Exploring the drivers of efficiency in organic and conventional soybean production

Reception of originals: 04/10/2018
Release for publication: 09/05/2018

Popović Rade
PhD in Agricultural Economics
Institution: University of Novi Sad, Faculty of Economics in Subotica
Address: Segedinski put 9-11, Subotica, Serbia
E-mail: popovicr@ef.uns.ac.rs

Žana Kleut
MSc in Agricultural Economics
Institution: University of Novi Sad, Faculty of Economics in Subotica
Address: Segedinski put 9-11, Subotica, Serbia
E-mail: zana.kleut@ef.uns.ac.rs

Danilo Đokić
MSc in Agricultural Economics
Institution: University of Novi Sad, Faculty of Economics in Subotica
Address: Segedinski put 9-11, Subotica, Serbia
E-mail: danilo.djokic@ef.uns.ac.rs

Abstract

The significance of soybeans in Serbia is reflected in the fact that Serbia is the fourth country in Europe for soybean production. In order to anticipate the possibility of increasing soybean production in Serbia and thus contribute to increasing the supply of safe, reliable and constant protein to soybean users on the EU market completely; the goal of this research is to determine technical and cost efficiency of conventional and organic soybean producers in Serbia using non-parametric efficiency measurement technique - Data Envelopment Analysis and then to determine the sources of inefficiency of soybean production. The model is the result of a study of soybean producers in organic and conventional production systems. Both technical and cost efficiency are higher for organic producers (0.95 and 0.77, respectively) than for conventional farmers (0.69 and 0.41, respectively). Tobit models have identified additional sources of technical and cost inefficiency. Factors as farm size, production system, share of family labour, share of rented land, land fragmentation affect technical and cost efficiency. Level of education of farm managers, soil analysis and seed type have a statistically significant impact on technical efficiency, while participation in the project affects cost efficiency. In addition, the increased demand for non GMO conventional and organic soybean, primarily from EU countries, represents the development potential of the soybean producers in Serbia.

Keywords: Data Envelopment Analysis (DEA). Tobit model. Inefficiency.

1. Introduction

Crop production in Serbia is changing since middle of 1970-es. With 5% growth rate in harvesting area soybean become third most important crop, after corn and wheat. In 2017 soybean harvesting area reached 203,000 hectares and 7.2% of utilised agricultural area (Statistical Office of the Republic of Serbia, 2017). Province of Vojvodina is the most important soybean production region with 95% share in sown area. The conventional production system in Serbia is basic, while organic soybean production is in the stage of development. A small number of producers are certified for such a production system, and quantities are mostly exported to the countries of the European Union.

The idea for this research was derived from a project entitled *"High-quality, GMO-free Soya from the Danube region"*, commissioned by the German Federal Ministry for Economic Cooperation and Development, designed to promote the cultivation and certification of GMO-free soybeans in the Danube region (GIZ, 2017). Also, a goal is to promote European cooperation and economic integration of the surplus areas of Central and Eastern Europe and offer safe, reliable and constant protein to soybean users and consumers all over Europe (Krön & Bittner, 2015). The key reason is a great demand for high-protein materials for livestock feed in Europe, because European agriculture has a deficit of about 70% high-protein materials of which 87% is met by imported soybean and soy meal (Watson et al., 2017). Serbia joined this project in 2014. The inclusion of Serbia is important primarily because of the growth of GMO-free soybean production in recent years (Popovic et al., 2016). Small areas under soybeans in the European Union, a great demand for high-protein materials for livestock feed, as well as increased exports of GMO-free soybeans to the EU market are significant trends that indicate the need for growth in soybean production in Serbia. According to that, the aim of this study is to determine technical and cost efficiency of organic and conventional soybean production in Serbia, as well as to reveal factors of inefficiency in soybean production.

