

# Innovation and total factor productivity growth in Serbian agriculture

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## ABSTRACT

The analysis of the total factor productivity (TFP) of Serbian agriculture is the main goal of this paper. To achieve it, data envelopment analysis (DEA) is used to calculate Malmquist productivity indices. Results showed that there was a significant TFP decline from 1999 to 2008 (annual mean TFP change was -4.6%) probably caused by transitional disturbances and agricultural reforms. On other hand, in the period after 2008 annual mean TFP change was 5%. This TFP growth is explained by technical change associated with the European integration process and better implementation of innovation. Therefore, it can be concluded that if technological change is generated by innovation, it could be a clear sign to agricultural policymakers to encourage investment in research and development, especially those research that has a positive impact on agricultural productivity growth and environmental performance such as organizational and information technology innovations. In addition, adequate investments in technology development can increase the competitiveness of the agricultural sector of Serbia, which is especially important in the case of full integration with the EU market.

**Keywords:** innovation, Serbia, total factor productivity

## INTRODUCTION

After the turbulent process of transition, a clear strategic goal of Serbia is integration into the European Union (EU), which requires radical economic and institutional reforms. These reforms, among other things, imply significant changes in the agricultural sector. In the case of Serbia, the economic importance of agriculture remains very high, although the share in GDP has significantly decreased

compared to the end of the 20th century (Figure 1). If the experiences of other Eastern European countries are taken into account, it can be expected that with the further process of European integration there will be a decrease in the importance of the agricultural sector, especially when the share of the agricultural sector in employment is considered. Certainly, the high economic importance of the agricultural sector suggests that it is necessary to take into account the competitiveness of this

sector, especially in the case when the relatively free flow of goods between EU countries and Serbia is enabled. According to Nowak and

Kaminska (2016) productivity is one of the most important indicators of competitiveness in the long run.

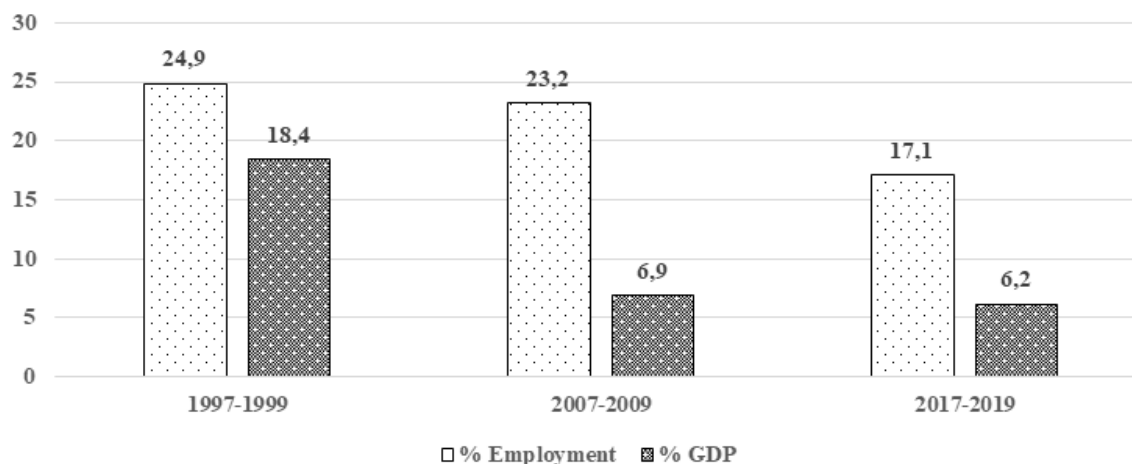


Figure 1. Share of agriculture in GDP and employment in Serbia (three years average)

Source: The World Bank, 2021.

According to Official Gazette of Republic Serbia (2014) strategic development goals for Serbian agriculture and rural areas are defined:

1. Increase of production growth and stability of producers' incomes;
2. Competitiveness improvement with adjustment to the requirements of domestic and international markets and with technological and technical improvement of the sector;
3. Sustainable resources management and environmental protection;
4. Improvement of the quality of life in rural areas and poverty reduction;
5. Efficient public policy management and institutional framework improvement for agricultural and rural areas development.

