

**THE IMPORTANCE OF POTATO PRODUCTION
IN THE REPUBLIC OF SERBIA IN ORDER TO EMPHASIZING
THE RURAL DEVELOPMENT¹**

*Aleksandra SAVIĆ,
Milan UGRINOVIC,
Marijana JOVANOVIĆ²*

*The rural areas in Republic of Serbia are areas whose main physical and geographical characteristics are using of land for the agricultural production and they amount 85% of total area. Agricultural production is the dominant activity. Major number of households disposes with a low cultivated land, achieves a low rate of productivity and profit. Potato is one of the main cultivated crops, both in areas where it is grown, as well as on importance for human consumption and processing industry. Because of the pronounced tendency of decline in average yields, there was an overall drop in production volume. which meets domestic consumption. Annual exports are 1%, mainly in countries in the region. After eradication of potato ring rot, caused by *Clavibacter michiganensis ssp. sepedonicus*, the European Commission has approved the export of potatoes to the EU market, which can be a significant incentive for greater investment in potato production. In this paper, the importance of the potato for rural development and emphasizing the production technology is presented with special accent on plant protection as an important factor in the production of this crop.*

Key words: rural development, potatoes, production, plant protection

Introduction

Potato (*Solanum tuberosum* L.) is one of the main cultivated crops, both in areas where it is grown, as well as on importance for human consumption and processing industry. It is the main raw material in the production of chips. Also, it is used as one of the most important materials in the alcohol and starch production (Lazic et al. 2004).

In Republic of Serbia, potatoes are planted on about 78 000 ha with annual production of 900. 000 t, and average yield of 11,4 t/ha (SORS, 2012). Annual potato production meets domestic demands and exports are only about 10. 000 tones per year. The average yields of potato are very low despite the good climatic conditions and the potato production is not profitable due to a low yields rather than a low prices (Milosevic et al. 2012/a). Because of the pronounced tendency of decline in average yields, there was an overall drop in production volume.

After eradication of potato ring rot, caused by *Clavibacter michiganensis ssp. sepedonicus*, the European Commission has approved the export of potatoes to the EU market, which can be a significant incentive for greater investment in potato production. However, in order to provide sufficient quantities of potatoes for export it is necessary to increase the arable area under potato crops and increase average yields.

Achieving higher average yields is very difficult because of the widespread practices: the use of uncertified seeds, the application of unsuitable pesticides, insufficient and inadequate utilization of fertilizers.

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² Aleksandra Savic, aleksandrasavic159@gmail.com, student at Faculty of Agriculture, Belgrade, Serbia, Ugrinović Milan, research assistant, milan.ugrinovic@gmail.com, Institute for Vegetable Crops, Karadjordjeva 71,11420 Smederevska Palanka, Serbia, Marijana Jovanovic, research assistant, manajov@yahoo.com, Institute of Agricultural Economics, Volgina 15 Street, 11060 Belgrade, Serbia.

Appearance of some diseases could be reduced by the use of certified seed tubers. Many farmers use their own seed tubers wanting to reduce costs for the purchase of certified seeds. They choose smaller tubers from previous season for sowing which are rarely uninfected. Potato virus Y (PVY) and Potato leaf roll virus (PLRV) are transmitted through the infected tubers from one growing season to another causing yield losses and poor economic result (Milosevic et al., 2012/b). Seed tuber certification is also mentioned as the measure for other potato pathogen control such as *Dickeya solani*, formerly known as *Erwinia chrysanthemi* (Toth et al., 2011).

Potato late blight, caused by *Phytophthora infestans*, occurs occasionally in Serbia due to a suitable weather conditions. It can be predicted and controlled only preventively by the application of appropriate fungicides. Otherwise, late blight can induce great yield losses in the unprotected potato crops (Martinez Noel et al. 2001; Ivanovic and Ivanovic 2004; Milosevic et al., 2004).

Aphids (*Aphididae*) can inflict minor damage by sucking of potato plants but they are important as transferors of harmful PVY and PLRV. They can transmit viruses from infected plants within the crop or from infected neighbour crops. That is especial danger for potato seed production (Byamukama et al. 2004; Milosevic et al. 2012/b).

Colorado potato beetle (*Leptinotarsa decemlineata* Say.) is the most harmful species in potato production. The greatest problem is occurrence of insect resistance to certain insecticides. Colorado potato beetle is ranked among 10 species that most rapidly develop resistance. To avoid the losses of yield, potato crops in Serbia are treated with insecticides two to four times during vegetation but sometimes without good results (Indić et al. 2012).

