

# ANALYSIS OF THE SELF-SUFFICIENCY OF WHEAT PRODUCTION IN BOSNIA AND HERZEGOVINA

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## ABSTRACT

**Wheat is recognized as a crucial staple food across nearly all countries. Achieving a specific level of self-sufficiency in primary food products is a common objective for nations, aimed at safeguarding domestic production, minimizing dependency on imports, and mitigating disruptions in global and regional supply chains. This study provides an analysis of wheat production and yields in Bosnia and Herzegovina, with the goal of evaluating the self-sufficiency of wheat production. The analysis covers the period from 2010 to 2019. The study places particular emphasis on spatial analysis, including production, yield, and self-sufficiency at the level of local administrative units. The findings indicate that Bosnia and Herzegovina's self-sufficiency in wheat production stands at 54%, with significant variability in production quantities across different local government units. These insights offer a foundation for future research that could delve deeper into the spatial-temporal, economic, and food security dimensions of wheat production.**

**Keywords:** Wheat, Production and yields, Self-sufficiency, Bosnia and Herzegovina.

## INTRODUCTION

Wheat (*Triticum*) is an annual plant and represents one of the most significant and widespread agricultural crops in the world. In human nutrition, wheat plays an irreplaceable role and is a main ingredient in staple food products such as bread and similar items (Kovačević & Rastija, 2014). Additionally, wheat is of great importance to the milling industry, the food processing industry, the pharmaceutical industry, and livestock feed production. It is characterized by a large distribution area due to its nature and polymorphism. The most favorable conditions for its cultivation are in the zone between 30 and 60° north latitude and 27 and 40° south latitude (Oleson, 1996; Nuttonson, 1955). The optimal temperature for wheat development is around 25°C, while the average temperature minima and maxima range from 3 to 4°C, and 30 to 32°C, respectively (Briggle, 1980).

Wheat has a high degree of adaptation when it comes to water availability. Although three-quarters of the world's land where wheat is grown receives between 375 and 875 mm of precipitation annually, it can be cultivated in most areas where the average annual precipitation ranges from 250 to 1750 mm (Leonard & Martin, 1963). According to Todorović and colleagues, the northern limit for cultivating winter wheat is at 67° north latitude, while in the southern hemisphere, this limit extends to the southern parts of South America, Africa, and Australia (Todorović et al., 2003). In terms of vertical distribution, wheat is grown up to 4000 meters above sea level in Asia, while in Europe it thrives up to an altitude of 1100 meters. Winter wheat provides higher and more stable yields

compared to spring wheat, making it more economically significant. On the other hand, spring wheat produces higher quality grain and flour and is significantly more resistant to drought and high temperatures (Jablonskyté-Raščé et al., 2013).

The three most important cereals on a global level are wheat, rice, and corn. These cereals are fundamental elements of human nutrition and account for nearly half of the calories in global diets, as well as two-fifths of global protein intake. Wheat alone provides one-fifth of the calories and protein in the global diet and is the most widely cultivated crop, grown on over 217 million hectares annually (Ernstein et al., 2022). In this context, it can be concluded that wheat plays a crucial role in ensuring global food security due to its significant presence in the diets of the world's population (Dixon, 2007; Shiferaw et al., 2013). Wheat production has varied globally from 200 to 240 million tons from 1961 to the present, with a peak in production recorded during the 1980s. The area sown with wheat globally has not significantly fluctuated, but over the past fifty years, there has been a noticeable trend of increasing wheat yields. Wheat yields have nearly quadrupled in the past fifty years (Ernstein et al., 2022).

Climate change impacts wheat production differently across various production zones worldwide. Some benefits of climate change may be observed in production zones at the far northern and southern latitudes, while production zones in the subtropical belt will face challenges due to rising temperatures and extended droughts (Xiong et al., 2020). It is important to note that over time, new pathogens and wheat diseases have emerged and spread, affecting yields in certain production areas around the world (Singh et al., 2008; Mottaleb et al., 2018).

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Each country aims to achieve the goal of self-sufficiency in the production of certain agricultural products, especially if favorable agro-ecological conditions exist within that country. According to the FAO, the concept of food self-sufficiency is "generally viewed as the extent of production whereby a country can meet its needs from domestic production" (Thomson & Metz, 1998). The pursuit of self-sufficiency is not in alignment with the concept of free markets and trade, and many critics argue that self-sufficiency undermines achieving economic efficiency in food production (Clapp, 2017).