The productivity growth of the agricultural sector could have a positive impact on achieving these goals. This growth is necessary to provide a sufficient amount of food and an adequate income for farmers. Total factor productivity (TFP) is probably the best measure of productivity change (Coelli et al. 2005). The analysis of the total factor productivity of Serbian agriculture is the main goal of this paper, and it is important for two reasons. First, improving agricultural productivity is often cited as one of the necessary preconditions for achieving Serbia's agricultural policy goals, primarily in terms of competitiveness. Second, TFP growth is usually considered to be the result of the combined influence of different factors. According to Färe et al. (1994), TFP growth could be decomposed into changes in technical efficiency and technical change that identify with the application of innovations in the observed sector. Decomposition of TFP is an additional goal of this research in order to

determine the importance of innovation for the growth of TFP in agriculture. Under the stated goals, the work is organized as follows. A brief explanation of the methods and data used follows the introduction. After that, the results of the research were presented, which were followed by a discussion. Finally, all the conclusions of this research are summarized.

## MATERIAL AND METHODS

Several productivity indices have been developed in previous researches (Kuosmanen and Sipiläinen, 2009; Reziti, 2020), however, the Malmquist productivity index was selected for this paper. TFP can be defined as the ratio of total output produced and total inputs used for a given production (Coelli et al. 2005). The choice of a given index was primarily influenced by the availability of data. In this paper, data envelopment analysis (DEA) is used to calculate Malmquist productivity indices. The same methodology is implemented as in the research of Coelli and Rao (2005). Two papers stand out when it comes to the use of the Malmquist index in European agriculture. Latruffe et al. (2008) analyzed the productivity of Polish agriculture for the period 1996-2000 and concluded that Polish agriculture still lagged in productivity in relation to the EU countries. Coelli et al. (2006) analyzed the TFP of Belgian agriculture in the period from 1987 to 2002 and showed that the average annual productivity growth rate (1%) is below the level of other developed countries. In this paper, one output and five inputs of agricultural production were selected in process of TFP calculation. The value of agricultural production expressed in international dollars is the only output in the analysis. This is also the most commonly used output in the analysis of agricultural productivity. On the input side, the following five variables were selected:

- Labor force expressed in thousands of persons employed in agriculture;
- Agricultural land expressed in thousands of hectares;
- Capital expressed as gross fixed capital formation;
- Mineral fertilizer is calculated as the sum of nitrogen, potassium, and phosphorus used in agriculture, expressed in tons;
- Livestock is presented as the number of livestock units.

The period from 1999 to 2018 is covered. The Food and Agriculture Organization of the United Nations (FAOSTAT, 2021) database was used for all variables.

## RESULTS AND DISCUSSION

Figure 2 shows land, labor, and TFP change in Serbia. Higher growth of land and labor productivity than TFP indicates that other factors of productivity, such as capital or livestock productivity, influenced the TFP slowdown. It is also interesting that there has been a decline in TFP and partial productivities in years with unfavorable climatic conditions in Serbia (e.g. 2012 and 2017), indicating that agriculture is still heavily influenced by weather conditions.

