SITUATION IN THE PRODUCTION OF THE MOST IMPORTANT LEGUMINOSIS IN THE REPUBLIC OF SERBIA

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Abstract

The fodde plants that are dominantly grown on arable land in the Republic of Serbia are cultivated alfalfa (Medicago sativa L.) and red clover (Trifolium pratense L.). The average area under alfalfa is grown, in period 2013-2024 is 64.392,5 ha, with an average yiel od 6 t ha-1. Red lover is grown on an average ara of 64.392.5 ha, with an average of 3.8 t ha-1. Apart from these two fodder crops, a significant place is also occupied by white clover (Trifolium repens L), Lotus corniculatus L, various annual forage legumes and grasses. Varieties that could meet the needs of the domestic market were created through the work of breeders. With the application of intensive agrotechnics and a rewarding method of utilization, high yields of hay of excellent nutritional value can be achieved. The domestic market is dependent on the import of fodder seeds, but with future investment we can expect a decrease in dependence and a strengthening of agricultural and livestock production in our country.

Key words: Fodder plants, Cultivated alfalfa, Red clover, Republic of Serbia.

Introduction

Fodder plants are a colloquial name for a large number of plant species characterized by the formation of a lush vegetative mass intended for livestock nutrition (Karagić et al., 2019). The study of biology and cultivation of fodder plants is a scientific discipline, which with the development of science has become equal to agriculture and animal husbandry and represents their bond (Arsić et al., 2013). Through fodder plants, the biology, cultivation and utilization of cultivated fodder plants are studied, in order to achieve the best yield and quality of coarse fodder (Jovanović et al., 2014).

Forage species can be cultivated as pastures and meadows or as arable crops, with the aim of being grown for conservation or for fresh food (Fuglie et al., 2021). Fodder is obtained by growing different vegetable gardens from the family *Poaceae, Fabaceae, Brassicaceae, Amamranthaceae*, etc., which is the most widespread in the flora of the Republic of Serbia (Dolapčev-Rakić et al., 2024). When it comes to the way in which fodder plants are dominantly used in production, we distinguish green fodder, hay, hay or silage, while protein peas are used for grain production (Karagić et al., 2012). A large number of fodder species can be grown as a joint crop with other plant species, and in this way, savings are achieved with regard to the consumption of concentrated nutrients (Karagić et al., 2016). The inclusion of fodder plants in the crop rotation leads to a reduction or complete omission of the application of mineral nutrients and leads to an increase in the use of mechanization (Katanski et al., 2022).

Jovanovic et al. (2013) state that the advantages of using fodder plants as a main or secondary crop in meadows and pastures are the achievement of constant surface utilization, which has a positive effect on soil characteristics. The soil remains loose, uninfected by diseases, enriched with organic residues and mineral substances. It is possible to accelerate the creation of sustainable systems on farms, because natural capital cannot necessarily be replaced by economic or social capital, although it is possible to find replacements for certain natural resources (Jovanović and Bekić, 2012).

The Republic of Serbia, in addition to significant natural conditions for the production of both perennial and annual fodder crops, cannot boast of current seed production, which meets domestic needs only in certain years (Đokić et. al., 2013).

Material and method

The paper will present the situation in the production of fodder plants in the territory of the Republic of Serbia, compared to the agroecological conditions for production, characteristics and conditions in agricultural production, as well as biological and genetic assumptions for the production of important fodder species. Climatic characteristics for forage crop production will be presented; processed morphological and biological characteristics and production technologies of the most important fodder species. Also, the spatial positioning of production and changes in the areas sown under fodder plants in the period between the last two Censuses of Agriculture will be shown. Relevant scientific literature will be used in the work, while the processed data will be presented systematically.

Results and discussion

Agroecological conditions for the production of important forage crops in the Republic of Serbia

The Republic of Serbia is located in the southeastern part of Europe, on the Balkan Peninsula, covering an area of 88,361 km^2. It extends between 41°53' and 46°11' north latitude and 18°49' and 23°00' east longitude. The climate of Serbia can be described as moderate-continental with more or less exposed local characteristics. Spatial distribution of climate parameters is conditioned by geographical position, relief and local influence. The average air temperature is 10.9°C at an altitude of 300 m; at altitudes between 300-500 m.a.s.l. is 10.0°C, and above 1000 m above sea level it is 6.0°C. The annual sums of precipitation on average increase with altitude and in the lower regions range from 540 mm to 820 mm. In areas with altitudes above 1,000 m, the average annual rainfall ranges from 700 to 1,000 mm, while on certain mountain peaks the average rainfall is over 1,500 mm of water sediment (hidmet.gov.rs).