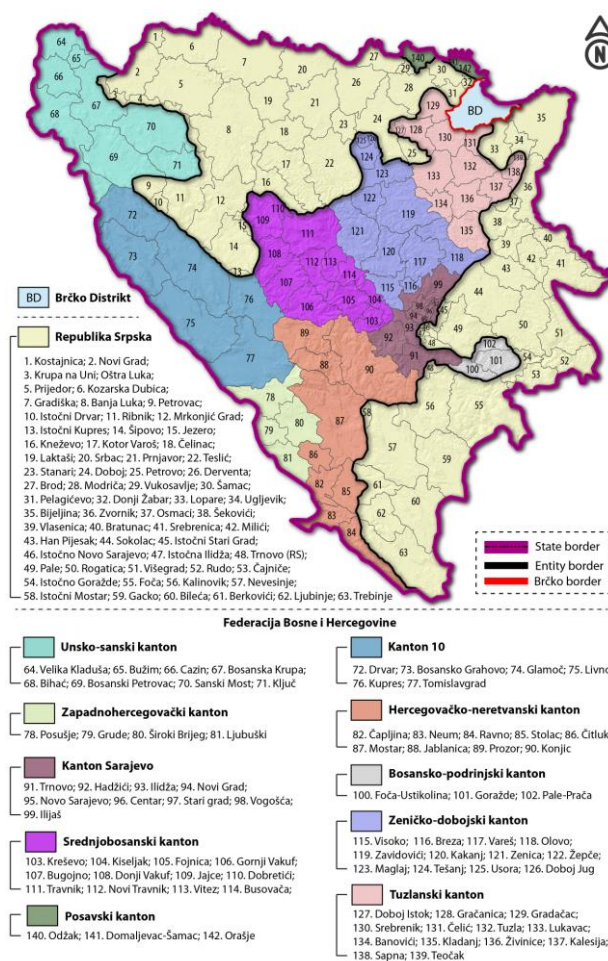
However, regardless of economic policy (protectionism or liberalism), most countries focus on achieving a certain level of self-sufficiency for key food products. The importance of self-sufficiency in the production of major agricultural products became particularly evident during the COVID-19 pandemic, when significant disruptions in global food supply chains were observed (Kakaei et al., 2022). Bosnia and Herzegovina, a net importer of food products, has not explicitly set goals for increasing production self-sufficiency in its strategic sectoral documents, but it has identified the deficit in foreign trade of agricultural products as a threat (Ostojic et al., 2019). Bosnia and Herzegovina imports between 300,000 and 400,000 tons of flour annually, while exports are around 40,000 tons per year (Ostojic et al., 2020). Mostly, high-quality flour is imported for the needs of the baking and food industries. Due to the inability to meet the demand for wheat and flour, the deficit must be covered through imports (Jalić et al., 2021).

The general aim of this study is to analyze the characteristics and trends of wheat production in Bosnia and Herzegovina and to assess the self-sufficiency of wheat production in order to determine the value of the production deficit in various years. The specific objectives of the study include analyzing the total production and yield of wheat in local government units in Bosnia and Herzegovina, providing insights into the geographic context of production and consumption of this crop.

## STUDY AREA

Bosnia and Herzegovina is a country in Southeast Europe. It borders the Republic of Serbia, the Republic of Croatia, and Montenegro. The total area of the country is 51,129 km<sup>2</sup> and it extends between 42°33'00" and 44°16'30" north latitude and 15°44'00" and 19°37'41" east longitude. The terrain is predominantly hilly and mountainous, significantly dissected by narrow river valleys. In the north, along the Sava River, there are larger plains, while in the southern and southwestern parts of the country, the landscape is dominated by karst terrain with plateaus and karst fields. The climate is mainly temperate continental with warm summers and cold winters (Ahmetbegović et al., 2015). The southern part of

