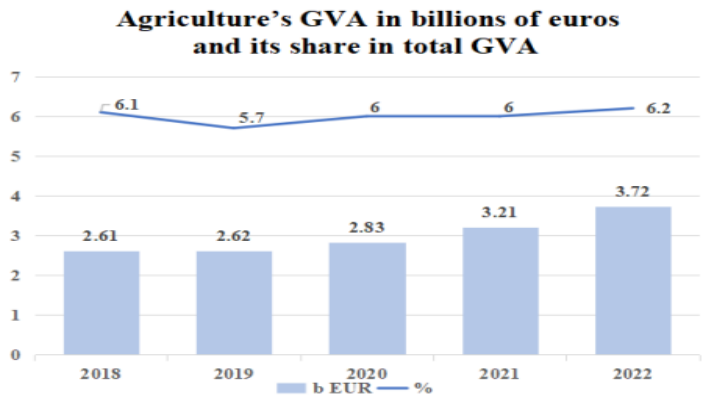
Introduction

Besides contributing to economic development, generating gross domestic product (GDP), and creating jobs, agriculture plays a crucial role in ensuring food security. These aspects have become important considering recent events, such as the COVID-19 pandemic and international conflicts among key agricultural producers in the energy and food markets.

As a major economic activity within the primary sector, agricultural production plays a significant role in the national economy of the Republic of Serbia. Although this sector holds considerable importance for GDP generation, a relative decline has been observed in recent years. Between 1996 and 2005, agriculture's average contribution to GDP was 19.37% (Milić & Pejanović, 2008). More recent studies reveal a significant decline in the share of gross value added (GVA) from agriculture in Serbia's overall GVA between 2002 and 2015. In 2002, the contribution stood at 17%, whereas by 2015, agriculture's share in total GVA had dropped to 8.2%. This decline is primarily because of the significant expansion of other sectors, particularly services, in total economic activity during this period (Novaković, 2019). These figures support the notion that as a country's economy grows, the relative contribution of agriculture to GDP tends to decrease.

According to data from the World Bank (2021), the primary sector in the European Union contributes an average of 1.6% to overall GDP. In Serbia, however, this share is notably higher, averaging around 6% between 2018 and 2022. In absolute terms, GDP generated by agriculture has shown a general upward trend, despite fluctuations caused by global inflation and weather conditions. During the period from 2018 to 2022, agricultural GVA grew by 1.11 billion euros (see Figure 1). While the relative share of the primary sector had fallen below 10% by 2015, economic activities in the secondary and tertiary sectors, which significantly contribute to GDP, have steadily increased. This trend can be considered positive, as the secondary and tertiary sectors generate higher value added compared to the primary sector (Milić et al., 2023).

Figure 1. Agriculture's GVA in billions of euros and its share in total GVA in Serbia from 2018 to 2022



Source: Author's analysis based on data from the Statistical Office of the Republic of Serbia

Analyzing the agricultural population helps to uncover key characteristics and trends within the agricultural sector, allowing for the identification of challenges and opportunities for future development. By examining demographic structure, employment, education, and other relevant factors, we can gain a deeper understanding of the agricultural population dynamics, its influence on rural development, and the factors that shape its productivity and sustainability. These analyses offer valuable insights for policymakers to design strategies that improve the efficiency, competitiveness, and long-term sustainability of agriculture.

Literature review

The demographic analysis of the agricultural sector provides insights into the characteristics of the population engaged in agriculture, including age structure, education, employment, and regional distribution. This data is essential for understanding the dynamics of rural communities and their contribution to agricultural production. Demographic analyses allow the identification of trends, such as the aging of the rural workforce, migration between rural and urban areas, and the need for policies that support the sustainability and development of rural communities.

Nikitović, Magdalenić, and Arsenović (2024) explore demographic processes in the Western Balkans through 2100 about varying socioeconomic conditions. Their study develops three scenarios for future activity patterns based on labor force survey data, considering actual labor participation rates. The results show that depopulation will probably be a prominent characteristic of the region in the coming decades, with international migration playing a more significant role in population trends than fertility. The authors argue that reducing emigration and transitioning to net immigration should be a long-term strategy for a more favorable future.

Popescu et al. (2021) analyzed labor and workforce characteristics in EU agriculture, identifying changes in employment numbers, the number of farmers, the jobs, agricultural land use, standard production, the structure by age, gender, and education level, based on Eurostat data. The general conclusion is that the aging of farmers and labor migration have led to a reduction in the agricultural workforce, but also to the growth of farm size and productivity. The authors also note that the education level of most agricultural workers is relatively low. New technologies, challenges posed by climate change, the need for environmental and biodiversity protection, and the preservation of rural landscapes require farmers to become central actors in rural communities (Popescu et al., 2021).

The analysis of agricultural populations also emerges in the context of crisis periods. Bochtis et al. (2020) aimed to assess the impact of the COVID-19 pandemic on the agricultural workforce and propose strategies for mitigating these effects. The authors concluded that around 50% of agricultural workers were considered being at moderate to high risk of infection, highlighting key vulnerabilities in the sector. Their study, which included many countries worldwide, proposes strategies to protect workers and improve the resilience and sustainability of the agricultural sector.