It can not be ignored the fact that chemical control of harmful pathogens and insects must be combined with appropriate agro-technical measures to ensure high yields. First of all, crop rotation is an almost cost-free measure which can improve plant nutrition, disease and weed suppression without additional investments. The risks associated with diseases and nutrient deficiencies in potato production are higher when the previous crop belongs to the *Solanacea* family. Pepper, tomato, egg plant, tobacco and especially potato are unsuitable as previous crops. Crop rotation is not widely used by farmers only because of the lack of knowledge and bad managing skills.

Except the use of certified tuber seeds, it is necessary to choose disease tolerant and resistant potato varieties (Brocic et al. 2001). With properly choosed varieties, plant protection costs can be reduced without significant yield losses. Irrigation is another important agro technical measures. Irrigation can achieve significantly higher yields especially in drought conditions (Milić et al. 2010).

For the protection of potato priority should be given to preventive measures: selection of resistant or tolerant varieties, using healthy and certified seed, use of cultural practices that create unfavorable conditions for the development of disease-causing agents and pests (crop rotation, the flat ripening optimalalno irrigation, the use of physical and mechanical measures and tools , the use of biological agents (insects, animals and microbial antagonists), the use of chemical substances handy (S, Cu). pesticides should be applied only in cases where the occurrence or abundance of pathogens or pests reach economic threshold.

In potato production may arise problems that occur due to improper use of chemical agents that are used in practice, unprofessional, and very often unnecessarily, which reflects negatively on the environment, and thus affects the profitability of this crop. It is necessary to carry out the implementation of the "code" of good agricultural practices and help farmers establish plans for integrated pest problem solving, where necessary. It is necessary to introduce farmers to implement effects of pollutants for a better understanding of how to reduce the influence of pesticides and finding cost-effective solutions.

Each production is based on the same goal, ie. earning the yield, which may reflect favorably on rural development. The ultimate outcome depends on a number of factors that can affect very much to reduce it. Care of crops and new quality and efficient solutions to increase yields and improve the quality, ensuring the success of production. Taking into account the time period in which Serbia is in the process of joining the World Trade Organization, as well as many other European integration, agriculture and rural areas have an important place in the overall social development, and implementation of these measures may contribute to increased yields and arable land under tubers , more money would be poured into the village and thereby create better conditions for achieving higher production which had a favorable effect on exports to the EU.

Materials and methods

The database used for this work, was the record book of the Institute of Vegetable Crops, Smederevska Palanka (accounting calculations), as well as datas collected from potato producers, members of the local Vegetable producers association. The calculation included the costs of the agro – technical measures conducted by members of association. The costs of certified potatoe seed tubers and average yields were also determined by interviewing. Average yield was calculated by dividing the overall production for 2011. year, with number of members of the association of vegetable growers. Using the interview method a set of seeds, plant protection and fertilizers applied by other producers (Registered producers - RPG) that are not members of the association of vegetable growers. Calculation of the potato, is shown in *Tab 1*.

Table 1. Preview calculation of the potato. Source: Author's calculations for the non-governmental organization that promotes engaging unemployed refugees and displaced persons in agricultural production

Potato producers:	traditional growing practice		members of the local Vegetable growers association	
	€ / ha	%	€ / ha	%
costs:				
chopping of plant debris	30	1,16	30	0,53
sampling and soil analysis	0	0	0	0
manure or / and mineral fertilizers	400	15,50	600	10,56
plowing	100	3,80	100	1,76
seeds / seedlings	0	0	2.300	40,49
tilling	50	1,94	50	0,88
fine tilling	40	1,55	40	0,70
planting / sowing	150	5,81	150	2,64
cultivation	60	2,33	60	1,06
human labour	500	19,38	500	8,80
watering - irrigation	0	0	450	7,92
chemical crop protection	150	5,81	150	2,64
pesticides	400	15,5	550	9,68
harvest (selecting and packaging)	700	27,13	700	12,32
Total costs/ha	2580	100	5680	100
income:				
average yields (kg)	11400	9400	24000	
price(€/kg)		0,35	0,35	
revenue - income/ha (€)		3290	8400	
profit €/ha		610	2720	

In order to improve fertilizers use efficiency, Ministry of agriculture provides

subsidies for soil sampling and analysis. Soil analysis is free of charge for registered producers (RPG).

Many manufacturers use their own production of tubers from the previous year. Therefore, in the calculation of production costs of traditional farmers reduced the average yield of 2 tons per hectare. This amount is used for planting next season.