thecountry, due to the influence of the Adriatic Sea, has a modified Mediterranean climate, while areas with high altitudes have a mountain climate characterized by short, cold summers and harsh winters. Forests and wooded land dominate land use, covering more than half of Bosnia and Herzegovina's territory. Agricultural land occupies about 37% of the total area, of which only 30% is arable land (Drašković et al., 2021). According to the 2013 census, Bosnia and Herzegovina had a population of 3,531,159 (ASBiH, 2016). Bosnia and Herzegovina has a very complex state structure and is divided into two entities (Republika Srpska and the Federation of Bosnia and Herzegovina) and the Brčko District as a special unit (Fig. 1). The administrative structure of the entities is not the same. The Republika Srpska territory covers 49% of the total territory of Bosnia and Herzegovina and is composed of municipalities and cities as local government units (54 municipalities and 10 cities). On the other hand, the Federation of Bosnia and Herzegovina consists of ten cantons as the first level of administrative division, and municipalities and cities as the second level of administrative division. The total number of local government units in the Federation of Bosnia and Herzegovina is 79.



**Figure 1.** Administrative-territorial division of Bosnia and Herzegovina.

## MATERIALS AND METHODS

The analysis of self-sufficiency in the production of an agricultural crop involves calculating the balance between production and imports on one hand, and consumption and exports on the other. Additionally, when calculating self-sufficiency, it is important to consider losses in production and storage, as well as the stock of the analyzed agricultural crop (FAO, 2017). Due to the underdevelopment and complexity of the statistical system in Bosnia and Herzegovina, and the unavailability of certain data, this study focuses solely on wheat production and consumption. Data on wheat imports and exports, which fall under the jurisdiction of the Indirect Taxation Authority of Bosnia and Herzegovina, are not available, and data on production/storage losses and stock are virtually non-existent.

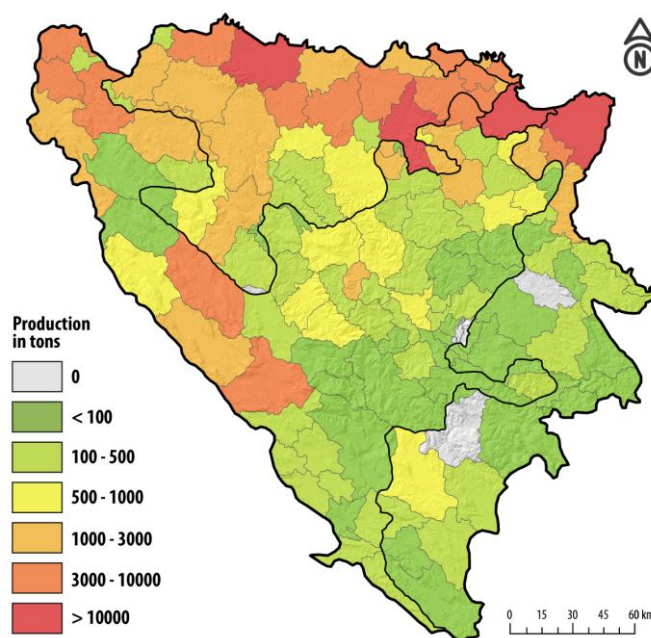
The study utilized official statistical data from the Agency for Statistics of Bosnia and Herzegovina, the Republika Srpska Institute of Statistics, and the Federal Institute for Statistics of Bosnia and Herzegovina, concerning the total production and yields of wheat in local government units. The analysis covers the period from 2010 to 2019. The Republika Srpska Institute of Statistics ceased collecting and processing data on total wheat production and yields at the local level after 2019, limiting the analyzed period to 10 years. For Republika Srpska, data were sourced from Statistical Yearbooks, while for the Federation of Bosnia and Herzegovina, data were taken from thematic bulletins titled "Crop Production in the FBiH." Data on total production and yields for the Brčko District were obtained from the Agency for Statistics of Bosnia and Herzegovina. Demographic data for the entities and the Brčko District, which relate to annual estimates, were sourced from the publications "Federation of Bosnia and Herzegovina in Numbers," "Statistical Yearbook of Republika Srpska," and "Demographics in the Brčko District." Demographic data for local government units were obtained from the publication "Population, Households, and Dwellings Census in Bosnia and Herzegovina 2013" (ASBiH, 2016). Data on wheat consumption per capita, or flour equivalent, were derived as average values from the study "Analysis of Trends in Production, Foreign Trade Exchange, and Consumption of Basic Food Products" (MPVŠ, 2018).

