Yuzuncu Yil University Journal of Agricultural Sciences, Volume: 32, Issue: 4, 30.12.2022

Yuzuncu Yil University
Journal of Agricultural Sciences
(Yüzüncü Yıl Üniversitesi Tarım Bilimleri Dergisi)
https://dergipark.org.tr/en/pub/yyutbd

ISSN: 1308-7576
e-ISSN: 1308-7584

Research Article

Wheat Self-Sufficiency in Turkey: Production and Climate Change in Focus

Zeynep ERDOGAN*[1], Fatma SELCUK[2], Aliye Ahu AKGUN[3]

[1,2,3]Department of Urban and Regional Planning, Faculty of Architecture, Istanbul Technical University, Istanbul, Türkiye

[1]https://orcid.org/0000-0002-4881-3524, [2]https://orcid.org/0000-0001-9564-7998, [3]https://orcid.org/0000-0001-9722-5131

*Corresponding author e-mail: erdogan17@itu.edu.tr

Article Info

Received: 06.07.2022
Accepted: 03.10.2022
Online published: 15.12.2022
DOI: 10.29133/yyutbd.114159

Keywords

Wheat,
Self-Sufficiency,
Climate Change,
Agricultural Land,
Turkey

Abstract: Due to the fact that they can be preserved for extended periods of time and are utilized in virtually all cuisines, wheat and wheat products are the most popular grains to grow and produce. Beyond the current climate change impacts, closed national borders and growing limits for import-export products throughout the pandemic phase have caused governments to question their ability to produce enough food to meet their own needs in the short term. One of the objectives of this research is to determine what variables affect wheat self-sufficiency in Türkiye, which is one of the world's major wheat suppliers, and to develop recommendations for wheat production areas in the face of climate change's predicted impacts. With respect to Türkiye, wheat self-sufficiency data from the Turkish Statistical Institute (2000 to 2020) and regional climate change projections data from the General Directorate of Meteorology for the years 2050 and 2080 were used to identify the most significant variables, as well as the relationship between those variables and self-sufficiency. The findings indicate that wheat production is the most essential component in achieving wheat self-sufficiency and that climate change has a significant impact on wheat productivity and the areas where wheat is grown. Following this, the study concludes by detailing prospective wheat production regions in current great plain areas in the context of regional climate change projections, as well as critical policies for sustainable wheat cultivation.

To Cite: Erdogan, Z, Selcuk, F, Akgun, A A, 2022. Wheat Self-Sufficiency in Turkey: Production and Climate Change in Focus. *Yuzuncu Yil University Journal of Agricultural Sciences*, 32 (4): 654-670. DOI: https://doi.org/10.29133/yyutbd.1141592

Footnote: This study is largely based on Zeynep Erdogan's ongoing PhD thesis and partly preliminary studies of Fatma Selçuk's ongoing MA thesis. Both theses are supervised by Aliye Ahu Akgün.

1. Introduction

The Covid-19 pandemic has affected not only health but also nutrition, food security, and food-related approaches all over the world (FAO, 2020). Many routines, such as dietary priorities, consumption patterns, and eating habits, have evolved with time (Chenarides et al., 2020; Grashuis et al., 2020; Laguna et al., 2020). Many individuals have made it a priority to have access to food as well as to use and store it for extended periods of time. Similarly, during the epidemic period, there has been a surge in food stockpiling and panic purchasing (Nicola et al., 2020). The current tendency has also had an impact on the overall efficiency of the food system (Nchanji and Lutomia, 2021). While food security and self-sufficiency have risen to the top of the priority list on a macro level, a rising trend in demand for critical nutrients and long-life foods (flour, bread, pasta, and so on) has been observed at the micro level. According to a study conducted by Ipsos Turkey (2020), pasta, legume, and flour, all of which can be stored at home, are among the top three food products whose use has increased the most during the pandemic. The situation in which various export restrictions on staple foods such as rice and wheat have been implemented as a result of the pandemic (Laborde et al., 2020) underscores the necessity of agricultural production and self-sufficiency at the same time.

The European Food Behaviors Report (EIT Food, 2020) is a key source of information on food priorities and consumption behavior in the early pandemic period, revealing that flour saw the greatest increase in consumption (27 percent), followed by vegetables (27 percent), and fruits (32 percent). According to Google trends for 2020, 9 out of the top 10 most sought recipes are for various types of bread from around the world. Similarly, "ekmek" which means "bread" in Turkish, leads Türkiye's list, and the top ten recipes in Türkiye are all connected to wheat products, such as bread and pastries. These searches may provide as a measure of people's food choices and relationships with wheat during the pandemic lockdown period. A new conundrum has emerged: how to ensure that the most basic of nutritional commodities, such as wheat, are constantly available.

When examining wheat self-sufficiency, both production-based and productivity-based elements should be considered. Self-sufficiency factors are determined as endogenous variables in this context, while climate change variables are determined as exogenous variables. Climate change affects agricultural production, productivity, and self-sufficiency in both direct and indirect ways. From this vantage point, the study's initial goal is to establish what factors contribute to wheat self-sufficiency in Türkiye agriculture. The article then focuses on how climate change would affect self-sufficiency and how this change will affect wheat production patterns and places in Türkiye. Although the term "self-sufficiency" has multiple meanings in different settings, it is assumed in this study to mean a situation in which wheat output exceeds consumption. The study not only identifies the major determinants influencing wheat sufficiency, but it also establishes a framework for linking agricultural production and productivity. We focus on Türkiye because developing countries with fertile lands and agricultural potential, such as Türkiye, are critical to satisfying the world's growing population's food needs (FAO, 2020b). At the same time, the study is one of the first in current studies on agricultural production, food security, and pandemics to bring wheat self-sufficiency into question in the face of climatic change.

The study is structured as follows: it begins with a review of the literature on agricultural production and self-sufficiency from the perspective of food security, including productivity. In the next sections, we primarily focus on wheat self-sufficiency and production within Turkish agricultural production, as well as the influence of climate change on wheat production. The fifth section describes the study's methodologies and the materials employed. The sixth part, as a findings section, discusses the primary elements affecting wheat sufficiency in Türkiye, as well as wheat production scenarios under the impact of climate change in Türkiye for the years 2050 and 2080. In the following section, we address the consequences of factors that affect wheat sufficiency, the relationship between agricultural self-sufficiency and productivity, including wheat production and losses, and how wheat production patterns in Türkiye may alter as a result of climate change. Finally, the research finishes with strategies, evaluations, and recommendations for ensuring Türkiye's agricultural self-sufficiency in the future.

1.1.Macro perspective: Agricultural production and self-sufficiency

In Maslow's (1943) hierarchy of needs, physiological needs are at the top, and one of these is feeding. Throughout history, agriculture has been a major element in meeting the nutritional needs of human people. A shift from production to consumption through time has resulted in an increase in the area impacted by farming. The scarcity or surplus in the amount of agricultural production affects a wide range of social groups, from farmers' incomes to investments in agriculture-based industries, from raw material procurement to food safety (Trewin, 1999; Bayraç and Doğan, 2016).

As the world's population grows, so makes the demand for food, and this trend is only expected to continue (Kruse, 2010). By the year 2050, food production must increase by 60% to meet this need (FAO, 2015). Access to food is known as one of the most essential human rights (UN, 1948). This right can be connected to the concept of food security, which is "the ability of all people to have access to the fundamental foods they require physically and economically at all times" when supply and demand are in balance (FAO, 1983). There are four primary components to food security, according to the World

Health Organization (WHO) (2019) and the Food and Agriculture Organization of the United Nations (FAO) (2006). Covid-19 has had a direct impact on these three pillars, particularly food availability (Laborde et al., 2020). The first step in providing food accessibility is to ensure that there is enough food to go around, and this is largely based on the availability of sustainable agriculture.

Self-sufficiency can be defined in a variety of ways and measured in a variety of ways. Food self-sufficiency is defined by FAO (1999) as "the extent to which a country can meet its own domestic food demands from its own domestic production." Generally, self-sufficiency refers to a country's ability to meet its own needs in terms of production and consumption (Soltani et al., 2020). There are some analysts who define self-sufficiency as a country's ability to meet all of its food needs only through domestic production without being dependent on food imports (Clapp, 2017). We define wheat self-sufficiency in this study as a supply of wheat that is equal to domestic demand and also provides surplus production of each type of wheat in the event of a predictable condition like climatic change or an uncertain period like a pandemic.