Potato is a vegetable that attack many diseases, weeds and pests. Very important is the proper selection and timely application of pesticides. Today, there are pesticides that prevent the development of disease and provide high quality application.

In Table 2, presents the correct choice of products for the treatment of potatoes, and the time of protection is recommended in order to achieve cost-effective production and achieve the highest possible yield.

Table 2. Preview potato protection program

Reason of protecting	Active substances	Costs (€/ha)
<i>Leptinotarsa decemlineata</i> , grčice, <i>Rhizoctonia solani</i>	Imidaklopid Tiametoksam Acetamiprid (Pensikuron) Abamektin	180
One-year narrow-leaved and broad-leaved weeds	Pendimentalin	50
Annual broad weeds	Metribuzin	40
<i>Agropyron repens</i> , <i>Sorghum halepense</i>	Kvizalofop – P Imidaklopid	30
<i>Phytophthora infestans</i>	Cineb, maneb, mankozeb, bakar	60
<i>Phytophthora infestans</i>	Propineb	30
Foliar feeding, <i>Phytophthora infestans</i>	Metalaksil	50
Foliar feeding, <i>Phytophthora infestans</i> , <i>Alternaria solani</i>	Propineb Pyraclostrobin+Boskalid	60
Overall costs		500

Results and discussion

In Serbia, the potatoes are grown mostly in the mountainous areas of central Serbia, on more than 78 000 ha, with overall annual production of 900 000 t, and average yield of 11.4 t per hectare. The average yield in Europe is higher for about 45%, despite the good ecological conditions in Serbia. Therefore, the production of potato in the future should pay more attention to an extraordinary given the huge economic importance of the plant.

Knowledge of certain costs and their share in the overall structure of production is important for decision making, when an economic analysis of the dominant group to recognize the costs, which mostly affect the cost structure of the final product (Kanisek et al. 2008.). Costs of production in addition to income is one of the most important factors that influence the production and profit. Development of a market economy they are a significant factor in competitiveness (Bosniac and Rodić, 2010).

Cost of human labor and fertilizer costs make up the bulk of a traditional farming system (Table 1). Are represented by 40 to 45% of the total costs. Besides labor costs are a significant proportion of the cost of fertilizer. On the other hand, the cost of procurement of certified seeds account for more 40% of the total costs of the members of the Association of vegetable growers. However, supply and use of certified seed is a prerequisite for achieving high yields (Milosevic et al. 2012/a). Additional investment in plant protection agents, certified seed and irrigation to achieve a higher average

yields. With an average yield of 24000 kg / ha, the value of production per unit area is € 8,400 / ha. When deducting production costs (Table 1), the net profit was 2,720 € / ha. At that average earnings yield is 3.67 times higher than the profits made in the traditional production system.

Seed production is realized higher total output and significant revenues compared to conventional scale production for consumption. Increased demand for seed potatoes initiated to produce seed potatoes. Seed potato production is located at higher altitudes because of the reduced risk of viral infections (Milosevic et al. 2012 / b). So to realize higher revenues in undeveloped areas at higher elevations.

In dry seasons, declining average yield per unit area. Supply of agricultural products in the market decreases and the preservation of the level of demand in the market price increase occurs. In the years when growing conditions are unfavorable, the irrigation achieve significantly higher yields that can compensate for the costs of additional investments and provide substantial profit (Milic et al. 2010).

Fertilizer costs are similar, but the absolute value of the percentage of fertilizer costs in the traditional farming system are much higher. On the basis of chemical analysis of soil nutrient use would be more effective without increasing fertilizer costs.

Given these facts and the excellent opportunities proizvodnjih areas, increasing the production of potatoes to 1 500 000 tons per year, would reflect favorably on rural development in the Republic of Serbia.

Conclusions

After eradication of potato ring rot, approved the export of potatoes to the EU market. By increasing the area planted with potatoes and increasing average yields, the annual potato production could be increased to 1 500 000 t. A large part of the production would be for export to the EU market.

Each production is based on the same goal, i.e. earning the yield, which may reflect favorably on rural development. The ultimate outcome depends on a number of factors that can affect very much to reduce it. Care of crops and new quality and efficient solutions to increase yields and improve the quality, ensuring the success of

The importance of the potato for rural development in Serbia is reflected in the fact that the increase in demand for certified seed potatoes resulted in increased production of seed potatoes, which is based in underdeveloped rural areas at higher altitude.

