# THE STATE AND PRODUCTION OF GRASSLANDS IN SERBIA

Violeta MANDIĆ*, Zorica BIJELIĆ, Vesna KRNJAJA, Maja PETRIČEVIĆ, Aleksandar STANOJKOVIĆ, Nevena MAKSIMOVIĆ, Violeta CARO PETROVIĆ

Institute for Animal Husbandry, Belgrade-Zemun, Serbia
*Corresponding author: violeta_randjelovic@yahoo.com

## Abstract

Given that Serbia (without Kosovo) has large areas under grassland, the aim of this study was to analyze the variation and trend of the areas, total production and yields over 71 years (1948-2018) and prognosis of yield in the next 30 years. The results indicated that the area of grasslands in Serbia declined over the last decade. Most grasslands in hilly-mountain region were degraded and without application of agrotechnical - remedial measures so that large areas were lost. In Autonomous Province of Vojvodina, areas of grasslands have been declining because have been converted into arable land. Total production of meadows increased while total production of pastures decreased during the observed period. The grasslands areas in Serbia showed low yields. In the Vojvodina region, meadows showed decrease in forage productivity, while pastures showed increase in forage productivity. Areas under meadows and pastures should be recultivated and brought into production in accordance with the needs of livestock development. This will result in higher quantity and higher quality production of green mass and hay. Unfortunately, depopulation and under-representation of animals per unit area represented a limiting factor for grassland exploitation. On the other hand, in the future yield growth rates of grasslands in Serbia and Central Serbia and pastures in Vojvodina will very low increase. Contrary, yields growth rates of meadows in Vojvodina will decrease by 2050.

**Keywords**: *Grasslands, Yield changes, Trend analysis, Serbia.*

## Introduction

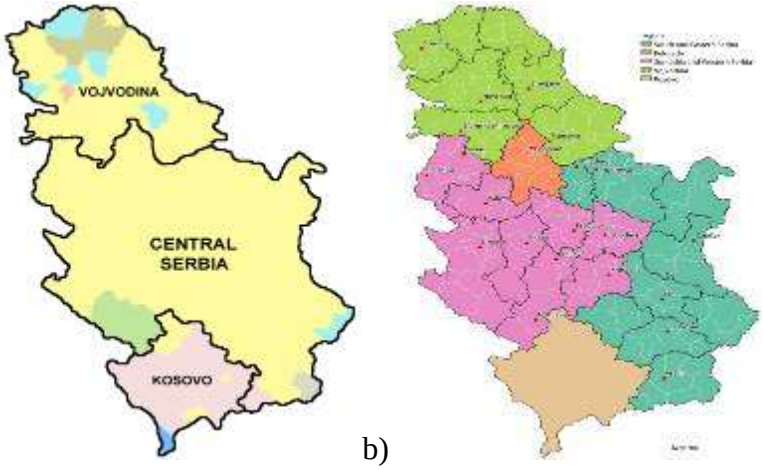
One-third of Earth's land surface is under grasslands (Lemaire *et al*., 2011). Grasslands are the important feed source for livestock and offer great potential for promoting livestock production sustainability. The livestock raised on semi-natural meadows and pastures has better organoleptic and nutritional qualities of the product (Coulon *et al*., 2004; Hopkins, 2009). Likewise, grasslands represent a significant source of food for wild animals. They protect soil from erosion, maintain biodiversity and genetic variability within species and contribute to landscape conservation (Đorđević-Milošević *et al*., 1997; Pärtel *et al*., 2005). Also, grasslands are vital to supply of water, regulation of flow, carbon storage and climate change mitigation (Bengtsson *et al*., 2019). In Serbia, grasslands cover a large area. In 2018, grasslands participated with 19.4% in the total utilized agricultural area (meadows participate with 10.1% and pastures with 9.3%) (Statistical Yearbook of the Republic of Serbia, 2019). They are characterized by a rich vegetation and floristic composition. Kojić *et al*. (2004) described 273 grasslands communities in Serbia, while Stošić and Lazarević (2007) pointed out that out of 48 grasslands associations in Serbia, only 10 were economically significant. The share of good-quality species of grasses and legumes in associations directly affect the production and quality of biomass for livestock production. Basically, their share in the natural grasslands of Serbia is small (Tomić *et al*., 2009; Simić and Vučković, 2014), but can be improved by NPK fertilization, especially with nitrogen (Djuric *et al*., 2007; Stević *et al*., 2011; Ivaniš *et al*., 2013; Zornić *et al*., 2018; Simić *et al*., 2019). High quality and