According to the first results of the 2023 Census of Agriculture, 4,073,703 ha of agricultural land are available, which is 21.3% less than the available agricultural land included in the Survey on the structure of agricultural holdings in 2018. Of this, 3,257,100 ha are used agricultural land (KPZ), 504,104 ha of forest area and 190,242 ha of other land. The largest area of agricultural land is in the Vojvodina Region, 1,474,709 ha, and the increase in area compared to 2018 was recorded only in the Belgrade Region (increase of 2.3%).

Serbia is a country with enormous potential and capacity for agriculture, for the development of all types of production, especially livestock production. The production of fodder plants, as a link between farming and animal husbandry, should occupy a more prominent place in the chain of sustainability of agricultural production.

Agrotechnical importance of fodder plants

According to the length of life, fodder plants can be annual, biennial or perennial. According to the types of fruits and nutrients obtained from fodder plants, they can be divided into four groups: grasses (grasses); legumes (legumes); root and tuberous plants and other plants for fodder (Đokić et al., 2019).

The grass family (*Poaceae*) includes the largest number of annual plants, the most important of which are green - fodder corn, fodder sorghum, Sudan grass, green rye, barley, oats, triticale and wheat. The annual legumes that deserve the most attention are protein-rich peas and vetches, broad beans, lupins, soybeans and cowpeas.

When it comes to the forms of growing fodder plants for livestock feeding, the following forms are the most common: (1) growing fodder plants as the main crops; (2) cultivation of fodder plants as winter intercrops; (3) cultivation of fodder plants as subsequent and/or lateral and (4) cultivation of fodder plants in the form of a green fodder conveyor (Vuković, 2014).

Cultivation of fodder plants as the *main crops* represents their cultivation on a certain area, in pure sowing of one crop and/or a mixture of certain species with agrotechnics and soil preparation, as well as for other arable field plants (green corn, fodder sorghum, Sudan grass, protein fodder peas, vetch, soy, beans, blah lupine, etc.). When fodder crops are sown in autumn (*winter cover crops*, cold-tolerant crops), the free space between the two crops is used to ensure the arrival of forage in early spring (green rye, winter oats, winter fodder barley, triticale, wheat, etc.)

After removing the winter intercrops, fodder plants can be grown as a *follow-up crop* during the same vegetation season. Cultivation of fodder plants as follow-up crops depends on various factors, especially on the possibility of irrigation, the period of removal of the previous crop, the fertility and richness of the soil. Species that can be used as a subsequent crop are early hybrids of corn for green food, Sudanese grass, early varieties of soybeans, vines, etc. A special form of fodder production is the *cultivation of fodder plants in the form of a green fodder conveyor.* This type of production implies planned, organized food production and feeding animals with fresh green food. This method implies the rational use of natural meadows and pastures, sown lawns and the cultivation of fodder plants on arable land and the production of hay, silage, haylage or juicy fruits of root-tuberous fodder plants (Jovanović et al., 2013).

The most important perennial legumes in the Republic of Serbia

Cultivated alfalfa (*Medicago sativa* L.) represents one of the most popular fodder plants that is cultivated worldwide on an area of 30 million hectares and is represented on all continents (Bouton, 2012), the largest European producer is France. It is grown for the production of green fodder, hay, haylage, grazing (Li et al., 2012), has high

nutritional value and wide adaptability (Katanski et al., 2022). It is characterized by a high genetic potential for hay yield (over 25 t ha^{-1}), a significant source of protein (2000-4000 t ha^{-1}) with a low content of cellulose and lignin, and this makes it desirable in ruminant nutrition.

Table 1. Areas and yield of alfalfa in the Republic of Serbia in the period 2014-2023. year.

	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Area (ha)										
Alfalfa	108.834	109.230	107.430	112.218	103.366	106.095	104.191	106.340	108.238	103.667
Yield (t/ha)										
Alfalfa	5	4	6	4	5	6	6	5	4	6

Source: SORS, Census of Agriculture 2023, Survey on the structure of agricultural holdings in 2018

When it comes to alfalfa production, the average production in the period from 2014-2023. in 2019 was 5.1 t ha^{-1}, while the years with the best yield of alfalfa were achieved in 2019, 2020 and 2023 and amounted to 6.0 t ha-1. Average areas sown with alfalfa in the period 2014-2023. amount to 106,960.9 ha. The year in which the production was the most widespread is 2017, when alfalfa was sown on 112,218 ha, after which the areas decrease (Table 1).