Due to the ongoing process of EU accession, a key issue for the Serbian agriculture is whether the farms will be able to adequately adjust to rapid changes in market liberalization and international competition. Findings in studies as Bojnec & Latruffe (2008), Mussa et al. (2012), Shrestha et al. (2016) show that farms efficiency analysis can serve as a reference for creators of agrarian policy, in order to support efficiency improvement on the farms or reduce the impact of negative factors on efficiency. In Serbia this analysis is rarely used, due to the small number of studies in this area, such as Popovic et al. (2016). For this reason, this study provides a contribution to the literature in the field of farm efficiency in Serbia.

The study is divided into several segments. The second part gives an insight into the methodological basis of research, followed by research results, whereas the last part draws discussion and policy implications on the basis of the previously presented results.

2. Literature Review

The Farrell's study (1957) builds the concept of cost efficiency measurement, based on technical and allocative efficiency. Several methods for efficiency measurement are developed after. One such model is nonparametric *Data Envelopment Analysis* (DEA). It is a mathematical method based on a linear programming, which is the most often applied on a sample of firms (at one point in time) and provide measures of relative efficiency among those firms (Coelli et al., 2005). DEA method does not require a priori specific function of production which is one of the advantages of this model (Coelli et al., 2005; Madau, 2015). It is notable that, depending on the aim of research, this method can be applied to different levels of research (comparison of different farms, regions or countries). Bojnec & Latruffe (2008) used DEA method to compared technical, allocative and cost efficiency of 13 farm production branches in Slovenia, over a ten-year period 1994-2003, with 130 individual family farms included in the empirical analysis. The results indicated that five farm production branches were fully efficient in this period: crop, dairy, livestock using own feed, fruit, and forestry.

Also, DEA can be applied on regional or national level of research. Kočišová (2015) investigated and compared the relative technical efficiency of the agricultural production in the 27 countries of the European Union (EU) at the national level during the period 2007–2011. The research included input and output-oriented models using the assumption of a variable return to scale and results showed that 13 agricultural sectors were determined to be relatively technically efficient in both models during the whole analyzed period.

This research is based on a comparison of the technical and cost efficiency of organic and conventional production. In the literature, there are many studies comparing these two production systems, from the aspect of efficiency as Bayramoglu & Gundogmus (2008), Beltrán-Esteve & Reig-Martínez (2014), etc. Artukoglu et al. (2010) analyzed technical efficiency of 62 organic and 62 conventional olive producing farms in Turkey, with the results indicating lower technical efficiency of conventional olive oil farms than that of organic farms. The same result is the conclusion of research Poudel et al. (2011) in which organic coffee producers were technically more efficient than conventional coffee farming. Contrary to these studies, Bayramoglu & Gundogmus (2008) pointed to a higher average technical but also cost efficiency of conventional raisin-producing households in Turkey.

The development of new empirical technique has enabled identification of the factors affecting the efficiency, which is particularly important for the implementation of agricultural policy measures. Many studies used a two-step analysis, which combines the DEA method and Tobit model (Tipi et al., 2009; Mussa et al., 2012; Idris et al., 2013; Haryanto et al., 2015; Mirza et al., 2015; Anang et al., 2016; Shrestha et al., 2016). Tobit model, which is defined by James Tobin (1958), is also knows as censored regression model. Model shows the relationship of independent variables with non-negative dependent variable, which is censored.

Idris et al. (2013) analyzed technical efficiency of 124 farms engaged in the production of pineapple in Malaysia. The results indicated that the size of farms, the use of family labour force and participation in associations have a statistically significant impact on technical efficiency of these farmers. In contrast to this study, Mirza et al. (2015) showed the importance of age, education and experience of farmers on technical efficiency of 120 farms that produce wheat in Pakistan. Also, among these factors important factors are family size, as well as land under wheat, while the power of the tractor is not statistically significant. Haryanto et al. (2015) analyzed the sample consists of 5,537 farms engaged in the production of rice, divided in 5 regions of Indonesia. The average technical efficiency of rice farming in Indonesia is about 0.77. There are significant differences between the regions. Also, the results of Tobit analysis indicated that there were several factors which influenced technical efficiency such as the use of certified seeds, pests and diseases control, the government assistance, education and irrigation. In contrast, net income, age, off-farm job, size of farm, season and access to credit were not statistically significant in the context of the model.