inexpensive forage production on grasslands should be the cornerstone of any cost-effective livestock production. However, in Serbia, the forage production potential of grasslands is not being utilized. Livestock production as a whole is underdeveloped due to low productivity and under-representation of animals per unit of area, especially in hilly-mountainous region of Serbia. Likewise, sparse population and depopulation with a pronounced trend of demographic extinction are an objective constraint on development of livestock and exploitation of grasslands.

The study analyses the area, production and yield change of meadows and pastures in Serbia during the period 1948 to 2018. Also, in this study we make a forecast of future yield trends based on historical data obtained from the Statistical office of the Republic of Serbia.

## Material and Methods

The data collected from the Agriculture in Serbia, 1947-1996 (1998) and Statistical Yearbook of the Republic of Serbia from 1997 to 2019 were used, referring to the area, production and yield of meadows and pastures of the Republic of Serbia (without Kosovo), Central Serbia and Vojvodina. Central Serbia includes following regions: South and Eastern Serbia, Belgrade and Šumadija and Western Serbia (Picture 1; source: a) https://es.m.wikipedia.org/wiki/Archivo:Serbia_ethnic02.png and b) http://www.lokalni-razvoj.org/upload/Book/Document/2012_06/Inter_Newsletter_1_English.pdf




a) b)

Picture 1. Republic of Serbia (a) and regions of Serbia (b).

Analytical and comparative methods were used in this paper. The mean area, total production and yield as well as their coefficient of variations and trends were calculated. Trend determined the tendency of time series data to increase or decrease over time. The linear least squares regression was used to predict trends in data ($y = ax + b$; y - area, total production or yield; a and b - parameters of the model). The Excel was used for statistical data analysis.

## Results and Discussion

According to Table 1, the area of meadows in Serbia ranged between 321812 ha (2017) to 670685 ha (1984), with a mean of 592182.8 ha and coefficient of variation 13.54%, during the 71-year period. The total production of meadows in Serbia ranged between 121060 t (1974) to 1334770 t (1984), with a mean of 975681.1 t and coefficient of variation 25.62%, during the 71-year period. The average annual yield of meadows in Serbia ranged between 0.955 t $ha^{-1}$

(1952) to 2.3 t $ha^{-1}$ (2016) with a mean of 1.70 t $ha^{-1}$ and coefficient of variation 17.2%, during the 71-year period. The average annual yield of meadows and coefficient of variation in Vojvodina were higher by 16.7 % (1.94 t $ha^{-1}$) and 11.6% (21.10%) than in Central Serbia (1.66 t $ha^{-1}$ and 18.09%, respectively) during this period.

Table 1. Descriptive statistics for area (ha), total production - TP (t) and yield (t $ha^{-1}$) of meadows in Serbia, Central Serbia and Vojvodina from 1948 to 2018.

| Region | Item | Mean | Minimum | Maximum | CV, % |
|---|---|---|---|---|---|
| Serbia | Area | 592182.8 | 321812 | 670685 | 13.54 |
| | TP | 975681.1 | 121060 | 1334770 | 25.62 |
| | Yield | 1.70 | 0.955 | 2.3 | 17.20 |
| Central Serbia | Area | 501593 | 305903 | 575670 | 12.45 |
| | TP | 834821.7 | 412030 | 1137009 | 21.95 |
| | Yield | 1.66 | 0.924 | 2.3 | 18.09 |
| Vojvodina | Area | 37248.9 | 15909 | 57805 | 21.03 |
| | TP | 72830.6 | 19820 | 153850 | 34.21 |
| | Yield | 1.94 | 1.02 | 2.888 | 21.10 |

CV – coefficient of variation (%)