The primary goal of agricultural production in most countries is to ensure that the population receives adequate and balanced nourishment. As part of a country's agricultural self-sufficiency, agricultural production is critical to preventing excessive foreign dependency (Acar and Aytüre, 2014; Bayar, 2018). There are no sustainable agricultural policies or policies that provide self-sufficiency in production when they are not based on production and resource productivity (Gülçubuk, 2020). Increased agricultural production is linked to agricultural self-sufficiency. Increasing cultivation areas is one of the most important methods for boosting agricultural production, and another is to enhance yield per unit area (Tuğay, 2012) while minimizing food losses. However, as arable land gets depleted, it is vital to find new ways to produce more goods with the help of already available agricultural inputs (Erçakar and Taşçı, 2011). As a result, the research focuses on preserving existing habitats and improving agricultural production and productivity.

Storage, marketing, and product price are just a few factors that can affect productivity. Other factors include the fragmentation of land, climatic conditions, land ownership, and organization, as well as agricultural inputs (seeds, fertilizers/pesticides) and irrigation (Mentz and Slater, 1999; Çelik, 2000). However, chemical inputs, seed advances, mechanization, expansion of arable land, and activation of irrigation potential might be represented as the most important variables in increasing agricultural production (Bayramoğlu, 2010). A second element that has an impact on production and productivity is the amount of food that is lost. In the food supply chain, food loss refers to a drop in quality and/or quantity losses. High food losses put the nation's food supply at risk (Keding et al., 2013). Due to food losses, there are more uncertainties and hazards. Food waste accounts for 14 percent of the world's food losses each year (FAO, 2020a). During the stages of food production, harvesting, and post-harvest activities (storage, processing, distribution, and consumption), food losses occur.

According to the level of development of the countries, food losses may vary (FAO, 2013). In middle- and high-income countries, the majority of food loss and waste occur in the distribution and consumption stage (FAO, 2011; Prusky, 2011; Permanandh, 2011). Food losses occur all the way up the food supply chain, despite the fact that food waste happens at the consumer and retail level (Cattaneo et al., 2020). The majority of the loss occurs during the production and post-harvest phases in low-income countries as well (FAO, 2011; Prusky, 2011; Permanandh, 2011).

1.2. Micro perspective: Agricultural production and self-sufficiency

In terms of total agricultural land and arable land amount, China and the United States are the two pioneer countries around the world. In addition to having an important agricultural land potential, Türkiye comes after its neighboring countries Russia and Ukraine (Figure 1.).

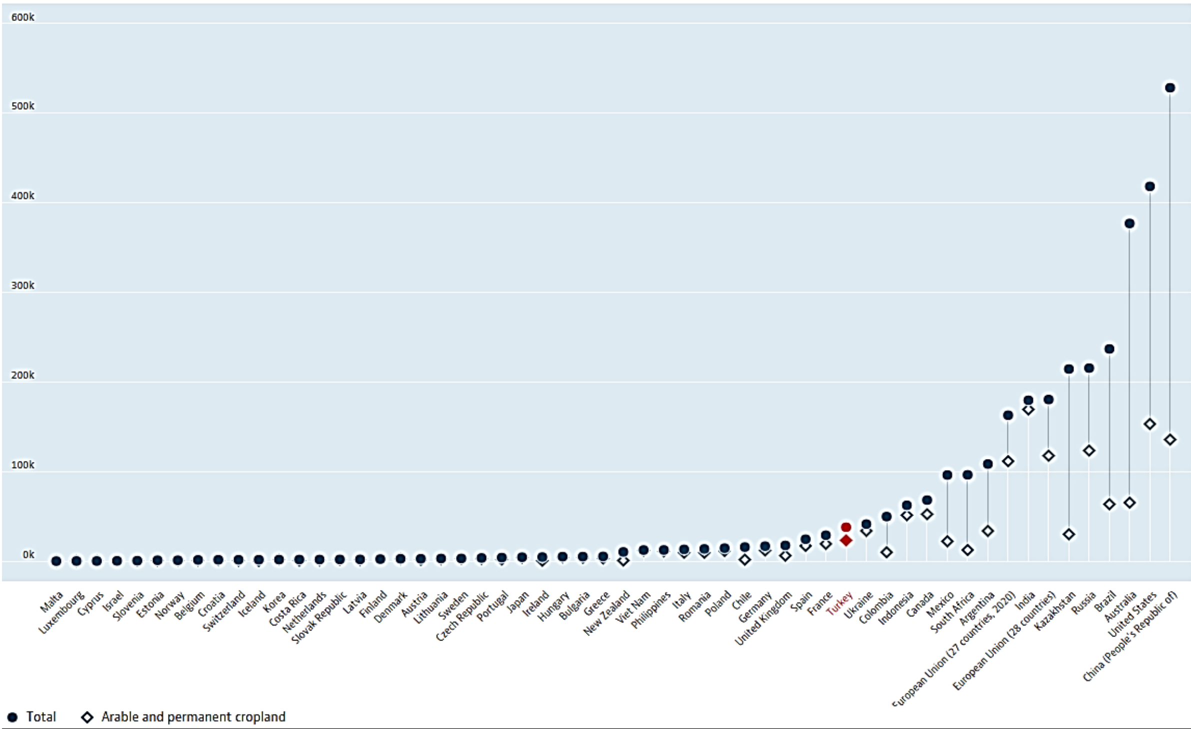


Figure 1. Agricultural Land- Total/Arable and Permanent Cropland, Thousand ha. (OECD, 2021).

To maximize output in Türkiye's agricultural sector, increasing the amount of arable land available for cultivation is a vital consideration. Because the amount of arable land in Türkiye is nearing its maximum, it is impossible to increase the boundaries of agricultural land, as is the case in many other countries (Bayar, 2018). Table 1. shows that since the 1980s, total agricultural land and cultivated land have decreased. On the map, wheat production areas and productivity values with the plain areas for 2020 are given (Figure 2.). The map shows that while Central Anatolia and Southeast Anatolia have a high-rate production in wheat, the west of Southeastern Anatolia, the east of the Mediterranean region, the west of the Aegean region, and the Marmara region have become prominent in terms of wheat productivity with the remarkable values.

Table 1. Total agricultural land and total arable/permanent cropland, Türkiye

Years	**1960**	**1970**	**1980**	**1990**	**2000**	**2010**	**2020**
Total arable and permanent cropland (thousand ha)	25.324	27.339	28.182	27.856	26.379	24.394	23.145
	1990	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Total agricultural land (thousand ha)	42.033	39.212	38.757	41.223	39.011	38.551	37.762

Source: TURKSTAT, 2021 (https://data.tuik.gov.tr/Kategori/GetKategori?p=tarim-111&dil=1)