In terms of research from the region focused on the demographic analysis of agricultural populations, one standout study is by Popescu, Dinu, and Stoian (2018), who analyzed rural populations in Romania from 2007 to 2016. The research shows an overall decline in the rural population of 3.26%, primarily because of low birth rates, high mortality rates, and migration. The rural population is aging, with an imbalanced ratio between individuals over 60 and those aged 0-14. Around 44.73% of the active population lives in rural areas, where 86% are engaged in part-time work. Agriculture employs 40.54% of the rural population, most of whom have limited formal education. Agricultural incomes are 12% lower than the national average. Implementing national rural development programs is expected to improve living standards by advancing education, technology, infrastructure, and social inclusion.

Other authors analyze the agricultural population from the perspective of technological revolutions. Agriculture is undergoing a technological revolution, known as Agriculture 4.0, which relies heavily on information technology. This advancement increases production efficiency, but many farmers in developing countries, including Hungary, struggle to adopt these innovations because of limited access to modern technology and equipment. This creates a long-term problem, termed agricultural deprivation, which is difficult to resolve (Bazsik, Bujdosó, & Koncz, 2022).

Methodology

The methodology for researching the demographic analysis of the agricultural sector in Serbia encompasses a series of steps and techniques used for the collection, analysis, and interpretation of relevant data. The methodology consists of the following elements:

Data Collection: Identifying relevant data sources related to the agricultural population of Serbia. This includes statistical data from national agencies, primarily the Statistical Office of the Republic of Serbia, surveys, and other applicable information sources.

Defining Variables: Defining the key demographic variables to be analyzed. The research examines the most significant statistical indicators related to employment in agriculture in Serbia, with a particular focus on trends over the past period. It investigates the employment rate in Serbia, the share of employed individuals in agriculture within total employment, and the demographic structure of workers in the agricultural sector, including gender, age, education, regional distribution, and type of settlement. Additionally, it compares the rate of informal employment in agriculture to that in other sectors, analyzing trends and providing insights into the current state of the labor market.

Data Analysis: This paper combines descriptive statistics and Probit regression analysis to examine the factors influencing employment trends in Serbia's agricultural sector. The analysis, conducted using STATA statistical software, estimates the probability of agricultural employment based on independent variables such as gender, age group, education level, region, and type of settlement. Since the dependent variable, agricultural employment, takes a binary form (1 if employed, 0 otherwise), the Probit model offers

a more suitable approach than linear regression. Predicted probabilities remain within the [0,1] range while accounting for non-linearity. Moreover, the model proves robust against common issues such as heteroscedasticity and non-normality, which frequently arise in socio-economic data analysis. Estimating marginal effects quantifies how factors like age and education influence the probability of agricultural employment. Combined with descriptive statistics, this approach provides a comprehensive understanding of the demographic and socio-economic drivers of employment, potentially supporting objectives such as rural workforce renewal and the development of sustainable strategies.

Results and discussions

Employment in Serbia (Labor Force Survey - LFS and Central Register of Mandatory Social Insurance - CROSO)

The employment rate in Serbia, measured through the Labor Force Survey (LFS), is a key indicator that reflects the share of employed individuals in the working-age population. This rate provides insights into the current state of the labor market and economic activity in the country. Analysis of the LFS allows for monitoring changes in employment over time, identifying structural changes in the workforce, and assessing the effectiveness of employment policies.

When examining the period between 2019 and 2023, it can be concluded that the employment rate has been gradually increasing. However, due to changes in methodology for processing data in the Labor Force Survey, the data from 2019 and 2020 are not comparable with data from 2021 onward. Therefore, if we consider the period between 2019 and 2020, we conclude that the employment rate increased by 1.01% during this period. Looking at the period between 2021 and 2023, there is a noticeable growth in the employment rate, with minor fluctuations. The employment rate increased by 4.86% when comparing the annual rates from 2021 and 2023. When examining the dynamics on a quarterly basis, it is observed that, except for 2020, the first quarter has the lowest employment rate due to a smaller number of seasonal jobs.

The unemployment rate in Serbia is an important economic indicator that measures the percentage of the active population that is actively seeking work but is currently unemployed. This rate is calculated as the ratio between the number of unemployed individuals and the total active population, which includes people aged 15 and older. A high unemployment rate typically indicates economic challenges and a lack of job opportunities, while a low unemployment rate suggests stability in the labor market. In recent years, the unemployment rate in Serbia has shown fluctuations. As previously mentioned, due to changes in methodology for processing data, the periods from 2019 to 2020 and from 2021 to 2023 should be analyzed separately. Between 2021 and 2023, a trend of decreasing unemployment was observed, which may indicate an improvement in the labor market. Specifically, the annual unemployment rate was lower by 15.32% in 2023 compared to 2021, with the unemployment rate falling from 11.48% to 9.72%, a decrease of 1.76 percentage points.

However, it is important to note that the unemployment rate can be influenced by various factors, including economic changes, employment policies, demographic trends, and other factors that may impact the workforce and economic activity. An example of this can be seen in the second quarter of 2020, when a significantly lower unemployment rate was recorded. The reduction in unemployment during this period can be explained by decreased job-seeking activity during the COVID-19 pandemic, rather than an increase in employment. In the last two quarters of 2020, the unemployment rate stagnated, indicating a reactivation of the unemployed who had been inactive during the lockdown. The number of people who were laid off increased by about 14,000, while the number of those who stopped working due to the end of temporary jobs within the calendar year significantly decreased in the third and particularly in the fourth quarter (Vladisavljević & Lebedinski, 2023).