The seed production of alfalfa in the Republic of Serbia is developed according to the needs of the domestic market. Alfalfa breeding is carried out by researchers from the Institute for Crop and Vegetable Agriculture in Novi Sad and the Institute for Forage Plants in Kruševac. The work of the leguminous department of the Novi Sad Institute of Crop and Vegetable Agriculture has made a significant contribution to breeding programs and the creation of new varieties (20 varieties registered in Serbia, as well as 9 varieties registered abroad (EU, Ukraine, Belarus and Ukraine)). Among the registered varieties, for intensive use with five/six cuttings per year, the varieties NS Jelena, NS Banat ZMS II, Banat VS and Nera are suitable. For a less intensive method of exploitation (four cuttings during the year), the following varieties are more suitable: NS median ZMS V and Niagara. All these varieties, with the application of intensive agrotechnics and a rewarding method of utilization, achieve high yields of hay of excellent nutritional value (Katanski et al., 2022a).

The assortment obtained at the Institute for Fodder Plants in Kruševac has a high genetic potential, both for seed production and for the most important agronomic traits (Đokić et al., 2013). Thus, the following varieties are available on the market: Alfalfa K-22, Alfalfa K-23, Alfalfa K-28 and Alfalfa K-42. All varieties achieve a high yield of high-quality green mass and dry matter, are rich in proteins, tolerate drought and low temperatures well, and regenerate quickly after mowing.

Red clover (*Trifolium pratense* L.) is one of the perennial fodder crops that is an inseparable part of improving production as part of conventional and sustainable systems in the production of fodder plants, i.e. annual and perennial species of clover

(*Trifolium sp.*) (Vasiljević et al., 2005). Considering that they possess nitrogen fixation abilities, they have found their place as cover crops and green manure in order to improve the physico-chemical properties of the soil (biosterilization of the soil) and soil erosion and excellent tolerance to acidity in the soil (unlike alfalfa) and can be grown in mountain areas of Serbia.

Table 2. Areas and yield of clover in the Republic of Serbia in the period 2014-2023. year.

	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Area (ha)										
Red clover	73.395	76.625	73.281	70.453	63.699	61.725	60.235	57.045	55.348	53.119
Yield (t/ha)										
Red clover	3	3	4	3	4	5	5	4	3	4

Source: SORS, Census of Agriculture 2023, Survey on the structure of agricultural holdings in 2018

The average area under clover in the Republic of Serbia is 64,392.5 ha in the period 2014-2023. year, with the fact that the areas were in constant decline from 2015 until 2023. The average clover yield in the Republic of Serbia is 3.8 t ha^{-1} (ten-year average), while the years with the highest yield are 2019 and 2020, when the clover yield was 5 t ha^{-1} (table 2).

For this reason, current goals in the breeding of this species are directed towards the creation of varieties characterized by the production of biomass that is tolerant to biotic and abiotic stress, higher protein content and digestibility (Vasiljević et al., 2011). In the past work on the breeding of red clover, the domestic assortment is available: Kolubara, Una, Avala, NS Mlava, NS Ravanica, NS Petnica and NS Sana (recognized in Serbia), Zoja and NS Sana (recognized in the EU), the Lara variety in Russia Federation and varieties of Una in Ukraine and Belarus (varieties of the Institute of Crop and Vegetable Agriculture).

Breeding work at the Institute for Fodder Plants in Kruševac resulted in four domestic varieties that are widely distributed in the Republic of Serbia. The following varieties are concerned: Kruševačka 17, Kruševačka 32, Kruševačka 38 and Kruševačka 39. These species are resistant to low temperatures and tolerant to the most important diseases and pests. Some cultivars can be sensitive to drought, and under irrigated conditions can achieve high dry matter yields, high protein content and low cellulose content.

Apart from the cultivated alfalfa and red clover, yellow clover (*Lotus corniculatus* L.) and white clover (*Trifolium repens* L.) occupy an important place in the production of fodder plants on the territory of the Republic of Serbia. Of the annual fodder crops, fodder peas (winter and spring forms), several types of winter and spring peas, fodder beans, lupins, bigna, sastric, chickpeas and others have the greatest economic importance. Among other fodder plants, selected varieties of fodder sorghum and

Sudanese grass, as well as fodder sorghum, are distinguished, which require relatively small investments and can be an adequate substitute in the case of a deficit of coarse fodder (Katanski et al., 2022).

Agricultural producers who decide to produce fodder plants on their farms can expect that by favoring the domestic assortment, they can achieve stable yields of high quality, as soon as the sustainability of agricultural production and further development of animal husbandry is achieved.

Conclusion

The production of domestic assortment of fodder plants in the Republic of Serbia is diverse, but it is not sufficient to fully satisfy domestic needs for seeds of important species. In that field, a lot of space has been left for the future development of seed production technologies, with an increase in the area under fodder plants. Although the production is not sufficient, the currently available assortment of alfalfa, red clover, white clover realizes a high yield of quality green mass and dry matter, they are rich in proteins, tolerate drought and low temperatures well and regenerate quickly after mowing.

Future investment in expanding the production of fodder plants can be expected to reduce dependence on seed imports and strengthen the link between agricultural and livestock production.

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