As for pastures, the average area in Serbia ranged between 294622 ha (2017) to 1061690 ha (1959), with a mean of 863855.1 ha and coefficient of variation 23.80%, from 1948 to 2018 (Table 2). For this period, the total production ranged between 262000 t (2000) to 825280 t (1959), with a mean of 488378.2 t and coefficient of variation 20.6%. The average annual yield in Serbia ranged between 0.326 t $ha^{-1}$ (2000) and 2.0 t $ha^{-1}$ (2018) with a mean of 0.62 t $ha^{-1}$ and coefficient of variation 49.5%. The average annual yield of pastures in Vojvodina (1.09 t $ha^{-1}$) was higher than in Central Serbia (0.546 t $ha^{-1}$) with a lower coefficient of variation (33.07% and 61.72%, respectively) during an investigated time period. The significantly higher mean yields of grasslands in the Vojvodina are the result of favourable growing conditions for the plants. Reasons for better plants growth include more favourable soil properties (deeper soils with better structure and chemistry) (Ćirić *et al*., 2012) compared to shallow mountain soils with low productivity (Simić *et al*., 2015).

Table 2. Descriptive statistics for area (ha), total production - TP (t) and yield (t $ha^{-1}$) of pastures in Serbia, Central Serbia and Vojvodina from 1948 to 2018.

| Region | Item | Mean | Minimum | Maximum | CV, % |
|---|---|---|---|---|---|
| Serbia | Area | 863855.1 | 294622 | 1061690 | 23.80 |
| | TP | 488378.2 | 262000 | 825280 | 20.60 |
| | Yield | 0.62 | 0.326 | 2.0 | 49.50 |
| Central Serbia | Area | 609891.5 | 226277 | 724569 | 22.84 |
| | TP | 293214.1 | 153590 | 504911 | 22.32 |
| | Yield | 0.546 | 0.262 | 2.0 | 61.72 |
| Vojvodina | Area | 127801.2 | 41554 | 186626 | 24.16 |
| | TP | 137897 | 55841 | 310840 | 37.89 |
| | Yield | 1.09 | 0.5 | 2.318 | 33.07 |

CV – coefficient of variation (%)

The regions showed the high coefficient of variation for all parameters of meadows and pastures, especially for yield, indicating a heterogeneous environment. In general, the yield oscillated with high amplitude. The yield, therefore, has fluctuated from year to year,

sometimes vary sharply. The high grassland yield stability must be the primary goal of livestock farmers. However, according to Li *et al*. (2011), the grassland biomass is significantly correlated to the rainfall. Grassland yield is influenced by total amount of annual rainfall and its frequency and intensity (Zhai *et al*., 2005). The lower amount of rainfall and higher temperatures at the summer months caused the mowing of grasslands at only once a year. In addition, permanent grasslands in Serbia have lower yields because they are spread on low productivity soils (Simić *et al*., 2015). The soil nutrients deficiencies and the habitat moisture are main factors determined development of grasslands in Serbia (Aćić *et al*., 2013). Also, the grassland has sub-optimal botanical composition with a low proportion of perennial legumes from 6.73% to 34.12%, low yields and poor quality of forage (Djuric *et al*., 2007). Djukic *et al*. (2008) pointed that the forage yield and quality of grasslands depend on the floristic composition, the soil type and climatic factors (rainfall, temperature and light). Also, low and unstable yields of natural grasslands are the result of the absence of application of agro-technical measures (Dubljević, 2007). The application of mineral fertilizer, especially nitrogen could significantly increase forage yield and quality of grasslands and consequently, the animal production (Delevatti *et al*., 2019). In general, nitrogen is the basis for high yields of natural grasslands (You *et al*., 2017). Tomić *et al*. (2018) concluded that the optimum nitrogen level for forage yield of natural grassland of the *Arrhenatheretalia* order on the Kopaonik is 80 kg $ha^{-1}$. Stošić and Lazarević (2007) concluded that the ratio N: $P_2O_5$: $K_2O$ should be 2-3: 1: 1 and N: P: K - 5-9: 1: 2, respectively. However, nitrogen fertilizer should be applied on grasslands at altitudes up to 1000 m a.s.l., because regenerative ability significantly decreases on grassland above 1000 m a.s.l. so it is not economically viable (Lazarević *et al*., 2004). Also, cattle manure as fertilizer can greatly improve grassland productivity, increase the proportion of legumes and crude protein contents of the grasslands (Nemera *et al*., 2017; Simić *et al*., 2019). The agrotechnical measures which should be implemented to improve grassland productivity are drainage, irrigation and landscape management, levelling, dragging, rolling and land clearing (destruction of bushes, deforestation, removal of stumps and stones). On the other hand, the undersowing is not recommended for use on grasslands in Serbia (Ćupina *et al*., 2005). The reason is that grasslands in Serbia are distributed on shallow, dry and scaffold soil, which makes it difficult to apply this measure. Similar, Huguenin-Elie *et al*. (2006) reported that undersowing of legumes in grasslands had no effects on forage yield and quality.