From 2021 to 2023, there has been a noticeable increase in overall, registered, and formal employment in Serbia. This trend indicates an improvement in the labor market and economic activity in the country. Analysis of employment trends over the past five years provides the following conclusions:

Total Employment: Although an increase has been recorded since 2021, total employment has not yet reached pre-pandemic levels. The number of employed individuals was 2.90 million in 2018, while in 2023, it was 2.84 million. It can be observed that although the number of employed individuals has not increased, the employment rate is rising. Various factors may contribute to this trend. For instance, better regulatory enforcement may compel employers to transition workers previously employed "under the table" to formal employment. Additionally, it is possible that some individuals are being removed from the employed list due to factors such as migration or retirement, but these positions are not being filled with new permanent hires. Generally, due to a declining population, the employment rate is falling.

Registered Employment: The study of registered employment is conducted based on data from the Central Register of Mandatory Social Insurance and the Statistical Business Register. Registered employment includes employees of legal entities, entrepreneurs, self-employed individuals, registered individual farmers, as well as employees in the public sector. It also includes employees based on various modalities of employment (in and out of formal employment), down to the level of municipalities and sectors of activity (Statistical Office of the Republic of Serbia, 2023). The number of registered employees has shown a growth trend from 2019 to 2023. This may indicate an increase in the formalization of employment relationships and a decrease in informal employment. The growth trend is observed in both total registered employment and registered employment excluding individual farmers.

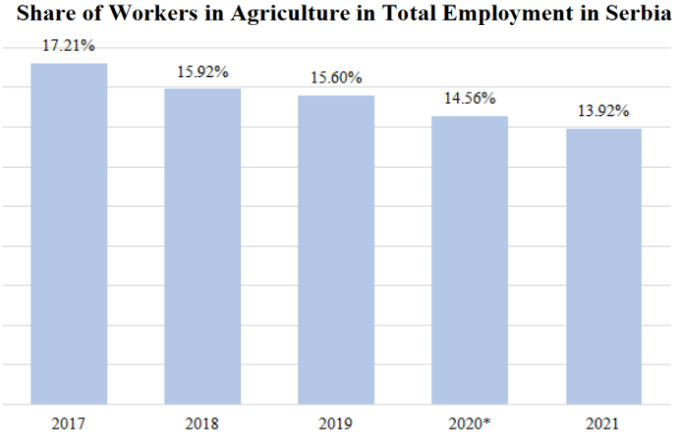
Formal Employment: Formal employment encompasses individuals who have a formal legal employment contract, i.e., an employment relationship established with an employer for a fixed or indefinite period, individuals who independently conduct activities in registered property, or who are founders of registered companies or

entrepreneurial ventures, as well as those engaged in agricultural activities registered with official state institutions (Statistical Office of the Republic of Serbia, 2021). Formal employment also records an increase during the same period from 2021 to 2023. However, as with total employment, the pandemic had a significant impact, with a clear decline observed in 2021 (Statistical Office of the Republic of Serbia, 2023).

Participation of Employed Persons in Agriculture in Total Employment in Serbia

Despite the gradual decrease in the unemployment rate in Serbia, the participation of those employed in agriculture has been steadily declining, and the number of agricultural households is also decreasing. Between 2017 and 2021, the share of workers in agriculture as a percentage of total employment fell by 3.29% (Trading Economics, 2023; Statistical Office of the Republic of Serbia, 2022) (Figure 2).

Figure 2. Share of Workers in Agriculture in Total Employment in Serbia from 2017 to 2021

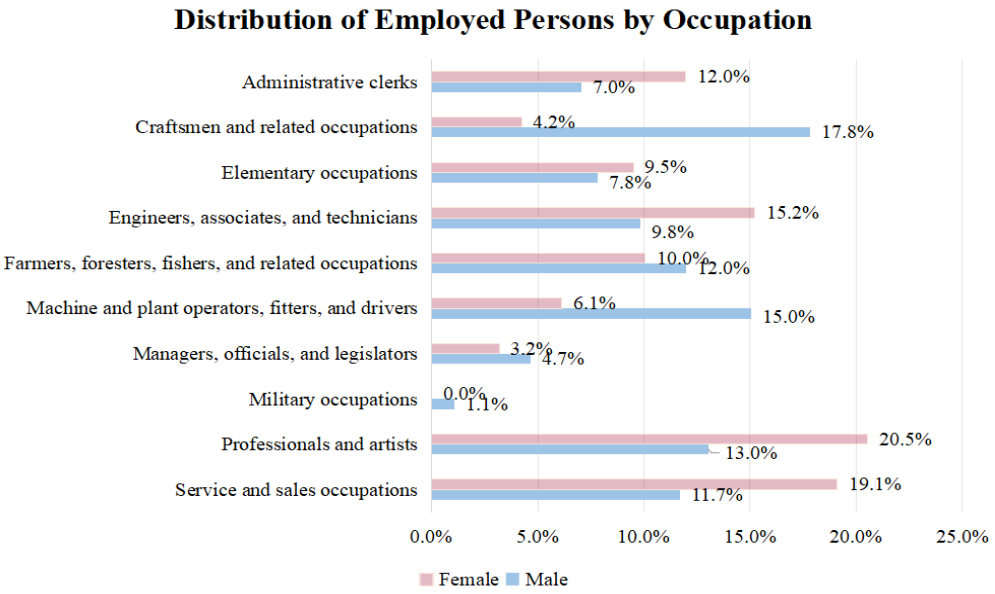


Source: Author's analysis based on data from the Statistical Office of the Republic of Serbia (LFS)