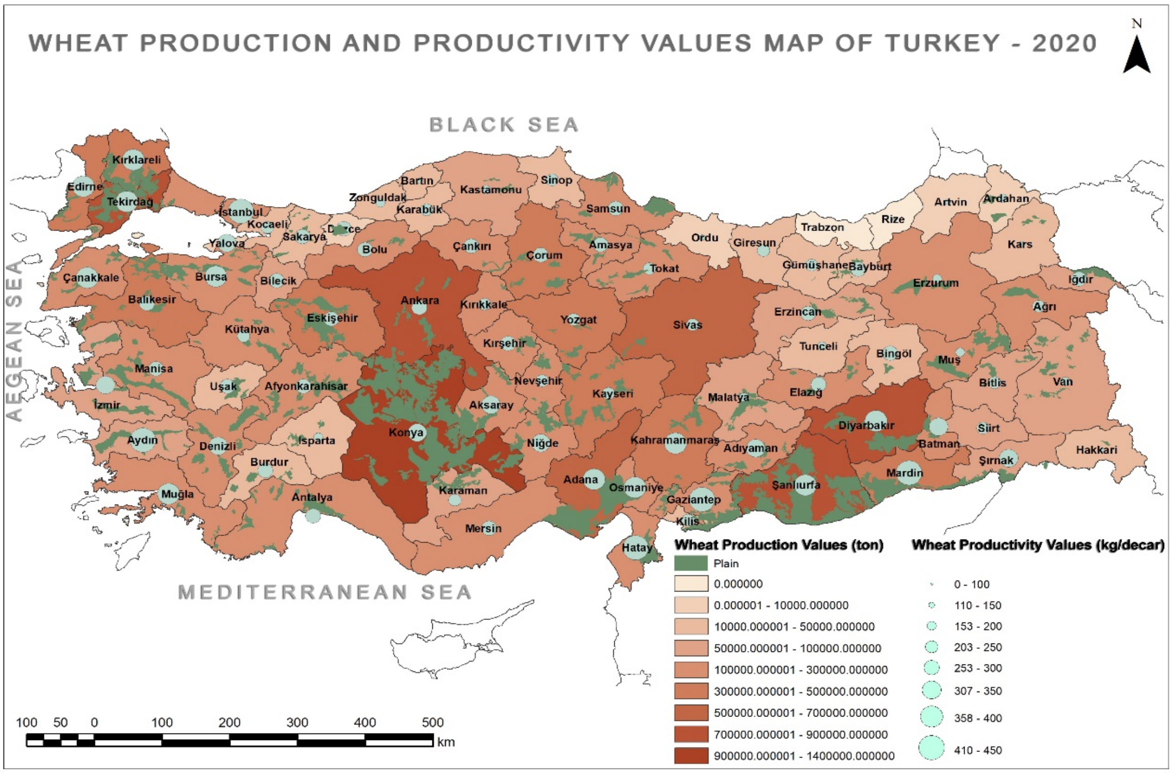


Figure 2. The map of wheat production and productivity values of Türkiye, 2020. *Source:* Based on the data derived from TURKSTAT (2020), map is prepared by the authors.

Besides the high input prices, Türkiye's agricultural land structure is exceedingly fragmented and small as a general concern (Demirdöğen et al., 2016). Although generalizations cannot be made for all agricultural products, irrigation and mechanization are not possible in small and fragmented areas. As a result, agricultural production and productivity are significantly impacted. In developing countries, 95% of food losses are due to "unintentional" mishaps that occur in the early stage of the supply chain (FAO, 2018). In Türkiye, most of the country's food losses occur during the production process. Fruits and vegetables suffer the greatest losses in plant/crop output, while grains suffer the least (Tatlıdil et al., 2013).

Wheat has been grown in Türkiye for more than a thousand years (Atalan-Helicke, 2019). After the financial crisis of 1929, official policies aimed primarily at wheat production in terms of agricultural policy in Türkiye. Wheat assistance purchases and price intervention were first implemented in 1932 under statute number 2056. Wheat was the target of price regulation and corrections under this statute (Silier, 1981). The second half of the 1930s saw the continuation of precautionary measures for wheat purchasing, such as the free charge of seeds, increased custom charges on wheat imports, and support for agricultural cooperation (Margulies and Yıldızoğu, 1990). At the end of the 1930s, wheat, which had been primarily an import, began to be exported (Özdinc, 2010). While wheat production grew in the 1950s, it relied on growing farmland, after the 1970s, it relied on a gain in productivity (Aysu, 2018). Since the 1980s, neoliberal policies and the free market have had a major impact on agricultural policies, and the state monopoly in the wheat market has shrunk as a result. Wheat production has not changed much in the recent three decades. However, imports of wheat have risen sharply in tandem with the country's growth as an exporter of flour (wheat) in the 2000s (FAOSTAT, 2021) (Figure 3.).

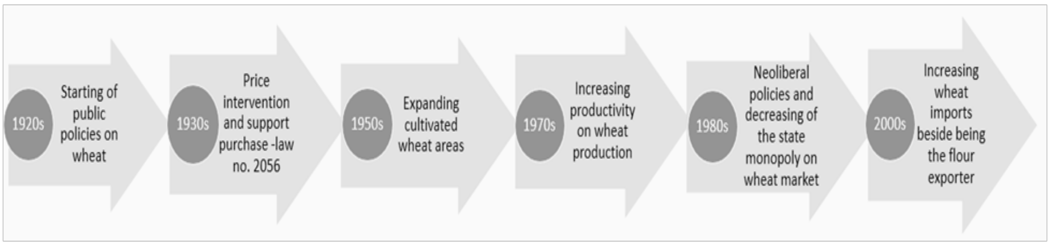


Figure 3. Timeline of wheat policies in Türkiye.

Türkiye is the 10th-largest agricultural exporter in the world, accounting for about 3% of global output (FAOSTAT, 2021; TMO, 2020). When it comes to grains, wheat is the most widely consumed and produced product (Demirbaş and Atis, 2005). Wheat accounts for 28 percent of the world's total cereal production, which totals 2.7 billion tonnes (FAO, 2021; USDA, 2021). About 66% of the world's wheat production is made by these five countries: China, India, the United States, and the Russian Federation (TEPGE, 2021, FAOSTAT, 2021). Türkiye accounts for around also 3% of global wheat production and ranks first in the world in terms of exports of processed wheat (wheat flour) (FAOSTAT, 2021).

Türkiye imports wheat primarily from Russia (62%) and Ukraine (15%) (TEPGE, 2021). Türkiye's wheat imports will be affected by any conflict between Russia and Ukraine that has an impact on wheat production in Russia and Ukraine. While 44 percent of Türkiye's cultivated grain fields are dedicated to wheat production (TURKSTAT, 2021), in terms of wheat exports, the country is a leader in both raw and processed wheat products (FAOSTAT, 2021). Türkiye's production has increased, even though the country's agricultural land has decreased during the past 15 years, as indicated in Figure 4. Because of the shrinkage of arable land, it is logical to assume that greater production is associated with higher productivity. Proof that production is greatly affected by productivity.

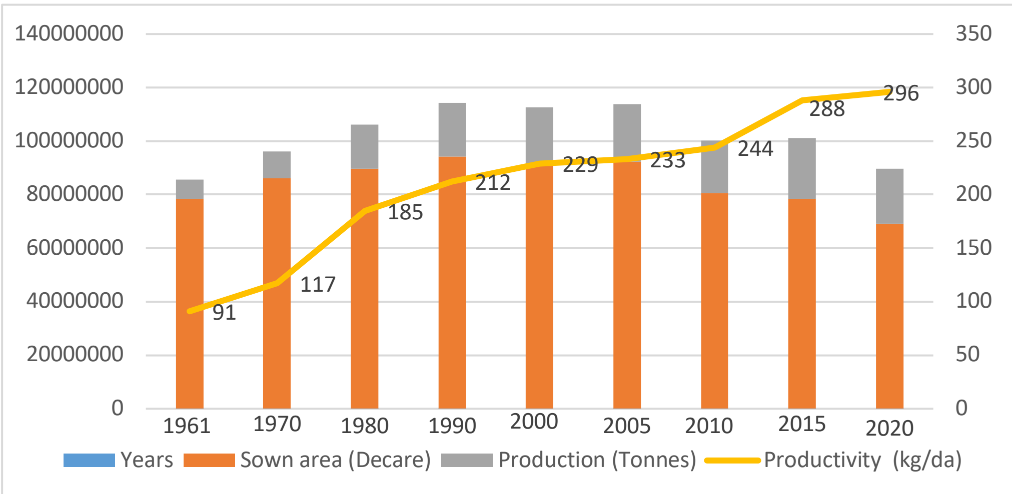


Figure 4. Wheat Sown Area, Production and Productivity, Türkiye. Source: FAOSTAT, 2021; TURKSTAT, 2021.

The last five years of data (2014-2019) demonstrate that wheat is among the top five items for international commerce with its many varieties, according to the Turkish Federation of Food and Drink Industry Associations (TGDF, 2020). Wheat flour and pasta are two of the top three exports, whereas durum wheat is the most common import. Even though the export value of wheat products is larger than the import value of durum wheat, wheat self-sufficiency should be studied in detail in the event of an emergency.

Wheat self-sufficiency is a concept that is met when looking into wheat production in depth. For example, how much of a product's demand in a certain location is met by local manufacturing. The TURKSTAT (2021a) report on self-sufficiency values notes that a percentage value of less than 100 indicates a shortage of supplies, whilst a percentage value of more than 100 indicates a surplus that may be stored or exported. The formula that is used by TURKSTAT is

[*Self-sufficiency = (Usable Production / Domestic Use)*100]*.

There have only been nine years in the last 20 years in which wheat self-sufficiency was between 95 and 100 percent on average in Türkiye, according to TURKSTAT (2021). (Figure 5). Despite Türkiye's apparent wheat self-sufficiency, the long-term viability of this position must also be considered.