Results in Figure 1-3 showed that the area and total production of meadows in Serbia and regions declined sharply in the last decade. So, these investigated parameters showed the similar tendency. Also, the yield of meadows in Serbia and Central Serbia had similar tendency of increase by 5.1 and 6.4 kg $ha^{-1}$, respectively (Figure 4). However, the yield of meadows in Vojvodina decreased by 8.2 kg $ha^{-1}$.

The area of pastures in Serbia declined after year 1998, in Central Serbia in the last decade (Figures 5 and 6). The total production of pastures in Serbia declined by 1648.2 t, while total production of pastures in Central Serbia increased by 1247.7 t. The area and total production of pastures in Vojvodina declined by 1412.2 ha and 1669.4 t, respectively (Figure 7). The yield of pastures in Serbia, Central Serbia and Vojvodina have slight increase tendency by 4.8, 7.2 and 0.7 kg $ha^{-1}$, respectively (Figure 8).

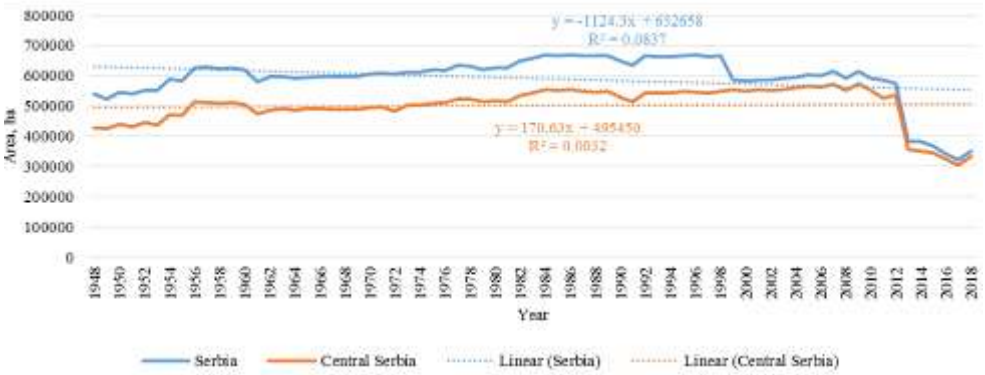



Figure 1. The area of meadows in Serbia and Central Serbia during 1948 – 2018.

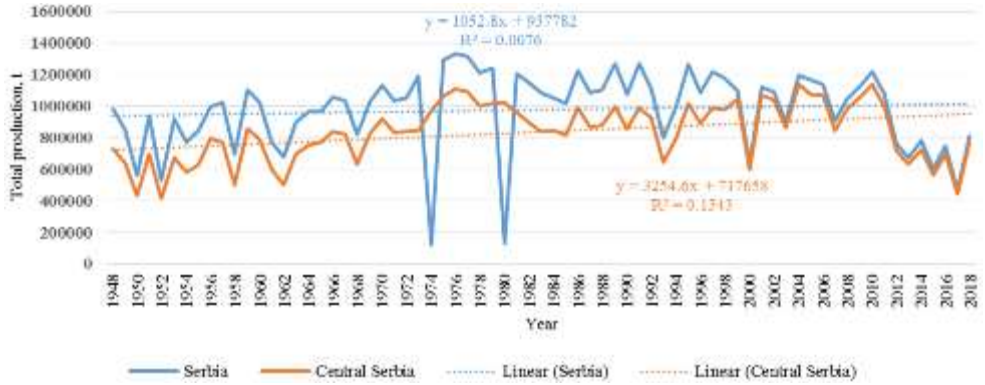



Figure 2. Total production of meadows in Serbia and Central Serbia during 1948 – 2018.