The participation of workers in agriculture in total employment continues to decline, and the number of agricultural households also shows a decreasing trend. From 2018 to 2022, the officially registered average net salaries in the agricultural sector were 14.84% lower than the overall average, with the largest difference observed in 2022, showing a 17.69% difference in net salaries (Statistical Office of the Republic of Serbia, 2022). It is important to note that a significant portion of informal employment includes agricultural activities, meaning that many farmers are employed informally, which poses challenges in monitoring changes in salaries.

When analyzing the structure of employment by occupation, it is concluded that in 2023, farmers accounted for 11% of the total number of employed persons, ranking them fourth among occupations. In terms of gender distribution, there are fewer women employed in agriculture, with a share of 10%, while men account for 12%. Figure 3 shows the percentage of employed persons by occupation and gender (Statistical Office of the Republic of Serbia, 2023).

Figure 3. Distribution of Employed Persons by Occupation and Gender in Percentages in Serbia in 2023



Source: Author's analysis based on data from the Statistical Office of the Republic of Serbia (LFS)

Demographic Structure of Employees in the Agricultural Sector - Gender, Regional, Age, and Educational Distribution

When considering total employment, agriculture accounts for 13.13%, with 373,200 employed workers. It is important to note that this figure includes both formal and informal employees. The gender distribution indicates that a greater number of men are engaged in agriculture, as men constitute 60.08%. This percentage is higher than the proportion of men in total employment, where they make up 54.75% of workers.

The regional distribution of total employment significantly differs from that of employed persons in the agricultural sector. Specifically, the highest number of farmers is found in the Šumadija and Western Serbia region, accounting for 46.80%, which is substantially higher than their participation in total employment, approximately 27%. The lowest participation in agriculture is in the Belgrade region, with a share of 6.06%, which is considerably lower than the share of employed individuals in the Belgrade region in total employment—27%. The Vojvodina region ranks second in terms of the number of employees in the agricultural sector, with a share of 24.81%, slightly less than its participation in total employment, while the South and East Serbia region holds the third position with a share of 22.32%, slightly higher than in total employment. Detailed data can be found in Table 1 (Statistical Office of the Republic of Serbia, 2023).

Table 1. Employed Workers by Sector (Agriculture), Gender, and Region in 2023 (in thousands)

	Republic of Serbia						
	Total	Sex		Serbia - North		Serbia - South	
		Male	Female	Belgrade Region	Vojvodina Region	Šumadija and Western Serbia Region	South and East Serbia Region
Employed Workers (15–89 years)	2842.0	1555.9	1286.1	792.0	743.4	766.1	540.4
Percentage	100%	54.75%	45.25%	27.87%	26.16%	26.96%	19.01%
Agriculture, Forestry, and Fishing	373.2	224.2	149.0	22.6	92.6	174.7	83.3
Percentage	13.13%	60.08%	39.92%	6.06%	24.81%	46.80%	22.32%

Source: Author's analysis based on data from the Statistical Office of the Republic of Serbia (LFS)

Table 2 indicates that the agricultural workforce is aging, as over 50% of employees in the agricultural sector are 55 years or older. The youngest employees, those aged 15 to 34, make up only 13.83% in agriculture, compared to 25.66% when considering all employees. The middle generation constitutes 35.66% of agricultural workers, while in total employment, this percentage is 51.56% (Statistical Office of the Republic of Serbia, 2023).

The age structure of the agricultural workforce in Serbia poses a significant challenge. The high percentage of employees in agriculture who are 55 or older indicates a need for rejuvenating the sector. This could have long-term consequences on productivity and competitiveness in agriculture, as older employees may have less energy and capacity for innovation. Therefore, it is crucial to implement measures to attract younger workers to agriculture and ensure conditions for the sustainable development of this sector.

However, Serbia is not the only country facing this issue. Among the 9.1 million farms in the European Union, the majority (57.6%) of farm managers (both genders combined) were at least 55 years old. Young farmers, defined as those under 40, accounted for only 11.9% of all farm managers. Young farmers are particularly rare in Cyprus (5.1%), Portugal (6.4%), Greece (7.2%), and Spain (7.7%). Their share was higher in Austria (23.4%) and Poland (21.0%). Conversely, a high percentage of farmers aged 65 or older has been noted in many countries; in Portugal, they made up half (50.3%) of all farmers, while high percentages were also recorded in Cyprus (46.4%), Spain (41.3%), and Romania (39.6%). These age structures emphasize the need for policies that encourage farm succession and promote a new generation of farmers (Eurostat, 2022).

