Economics of agriculture
SI – 2
UDK: 631.111 (23.01):633.1

POSSIBILITIES ALTERNATIVE GRAIN PRODUCTION IN THE HIGHLANDS AREA OF CENTRAL SERBIA

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Summary

Two-year investigations of possibilities production of alternative grains (buckwheat, quinoa, triticale and spelt) were carried out at five sites hilly-mountainous regions of Serbia. These are around Valjevo in western Serbia, Nova Varos and Pozega in southwestern Serbia, in Kucajna village (municipality Kucevo) and Zajecar in eastern Serbia. Results from experimental fields in Stara Pazova (Srem) served as control. The alternative grains are grown using standard agricultural technology used in commercial production. Mineral fertilization and crop protection with pesticides are not carried out. Weeds are suppressed by hand during vegetation period.

The largest grain yields per unit area were obtained on the test trials at soil chernozem type in Srem. However, the results achieved in less fertile soil on hilly-mountainous regions of Serbia and changed agroecological conditions indicate that these plants can be successfully grown in less favorable conditions for agricultural production.

This is of particular importance for small rural households, which would changing the sowing structure significantly increase the production per unit area as an alternative grain products greatly appreciated to make high-quality and healthy food.

As the demand for these products continue to rise on the world market, we should look for an opportunity for improvement of our rural areas where there are natural resources for the production of these field crops.

***Key words**: alternative grains, buckwheat, quinoa, triticale, spelt, hilly-mountainous region.*

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Introduction

Crop production of mountainous regions of Central Serbia is characterized by growing traditional field crops in the system of semi intensive to extensive usage of agricultural land. Therefore, yields and total agricultural production, so small that the unfavorable weather for years do not meet even the needs of their own holdings. The reasons for this kind of use of arable land are numerous, mainly small and fragmented land, poor agricultural mechanization and equipment prevailing elderly households. Another reason is the presence of crops that can not be achieved major gains per unit area, especially as the farming products are not in the best way. Traditional production of the most abundant crop plants the right grain of wheat, barley and oats, or corn for grain production often does not meet either the needs of the household as the yields of these products run from the use of inadequate agrotechnics systems.

Improving the general condition of crop production in highlands areas without major investment in cultural practices can be achieved by modifying the sowing structure. So, instead of winter wheat, with yields on poor soils and the application of inadequate nutrition of plants do not exceed 3,000 kg ha^{-1}, inadequate nutrition of plants do not exceed 3,000 kg ha^{-1}, should be sown any other rights of wheat that are better adapted to environmental conditions in these areas. These are triticale, spelt wheat and naked oat spelled or right grain, which, due to the high nutritional value, in today's increasingly being used directly as human food or to produce food products that are categorized as functional and safe food. Changing cultivars of corn would significantly increase overall agricultural production.

Rather than dent corn hybrids for grain should be grown for the production of hybrids concentrated silage. Dent hybrid or flint hybrids should occupy a larger area because the grain or flour is increasingly present in the human diet. Triticale is increasingly used in the diet of all species of domestic animals because it has more nutritional value than other true grains (Đekić et al. 2009). Buckwheat, our traditional plant species of mountainous areas, due to its high nutritional value, it is common in preparing different meals at home, but also raw materials for production of semi-finished and finished dishes. In addition to these grains in the production should be introduced and for us a new alternative grains (Stallknecht et al. 1996). One of these grains is quinoa, a plant that was brought from South America and already in some European countries because it is grown for food to be greatly appreciated. By its food and grain quinoa digestible values at the level of wheat and the weight loss are more valuable (does not contain gluten).

The aim of this researching was to determine the most appropriate alternative grain production technology in hilly and mountainous region of Serbia with the use of existing agricultural mechanization. The results were compared with production in Srem in the vast natural soil fertility.

Material and method

The subject of research is finding the optimal technology of alternative grain buckwheat, quinoa, triticale and wheat spelt in the mountainous region of Serbia. Research has had a comprehensive nature, since it includes four types of crop grown in the two-year period in the following areas:

A. Western Serbia (Valjevo)
B. Eastern Serbia (Kučevo, Zajecar, Pirot)
C. Southwest Serbia (Nova Varos, Pozega)
D. Test essay in the field of Srem (Stara Pazova Surduk).