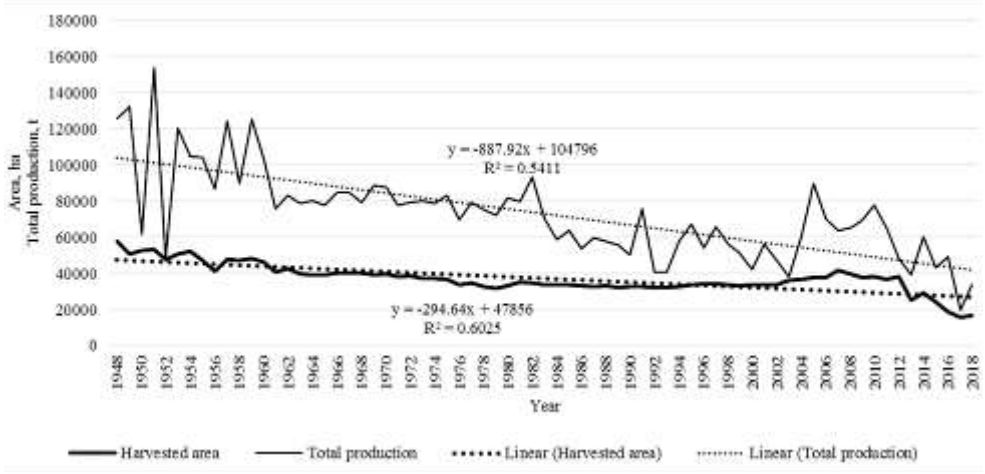



Figure 3. The area and total production of meadows in Vojvodina during 1948 – 2018.

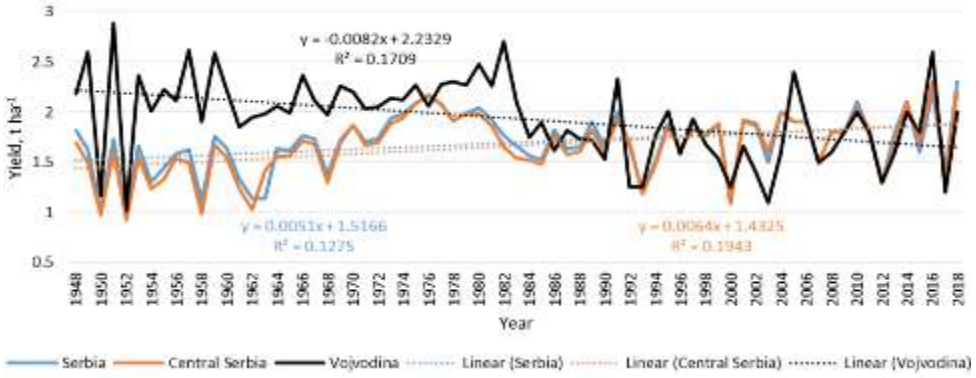



Figure 4. Yield of meadows in Serbia, Central Serbia and Vojvodina during 1948 – 2018.

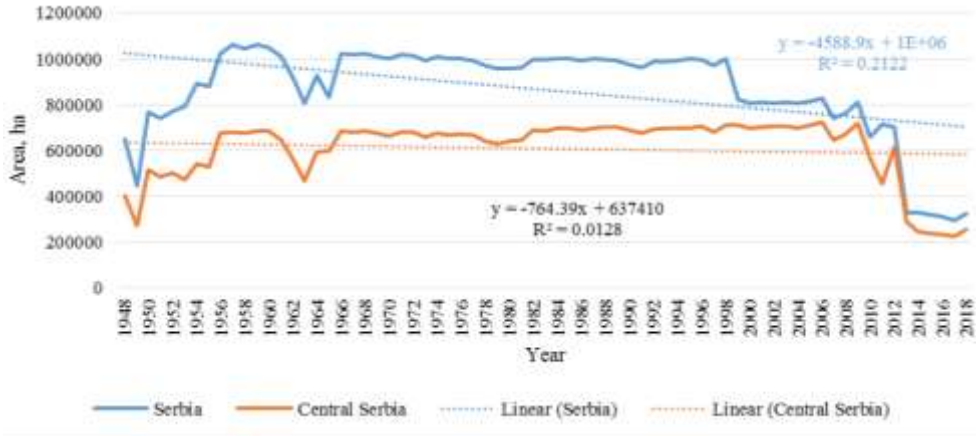



Figure 5. The area of pastures Serbia and Central Serbia during 1948 – 2018.