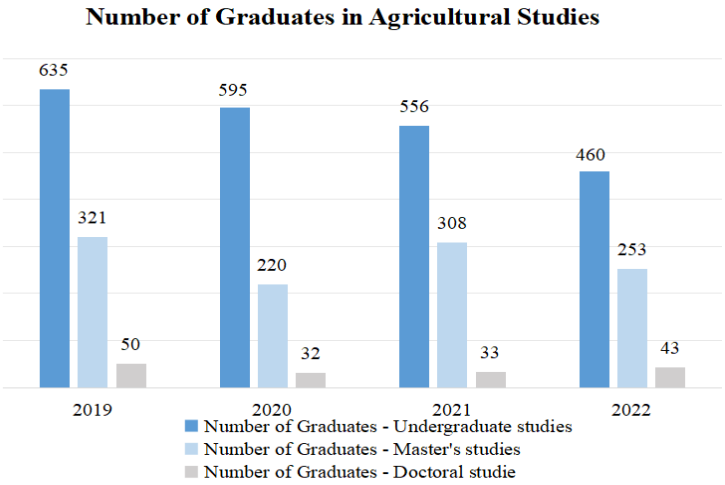
Table 2. Total Employed Workers and Those in the Agricultural Sector by Age Group in 2023 (in thousands)

	15–34	35–54	55 and older
Total	729.2	1465.4	647.4
Percentage	25.66%	51.56%	22.85%
Agriculture, Forestry, and Fishing	51.6	133.1	188.5
Percentage	13.83%	35.66%	50.51%

Source: Author's analysis based on data from the Statistical Office of the Republic of Serbia (LFS)

The current situation in Serbia shows a gradual decline in the number of graduates in agricultural studies, forestry, fishing, and veterinary medicine (Figure 4). Regarding master's degree studies, the situation is somewhat more stable, with fluctuations over the past four years, but without a clear downward trend. As for doctoral studies, the number of PhDs in agriculture has remained relatively stable, at around 40 per calendar year (Statistical Office of the Republic of Serbia, 2022).

Figure 4. Number of Graduates in Agricultural Studies in Serbia from 2019 to 2022



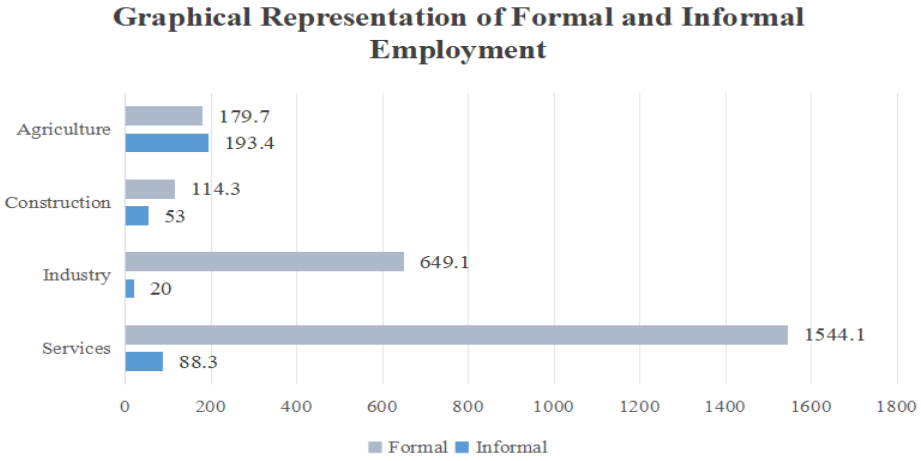
Source: Author's analysis based on data from the Statistical Office of the Republic of Serbia (LFS)

Informal Employment Rates in Agriculture and Outside Agriculture

In 2023, the number of formally employed individuals increased by 34,200, while the number of informally employed individuals decreased by 10,800 compared to 2022. This dynamic resulted in a reduction of the informal employment rate by 0.5 percentage points from the previous year, reaching a level of 12.5%. The agricultural sector experienced a decrease of 5,400 informally employed individuals, the service sector saw a decline of 3,300, and the industrial sector recorded a drop of 1,900. Conversely, the construction sector reported a similar number of informally employed individuals as in the previous year.

In 2023, the total number of informally employed persons across all sectors in Serbia was 354,700, while formal employment reached 2,487,200 workers. In other words, formal employment accounted for 87.52% of total employment, while informal employment comprised 12.48%. According to Figure 5, which displays the number of formally and informally employed individuals in 2023 by four main economic sectors, the agricultural sector stands out as the leader in the number of informally employed persons, both in absolute and relative terms. Specifically, in agriculture, 51.84% of employees are informally employed, indicating that this proportion is about four times higher than in total employment. No other sector exhibits such a drastic share of informal employment as that among agricultural workers (Statistical Office of the Republic of Serbia, 2023).