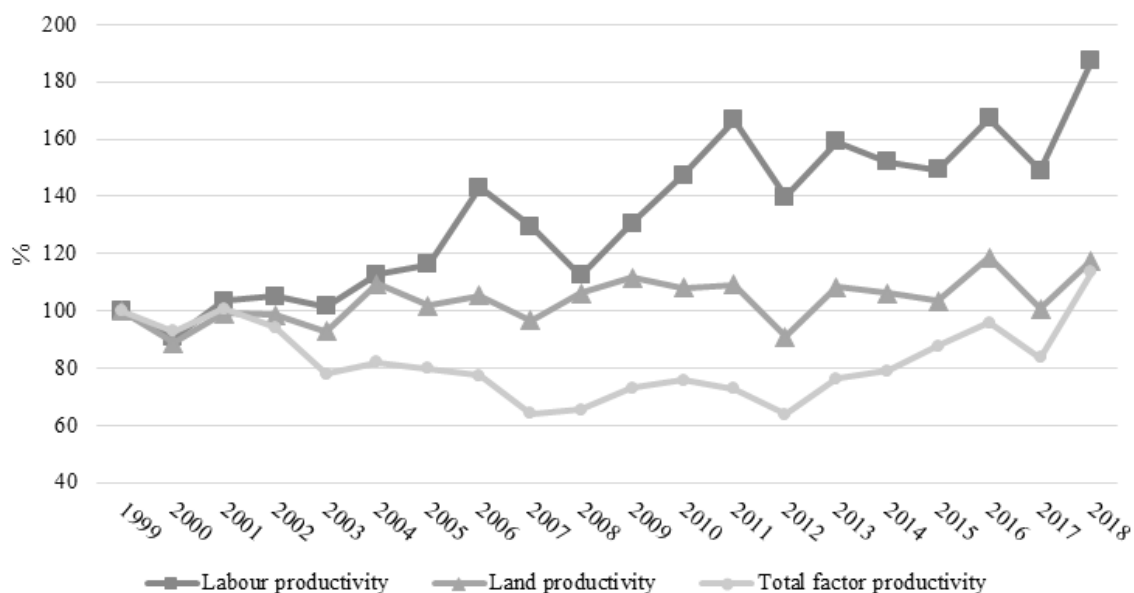


Figure 2. Partial productivities and total factor productivity change in Serbian agriculture (1999=100)

Source: own calculations based on FAOSTAT database

Due to the specific political situation, the transition process started later in Serbia, so it can be assumed that it is a crucial cause of TFP decline in the initial period. Roughly speaking, the observed period can be divided into two stages. The first stage covers the period from 1999 to 2008 and can be called „the late transition period“. This period is characterized by a decline in total factor productivity (annual mean TFP change was -4.6%) and technological regression. This decline could be explained by disturbances caused by property rights reforms and enterprise restructuring that are characteristics of transition countries (Jackson and Swinnen, 1995). The second stage covers the period from 2009. It can be considered as a period of European integration. Table 1 shows mean technical efficiency change, technical changes, and total factor productivity change in Serbia, for two periods. There has been a significant increase in TFP since 2009 (annual

mean TFP change was 5%), indicating that the EU integration process has had a positive effect on the agricultural sector of the country. This growth of total factor productivity was caused by technological changes often associated with innovation. For example, Mohnen and Hall (2013) concluded that innovation leads to a better productivity performance. Also, according to Fuglie et al. (2019) TFP are driven by innovations through investment in research and development (R&D). Furthermore, Kijek and Matras-Bolibok (2019) showed that there is positive effect of innovation externalities on TFP in European regions.

Table 1. Annual mean efficiency change, technical change and TFP change in Serbia

	Efficiency change	Technical change	TFP change
1999-2008	1.00	0.954	0.954
2009-2018	1.00	1.05	1.05

Source: own calculations based on FAOSTAT database

Kline and Rosenberg (2010) suggested that the process of innovation must be viewed as a series of changes in a complete system not only of hardware, but also of market environment, production facilities and knowledge, and the social contexts of the innovation organization. Therefore, in the case of Serbia, it is necessary to pay special attention to organizational innovations to use agricultural inputs more adequately, which would lead to increased productivity in this sector. Also, according to Jurjević et al. (2019), the positive impact of information technology innovation on the sustainability of agriculture is indisputable and future goals of agricultural policy in Serbia should include modernization of this sector. Moreover, since Serbia's strategic goal is to join the European Union, it should be noted that the current European Commission proposal consists of the general objectives that are branched into nine specific objectives linked by common one: increasing knowledge, encouraging innovation, and applying digitalization in the agricultural sector and rural areas (Matthews, 2018).