To facilitate spatial analyses, a specialized geospatial database was developed, incorporating statistical data related to demographics, wheat production, and yields at the local government unit level. Boundaries for local government units, cantons, entities, and the national level were sourced from the Open Street Maps repository and converted to the national coordinate system. The collection, processing, and visualization of geospatial data were conducted using the open-source software package QGIS, version 3.16.3.

## RESULTS AND DISCUSSION

Wheat production in Bosnia and Herzegovina during the analyzed period had an annual average of 238,500 tons. Republika Srpska contributed 64% to the total wheat production in Bosnia and Herzegovina on average. In contrast, the Federation of Bosnia and Herzegovina had a significantly lower share, averaging 30% of the total wheat production. The lowest production values were recorded in 2014, with only 170,000 tons, while the peak production during the analyzed period occurred in 2016, reaching 307,000 tons. Throughout the analyzed period, there was an observed increasing trend in wheat production in Bosnia and Herzegovina.

Wheat production in Bosnia and Herzegovina is most prominently concentrated in the northern regions of the country, specifically in Semberija, Posavina, and Lijevo Polje (Fig. 2).



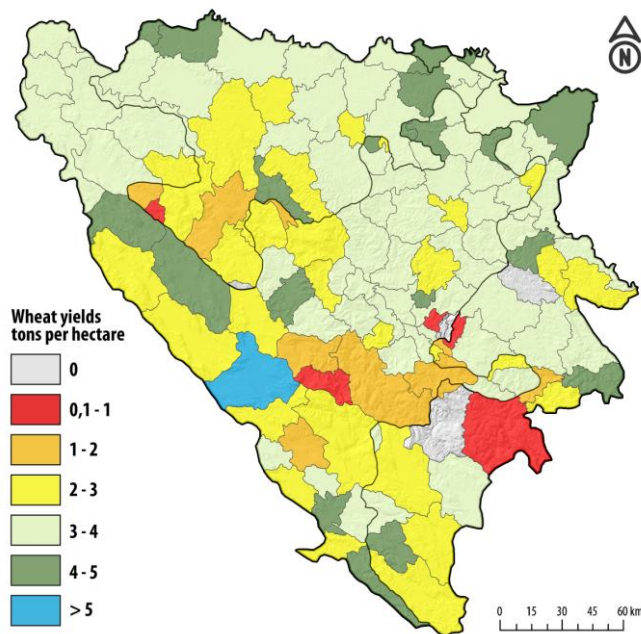
**Figure 2.** Average wheat production values for the period 2010–2019.

Significant wheat cultivation is also found in the middle and lower river valleys of Una, Sana, Vrbas, Bosna, and Drina, predominantly within local government units administratively belonging to Republika Srpska. In the Federation of Bosnia and Herzegovina, wheat production is most prevalent in the Posavski canton, Una-Sana canton, and Canton 10, while smaller quantities are produced in the Central Bosnia, Tuzla, and Zenica-Doboj cantons. Low levels of wheat production are observed in local government units located in the eastern part of Republika Srpska, as well as in Eastern and Western Herzegovina and the Sarajevo canton area.



According to official data from the Republika Srpska Institute of Statistics, there was no recorded wheat production in the municipalities of Kupres, Han Pijesak, and Kalinovik during the observed period. The Federal Institute for Statistics did not record wheat production in the urban municipalities of Centar, Stari Grad, and Novo Sarajevo. The local government unit with the highest average wheat production during the analyzed period was the City of Bijeljina, with an average production of 50,645 tons. Bijeljina recorded a peak production of 68,188 tons in 2017, accounting for 23.3% of the total wheat production in Bosnia and Herzegovina. The second-highest wheat-producing local government unit was Gradiška, with an average production of 13,855 tons during the observed period. The Brčko District had a slightly lower average wheat production (13,288 tons) compared to Gradiška, while the City of Doboj averaged a production of 10,622 tons. Other local government units in Bosnia and Herzegovina had annual wheat production figures below 10,000 tons during the observed period (Fig. 3).

The average annual wheat yield in Bosnia and Herzegovina was 3.66 tons per hectare. This yield is lower compared to neighboring Serbia (4.56 t/ha) and Croatia (5.6 t/ha), but higher than in neighboring Montenegro (FAOSTAT, 2022).