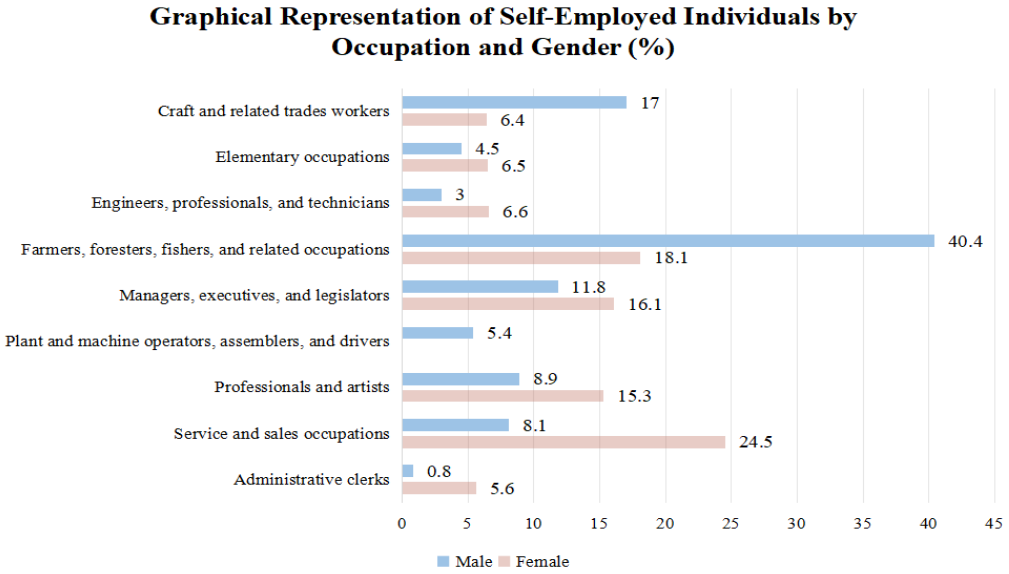
Figure 5. Representation of Formal and Informal Employment by Economic Sector in Serbia in 2023



Source: Author's analysis based on data from the Statistical Office of the Republic of Serbia (LFS)

When considering self-employed individuals by occupation and gender, the agricultural sector again takes the lead, particularly among men. Specifically, 40.4% of self-employed men work in agriculture. The situation is somewhat different among women, where the highest proportion of self-employed individuals comes from the service and trade sectors, accounting for a total of 24.5% of self-employed women. Self-employed women in agriculture represent 18.1% (Figure 6). On the other hand, the smallest number of self-employed individuals is found among administrative staff, both among men and women (notably, there are no self-employed women among machine and plant operators, assemblers, and drivers) (Statistical Office of the Republic of Serbia, 2023).

Figure 6. Representation of Self-Employed Individuals by Occupation and Gender in Percentages in Serbia in 2023



Source: Author's analysis based on data from the Statistical Office of the Republic of Serbia

Application of STATA Software: Regression Analysis of Employment in the Agricultural Sector

Regression analysis of binary (dichotomous) variables is a common task in applied statistics. Models that address binary outcomes focus on the probability p of one outcome occurring, while the alternative outcome has a probability of 1−p. Two standard models for binary outcomes are the logit model and the probit model. These models use different mathematical functions to determine the probability p as a function of the regressors, with estimated coefficient values obtained using the maximum likelihood (ML) method. The linear probability model (LPM), which is fitted using ordinary least squares (OLS), is also frequently used in this type of regression (Cameron & Trivedi, 2009).

The general form of multiple (linear) regression analysis is:

$$Y=\beta_0+\beta_1 x_1+\beta_2 x_2+\ldots+\beta_k x_k+u \quad (1)$$

Where:

Y - dependent variable (also known as the response variable or target variable);

$x_1, x_2, \ldots, x_k$ - independent variables (also known as predictor variables or regressors);

β_0 - model constant;

$\beta_1, \beta_2, \ldots, \beta_k$ - regression coefficients that quantify the impact of each independent variable on the dependent variable;

u - random error or residual, encompassing the effects of all other factors not included in the model.

If the dependent variable is binary, the model is evaluated in the following form:

$$E(y) \equiv p \equiv P(Y=1) = f(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k + u) \quad (2)$$

Where:

p - the probability that the binary variable takes the value 1;

f - probability distribution function (which can be logit or probit).

Probit regression in this study was conducted to examine the probability of employment in agriculture based on the following independent variables: gender, age group, education, region, and type of settlement. The dependent variable is employment in the agricultural sector. The source of microdata for the regression analysis is the Labor Force Survey, issued by the Statistical Office of the Republic of Serbia.

In the data selection process, a value of 1 is assigned to the agricultural sector, while other sectors are assigned a value of 0. For the independent variables, dummy variables are used for specific categories:

- Gender: male = 0, female = 1;
- Age group: data is extracted for the age group 15-64 years;
- Education: primary education = 1; secondary education = 2; higher education = 3;
- Region: four regions: Belgrade; Southern and Eastern Serbia; Vojvodina; Šumadija and Western Serbia;
- Type of settlement: rural area = 0, urban area = 1.

The results obtained using STATA software are presented in Tables 3 and 4.

Table 3. Output from STATA Software - Probit Regression

	Coefficient	Standard Error	Z-value	P-value
Female	-0.1351093	0.0190059	-7.11	0.000
Age group:				
15-19	0.314135	0.0886649	3.54	0.000
20-24	-0.0265187	0.0572972	-0.46	0.643
25-29	-0.0674448	0.0530054	-1.27	0.203
35-39	0.0299762	0.0471174	0.64	0.525
40-44	0.0950681	0.0444984	2.14	0.033
45-49	0.233147	0.0429839	5.42	0.000
50-54	0.3041624	0.0417999	7.28	0.000
55-59	0.3794928	0.0418243	9.07	0.000
60-64	0.5277929	0.0427915	12.33	0.000
Education:				

