CROPS DIVERSITY AND CROPPED YIELD EVOLUTION UNDER CLIMATIC CONDITIONS FROM BRAȘOV COUNTY

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Abstract. *Under the impact of climatic changes, there is an urgent need to adopt all necessary changes in the agricultural cropping system. To accomplish this main purpose, the hierarchy of crop development in a particular region must be studied to serve as a bridge for appropriate crop cluster set recommendations. Therefore, our study aimed to assess and overlap the climatic condition and crop diversity between 2016 and 2020. Over the five studied years, a set of parameters were interconnected. Climatic principal parameters such as average temperature, maximum and minimum average temperature, and precipitation quantity were extracted from meteomanz.com database. Also, the agricultural dataset was employed from the national institute of statistics, and the analyzed parameters were total cropped area, total vegetable production, total average production, and private sector average production. We have seen that overall cropped area decreased over the years, also for specific crop groups like cereals, sugar beet, potatoes, or vegetables, the only increase was seen for oily plants. The total vegetable production followed the same pattern, with the only difference for grain maize where it was a 10% increase together with oily plants of 17% in 2020 compared with 2016. The crops with decreased interest were oat and barley, peas for grain, bean for grain, soybeans, sugar beet, tomato, and onion. This lower interest could be motivated by the fact that a lower amount of precipitation was expected. All these crop diversities, respectively cropped areas with different productions, were determined by a slight increase of average maximum temperature of 0.4°C and of the average minimum temperature of almost 1°C. In Brasov's area prevail 15 principal crops, and the cropped surfaces suffer slight changes over the analyzed period.*

Keywords*: cropped area, production, precipitation, temperature*

INTRODUCTION

The strategies of crops establishment must be changed and adapted following climate change scenarios and predictions (LABEYRIE et al., 2021). Substantial changes are expected in most areas, and the farmers are yet facing increased pressure because of high market demand (MELDRUM et al., 2018, FAO, 2022), urbanization shifts (UDAYKUMAR et al., 2021) and different nutritional customs (RUGGIERI et al., 2021). Many studies highlight that the diversity is reducing with high speed mainly because of economic efficiency requirement from social point of view (RUGGIERI et al., 2021; ROSA-SCHLEICH et al., 2019), but there are other reasons like climate conditions change over the last decade and the adaptation level of particular crops (SULTAN et al., 2019, CROITORU et al., 2020). In Romania, climate changes and principal climatic parameters influence the crops distribution over the entire country. The question is what in the degree of change for each zone? Reason of which we took into study one single county. Brașov County is located in the southeastern part of Transylvania, on the middle course of the Olt River, inside the Carpathian arc. It is one of the 41 counties from Romania

and represents a share of 2.2% of the total country area around 5.363 km (ANTAL and GUERREIRO, 2021) with an average altitude of 1071m. From a geographical point of view, it occupies, most of the Brașov and Făgăraș depression. It is located in the central part of Romania, at the junction of two large mountain ranges; the Eastern Carpathians and the Southern Carpathians. This particularity offers no hot summers with nu dry seasons with a moderately cold weather of temperate-continental climate (ANTAL and GUERREIRO, 2021). In agriculture, Brașov County is notable for the production of sugar beet and potatoes, but also for animal husbandry. It ranks 3rd in the national hierarchy in potato cultivation and 4th in the production of sugar beet and meat. Large-scale agriculture is used with advanced technology in purpose to increase productivity. The aim of this study was to assess under climate change, the crop diversity, total cropped area, total agricultural yield, and average yield per hectare between 2016 and 2020 production years from Brașov.

MATERIAL AND METHODS

After a rigorous selection of trusted data, two databases were analyzed. The climatic database was extracted from an online historical database namely meteomanz.ro accessed on 10 October 2021. A search was performed after selecting the country Romania, station BRAȘOV-GHIMBAV (15300) location: 45 41N, 25 31E, 535 masl. Statistics regarding agricultural status were employed from the national institute of statistics insse.ro accessed on 21 December 2021. The vegetation period was established for each crop (Figure 1), afterward the crops were grouped into 10 classes depending on the specific requirements and this ranking would be further used for expanding climatic graphs. Basically, all database was split and extended to all 10 ranking classes. Average values were calculated and used for further explanations. The plants were selected according to the vegetation period and thus the climate requirements were evaluated.