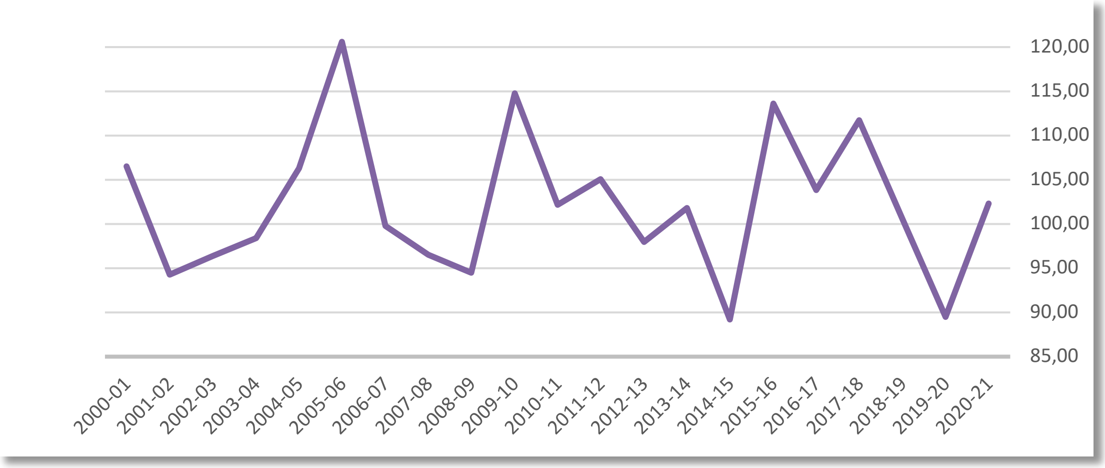
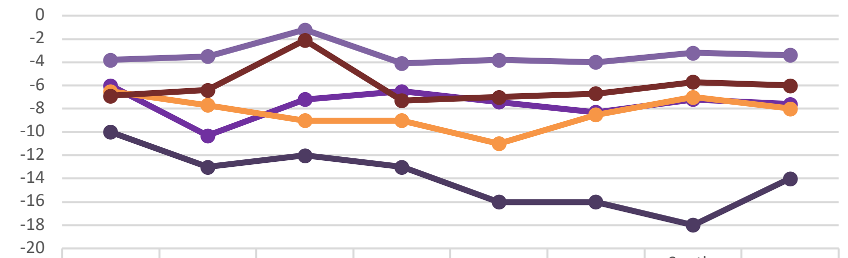


Figure 5. Degree of wheat self-sufficiency in Türkiye. Source: TURKSTAT, 2021.

Since the 1950s, increasing levels of greenhouse gas emissions have signaled the onset of climate change. Temperatures rise as a result of increased greenhouse gas and CO2 emissions, and precipitation patterns alter as well (IPCC, 2018). Climate change is affecting the environment, society, and economy, and agricultural food production is one of the most affected areas. Increases in high temperatures and decreased precipitation have led to an increase in drought, a drop in soil moisture, and a fall in crop yields (FAO, 2016).

Climate change has a significant impact on the world's primary grain products, including wheat. For each degree Celsius increase in temperature, global wheat yield is predicted to be lost by 6.0 ±2.9% (Zhao et al., 2017). Climate change may lead to a progressive decline in wheat planting areas due to an increase in average sunshine duration in wheat-producing regions (Karapınar et al., 2020). A wide range of climates is suitable for wheat. However, highly humid and hot climates are detrimental to the crop's growth. The ideal climate for growing wheat calls for temperatures ranging from 5 to 15 degrees Celsius and annual precipitation of 500-600 millimeters (mm) in order to achieve excellent yields (KTB, 2016).

Located in the semi-arid climate zone, Türkiye is one of the regions most affected by climate change. According to experts, most of Türkiye's wheat-producing regions, including Central Anatolia and Southeastern Anatolia, are likely to be faced with more severe and frequent droughts in the future decades (OECD, 2021). Climate change is anticipated to reduce wheat cultivation area, wheat production, and yield in seven regions of Türkiye in 2050 and 2080 (Dellal, McCarl & Butt, 2011; Eruygur and Özokçu, 2016; Dellal and Ünüvar, 2019). This is due to the increase in temperature and decrease in precipitation. Figure 6. below shows the estimated values for wheat by region based on existing studies in the literature.



	Black Sea	Marmara	Aegean	Mediterranean	Central Anatolia	Eastern Anatolia	South-Eastern Anatolia	Turkey
2050 (Dellal, Mccarl, & Butt, 2011)	-6	-10,3	-7,2	-6,5	-7,4	-8,3	-7,2	-7,6
2050 (Eruygur, & Özokçu, 2016)	-3,8	-3,5	-1,2	-4,1	-3,8	-4	-3,2	-3,4
2050 (Dellal & Ünüvar, 2019)	-6,5	-7,7	-9	-9	-11	-8,5	-7	-8
2080 (Eruygur, & Özokçu, 2016)	-6,9	-6,4	-2,1	-7,3	-7	-6,7	-5,7	-6
2080 (Dellal & Ünüvar, 2019)	-10	-13	-12	-13	-16	-16	-18	-14

Figure 6. The estimated values for wheat by regions for 2050 and 2080. Source: Based on studies of Dellal, McCarl & Butt, 2011; Eruygur & Ozokcu, 2016; Dellal&Ünüvar, 2019. Graph is prepared by the authors.

2. Material and Methods

The study is organized into two sections: statistical and spatial data analysis. As a first step, we looked at statistics on Türkiye's wheat values to determine its level of wheat self-sufficiency. The current variables on wheat self-sufficiency by TURKSTAT have been used to determine the primary factors of self-sufficiency. A table including sixteen variables (wheat production, area sown, harvest losses, Supply=Use, Usable production, Imports, Imports EU 27-28, Domestic use, Seed use, Animal Feed, Human consumption, Losses, Exports, Exports EU 27-28, Change in stocks, and Human consumption per capita) is used by TURKSTAT to explain the wheat self-sufficiency values. These TURKSTAT-determined variables are intimately linked to wheat production and consumption, as well as export and import. It is clear from the table content that every variable has some bearing on wheat production, even if they are not all included in the self-sufficiency calculation (TURKSTAT, 2021). In this study, the most recent TURKSTAT data on wheat self-sufficiency in the ten-year period from 2000-2001 to 2020-2021 was used.

The study examines how the variables listed in the wheat self-sufficiency table affect the concept's meaning. It is required to employ a method to establish the relationship between the value of self-sufficiency and the other variables in order to identify which variable is the most effective. To begin, we used a Chi-square test to see if the variables and self-sufficiency scores are linked or dependent on one another. The Chi-square test shows that one cell (25.0 %) have an expected count is less than 5. Fisher's Exact Test results are utilized when this rate is greater than 20%, and the frequency value in a 2x2 table is less than 5. (Suresh, 2019; UPENN, 2008). Additionally, a correlation analysis was carried out to verify the validity of the findings. If there is a correlation between two or more variables, the strength and direction of the association can be determined using this technique. Both methods are appropriate for this study's purpose. While the wheat self-sufficiency value is a dependent variable, the other values are the study's independent variables. In the first step, the goal is to identify the most important endogenous variables that contribute to self-sufficiency.

In the subsequent phase, we focus on exogenous variables such as climate change. There are three general kinds of research on wheat yields in Türkiye and four studies on specific regions, according to the literature. In this context, studies on Türkiye from all regions are uncommon. Due to this limitation, wheat yield values in this study were relied on average projections from regional studies. In order to make an assessment of climate change, basin-based temperature and precipitation forecasts in the TR2015-CC report (*Yeni Senaryolar ile Türkiye İklim Projeksiyonları ve İklim Değişikliği*) of the Turkish State General Directorate of Meteorology were used. We processed the temperature and precipitation projections data produced by the General Directorate of Meteorology for basins according to the RCP8.5 scenario and GFDL-ESM2M global model in the Arc-GIS 10.7 program. Temperature and precipitation projection data for the years 2050 and 2080 were used in the study since these are the base years of the yield studies obtained from the literature (see Dellal, McCarl & Butt, 2011; Eruygur & Ozokcu, 2016; Dellal&Ünüvar, 2019). Using TURKSTAT (2021) high wheat production and yield statistics, great plain borders, regional yield studies, and climate change estimates, we analyzed climate change's effects on wheat yield/productivity in Türkiye. Great plain boundaries were constructed in ArcGIS 10.7 by digitizing plain boundary coordinates (X-Y coordinates) data obtained from the Turkish Ministry of Agriculture and Forestry's Agricultural Land Assessment and Management Automation (TADPortal) website.