Shrestha et al. (2016) used a Tobit model to detect the impact of farm specific variables on technical, allocative, scale and cost efficiency on a sample of 502 farms engaged in the production of vegetables in Nepal. Farm specific variables include seed type, training of farmer manager, credit access, market access, external support index, gender of farm manager, women participation index. The results of this study pointed the role of women in vegetable production, where women showed to be more efficient managers. On the other hand, some studies that include gender of managers in their analysis proved that it has no influence on efficiency. One of these studies is the research of Mussa et al. (2012) in which gender of managers had no statistical significance on technical efficiency, unlike age, family size, livestock size, participation in associations and nonfarm activities.

3. Material and Methods

Analyzed sample contains of 39 soybean producing farms, ranging from small to large. The variables taken into models are from 2016 production year. The sample of farms is in line with the current structure of soybean production in the northern region of Serbia (region of Vojvodina), according to the criteria of the size of the farms and the production system. Both organic and conventional systems of production were analyzed. The project included 12 organic soybean producers and 19 farms in the conventional production system. All farms included in the project received significant agriculture extension support. Also, 8 conventional producers, who did not participate in the project, were selected as the control group for comparison with the conventional producers participating in the project.

The analysis has been decomposed in two parts, wherein a first part includes the measurement of technical and cost efficiency using DEA, which is linear programming model. The efficiency of a firm consists of two components: technical efficiency, which reflects the ability of a firm to obtain maximal output from a given set of inputs and allocative efficiency, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices and the production technology (Coelli et al., 2005). Combination of these two measures provides a measure of total cost efficiency.

DEA apply on set of entities called Decision Making Units (DMU) which convert multiple inputs to multiple outputs. Basic DEA models are CCR developed by Charnes, Cooper and Rhodes and BCC model developed by Banker, Charnes and Cooper, in which the first model is based on the presumption of constant returns to scale (CRS), while the second model is based on the variable returns to scale (VRS) (Kočišová, 2015). Depending on these presumptions, technical efficiency is decomposed into three dimensions: overall technical efficiency, pure technical efficiency and scale efficiency. Overall technical efficiency refers to technical efficiency using the CCR model, while pure technical efficiency relates to technical efficiency using the BCC model (Anang et al., 2016). Scale efficiency is the ratio of overall technical efficiency (CRS DEA) and pure technical efficiency (VRS DEA) (Tipi et al., 2009; Anang et al., 2016).

Another important aspect of DEA method is to select the orientation. Depending on whether the input-oriented or output-oriented DEA model, technical efficiency indicates the possibility of reducing the inputs with the same output or the possibility of increased output without altering the inputs quantities used (Coelli et al., 2005). Control of the variables of production is one of the selection criteria for orientation (Tipi et al., 2009). As farmers have greater control over inputs, under this analysis, input-oriented DEA methods is used in this study.

Accordance with the methodology Coelli et al. (2005) an input-oriented CCR model, which was the first to be widely applied, is given below for *I* Decision Making Units (DMU):

$$\begin{aligned} &\min_{\theta,\lambda} \theta, \\ \text{st}\quad &-q+Q\lambda \geq 0, \qquad [1] \\ &\theta x_i - X\lambda \geq 0, \\ &\lambda \geq 0, \end{aligned}$$

Where: θ is a scalar and λ is I x 1 vector of constants. The value of θ will be the efficiency scores for firm *i*. This linear programming problem must be solved *I* times, once for each firm in the sample. A θ value of 1 indicates that the firm is technically efficient according to the Farrell (1957) definition.