**Figure 3.** Average wheat yields for the period 2010–2017.

The lowest wheat yield for Bosnia and Herzegovina was recorded in 2010, at 2.7 t/ha, while the highest yield was noted in 2016, at 4.3 t/ha. During the observed period, the average wheat yield in Republika Srpska was 3.67 t/ha, whereas in the Federation of Bosnia and Herzegovina (3.63 t/ha) and the Brčko District (3.59 t/ha), the values were slightly lower. The average wheat yields per unit area showed an increasing trend

over the analyzed period. More than 50% of local government units have average annual wheat yields ranging from 3.1 to 4 tons per hectare. Slightly lower yields, ranging from 2.1 to 3 t/ha, were observed in 32 local government units. When examining the territory of Bosnia and Herzegovina, a pattern in average annual yields can be observed. The southern part of the Banja Luka region, which encompasses mountainous areas, exhibits wheat yields that are below the national average.

Areas with yields below the national average include the municipalities of Bosansko Grahovo, Livno, and Kupres, as well as most municipalities in Western and Eastern Herzegovina. In the eastern part of the country, lower average yields were observed in the municipalities of Srebrenica, Milići, and Čajniče. Across the rest of Bosnia and Herzegovina, average yields generally ranged between 3.1 and 4 tons per hectare. High average yields were noted in local government units located in Semberija and Posavina. Additionally, municipalities in Canton 10 (Drvar and Glamoč) and two municipalities in the Herzegovina-Neretva Canton (Čapljina and Ravno) also reported high yields. According to official statistics, the local government unit with the highest average yields during the observed period was Tomislavgrad, which averaged wheat yields of 6.03 t/ha.

Most local government units in Bosnia and Herzegovina have exhibited positive trends in increasing average wheat yields during the observed period. However, negative trends in yields have been identified in 15 local government units: Krupa na Uni, Petrovac, Istočni Drvar, Šipovo, Kotor Varoš, Gornji Vakuf, Busovača, Jablanica, Čapljina, Šekovići, Srebrenica, Rogatica, Pale, Trnovo (FBiH), and Trnovo (RS). The municipality of Sokolac has maintained constant yield values throughout the observed period.

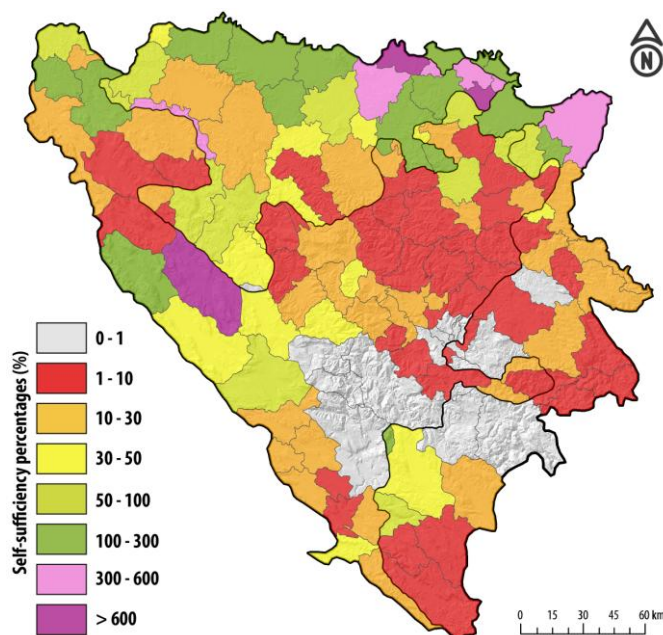
Assessing the self-sufficiency of wheat production involves analyzing total wheat production and consumption. It is crucial to consider demographic dynamics, food consumption levels, and shifts in consumer preferences regarding specific food products during this analysis. Due to the insufficient number of input parameters necessary for calculating wheat consumption per capita for each year, this study has utilized values from the report “Analysis of Trends in Production, Foreign Trade, and Consumption of Basic Food Products for the Period 2014-2017,” prepared by the Ministry of Agriculture, Water Management, and Forestry of Republika Srpska. According to this study, the average wheat consumption per capita was 162.9 kg, or 122.1 kg in flour equivalent. For further analysis, the value pertaining to consumption in flour equivalent was used.