3. Results and Discussion

As previously stated, in order to assess the association between wheat self-sufficiency and the other variables using TURKSTAT self-sufficiency data, the Fisher's Exact Test value was applied to the chi-square test table in the analyzing section. This test just displays the p-value that can be tracked on the exact sig column (2-sided).

Table 2. Results of Chi-Square Test

Variables	**Value[a]**	***df***	***p***
Wheat Production	13.747	1	**0.000**
Area Shown	0.043	1	1.000
Harvest Losses	3.834	1	**0.086**
Supply Use	0.043	1	1.000
Usable Production	13.747	1	**0.000**
Imports	0.043	1	1.000
Imports EU*	0.095	1	1.000
Domestic Use	2.376	1	0.198
Human Consumption	5.838	1	**0.030**
Seed Use	0.043	1	1.000
Animal Feed	1.173	1	0.395
Losses	3.834	1	**0.086**
Exports	1.173	1	0.395
Exports EU*	0.095	1	1.000
Change in Stocks	3.834	1	**0.086**
Human Consumption per capita (kg)	0.043	1	1.000

*Except for these variables [a.2 cells (50.0%)], Fisher's Exact Test a.1 cells (25.0%) have an expected count of less than 5. The minimum expected count is 4.76.

Wheat production and Useable production are significant at a 99 percent confidence level ($p=0.000$; $p<0.01$), and human consumption is significant at 95 percent ($p=0.030$; $p<0.05$), according to p-value data. In addition, losses, harvest losses, and stock change are all significant at 90% ($p=0.030$; $p<0.10$). According to the findings, wheat self-sufficiency is primarily determined by wheat production and usable production, with human consumption coming in second. Losses and stock changes are also significant, but only in the third degree (Table 2.).

The correlation analysis is used to determine the strength and direction of the association between wheat self-sufficiency and the factors. The value (r) can range between -1.0 and 1.0, indicating both a negative and positive correlation. Correlation is moderate if the value of r is $0.40 \leq r < 0.60$. If the number is $0.60 \leq r < 0.80$, this indicates a strong positive correlation. If the number is more than 0.8, it indicates that the variables have a very strong positive connection.

Table 3. The results of the correlation analysis

		Wheat Production	Usable Production	Losses	Harvest Losses	Human Consumption	Domestic Use	Degree of self sufficiency (%)
Degree of Self-Sufficiency (%)	Correlation Coefficient	**0.831****	**0.787****	**0.612****	**0.589****	**-0.529***	**-0.488***	1.000
	Sig.(2-tailed)	0.000	0.000	0.003	0.005	0.014	0.025	

**Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed).

Table 3. displays the values for which the association is significant at the 0.01 level (99 percent). The correlation of four variables (wheat production, harvest losses, useable production, and losses) is significant at the 0.01 level, according to correlation analysis. The r-values demonstrate a very high positive association between wheat production and wheat self-sufficiency. Then, a high positive link with usable production is discovered, as is a moderate positive correlation with harvest losses and losses. On the other hand, the correlation of two variables (human consumption and domestic use) is significant at the 0.05 level. Wheat self-sufficiency has a moderate negative correlation with human consumption and domestic use, as expected.

When the Chi-square test and the Correlation analysis are compared, it appears that wheat production is the most important variable in wheat self-sufficiency. Usable production is a significant factor as wheat production value. Both analyses share these two characteristics. Production and self-sufficiency are believed to have a positive and directly proportionate relationship. In parallel with the Chi-square test, harvest losses and losses have become prominent as another significant factor in the correlation analysis. This positive correlation is based on the relationship between production and losses. This outcome was anticipated because, as production increases, so make losses (Figure 7.). The main point is to repurpose all types of waste in the consuming process.

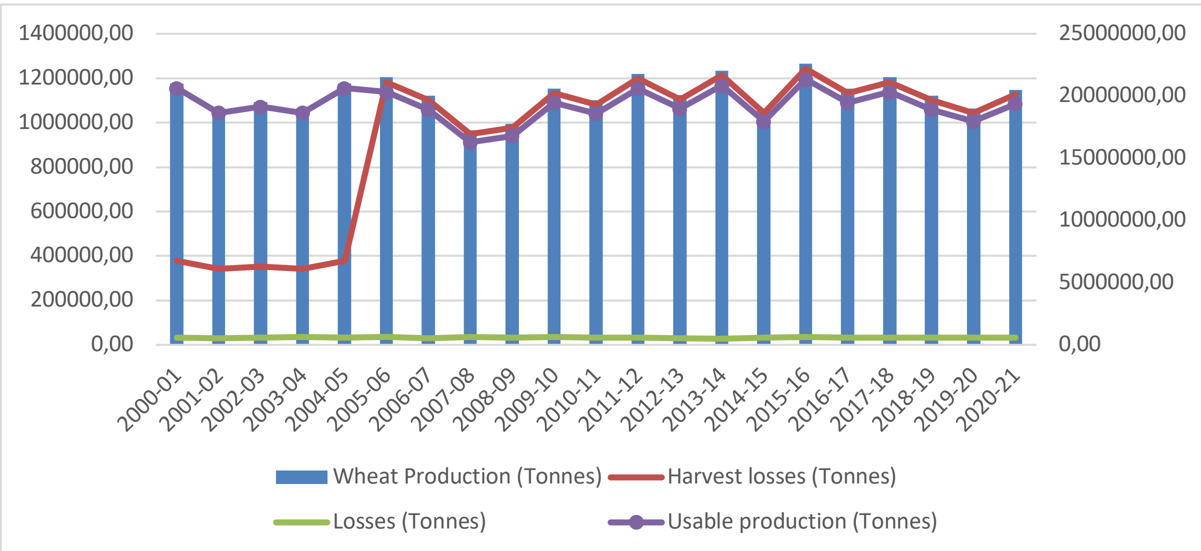


Figure 7. Variables of Wheat Production and Losses from 2000 to 2021, Türkiye (TURKSTAT, 2021).

In addition, consumption values, including human consumption and domestic use, are factors that negatively affect self-sufficiency. In the Fisher's Exact Test, human consumption is linked to wheat self-sufficiency. The correlation between human consumption and domestic use is significant at 0.05 level, and there is a moderate negative association (r= -0.529 and r= -0.488) with wheat self-sufficiency. This suggests that these elements have an inverse relationship with wheat self-sufficiency in the correlation analysis.

Both analyses show comparable results in terms of which variables have a greater impact on the degree of wheat self-sufficiency. The most essential component for the degree of self-sufficiency is all types of wheat production, including usable and total values. At the same time, all types of losses, including harvest and total values, emerged as important factors for wheat self-sufficiency in both analyses. Another important issue is that consumption and domestic use factors are negatively related to wheat self-sufficiency.

In terms of climate change, the increase in warmth and decrease in precipitation are predicted to have a negative impact on conditions, particularly in the Eastern Mediterranean, Eastern Anatolia, Southeastern Anatolia, and Central Anatolia regions where wheat production and yield are high. The maps for the years the 2050s and 2080s were made using the General Directorate of Meteorology's temperature and precipitation projections, as well as wheat yield estimation findings obtained from the regional studies, which were added to maps and integrated with large plain areas. The yield forecast estimates provided by the regional studies were compared to the temperature and precipitation forecasts to determine whether regions' wheat production conditions could be adversely affected. According to the findings of the studies, wheat yield is affected by temperature and, in particular, precipitation. While average yearly precipitation of 500-600 mm results in higher quality and more productive wheat, the average precipitation in Türkiye's regions has ranged from 400 (Central Anatolia) to 700 (Black Sea) mm over the last ten years. Wheat production is heavily dependent on precipitation, and when there is little precipitation, yield suffers.

The temperature will rise in all regions of the country in the 2050s, according to climate change forecasts shown in Figure 8., while precipitation will decrease in general except for the East Black Sea region and around Hatay province. It is projected that yield will be lower in areas where the temperature and precipitation are lower. However, the yield is expected to decline at a slower rate in the Black Sea and Aegean regions than in other regions. For example, while precipitation is anticipated to fall by up to 30 percent in the Konya Plain and its immediate surroundings, the study's findings reveal that yield will decline by 7.4 percent in the Central Anatolia region. With 7.2 percent, the Marmara area comes second in terms of yield value decrease (Eruygur and Özokçu, 2016; Dellal and Ünüvar, 2019). The South-Eastern Anatolia region is another key production area that will be impacted by climate change. In this region, where the huge plains are densely located, the average precipitation is projected to fall by up to 15%, and yield will fall by 5.9% on average (Figure 8.).