Agrotechnic is adapted to each type individually and adapted to specific weather and soil conditions of the studied area (Panković and Malesevic, 2006). During the experiment, the execution and analysis of agrometeorological and soil conditions at these locations. The research comprised phenological observations, and analysis of the dynamics of growth and development of plants during the growing season to determine the most suitable technology of production adapted to local environmental conditions. After harvest, crop yields were calculated per unit area and a certain quality of derived products. During the study were monitored and analyzed the most important meteorological parameters - the schedule and amount of precipitation and temperature conditions during the growing season of plants (Tables 1 and 2).

Table 1 Monthly and annual precipitation, mm

Place	Valjevo		Kučevo		Nova Varoš		Stara Pazova	
Month	2009.	2010.	2009.	2010.	2009.	2010.	2009.	2010.
1.	22	40	39	40	30	43	38	35
2.	12	42	25	51	27	38	33	38
3.	67	49	40	61	69	44	53	32
4.	25	37	17	54	23	60	16	55
5.	64	46	28	30	31	33	60	45
6.	118	86	98	64	113	72	115	68
7.	79	101	65	86	58	99	70	94
8.	59	55	37	45	66	58	44	67
9.	45	58	39	30	68	76	29	42
10.	18	-	41	-	22	-	25	-
11.	19	-	33	-	35	-	24	-
12.	38	-	28	-	8	-	26	-
Total:	556	514	490	461	550	473	533	441

Table 2 Annual Calendar of heat, ^0C

Place	Valjevo		Kučevo		Nova Varoš		Stara Pazova	
Month	2009.	2010.	2009.	2010.	2009.	2010.	2009.	2010.
1.	-1	-1	-1	-2	-2	-1	-1	-1
2.	-1	-2	-3	-1	-2	0	2	0
3.	4	6	4	5	4	5	6	8
4.	7	10	14	15	10	9	11	12
5.	14	19	17	19	14	14	17	18
6.	19	23	19	20	18	18	18	19
7.	23	22	21	20	20	19	23	20
8.	22	21	22	23	20	20	23	22
9.	16	19	19	19	18	19	20	21
10.	11	-	12	-	10	-	17	-
11.	7	-	8	-	5	-	9	-
12.	3	-	2	-	1	-	4	-
Average	10.4	-	11.5	-	9.7	-	11.6	-

The highest annual rainfalls were in western Serbia (556 mm). They were decreasing to the east of the republic. The least precipitation was in the experimental farm of Kucevo, 490 mm. Arranged by months were similar on all localities with distinct peaks in June and minimum in February. In quantity and distribution of natural water regime was equal to the water needs of plants in both years. Annual Calendar of heat is less varied by location and had a uniform distribution by month. Differences of the smallest (Nova Varos) to the largest average annual temperatures (Stara Pazova) were 1.9^0C.

All data were processed with the statistical analysis for two factorial experiments. Locality of Srem (sample plots in the Stara Pazova and Surduk) served as standard of the research results.

Results and discussion

Grain yield. Results of two-year researching of the influence of agrometeorological conditions on the yield of buckwheat seeds, quinoa, triticale and Spelt showed that they significantly affect the success in producing these alternative grains (Table 3).

Table 3 Grain yield, t ha^{-1}

Place	Buckwheat*			Quinoa*			Triticale			Spelt*		
Year	2009.	2010.	x	2009.	2010.	x	2009.	2010.	x	2009.	2010.	x
A	0.91	0.72	0.82	-	-	-	4.62	4.36	4.49	-	2.92	2.92
B	1.22	0.67	0.95	0.62	0.73	0.83	4.46	4.84	4.65	2.96	3.11	3.04
C	1.33	1.31	1.32	0.73	0.65	0.69	3.00	2.45	2.73	-	2.71	2.71
D	1.54	1.77	1.66	1.55	1.79	1.67	4.89	4.39	4.64	3.78	3.98	3.88
x	1.25	1.12	1.19	0.97	1.06	1.02	4.24	4.01	4.13	3.37	2.48	2.93
$LSD_{5\%}$	0.23	0.19	0.33	0.25	0.37	0.34	0.82	0.46	067	0.78	0.49	0.63
$LSD_{1\%}$	0.56	0.47	0.83	0.63	0.91	0.83	2.01	1.13	1.64	1.91	1.19	1.55