	Coefficient	Standard Error	Z-value	P-value
Secondary education	-0.6626029	0.0213947	-30.97	0.000
Higher education	-1.144101	0.0358586	-31.91	0.000
Region:				
Southern and Eastern Serbia	0.5399358	0.0376843	14.33	0.000
Vojvodina	0.7872773	0.0378323	20.81	0.000
Šumadija and Western Serbia	0.9309358	0.0362038	25.71	0.000
Urban	-0.9954068	0.0219479	-45.35	0.000

Source: Author's analysis based on data from the Statistical Office of the Republic of Serbia

The probit regression conducted on a sample of 38,796 observations yielded significant results, with an LR chi2(16) value of 8309.03 and a P-value less than 0.0001, indicating a high level of statistical significance for the model. McFadden's likelihood ratio index, with a value of 0.26, indicates a very good fit for the model.

The results in Table 3 provide a clear picture of the factors affecting the probability of employment in agriculture, highlighting the significance of gender, age, education, and geographical structure of the population, as well as the type of settlement. While the coefficients in the probit regression indicate the impact of independent variables on the latent dependent variable (probit index), the marginal effects demonstrate the influence of independent variables on the probability of the dependent variable. Consequently, the analysis of average marginal effects shows the impact of various factors on the probability of employment in agriculture (see Table 4).

Table 4. Output from STATA Software - Marginal Effects

	Coefficient	Standard Error	Z-value	P-value
Female	-0.0226529	0.003153	-7.18	0.000
Age group:				
15-19	0.0515277	0.015872	3.25	0.001
20-24	-0.003755	0.0080892	-0.46	0.643
25-29	-0.0093714	0.0073407	-1.28	0.202
35-39	0.0043549	0.0068354	0.64	0.524
40-44	0.0142172	0.0065919	2.16	0.031
45-49	0.0369932	0.0066263	5.58	0.000
50-54	0.0496912	0.0065271	7.61	0.000
55-59	0.0638864	0.0066805	9.56	0.000
60-64	0.0939742	0.0072465	12.97	0.000
Education:				
Secondary education	-0.1450956	0.0053315	-27.21	0.000
Higher education	-0.2086821	0.0059104	-35.31	0.000
Region:				
Southern and Eastern Serbia	0.0650952	0.0040456	16.09	0.000
Vojvodina	0.1082607	0.0045646	23.72	0.000

	Coefficient	Standard Error	Z-value	P-value
Šumadija and Western Serbia	0.1373918	0.0043129	31.86	0.000
Urban	-0.1650247	0.0033591	-49.13	0.000

Source: Author's analysis based on data from the Statistical Office of the Republic of Serbia

The results show that women have a 2.27% lower probability of employment in agriculture compared to men, when controlling for the effects of other factors. This difference is statistically significant, with a Z-value of -7.18 and a P-value of 0.000.

Individuals in the age group of 15-19 years have a 5.15% higher probability of employment in agriculture compared to the reference group (30-34 years). For age groups 20-24, 25-29, and 35-39 years, the differences are not statistically significant. Individuals aged 40-44 have a 1.42% higher probability of employment in agriculture compared to the reference group. The age group of 45-49 years has a 3.70% higher probability of employment in agriculture compared to the reference group. Individuals aged 50-54 have a 4.97% higher probability, while the age group of 55-59 has a 6.39% higher probability of employment in agriculture compared to the reference group. Finally, individuals aged 60-64 have a 9.40% higher probability of employment in agriculture compared to the reference group, when controlling for other factors.

Individuals with secondary education have a 14.51% lower probability of employment in agriculture compared to those with primary education. Those with higher education have an even lower probability of employment in agriculture, at 20.87% compared to those with primary education, when controlling for the effects of other factors.

Regional analysis indicates that individuals living in the Southern and Eastern Serbia region have a 6.51% higher probability of employment in agriculture compared to those in Belgrade. Similarly, residents of Vojvodina have a 10.83% higher probability of employment in agriculture compared to Belgrade, while individuals from the Šumadija and Western Serbia region have a 13.74% higher probability of employment in agriculture when controlling for the effects of other factors.

The results show that individuals living in urban areas have a 16.50% lower probability of employment in agriculture compared to those in rural areas, which is highly statistically significant with a P-value of 0.000.

These results clearly indicate significant differences in the probability of employment in agriculture based on gender, age group, education, geographical region, and type of settlement, providing deeper insight into the employment structure in this sector.

Regarding the quality of the conducted model, it correctly classified 86.94% of all observations, indicating relatively high overall accuracy in predicting employment in agriculture. The model exhibits high specificity and overall accuracy, meaning it is very effective at identifying those not employed in agriculture. However, its sensitivity is relatively low, suggesting that the model has difficulties accurately identifying all

individuals employed in agriculture. The high negative predictive value indicates that the model reliably identifies those not employed in agriculture, but is less reliable in identifying those who are employed (Figure 7).