The average temperature in Eastern Anatolia and South-Eastern Anatolia is anticipated to rise by 5-6°C by the 2080s, according to forecasts shown in Figure 9. Following that, it is expected that temperatures in Central Anatolia, the Mediterranean, and the Southern Aegean will dramatically rise by 3.5 -4°C. Precipitation in Türkiye will decrease by more than 15% in the 2080s, while precipitation in the western Mediterranean region decrease by more than 30%. Furthermore, when all regions are considered, the regions with the greatest reduction in wheat output in the 2080s are South-Eastern Anatolia, Central Anatolia, and Eastern Anatolia. Wheat yield declines are expected to be less severe in the Aegean and Black Sea regions. South-Eastern Anatolia is one of the locations with high production and productivity, as well as tightly packed huge plains. However, as indicated in Figure 9., the yield in the South-Eastern Anatolia region is expected to fall the most, by an average of 11.85 percent in the 2080s (Eruygur and Özokçu, 2016; Dellal and Ünüvar, 2019).

The region of South-Eastern Anatolia is followed by the region of Central Anatolia, where both production regions are concentrated, and yields will decline by an average of 11.5 percent owing to climate change (Eruygur and Özokçu, 2016; Dellal and Ünüvar, 2019). The Konya Plain, one of Türkiye's largest plains, is located in Central Anatolia, which has the highest wheat production in the country. Furthermore, as temperatures rise in the Eastern Anatolia region, it is projected that production areas will suffer, and yields will plummet dramatically (Figure 9.).

In conclusion, the research findings first reveal that the most important variable affecting self-sufficiency is wheat production. Losses and human consumption are also significant variables. It is obvious that providing self-sufficiency is fundamentally dependent on the production and its relationship to other challenges. Second, current climate change forecasts and analyses reveal that the effects of climate change will steadily rise, and this shift will have a detrimental impact on wheat production. Wheat production will decline if adequate precipitation is not delivered and temperatures rise. According to forecasts for the 2050s and 2080s, the primary wheat production areas of Central

Anatolia, South-Eastern Anatolia, Eastern Anatolia, and Eastern Mediterranean will be the regions most affected by climate change in terms of wheat yield and production.

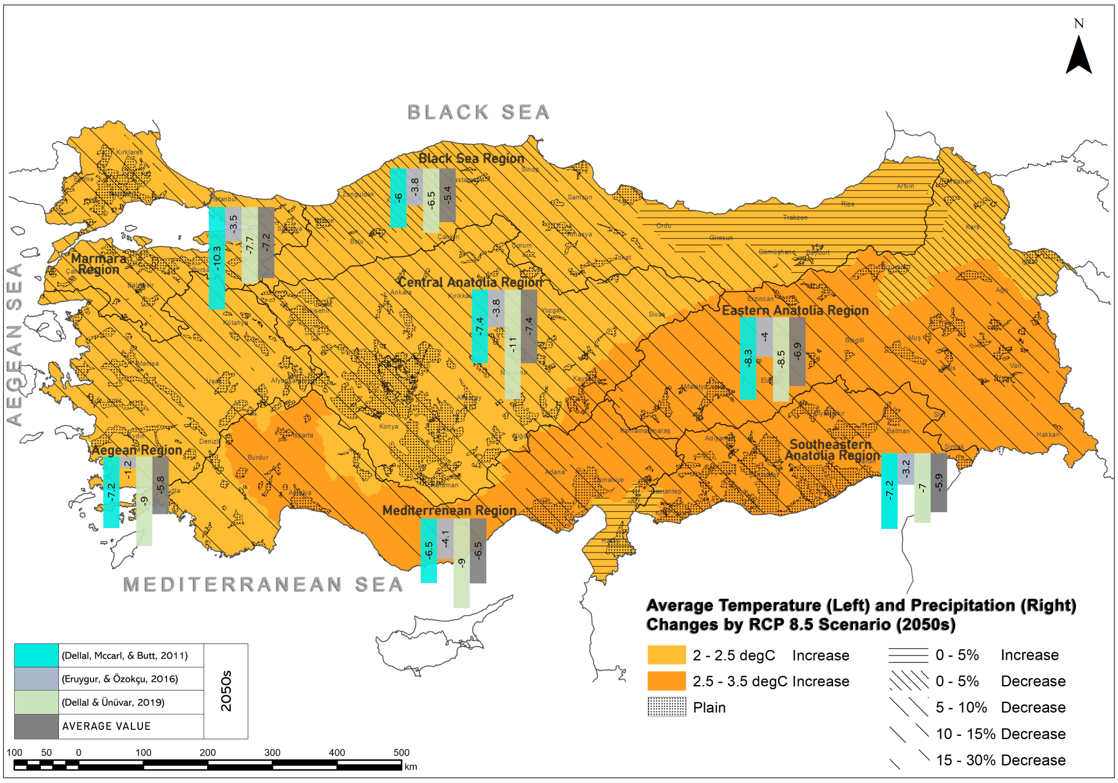


Figure 8. Average Annual Temperature and Precipitation Change by RCP 8.5 Scenario and Wheat Productivity Forecasts (2050s). *Source:* Prepared by the authors.

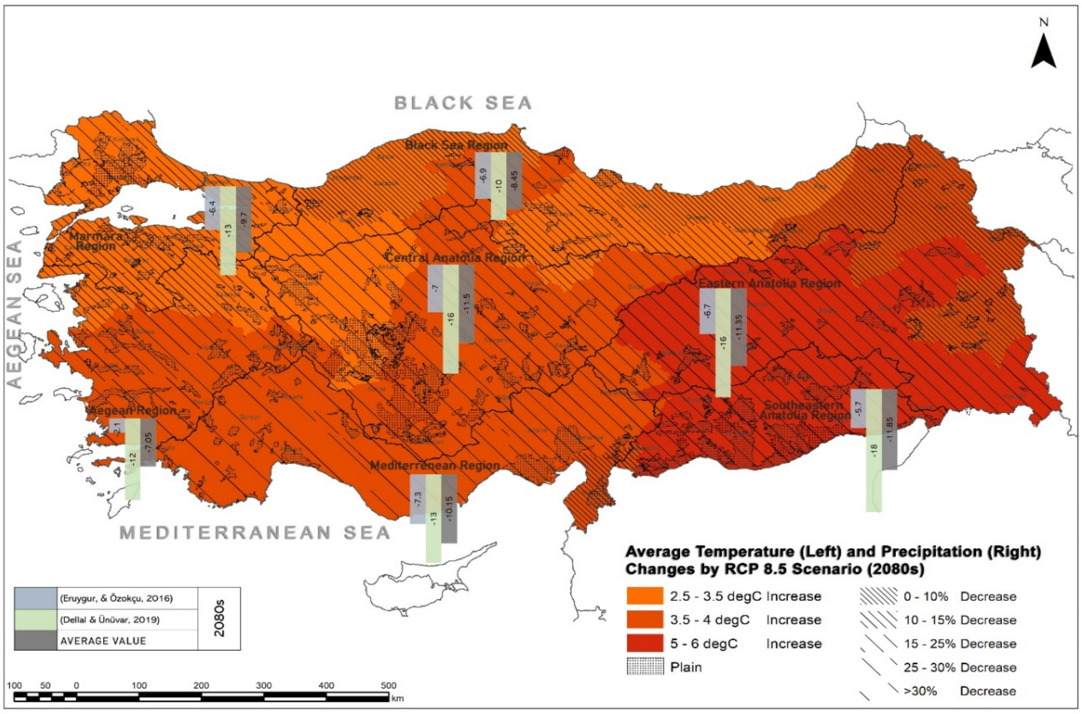


Figure 9. Average Annual Temperature and Precipitation Change by RCP 8.5 Scenario and Wheat Productivity Forecasts (2080s). Source: Prepared by the authors.

Conclusion and Recommendations

Due to the Covid-19 pandemic, which has been described as an unpredictable crisis, there has been a spike in the consumption of foods that can be stored at home for an extended period. Furthermore, essential foods such as wheat and wheat products such as bread, pasta, and flour are becoming more consumed products around the world. Self-sufficiency and fulfilling domestic food demands have become a major concern for many countries, particularly following recent food trade restrictions. Similarly, in terms of domestic demand and production potential in Türkiye, wheat has emerged as an important agricultural product. From this vantage point, whether wheat output fulfills domestic demand and/or what factors influence wheat self-sufficiency has emerged as a key research subject.