*A - Western Serbia, B - East Serbia, C - South West Serbia, D - Srem. * Skinned grain*

The lowest average yield of buckwheat was in western Serbia 0.8 t ha^{-1} and the largest in Srem, 1.66 t ha^{-1}. Significant individual variations were observed between the locations A, C and D, then the B, C and D and between B and C and C and D. The differences in yield weather conditions had no significant effect because the meteorological conditions in both years had similar values. Quinoa did not grown on site A and the lowest grain yield was the site of C 0.69 t ha^{-1}. In eastern Serbia, the average yield was 20% higher, but the differences were significant only in relation to locality D. The average yield of triticale at sites A, B and D was higher than 4.45 t ha-1. On the south-western Serbia was significantly lower, 2.73 t ha^{-1}. These crops are grown here on the growing surfaces. The agrotechnic is adapted to the environmental conditions and land and achieve the high yield (Panković and Malesevic, 2006). At the locality C on the decreasing of yield was affected the factors that were not included in the researching. Spelt was sown in the first year in B and D locality, and the second on all four location. Consistent average yield in the first three locations and significantly higher in the Srem showed that this corn should be grown in the mountainous region of Serbia.

That the yield of buckwheat has a strong influence of soil fertility have shown results on the effects of supplementary feeding of plants that cite Filipovic et al. (2005), and applied technology of production system (time and method of sowing) to highlight Choi et al. (1990).

For us quinoa is unknown crop that was first sown in the trials, the 2008th year. First results show that in our climatic and soil conditions gives high yields (Glamočlija et al., 2009, and 2010). By comparison with results those obtained by Bois et al. (2006), it can be successfully grown at high altitudes because it is tolerant of spring frosts and drought (Garcia et al., 2007). The yields obtained in experiments in different soil conditions suggest that the potential yield quinoa depends on the chemical and physical properties of soil. These results confirm research Jacobsen's (2003) with a large number of trials with a large geographical area. Triticale grain is an alternative that is in many traits (yield, grain quality, adaptability to different environmental conditions) exceeded the parental wheat and rye components. In the central areas of the republic at altitudes up to 800 feet triticale gives higher yields than other real grain (Đekić et al., 2009 and

2010). Spelt is a type of wheat that has long ceased to be cultivated in our country, but due to the increasing demand for flour of wheat (Zielinski et al. 2008), is involved in a program of research. The object of study is Nirvana, our first variety of spelt selected in the Institute of Field and Vegetable Crops.

Conclusion

Based on the results of these studies can be done the following conclusions:
- Grain yield in two-year study and compared with the best agricultural regions of Serbia show that highlands area has a favorable environmental conditions for the cultivation of alternative grains;
- Production and yields of triticale were uniform in all locations, indicating that local varieties are very suitable for growing on different soil types of highlands areas of central Serbia;
- Natural conditions in the mountainous area were favorable for the cultivation of buckwheat, so that the average yields were satisfactory compared with the test trials;
- Quinoa is, according to preliminary results showed good adaptation to the conditions of high humidity and the soil less natural fertility. Large yields obtained in the Srem showed that it has great potential for yield;
- Spelt is successfully grown in the highlands area. Therefore, in future this grain should be included in the structure of planting, primarily because the increasing demand for food products with a share spelled flour (bread, pasta);
- These, and other species that are currently underrepresented in our production, should be introduced into commercial production to meet the needs of the domestic food industry and think about exporting. Due to the fact that most of the agricultural areas of central Serbia away from the big polluters Urban Environment (large settlements, industrial plants, roads), fulfilled the conditions for organizing the production of alternative grains on the principle of ecological (organic) agriculture.

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