Figure 7. Model Quality Assessment

Probit model for agri_sektor

Classified	True D	True ~D	Total
+	1374	875	2249
-	4193	32354	36547
Total	5567	33229	38796

Classified + if predicted Pr(D) >= .5
True D defined as agri_sektor != 0

Sensitivity	Pr(+| D)	24.68%
Specificity	Pr(-|~D)	97.37%
Positive predictive value	Pr(D| +)	61.09%
Negative predictive value	Pr(~D| -)	88.53%
False + rate for true ~D	Pr(+|~D)	2.63%
False - rate for true D	Pr(-| D)	75.32%
False + rate for classified +	Pr(~D| +)	38.91%
False - rate for classified -	Pr(D| -)	11.47%
Correctly classified		86.94%

Source: Author's analysis based on data from the Statistical Office of the Republic of Serbia

Conclusion

The analysis of employment data in Serbia reveals several key trends and challenges. The employment rate is increasing, while the unemployment rate is declining, suggesting positive changes in the labor market. However, changes in the methodology for data processing complicate direct comparisons of data before and after 2021. The agricultural sector continues to see a steady decline in its share of total employment, accompanied by an increase in informal employment. Agriculture has the highest proportion of informally employed individuals, which presents challenges for monitoring wages and working conditions.

The demographic structure of agricultural workers shows a high percentage of older individuals, while the participation of younger workers is very low. This age structure indicates a need for rejuvenation in the sector to ensure long-term sustainability and competitiveness. The regional distribution of employed individuals reveals that the highest number of farmers is in Šumadija and Western Serbia, while Belgrade has the fewest employed in agriculture. Agriculture is the most common occupation among the self-employed, particularly among men. To enhance the sector, it is essential to

encourage young farmers, formalize employment in agriculture, and adapt policies to increase productivity and competitiveness.

The results of the regression analysis show significant differences in the probability of employment in agriculture based on the examined factors. Women have a lower probability of employment in agriculture compared to men. The age group of 15-19 years has a higher probability of employment in agriculture compared to the reference group (30-34 years), while older age groups, particularly those aged 50-54 and 55-59 years, have a significantly higher probability of employment in agriculture. Education plays an important role in the probability of employment in agriculture: individuals with secondary and higher education have significantly lower probabilities of employment in this sector compared to those with primary education. Geographic regions also show significant differences. Individuals living in Southern and Eastern Serbia, Vojvodina, and Šumadija and Western Serbia have a higher probability of employment in agriculture compared to residents of Belgrade. Furthermore, individuals living in urban areas have a significantly lower probability of employment in agriculture compared to those from rural areas.

The model used in the analysis demonstrates high overall accuracy in predicting employment in agriculture, with particularly high specificity. The results provide deeper insights into the structure of employment in agriculture, highlighting the importance of various demographic, educational, and geographic factors. They can contribute to a better understanding of the dynamics of employment in agriculture and assist in developing effective policies to support and grow this sector. Given the lower probability of employment for women in agriculture, specific training and support programs can be developed to increase their participation in this sector. Since older age groups show a higher probability of employment in agriculture, programs aimed at young farmers can help encourage greater involvement of the younger population in rural areas. Based on the obtained results, efforts can be made to promote agriculture as an attractive career through educational programs and to provide additional opportunities for education in agronomy and related fields. On the other hand, increased support for regions with a higher probability of employment in agriculture, such as Southern and Eastern Serbia, Vojvodina, and Šumadija and Western Serbia, can help maintain and improve agricultural production. Given the higher probability of employment in agriculture for individuals living in rural areas, rural development strategies can include improving infrastructure, working conditions, and access to markets for farmers.

Serbia has the potential for further development of the agricultural sector due to its fertile land and tradition in agricultural production. However, to capitalize on these opportunities, the state faces certain challenges, including the need to modernize agricultural practices, improve supply chains, and adapt to global trends in consumer preferences. Integrating innovations, technological advancements, and government support for the sector are key elements that can enhance this sector. Addressing the issue of an aging agricultural workforce in conjunction with education may be crucial for long-term solutions. Providing education on modern agricultural techniques,

technologies, and innovations can help increase productivity and efficiency in the sector. The younger generation can be trained to utilize new technologies, which may attract more young people to engage in agriculture. Additionally, agricultural education in schools can also assist in this situation. Introducing agricultural education into the school system can spark young people's interest in agriculture and provide them with foundational knowledge of this sector from an early age. This could include practical activities such as gardening or managing small farms within educational programs.

Scholarship and support programs also play a key role. Developing scholarship and financial support programs for young people who wish to pursue education in agriculture can motivate them to choose a career in this sector. These programs may include subsidies for agricultural education, scholarships for agricultural colleges, or support for internships on farms. Supporting research and innovations, as well as investing in research and development in agriculture, can create new opportunities for improving the sector and attract young people interested in innovations and technological progress.

Agriculture in Serbia continues to play an important role in traditional lifestyles, especially in rural areas. Many families rely on agriculture as their main source of income, and knowledge and labor in the field are often passed down from generation to generation. Additionally, agriculture is a seasonal activity. During certain times of the year, such as spring and autumn, more labor is needed for land preparation, planting, or harvesting. As a result, many people who cannot find year-round employment seek seasonal jobs in agriculture.

Insufficient investment in agriculture, particularly in rural areas, leads to many farms remaining small or medium-sized. This often results in a lack of formal job opportunities in agriculture, forcing people to turn to informal employment on family farms or as seasonal workers. Moreover, the complexity of administrative procedures, high taxes, and costs for employers can make formal employment in agriculture challenging. This can encourage people to prefer informal jobs to avoid such challenges.

Conflict of interests

The authors declare no conflict of interest.

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