References

1. Bošnjak D., i Rodić V. (2010): Ekonomska analiza proizvodnje soje u Vojvodini. Ratarstvo i povrtarstvo 47 (1), 193-202.
2. Bročić Z., Momirović N., Đekić R., Barčik B., Bogdanović Z. (2001): Ispitivanje sortimenta krompira u različitim agroekološkim uslovima Srbije, Savremena poljoprivreda, vol. 50, no. 1-2, pp. 277-282.
3. Byamukama E., Gibson R.W., Aritua V., Adipala E. (2004): Within-crop spread of sweet potato virus disease and the population dynamics of its whitefly and aphid vectors Crop Protection, Volume 23, Issue 2, Pages 109-116
4. Indić D., Vuković S., Tanasković S., Grahovac M., Kereši T., Gvozdenac S., Savčić-Petrić S. (2012): Screening Test for Detection of *Leptinotarsa decemlineata* (Say) Sensitivity to Insecticides, Pestic. Phytomed. (Belgrade), 27(1), 2012, 59–67
5. Ivanović M., Ivanović M. (2004): *Phytophthora infestans* - poreklo i istorijat, Biljni lekar 32, (1): 44-49.
6. Jovanović M., Njegovan N., Nastić L. (2011). "Advantages of rural development in municipalities of the Serbia- Danube Region" Međunarodna konferencija "Politike ruralnog razvoja iz perspektive proširenja EU", tematski zbornik, Ečka 8-9.09.2011. Institut za ekonomiku poljoprivrede. ISBN 978-86-6269-004-3. str 23-29.
7. Kanisek J., Deže J., Ranogajec Lj., Miljević M. (2008): Ekonomska analiza proizvodnje šećerne repe. Poljoprivreda / Agriculture 14 (1), 35-40.

8. Lazić M.L., Rašković S., Stanković M.Z., Veljković V.B. (2004): Enzymatic hydrolysis of potato starch and ethanol production, *Chem. Ind.*, vol. 58, no. 7-8, Pages 322-326.
9. Martínez Noél G. M. A., Madrid E. A., Bottini R., Lamattina L. (2001): [Indole acetic acid attenuates disease severity in potato-*Phytophthora infestans* interaction and inhibits the pathogen growth in vitro](#), *Plant Physiology and Biochemistry*, Volume 39, Issue 9, Pages 815-823
10. Milić, S., Bošnjak, Đ., Maksimović, L., Pejić, B., Sekulić, P., Ninkov, J., & Zeremski-Škorić, T. (2010). Prinos i struktura prinosa krompira u zavisnosti od navodnjavanja. *Ratarstvo i povrtarstvo*, 47(1), 257-265.
11. Milošević D., Ivanović M., Ivanović M. (2004): Epidemic occurrence of potato and tomato late blight in Serbia, *Pestic. Phytomed. (Belgrade)*, 19, (3): 159-166.
12. Milošević D., Milenković S., Bročić Z., Savić J., Jovović Z. (2012 a): Production and Requirements for Pre-basic Seed Potato Material in the Republic of Serbia and the Republic of Srpska, *Ratar. Povrt. 49*, 86-91
13. Milošević D., Stamenković S., Perić P. (2012 b): Potential Use of Insecticides and Mineral
14. Oils for the Control of Transmission of Major Aphid-Transmitted Potato Viruses, *Pestic. Phytomed. (Belgrade)*, 27(2), 97-106
15. Plan strategije ruralnog razvoja, 2009.-2013., Ministarstvo poljoprivrede, trgovine, šumarstva i vodoprivrede
16. SORS 2012 - Statistical Office of the Republic of Serbia - www.stat.gov.rs poseta 05.09.2012.
17. Toth I. K., van der Wolf J. M., Saddler G., Lojkowska E., He´lias V., Pirhonen M., Tsrer (Lahkim) L., Elphinstone J. G. (2011): *Dickeya* species: an emerging problem for potato production in Europe, *Plant Pathology* 60, 385-399
18. Jovanović M., Vučković S., Potrebić V. (2012). „Possibilities for rural development of agriculture in mountain areas of Serbia”, *Научное издание «Аграрная наука, творчество, рост», Сборник научных трудов по материалам Международной научно практической конференции (г. Ставрополь, СтГАУ, 21-22 февраля). УДК 657:005.342, ISBN 978-591628-084-7*
19. Indić D., Vuković S., Tanasković S., Grahovac M., Kereši T., Gvozdenc S., Savčić-Petrić S. (2012): Screening Test for Detection of *Leptinotarsa decemlineata* (Say) Sensitivity to Insecticides, *Pestic. Phytomed. (Belgrade)*, 27(1), 2012, 59-67