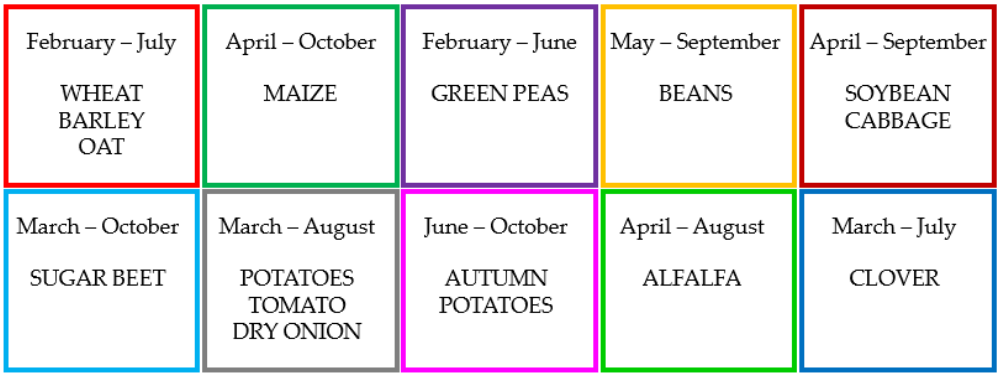


Fig. 1. Vegetation period of all crops grown in Brașov, a total of ten principal cycles

RESULTS AND DISCUSSIONS

In the assessed range 2016-2020, in Brașov County were cultivated with increased interest fifteen principal crops respectively: wheat, barley, oat, maize, green peas, beans, soybean, sugar beet, potatoes, tomato, dry onion, autumn potatoes, cabbage, alfalfa, and clover. All these fifteen crops were compiled in 10 classes set by the vegetation period time. All the

crops benefit from precipitation in the entire vegetation period from all years together in average between 60-80 mm, so less than 100 mm (Figure 2).

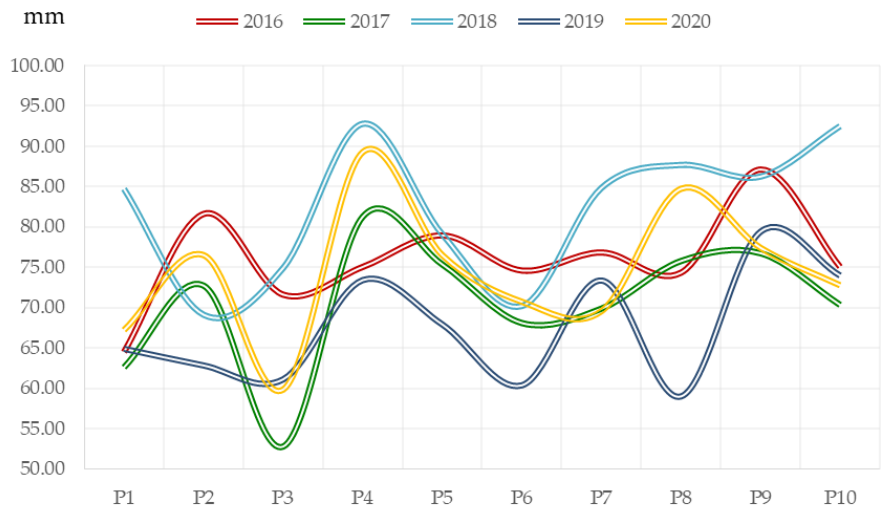


Fig. 2. Precipitation level for all ten selected crops, a value measured as average between specific requirements of each similar groups of plants in terms of established vegetation period (mm)