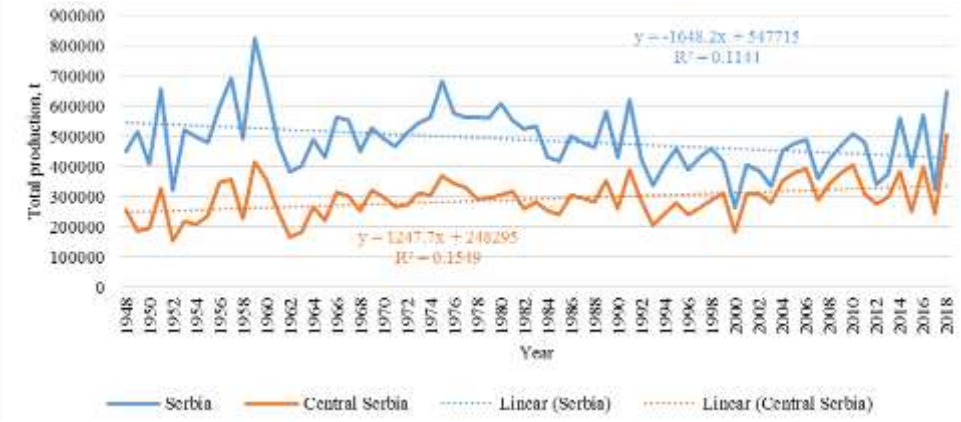



Figure 6. Total production of pastures in Serbia and Central Serbia during 1948 – 2018.

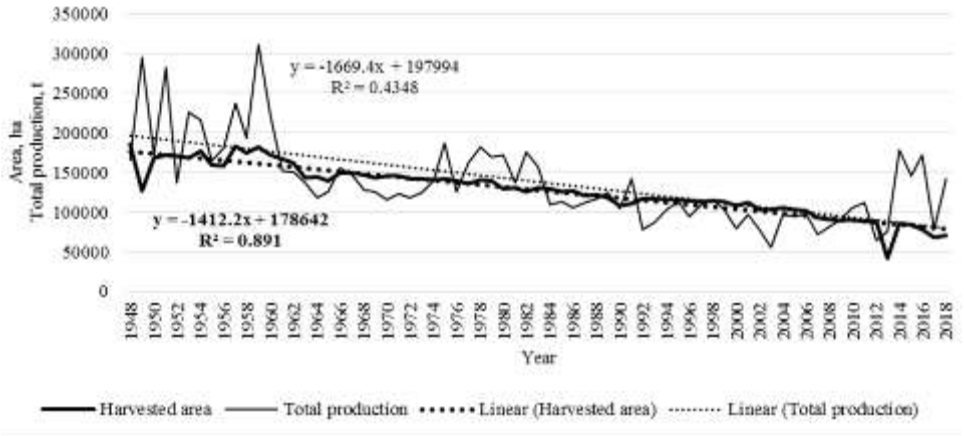



Figure 7. The area and total production of pastures in Vojvodina during 1948 – 2018.