To explore wheat self-sufficiency, we focused on endogenous and external variables. To begin, we used TURKSTAT's wheat self-sufficiency statistics (2000-2020). The Chi-Square Test and Correlation Analysis were used to investigate the association between wheat self-sufficiency and the other factors. According to the findings of the analysis, wheat production has been the most important variable in terms of self-sufficiency. This production value encompasses all types of production, such as useable production. This finding is consistent with previous research that has highlighted the relationship between agricultural self-sufficiency and production. Aside from production, losses are a significant challenge for self-sufficiency. As stated in the literature, providing food security and self-sufficiency is dependent on the balance between agricultural production and losses. Second, productivity is an important factor in increasing output. Productivity is intimately tied to production; a decrease in productivity has a direct impact on self-sufficiency. Climate change, as an exogenous element, is quite effective at this stage. The analyses revealed that rising temperatures and decreasing precipitation would have a detrimental impact on wheat yield and productivity. Wheat yields are anticipated to fall in all regions of Türkiye in the 2050s and 2080s because of climate change.

In order to guarantee self-sufficiency and food security, arrangements should be established to ensure the long-term viability and productivity of regional wheat production throughout Türkiye. For instance, agricultural infrastructure should be developed from production through post-harvesting, including all linked issues, within agricultural policy. Furthermore, in terms of wheat policy, the government should help producers, and agricultural incentives for wheat should be expanded and administered at the level of developed countries. The buying price should be set at a greater level than the cost. Furthermore, input costs should be reduced. It could be solved with a solid technology foundation and agricultural innovation. Even if these new investments are overpriced, they offer significant potential for long-term production efficiency.

Under these conditions, increasing production and productivity is largely concerned with preserving all of their current values, such as soil, seed, and so on. The initial phase in this process is to create intervention forms to enhance cultivated areas while still protecting existing wheat production places such as large plains and agricultural lands. As is well known, arable areas in many countries have nearly surpassed their carrying capacity. Thus, while only a few countries may be able to expand their agricultural regions, Türkiye may be one of them. Despite the fact that Türkiye uses the majority of its agricultural land, it may be possible to use all arable land and reduce fallow lands. Existing agricultural land should be protected and prevented from being misused while arable land is being used, with no exceptions. According to this viewpoint, the framework or border of agricultural policy should be formed within the contexts of sustainability, food security, and self-sufficiency. Moreover, in a country like Türkiye with small and fragmented agricultural regions, land consolidation and mobilization of sustainable irrigation potential should be prioritized in terms of production efficiency.

In a nutshell, Türkiye, as a prominent agricultural country, should maintain present grain production potential for not only its own people but also for the global population. However, Türkiye's production is not at the expected level, despite the fact that it is self-sufficient in wheat. This research reveal providing self-sufficiency is fundamentally dependent on the production and its relationship to other challenges. It is obvious that climate change will also have a great long-term impact on productivity. Thus, arrangements should be established to ensure the long-term viability and productivity of regional wheat production throughout Türkiye. It can achieve this goal primarily by avoiding the loss of current agricultural areas suited for production and increasing productivity in accordance with climate change. A climate-change-compatible production model should be promoted in all locations where wheat production has already occurred or will occur, particularly in the regions of

South-Eastern Anatolia, Central Anatolia, Eastern Anatolia, and the Eastern Mediterranean. All of these reforms will secure the country's long-term food security and self-sufficiency. Finally, studies like this one, which is one of the priority projects for the relevance of agricultural production and its consequences in the pandemic process, should be expanded, particularly in agriculturally potential countries like Türkiye. These studies would benefit agricultural productivity in other producing countries throughout the world.

References

Acar, M., & Aytüre, S. (2014). *Tarım ve Tarım Politikalarının Geleceği*. Bursa, Turkey: Ekin Yayınları.

Atalan-Helicke, N. (2019). Markets and Collective Action: A Case Study of Traditional Wheat Varieties in Turkey. *Journal of Economy Culture and Society,* 59, 13-30. https://doi.org/10.26650/JECS402676

Aysu, A. (2018). Buğday: Beslenme Kültürü ve Politikalar. *İzmir Akdeniz Akademisi Dergisi,* 4, 82-90. doi: 10.32325/iaad.2018.35

Bayar, R. (2018). Arazi Kullanımı Açısından Türkiye'de Tarım Alanlarının Değişimi. *Coğrafi Bilimler Dergisi,* 16 (2), 187-200. https://doi.org/10.1501/Cogbil_0000000197

Bayramoğlu, Z. (2010). Tarımsal Verimlilik ve Önemi. *Selcuk Tarım ve Gıda Bilimleri Dergisi*, 24 (3), 52-61.

Bayraç, H., & Doğan, E. (2016). Türkiye'de İklim Değişikliğinin Tarım Sektörü Üzerine Etkileri. *Eskişehir Osmangazi Üniversitesi İİBF Dergisi*, 11 (1), 23-48.

Cattaneo, A., Sanchez, MV., Torero, M., & Vos, R. (2020). Reducing Food Loss and Waste: Five Challenges for Policy and Research. *Food Policy*, 98, https://doi.org/10.1016/j.foodpol.2020.101974

Clapp, J. (2017). Food Self-sufficiency: Making Sense of It, and When It Makes Sense. *Food Policy*, 66, 88-96. https://doi.org/10.1016/j.foodpol.2016.12.001

Çelik, N. (2000). *Tarımda Girdi Kullanımı ve Verimliliğe Etkileri.* Uzmanlık Tezi. DPT: 2521, Ankara, Turkey.

Chenarides, L., Grebitus, C., Lusk, JL., & Printezis, I. (2020). Food Consumption Behaviour during the Covid-19 Pandemic. *Agribusiness*, 37 (1), 44-81. https://doi.org/10.1002/agr.21679

Dellal, İ., & Unuvar, İ.F. (2019). Effect of Climate Change on Food Supply of Turkey. *Journal of Environmental Protection and Ecology,* 20 (2), 692-700.

Dellal, İ., McCarl, B.A., & Butt, T. (2011). The Economic Assessment of Climate Change on Turkish Agriculture. *Journal of Environmental Protection and Ecology,* 12 (1), 374-385.

Demirdöğen, A., Olhan, E., & Chavas, J.P. (2016). Food vs. Fiber: An Analysis of Agricultural Support Policy in Turkey. *Food Policy,* 61: 1-8. doi: 10.1016/j.foodpol.2015.12.013

Demirbaş, N., & Atış, E. (2005). Türkiye Tarımında Gıda Güvencesi Sorununun Buğday Örneğinde İrdelenmesi. *Ege Üniversitesi Ziraat Fakültesi Dergisi*, 42 (1), 179-190.

Demirbaş, N., Niyaz, O.C., & Apaydın, Y.M. (2017). *An Evaluation on Problems within the Food Supply Chain in Turkey in Terms of Food Losses and Waste*. Paper presented in: 3th International Balkan and Near Eastern Social Sciences Conference Series, Edirne, Turkey.

Demirbaş, N. (2018). *Dünyada ve Türkiye'de Gıda İsrafını Önleme Çalışmalarının Değerlendirilmesi.* Paper presented in: VIII. IBANESS Congress Series, Plovdiv: Bulgaria, Available at: http://www.ibaness.org/conferences/plovdiv_2/ibaness_plovdiv_proceedings_draft_10.pdf Access date: 24.12.2020.

Demirbaş, N. (2019). *İyi Tarım Uygulamalari ve Meyve Bahçelerinde Ortaya Çıkan Üretim, Hasat ve Hasat Sonrası Kayıpları Azaltabilir mi*? Paper presented in: XII. IBANESS Congress Series on Economics, Business and Management. Plovdiv, Bulgaria.

EIT Food, (2020). Covid-19 Study: European Food Behaviours: Covid-19 Impact on Consumer Food Behaviours in Europe. https://www.eitfood.eu/media/news-pdf/COVID-19_Study_-_European_Food_Behaviours_-_Report.pdf Access date: 08.03.2021.

Erçakar, M.E., & Taşçı, M. (2011). Tarım Ürünlerinde Verimlilik-Fiyat İlişkisi: Türkiye Üzerine Ampirik Bir Uygulama. *Electronic Journal of Social Science,* 10 (36): 171-186 https://dergipark.org.tr/en/download/article-file/70272 Access date: 08.06.2022.