If price data are available and a behavioural objective, such as cost minimisation or revenue or profit maximisation, is appropriate, then it is possible to measure allocative efficiencies as well as technical efficiencies, whereby allocative efficiency (AE) is the ratio of the total cost efficiency (CE) and technical efficiency (TE): AE=CE/TE (Coelli et al., 2005). In this research, the model under CRS assumption was used. This model was applied in the research of Shrestha et al. (2016) and is defined as:

$$\begin{aligned} &\min W_i' X_i^* \\ &x_i \lambda \qquad [2] \\ &\text{Subject to: } Y_i \leq Y\lambda \\ &X_i^* \geq X\lambda \\ &\lambda \geq 0, \end{aligned}$$

Where: X_i^* is a cost-minimizing vector of input quantities for the i^{th} farm (DMU), given its input price vector W_i and total output level Y_i. These three measures (TE, AE and CE) can take values ranging from 0 to 1, where a value of 1 indicates full efficiency (Coelli et al., 2005). The program DEAP version 2.1 was used in order to calculate all three efficiency measures of soybean producers in Serbia.

Descriptive statistics for variables used for DEA method are shown in Table 1. Net profit and adjusted gross margin are used as outputs. The determined amount of the value of the active substance taken out by yield unlike the cost of applied fertilizers was used as a corrective element for determining the adjusted gross margin in the production of soybean, which is a more adequate indicator of the achieved result. Inputs used in the model are: diesel fuel, seed, NPK fertilizer, labour, land, pesticides and fixed and other costs.

Table 1: Descriptive statistics for variables used for DEA method

Variables	Unit	Mean	Standard Deviation	Minimum	Maximum
Output					
Net profit	RSD*/ha	106, 809.6	61, 397.02	5, 141.4	215, 884.7
Adjusted gross margin	RSD/ha	128, 597.4	52, 331.19	70, 030.0	228, 451.0
Inputs					
Diesel fuel	l/ha	104.8	16.51	70.0	142.7
Seed	kg/ha	91.9	11.22	61.5	120.0
Fertiliser (NPK)	kg/ha	343.9	79.69	187.0	692.0
Labour (family + hired)	h/ha	70.9	75.63	6.5	254.3
Land	ha	1.0	0	1.0	1.0
Pesticides	No/ha	1.7	1.40	0.0	5.0
Fixed and other costs	No/ha	1.0	0	1.0	1.0
Inputs Costs					
Diesel fuel	RSD/l	129.3	5.37	110.0	135.0
Seed	RSD/kg	89.4	13.65	46.0	107.0
Fertiliser (NPK)	RSD/kg	96.6	0.60	94.4	97.0
Labour	RSD/h	185.4	28.75	125.0	250.0
Land use	RSD/ha	46, 279.1	18, 042.21	21, 291.4	77, 719.8
Pesticides	RSD/No	3, 525.1	2, 925.1	0.0	9, 882.0
Fixed and other costs	RSD/ha	8, 887.6	7, 100.8	0.0	26, 255.8

*Note: * official currency in Serbia; ***

The quantities of Nitrogenous, Phosphoric and Potassium fertilizers in the soybean production include the amounts of active substances that are incorporated using organic and mineral fertilizers, amount of nitrogen bound to nitrogen fixation, as well as the amounts of nutrients taken out, depending on the yield level of the soybean and the way of using soybean straw. Input costs computed by multiplying the amount of input used by the market price of the input. All soybean gross margin budgets were developed per 1 hectare.

As already mentioned in the literature review, there are many studies that used this model as a base for detecting factors of inefficiencies in agricultural production, such as: Idris et al. (2013), Haryanto et al. (2015), Shrestha et al. (2016), etc.

Drawing from the literature listed above standard Tobit model of a farm "*i*" is defined as:

$$Y_i^* = x_i'\beta + u_i \qquad i = 1, 2, 3, ..., n$$
$$Y_i = Y_i^*, \text{ if } Y_i^* > 0 \qquad [3]$$
$$Y_i = 0, \quad \text{if } Y_i^* \leq 0$$

Y_i^* is a latent variable; Y_i is the observed depended variable, x_i is vector of explanatory variables (farm specific variables), β is vector of unknown parameter to be estimated, u_i is random error term that is independently and normal distributed with zero mean and the constant variance $(0, \delta^2)$.