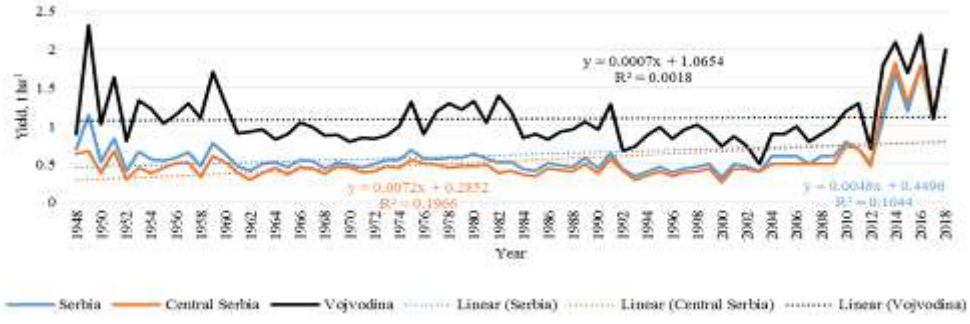



Figure 8. Yield of pastures in Serbia, Central Serbia and Vojvodina during 1948 – 2018.

In general, area of grasslands decreased due to the decline of ruminant population in Serbia. Unfortunately, without livestock development, permanent meadows and pastures will continue to be inadequately used. Similar to our results, Egoh *et al*. (2016) find that the grasslands worldwide have been in drastic decline during the last decades. This phenomenon is the result of conversion to arable land for production of animal feed crops and lack of management and abandonment (Queiroz *et al*., 2014).

Basically, the production potential of better natural grasslands and their quality can be increased by the application of agrotechnical measures, especially fertilization and weed control. Also, through the planned utilization and cultivation of pastures, the floristic composition would be improved and preserved.

Essentially, the interest in improving the production of meadows and pastures has decreased due to the reduction in the number of ruminants (cattle, sheep and goat). For that reason the grasslands are increasingly degraded and reduced and in more remote areas they are under extreme degradation and shrub vegetation develops. Such surfaces are further gradually excluded from the production cycle. The large increasing production and supply of livestock breeding, as well as agricultural policy developments are essential for grassland farming system and sustainable agricultural development.

The time series analysis predicts the future by projecting the historical data. Therefore our forecast is based on random trends and relationships existing in the historical data from 1948 to 2018. We find that yields of grasslands in Serbia and Central Serbia and yield of pastures in Vojvodina will increase by 2050 (Figure 9). However, these are very low yield growth rates. Contrary, yields of meadows in Vojvodina will decrease by 2050. Essentiality, there is almost no or little agronomic input in the grasslands of Serbia, so there are no technological

improvements in dry matter productivity. Contrary, Qi *et al*. (2018) estimated that dry matter yield of grasslands in the United Kingdom will decrease by about 2.5 to 5% from 2020s to 2050s.

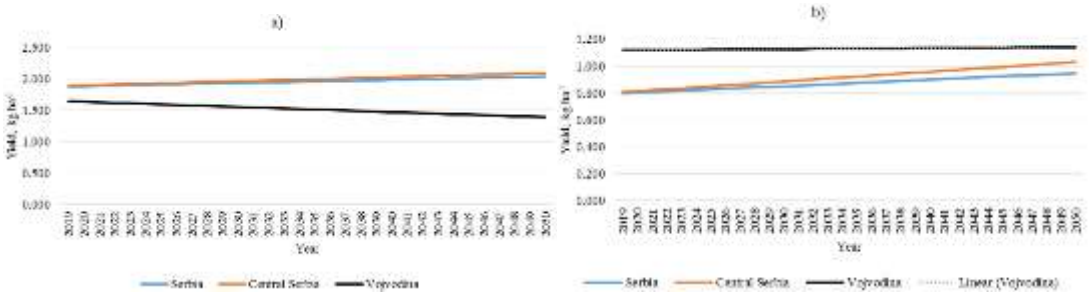



Figure 9. Yield prognosis for meadows (a) and pastures (b) in Serbia, Central Serbia and Vojvodina.

## Conclusions

The study emerges as an important information tool in understanding the change in the area, production, and yield of Serbian grasslands, with particular reference to factors and problems which influence high and stable production. Serbia has large areas under grasslands. They should be a major feed production resource. These grassland forage resources should be brought to a much higher level of productivity and quality in order to improve the productivity and quality of livestock. The forecast shows the grassland production having a weak upward trend. In general, areas under meadows and pastures should be recultivated and brought into production in accordance with the needs of livestock development. This will result in higher quantity and higher quality production of green mass and hay. Our study needs to be further refined and take into account climate change, rising carbon dioxide emissions in the atmosphere and technological advances based on annual yield.

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