The precipitation ranges for the first vegetation period (P1) and second (P2) was between 62 and 85 mm with the most higher value in the year 2018 (P1) and 2016 (P2). The lowest precipitation (P3) range was observed for the vegetation period of green peas between 52-75 mm with the highest value in 2018 followed by a decrease of 18% in 2019 and 20% in 2020 compared with the higher registered value. Beans crop (P4) benefit from the higher water input between 73-90 mm with the most higher value in 2020 (89.28 mm). Soybean and cabbage received between 67-80 mm (P5) in 5 years with a high amount in 2018. Sugar beet (P6) received precipitation in a range between 60-75 mm. Precipitation between 69-85 were registered in the vegetation period of potatoes, tomatoes and dry onion (P7) with the higher value in 2018 and the lowest value in 2020. The potatoes yield (P8) received a high amount of water in 2018 (97.64 mm) and a low amount of water in the next year (2019) around 58.96 mm. Alfalfa (P9) had between 76-88 mm water from precipitation with a similar level around 87 in 2016 and 2018 and the lowest value in 2017. A similar crop, clover (P10) received the highest precipitation amount of 92.44 mm in 2018 in comparison with all the other crops.

The entire cropped area was the highest in 2016 around 74707 ha. In 2017 and 2018 the cropped area decreased by 7%. In 2018 it was also a slight decrease of around 4650 ha to have in 2020 a total of 67266 ha cropped.

The total agricultural yield was directly influenced by the amount of precipitation. Overall cropped area decreased over the years, also for specific crop groups like cereals, sugar beet, potatoes, or vegetables, the only increase was seen for oily plants. In general, legumes produced in total for the five years were around 8500-8900 t ha^{-1} with the higher yield in 2018

(8863 t ha^{-1}) (Figure 3). Oily plants yielded between 8100 and 10007 t ha^{-1} with the higher value in 2018. The potatoes yield was the highest in 2016 around 195336 t ha^{-1} and the lowest value in 2020 at about 63735 t ha^{-1}. The total agricultural production for sugar beet was the highest in 2017 reaching a value of 134962 t ha^{-1} and the lowest value in 2020 of 50137 t ha^{-1}. The most higher values were registered over the five studied years to cereals. Around 226166 t ha^{-1} was the highest yield in 2018 and the lowest in 2020 (187115 t ha^{-1}).

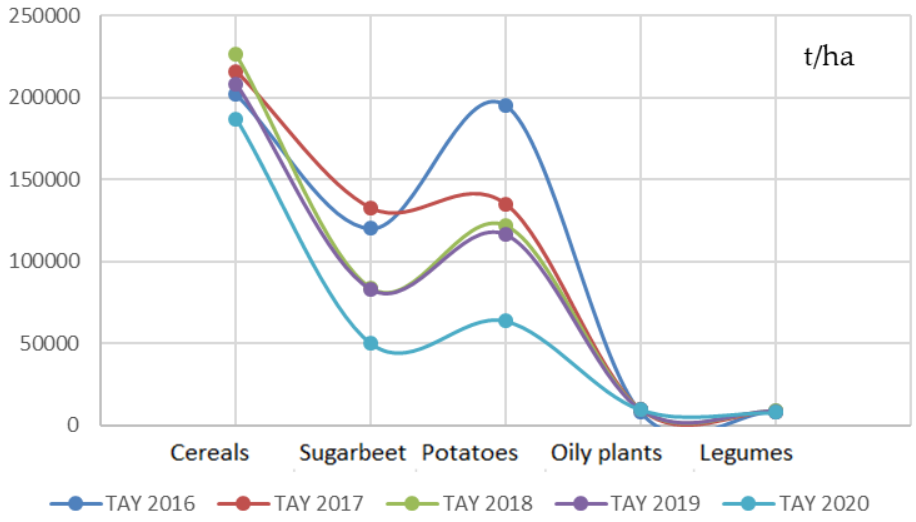


Fig. 3. Total agricultural yield (TAY) assessed for all five crop classes from Brașov, evolution between years 2016-2020 (t ha^{-1})