The variables used in Tobit model are given in Table 2. The choice of these variables is influenced by available statistical information, as well as the experience of the preceding studies which used Tobit model.

In accordance with the basic model, the empirical Tobit model specification is written as follow:

$$\textbf{\textit{TE or CE}} = \beta 0 + \beta X_{1(age)} + \beta X_{2(gender)} + \beta X_{3(education)} + \beta X_{4(project)} + \beta X_{5(farm\ size)} + \beta X_{6(system)} + \beta X_{7(family\ labour)} + \beta X_{8(rented\ land)} + \beta X_{9(size)} + \beta X_{10(fragmentation)} + \beta X_{11(seed)} + \beta X_{12(machinery)} + \beta X_{13(off\text{-}farm)} + u_i$$

Tobit model are estimated using Maximum Likelihood Method. For this analysis, program EView version 9.5 was used.

Table 2: Description of variables used in the Tobit regression analysis

No.	Farm-specific variables	Description
X_1	Age of the farm managers	Years
X_2	Gender of farm managers	1- Male; 0- Female
X_3	Level of education of farm managers	1- without formal education; 2- primary education; 3- secondary education; 4- higher education; 5- faculty
X_4	Participation in the project (training of farm managers)	1- Yes; 0- No
X_5	Farm size	1- Small farms (less than 5 hectares); 2- medium farms (5 to 20 hectares); 3- large farms (over 20 ha)
X_6	Production system	1- conventional, 0- organic
X_7	Share of family labour	%
X_8	Share of rented land	%
X_9	Land fragmentation	Number of plots
X_{10}	Soil analysis	1- Yes; 0- No

X_{11}	Seed type	1- purchased seed; 2- combination (purchased and seed from own production); 3- from own production
X_{12}	Use of machinery	1- own mechanization; 2- combination (own mechanization and paid services); 3- paid services
X_{13}	Off-farm income	1- Yes; 0- No

4. Results of the Analysis

In this study, input-oriented DEA method under CRS assumption was used to calculate technical and cost efficiency for the soybean producers in Vojvodina region (Table 3).

Table 3: Frequency distributions of technical and cost efficiency scores obtained with Data Envelopment Analysis (DEA)

Efficiency scores	TE		CE	
	Organic	Conventional	Organic	Conventional
<0.40	0	1	0	13
0.40-0.49	0	3	1	9
0.50-0.59	0	5	0	5
0.60-0.69	0	6	1	0
0.70-0.79	1	5	5	0
0.80-0.89	0	2	3	0
0.90-0.99	6	1	1	0
1.00	5	4	1	0
No. of farms	12	27	12	27
Mean	0.95	0.69	0.77	0.41
Std. Dev.	0.07	0.19	0.15	0.08
Min	0.77	0.33	0.41	0.25
Max	1	1	1	0.55

The average cost and technical efficiency scores were higher for organic producers of soybean than conventional producers. From the aspect of technical efficiency, in the total number of organic producers, 42% were evaluated as fully efficient (TE= 1), while all organic producers had efficiency scores more than 0.70. The results for conventional producers indicate lower level of technical efficiency. Distribution of cost efficiency scores indicates that 48% of conventional farms have a lower cost efficiency scores than 0.40, while all conventional producers have a scores less than 0.60. In general, the estimation level of cost and technical efficiency for conventional producers, in relation to organic, suggest that significant cost savings could be achieved through a more efficient use of input and reallocation of inputs.

Using the method of DEA, the results indicate lower technical and cost efficiency of conventional producers than organic producers. More precisely, organic farms whose managers have university education, with average farm size from 5 to 20 hectares, greater share of family labour in total and smaller share of rented land, are the most technical efficient. In this study, the importance of these farms (up to 20 hectares) was confirmed through a higher technical and cost efficiency comparing to the large farms, which indicates misallocation of resources on larger farms. The calculated coefficients of Tobit regression are shown in Table 4.