The level of self-sufficiency in wheat production in Bosnia and Herzegovina during the analyzed period averaged 54.5% (Tab. 1). The highest average levels of self-sufficiency in wheat production were recorded in Brčko District (130.6%) and in Republika Srpska (109.3%).

**Table 1.** Estimation of wheat production self-sufficiency (in %) for the period 2010–2019.

Year	BiH	FBiH	RS	BD
2010	30,9	17,5	59,1	97,5
2011	44,8	23,8	91,3	107,6
2012	48,1	24,1	104,1	68,6
2013	61,7	26,9	125,8	88,4
2014	39,4	19,6	75,1	68,8
2015	49,6	26,6	89,4	137,7
2016	71,6	33,0	137,9	226,2
2017	68,2	28,6	139,9	177,1
2018	68,4	27,5	143,4	167,3
2019	62,1	26,5	126,8	167,4

These figures indicate that Brčko District and Republika Srpska are capable of fully meeting their wheat consumption needs through domestic production (Fig. 4). Conversely, the average self-sufficiency in wheat production in the Federation of BiH is markedly low, at only 25.4%, meaning that wheat production in the Federation of BiH can satisfy only a quarter of its population's consumption needs. Regarding the trends in self-sufficiency, it can be noted that both entities and Brčko District have shown positive trends over the analyzed period.



**Figure 4.** Assessment of wheat production self-sufficiency in local administrative units, 2010–2017.

Analyzing the average values of wheat production self-sufficiency in local administrative units, it can be concluded that 73.4% of these units have a self-sufficiency percentage below 50%. It is important to highlight that in Bosnia and Herzegovina, a total of 17 local administrative units have a self-sufficiency rate below 1%. Local administrative units that cannot meet the needs of their population with domestic production are: Han Pijesak, Pale, Trnovo (RS), Vogošća,

Ilidža, Sarajevo municipalities (Stari Grad, Novo Sarajevo, Novi Grad, and Centar), Istočno Novo Sarajevo, Foča, Kalinovik, Konjic, Mostar, Jablanica, Prozor, and Kupres (RS). These local administrative units are concentrated in the Sarajevo Canton, Herzegovina-Neretva Canton, Sarajevo-Romanija region, and the northern part of the Trebinje-Foča region. On the other hand, the analysis identified a total of 26 local administrative units where wheat production on their territory fully meets the consumption needs of the local population. Nine local administrative units even produce three times more than the needs of their local population. The municipalities with the highest levels of self-sufficiency in wheat production in Bosnia and Herzegovina are Glamoč (961%), Pelagićevo (778%), and Brod (699%).

## CONCLUSION

Wheat production in Bosnia and Herzegovina between 2010 and 2019 exhibited a positive growth trend. Depending on climatic conditions, sown areas, applied agronomic measures, subsidies, and purchase prices in a given year, production varied from 145,000 to 307,000 tons during the observed period. The average wheat yield in Bosnia and Herzegovina stands at approximately 3.66 tons per hectare, which is lower compared to neighboring Serbia and Croatia. Wheat production is predominantly concentrated in the regions of Semberija, Posavina, and Lijeve polje, as well as the river valleys of Una, Sana, Vrbas, Bosnia, and Drina. Considering the entities, the Republic of Srpska accounts for about 64% of the total wheat production in Bosnia and Herzegovina.

The self-sufficiency in wheat production in Bosnia and Herzegovina is approximately 54%, indicating that domestic production covers just over half of the domestic consumption. It is important to note that a portion of the produced wheat is redirected for livestock feed due to lower prices, which implies that the effective self-sufficiency rate is somewhat lower than stated. Analysis of lower administrative units reveals that 73.4% of local administrative units in Bosnia and Herzegovina have a wheat self-sufficiency rate below 50%. This data is concerning, especially given that some local administrative units possess favorable spatial and production conditions for organizing and increasing wheat production. The wheat deficit in Bosnia and Herzegovina is covered by imports, mainly from Serbia, Croatia, and Hungary.

To enhance production, particularly wheat yields, it is essential for entity and cantonal ministries to continue their current activities aimed at supporting and improving production. Additionally, demographic trends, dietary habits, and a mild increase in wheat production suggest that the self-sufficiency rate in wheat production is expected to rise in the coming period.

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