Average temperature (T) was calculated as specific for each one of ten vegetation periods like all climatic parameters (Figure 4). Cereals developed around 11°C (2017-2020 T) with the higher value of 12.38 registered in 2016. Maize developed under optimal average temperature between 15-17°C (VÂTCĂ et al., 2021). Green peas had a temperature range between 9.60-10.88°C. A range between 17.5-18.12°C helped the bean from May to September to yield. Soybean and cabbage developed under 16-17.5°C. A range of only 14-15°C was available for sugar beet crop with a higher value in 2018. From March until August, potatoes, tomatoes and dry onion have grown under average temperature of 14-16°C, with higher average temperature in 2018 and the lowest in 2020. In Brașov, autumn potatoes developed well at an average temperature between 16-17.2°C. In Pakistan, potato grows well at a mean temperature between 21-22.5°C (NAZ et al., 2022). Alfalfa developed at an average temperature between 15.8 and 17.9°C from April until August. Clover crop had average temperature values in the vegetation period between 12.9 and 14.5°C.

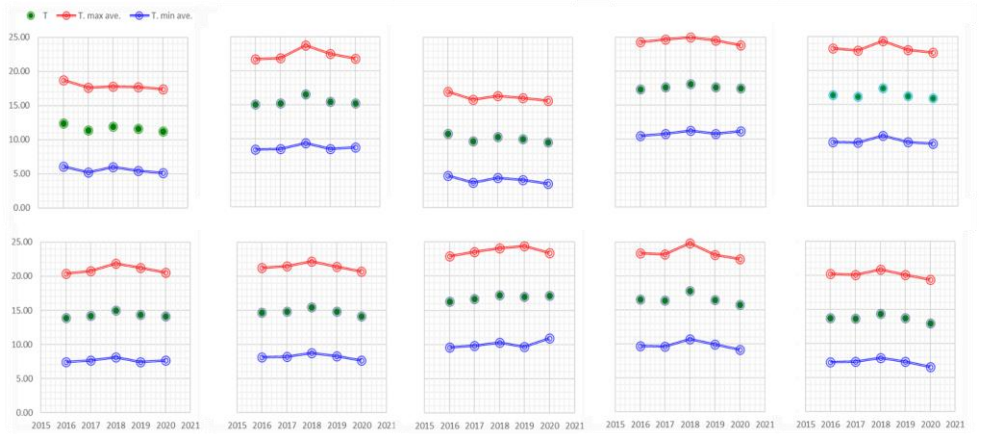
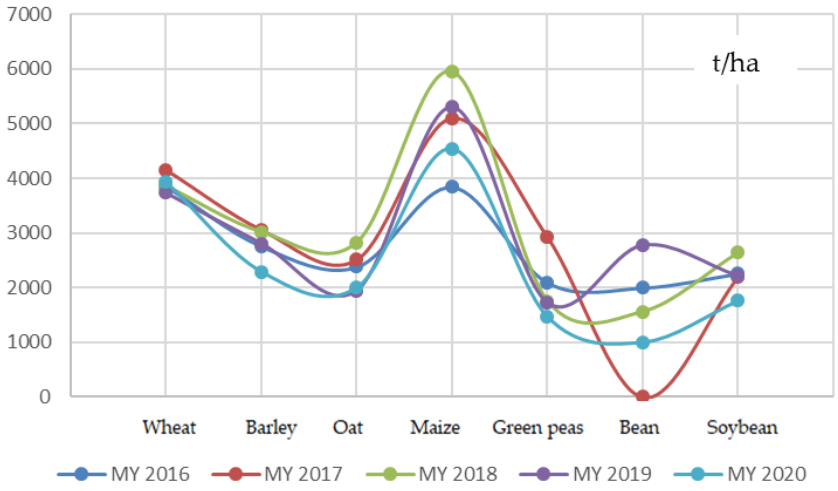


Fig. 4. Climatic representation of the parameter temperature respectively average temperature (green), average maximum temperature (red) and average minimum temperature (blue) for all 10 major groups made from all 15 crops as in Figure 1 grown in Brasov between 2016-2020

Average yield per (MY) hectare comprises 2 major classes. First class was composed from wheat, barley, oat, maize, green peas, bean, soybean with average yield per hectare between 1000 and 6000 t ha^{-1}. In 2017 year there was no registered yields for bean (Figure 5.A.). The most higher value was registered for maize in 2018 (5946 t ha^{-1}).

A.



B.