A higher level of education indicates a greater technical efficiency of farms. The results show that the average technical efficiency of farms whose farmers have university education is 0.81, which is the best result compared to other levels of education.

The size of the farms is statistically significant from the aspect of technical and from the aspect of cost efficiency. For a more detailed analysis, farms are divided into three groups: small farms (less than 5 hectares), medium farms (from 5 to 20 hectares) and large farms (over 20 hectares). The technical efficiency of the first group is 0.70, 0.83 for the second group and 0.74 for the third group, which indicates that, in the sample, farms from 5 to 20 hectares are technically most efficient. In terms of cost efficiency, medium farms (from 5 to 20 hectares) are also the most efficient, with an average efficiency of 0.54, which is higher than the efficiency of small farms (0.48) and large farms (0.52).

Table 4: Results of Tobit model for inefficiency factors of technical and cost efficiency

No.	Farm-specific variables	Technical Inefficiency		Cost Inefficiency	
		Coefficient (β)	Significance	Coefficient (β)	Significance
X_1	Age of the farm managers	0.001337 *(0.00184)*	0.4680	0.001501 *(0.00091)*	0.1014
X_2	Gender of farm managers	-0.007375 *(0.08306)*	0.9293	-0.013476 *(0.04129)*	0.7442
X_3	Level of education of farm managers	0.062628 *(0.02825)*	0.0266**	0.006253 *(0.01404)*	0.6562
X_4	Participation in the project	-0.00001 *(0.07096)*	0.9998	0.059315 *(0.03528)*	0.0927***
X_5	Farm size	0.102799 *(0.05294)*	0.0522***	0.115798 *(0.02632)*	0.0000*
X_6	Production system	-0.204049 *(0.06625)*	0.0021*	-0.374499 *(0.03293)*	0.0000*
X_7	Share of family labour	0.117920 *(0.05281)*	0.0256**	0.069268 *(0.02625)*	0.0083*
X_8	Share of rented land	-0.002246 *(0.00069)*	0.0013*	-0.001041 *(0.00034)*	0.0026*
X_9	Land fragmentation	-0.004952 *(0.00192)*	0.0100*	-0.007091 *(0.00095)*	0.0000*

X_{10}	Soil analysis	0.099002 *(0.05938)*	**0.0955***	0.025661 *(0.02952)*	0.3848
X_{11}	Seed type	0.081788 *(0.03310)*	**0.0135**	0.009434 *(0.01646)*	0.5665
X_{12}	Use of machinery	-0.026619 *(0.04374)*	0.5429	-0.012478 *(0.02175)*	0.5652
X_{13}	Off-farm income	0.035937 *(0.04698)*	0.4444	-0.022016 *(0.02336)*	0.3460

*Note: values in parentheses are asymptotic standard errors; *, **, *** indicate significant at 1, 5 and 10% levels, respectively.*

5. Discussion

Unfavourable educational structure, which is characteristic of farm production in Serbia, has a significant impact on the further development of this sector. Tzouvelekas et al. (2002) emphasize that education is a strong complement to most of the inputs utilized in production process and its importance is indispensable. These results are extremely significant from the perspective of the creators of the agrarian policy with regard that advisory services usually organize training to improve the education of farmers. Positive relationship between level of education of farmers and technical efficiency is also represented in the model of Haryanto et al. (2015). In this study, it is shown that farmers with a higher level of education apply better production practice, through the efficient use of inputs. How the extension service is a direct link between farms and new knowledge, it is necessary to increase the issuance of the agricultural budget in the direction of increasing training and seminars for farmers across the country. This type of learning has proven to be extremely important, given that most of the farms in Serbia are facing traditional structure of production. It also requires various social programs, primarily related to training and improving the managerial skills of women in agriculture and young farmers. These actions can significantly contribute to increasing the efficiency.