Paunov and Planes-Satorra (2019) indicate that a sectoral approach is needed when designing innovation policies in some domains, especially regarding data access and digital technology adoption policies. However, the problem of lack of financial resources characterizes Serbia, as is the case in most of the countries exposed to the transition process. Therefore, it is questionable whether it is possible to apply this sectoral approach.

Modest funds should be directed towards the development of technologies whose application with minor adaptations is possible in several sectors. Another possible solution is to connect with foreign institutions within the project whose outcome is applied innovations in agriculture. Of course, a necessary condition is that domestic institutions have the capacity for such significant undertakings. Projects focusing on environmental protection and the production of safe food can be particularly interesting, especially when the European Green Deal and Farm to Fork strategies are taken into account. Finally, Serbia, as a candidate country, has access to certain European Union funds, primarily under IPARD funds. Đurić and Puškarić (2017) concluded that with aim of as much as possible utilization of funds from the IPARD program, it is crucial to provide adequate training for the potential users of these funds through appropriate advisory services. They also stated that the best way for efficient use of this pre-accession fund is to identify a small number of real priorities in financing agriculture and rural development. This is especially important because of process of harmonization of Serbian agricultural policy to Common Agricultural Policy (CAP) of EU. In that context, significant contribution can give Agricultural Knowledge and Innovation Systems (AKIS) which can improve knowledge and services in agriculture and rural areas.

## CONCLUSION

Several conclusions can be drawn from the analysis. First, the economic importance of the agricultural sector is relatively high in Serbia which implies that it is necessary to pay special attention to the competitiveness of this sector. Second, in the observed period, the development of the Serbian agricultural sector can be divided into two stages: „late transition“ and European integration process, with an opposite trend in TFP change. Third, TFP growth in the second stage is influenced by the technical change which emphasizes the importance of innovation for the development of Serbian agriculture. Fourth, higher growth of land and labor productivity than TFP indicates that other factors of productivity, such as capital or livestock productivity, influenced TFP slowdown.

If technological change is generated by innovation, this can be a clear sign to agricultural policymakers to encourage investment in research and development, especially those research that has a positive impact on agricultural productivity growth and environmental performance. In addition, adequate investments in technology development can increase the competitiveness of the agricultural sector of Serbia, which is especially important in the case of full integration with the EU market. An aggravating circumstance is that the agricultural policy budget of Serbia is very limited, which is why funds are mainly directed to solving social issues in rural areas. One of the solutions is European funds that are available to candidate countries such as IPARD.

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# Inovacije i rast ukupne faktorske produktivnosti u srpskoj poljoprivredi

## SAŽETAK

Analiza ukupne faktorske produktivnosti (TFP) srpske poljoprivrede glavni je cilj ovog rada. Da bi se to postiglo, za izračunavanje Malmquistovih indeksa produktivnosti koristi se analiza omeđivanja podataka (DEA). Rezultati su pokazali da je došlo do značajnog pada TFP-a u razdoblju 1999. - 2008. (godišnja srednja promjena TFP-a bila je -4,6%), što je vjerojatno uzrokovano tranzicijskim poremećajima i poljoprivrednim reformama. S druge strane, u razdoblju nakon 2008. godišnja srednja promjena TFP-a iznosila je 5%. Ovaj rast TFP-a objašnjava se tehničkom promjenom povezanom s procesom europskih integracija i boljom implementacijom inovacija. Stoga se može zaključiti da ako se tehnološka promjena generira inovacijama, to bi mogao biti jasan znak kreatorima poljoprivredne politike da potaknu ulaganja u istraživanje i razvoj, posebno ona istraživanja koja imaju pozitivan utjecaj na rast poljoprivredne produktivnosti i ekološke performanse kao što su inovacije u organizacijske i informacijske tehnologije. Osim toga, adekvatna ulaganja u razvoj tehnologije mogu povećati konkurentnost poljoprivrednog sektora Srbije, što je posebno važno u slučaju pune integracije s tržištem EU.

**Ključne riječi:** inovacija, Srbija, ukupna faktorska produktivnost