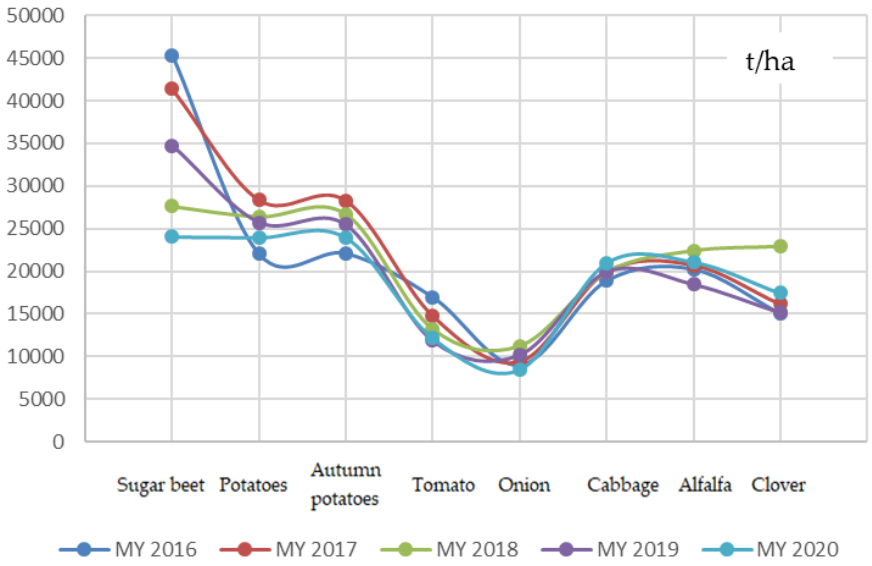


Fig. 5. Average yield per (MY) hectare (ha) of all 15 species cultivated in Brașov (t/ha); A. First crop class with average yield up to 6000 t ha^{-1}; B. First eight crops with the highest average yield between 9000-45000 t ha^{-1}

Other studies found that wheat yield was around 7000-7600 kg ha^{-1} (VIDICAN et al., 2020, IMPORTS, 2017) more than statistics are declared in Brașov arround 4000 kg ha^{-1}.

The second class (Figure 5.B.) combines the crops sugar beet, potatoes, autumn potatoes, tomato, onion, cabbage, alfalfa and clover. All eight crops gave the higher average yield per hectare between 9000 and 45000 t ha^{-1}. Sugar beet gave the highest average yield per hectare of 45321 t ha^{-1} in 2016 mainly because of the low amount of precipitation combined with average of minimum temperatures. Each year the average yield per hectare decreased and in 2020 it was only 24046 t ha^{-1}. Two crops, tomato and onion had close average yield per hectare between 8500 and 17000 t ha^{-1}.

The average yield per hectare decreased in 2020 compared to 2016 for barley, oat, green peas, bean and soybean crops. Maize and wheat developed well and even if TAY for cereals decreased with 7%, the average yield (MY) increased with 18% for maize and 2% for wheat.

For the crops with high cropped area, MY for sugar beet, tomato and cabbage was lower in 2020 compared with 2016. In case of sugar beet, a reduction of average yield per hectare with around 50%. Tomato average yield per hectare decreased with 28% and onion with 6% in 2020 compared with 2016. MY increased for potatoes and autumn potatoes in 2020 if we see the 2016 with 9%, cabbage with 11%, alfalfa with 4% and clover with 16%.

CONCLUSIONS

Overall cropped area decreased over the years, also for specific crop groups like cereals, sugar beet, potatoes, or vegetables. The total vegetable production from 2020

compared with 2016 followed the same tendency, except maize were TAY registered 10% increase and oily plants by 17%. The crops with decreased interest were oat and barley, peas for grain, bean for grain, soybeans, sugar beet, tomato, and onion. This lower interest could be motivated by the fact that a lower amount of precipitation was expected. All these crop diversities respectively cropped areas with the different yielding pattern were determined by a slight increase in average maximum temperature of 0.4°C and of the average minimum temperature of 0.91°C. In Brasov prevail a number of 15 principal crops and the cropped surfaces suffer slightly changes over the analyzed period.

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