Since a soybean production is more labour intensive than other crops it appears that middle sized farms relied on family labour are optimal for efficient soybean production. The results of various studies indicate a different effect of farm size on efficiency. In some studies, such as Tipi et al. (2009) and Idris et al. (2013) large farms are more efficient while the researches of Taraka et al. (2010) and Anang et al. (2016) indicated a negative relationship between the size of the farm and technical efficiency, wherein the farmers with small size of farm could concentrate on their farms more than the larger.

As expected on the basis of previous DEA results, the production system is statistically significant from the aspect of technical and cost efficiency. Observed from the aspect of technical efficiency, there are several studies that have the same conclusion such as Artukoglu et al. (2010) and Poudel et al. (2011). On the other hand, there is very little research that compares the cost efficiency of organic and conventional producers, which points to the contribution of this study.

The results of the Tobit models also indicate the positive impact of the family labour on both technical and cost efficiency, which is consistent with the results of Taraka et al. (2010) and Idris et al. (2013). Tzouvelekas et al. (2002) point to the importance of "power of incentives and the motivation of family labour". Also, these authors emphasized the importance of land ownership, because farmers are tempted to "mine" the soil if land is not owned by them, which significantly affects efficiency. Results of this study are in line with this assumption, because a higher share of rented land has a negative effect on technical and cost efficiency. The same conclusion is set forth in the study of Taraka et al. (2010) where property on the land is a sign of the wealth of farmers and could create the availability of inputs and resource and provide new technology.

Land use management has great importance for the efficiency of farming. Land fragmentation, represented by the number of plots, is negatively related to technical and cost efficiency. The average technical and cost efficiency of farms with one plot is 0.78 and 0.57, respectively, which is higher than the efficiency of farms with more than one plot (TE= 0.76, CE= 0.48). A larger number of plots increases total costs and affects the increase in labour and machinery use. Tipi et al. (2009) also indicate a negative relationship between land fragmentation and technical efficiency, primarily as a large number of plots causes loss of farmland area, but also time loss in travel and inconvenience in management. An example of good land use management is soil analysis. In this research, soil analysis has a positive impact on the technical efficiency, whereby technical efficiency is higher in the case of farms that have done soil analysis (0.81), compared to those that are not (0.62). These results are expected as soil analysis affects the effective use of mineral fertilizers, which has multiple benefits, both cost saving for farmers and the environment.

Another variable that affects technical efficiency is the seed type. This factor is included in the Tobit models of the following studies: Taraka et al. (2010), Haryanto et al. (2015), Shrestha et al. (2016). For a more detailed analysis, the farms in this study are divided into three groups: farms with purchased seed, combination (purchased and seed from own production) and farms with seed from own production. The results indicated that technically the most efficient organic farmers who use seed from their own production (0.97), while farmers who use purchased seeds (0.70) and farmers who combine seeds (0.74) have poorer results. These results also indicate the difference between organic and conventional production, since it is a characteristic of organic producers to use seed from their own production. Also, these results are contrary to the above-mentioned research.

Participation in the project had a positive impact on cost efficiency. The training and workshops within the project are focused on improving the farming practice, assistance in the decision-making process with optimal choice, timing and allocation of inputs. The aim of the project was to connect farmers for the exchange of information and modern practices, which has contributed to the fact that more efficient farmers are farmers who participated in the project, compared to the farmers from the control group. These results point to the importance of organizing training and cooperation of farmers, as this affects the improvement of farming practice as well as efficiency. A positive link between training of farmers under the program and the cost efficiency is expressed in the survey of Shrestha et al. (2016).

A positive effect was the implementation of the program *"High-quality, GMO-free soya from the Danube region"* in Serbia, given the better results of the project participants in relation to the control group. The project is based on monitor the parameters of business within the soybean production. Accordingly, future research will move towards research of technical progress, which includes perennial research. Such research will represent a contribution to this study.

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7. Acknowledgement

The authors are grateful to German Federal Ministry for Economic Cooperation and Development, Donau Soja organization and all lead executing agencies in the project, for their support. We would also like to show our gratitude to the soybean producers in Serbia for their cooperation and for providing the data set to undertake this study.