Eruygur, H.O., & Özokcu, S. (2016). Türkiye'de İklim Değişikliğinin Buğday Verimi Üzerine Etkileri: Bir Heterojen Panel Çalışması. *Ekonomik Yaklaşım*, 27 (101): 19-255.

FAO, (1983). *Policy Brief 2006- Food Security.* http://www.fao.org/fileadmin/templates/faoitaly/documents/pdf/pdf_Food_Security_Cocept_Note.pdf Access date: 08.03.2021.

FAO, (1999). *Implications of Economic Policy for Food Security: A Training Manual.* Available at : http://www.fao.org/3/x3936e/x3936e03.htm Access date:19.02.21.

FAO, (2006). *Food Security Policy Brief.* http://www.fao.org/fileadmin/templates/faoitaly/documents/pdf/pdf_Food_Security_Cocept_Note.pdf Access date: 08.03.2021.

FAO, (2009). *Declaration of the World Food Summit on Food Security* (PDF). Rome.

FAO, (2011). *Global Food Losses and Food Waste-Extent, Causes and Prevention*. Rome. http://www.fao.org/3/mb060e/mb060e.pdf Access date: 08.03.2021.

FAO, (2013). *Report of the Expert Consultation Meeting on Food Losses and Waste Reduction in the Near East Region: Towards A Regional Comprehensive Strategy*. Egypt, 33.

FAO, (2015). News. http://www.fao.org/news/story/en/item/275009/icode/ Access date: 08.03.2021.

FAO, (2016). *The State of Food and Agriculture- Climate Change, Agriculture and Food Security*. Rome. https://www.fao.org/3/i6030e/i6030e.pdf Access date: 08.06.2021.

FAO, (2018). *Save Food: Global: Global Initiative on Food Loss and Waste Reduction*.

FAO, (2019). *The State of Food and Agriculture, Moving Forward on Food Loss and Waste Reduction.* Rome. http://www.fao.org/3/ca6030en/ca6030en.pdf Access date: 08.03.2021.

FAO, (2020). *Coronavirus disease 2019 (COVID-19): addressing the impacts of COVID-19 in food crises*, http://www.fao.org/3/ca8497en/ca8497en.pdf . Access date: 20.04.2021.

FAO, (2020a). *Food Loss and Food Waste.* http://www.fao.org/food-loss-and-food-waste/flw-data)#:~:text=Initial%20estimates%20of%20the%20FLI,the%20retail%20and%20consumption%20levels. Access date: 08.03.2021.

FAO, (2020b). *FAO in Turkey*. http://www.fao.org/turkey/fao-in-turkey/turkey-at-a-glance/en/ Access date: 03.04.2021.

FAO, (2021). *Cereal Supply and Demand Brief,* http://www.fao.org/worldfoodsituation/csdb/en/ Access date: 12.04.2021.

FAOSTAT, (2021). *Crops Data*. https://www.fao.org/faostat/en/#data/QCL/visualize Access date: 10.12.2021.

Gülçubuk, B. (2020). *Covid-19 Sonrasinda Tarim Politikalarinin Geleceği*, Istanbul Politik Araştirmalar Enstitüsü, Politika Raporu. FriedRich-Eberth-Stiftung: Temmuz: 012.

Grashuis, J., Skevas, T., & Segovia, M.S. (2020). Grocery Shopping Preferences During the Covid-19 Pandemic. *Sustainability*, 12, 5369, doi:10.3390/su12135369

IPCC, (2018). Global Warming of 1.5°C. Chapter 3: Impacts of 1.5°C of Global Warming on Natural and Human Systems. Intergovernmental Panel of Climate Change.

Ipsos, Turkey (2020). *How Coronavirus Affects Spending of the Fast Moving Consumer Goods.* https://www.ipsos.com/tr-tr/koronavirus-hane-ici-hizli-tuketim-urunleri-harcamalarina-nasil-etki-ediyor Access date: 08.03.2021.

Karapınar, D., Özertan, P., Tanaka, D., An, N., & Turp, M.T. (2020). *İklim Değişikliği Etkisi Altında Tarımsal Ürün Arzının Sürdürülebilirliği. 1.5. İklim değişikliği ve Tarım: Etkiler, Risk ve Kırılganlıklar*. İstanbul, Turkey: TÜSİAD.

Keding, G.B., Schneider, K., & Jordan, I. (2013). Production and Processing of Foods as Core Aspects of Nutrition-Sensitive Agriculture and Sustainable Diets. *Food Security*, 5 (6), 825-846. https://doi.org/10.1007/s12571-013-0312-6

Kruse, J. (2010). *Estimating Demand for Agricultural Commodities to 2050*. Global Harvest Initiative. https://pdf4pro.com/view/estimating-demand-for-agricultural-commodities-132658.html Access date: 28.12.2020.

KTB, (2016). *Karaman'da Buğday, Mısır, Ayçiçeği Tarımı ve Üretimi.* Karaman, Turkey.

Laguna, L., Fiszman, S., Puerta, P., Chaya, C., & Tárrega, A. (2020). The Impact of COVID-19 Lockdown on Food Priorities. Results from a Preliminary Study Using Social Media and an Online Survey with Spanish Consumers. *Food Qual Prefer,* 86: 104028. doi: 10.1016/j.foodqual.2020.104028

Laborde, D., Martin, W., Swinnen, J., & Vos, R. (2020). Covid-19 Risks to Global Food Security. *Science*, 369 (6503), 500-502. doi: 10.1126/science.abc4765

Maslow, A.H. (1943). A Theory of Human Motivation. *Psychological Review*, 50 (4), 370–396. https://doi.org/10.1037/h0054346

Margulies, R., & Yıldızoğlu, E. (1990). "Tarımsal Değişim: 1923-70", *Geçiş Sürecinde Türkiye* içinde, Der: Schick IC, Tonak EA, İstanbul, Turkey: Belge Yayınları-544, pp. 285-309.

Mentz, D., & Slater, H. (1999). International Agricultural Research: A Fertile Field for Global Progress. *Development Bulletin,* 49, Australia: Development Studies Network Ltd., pp. 59-61.

Nchanji, E.B., & Lutomia, C.K. (2021). Regional Impact of COVID-19 on the Production and Food Security of Common Bean Smallholder Farmers in Sub-Saharan Africa: Implication for SDG's. *Global Food Security,* 29, https://doi.org/10.1016/j.gfs.2021.100524.

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., Agha, M., & Agha, R. (2020). The Socio-Economic İmplications of the Coronavirus Pandemic (COVID-19): A Review. *International Journal of Surgery*, 78: 185–193. https://doi.org/10.1016/j.ijsu.2020.04.018

OECD, (2021). *OECD-FAO Agricultural Outlook* 2020-2029.

Özdinç, H.K. (2010). Tarımda Kamu Politikalarının Başlangıcı: "Buğday Meselesi", 1932-1945. *Abant Izzet Baysal University- Journal of Social Sciences*, 1 (20), 1-12 296.

Permanandh, J. (2011). Factors Affecting Food Security and Contribution of Modern Technologies in Food Sustainability. *Journal of the Science of Food and Agriculture*, 91 (15), 2707-2714. doi:10.1002/jsfa.4666

Prusky, D. (2011). Reduction of the Incidence of Post-Harvest Quality Losses, and Future Prospects. *Food Security*, 3 (4), 463-474. https://doi.org/10.1007/s12571-011-0147-y

Silier, O. (1981). *Türkiye'de Tarımsal Yapının Gelişimi (1923-1938)*. İstanbul, Turkey: Boğaziçi Üniversitesi Yayını.

Soltani, A., Alimagham, S.M., Nehbandani, A., Torabi, B., Zeinali, E., Zand, E., Vadez, V., van Loon, M.P., & van Ittersum, M.K. (2020). Future Food Self-Sufficiency in Iran: A model-based Analysis. *Global Food Security*, 24: 100351, https://doi.org/10.1016/j.gfs.2020.100351.

Suresh, A. (2019). What is the Chi-square Test and How Does it Work? An Intuitive Explanation with R Code. https://www.analyticsvidhya.com/blog/2019/11/what-is-chi-square-test-how-it-works/ Access date: 03.04.2021.

Tatlıdil, F.F., Dellal, İ., & Bayramoğlu, Z. (2013). *Food Losses and Waste in Turkey*. FAO: 67.

TEPGE, (2021). Tarım Ürünleri Piyasaları, Buğday. https://arastirma.tarimorman.gov.tr/tepge/Belgeler/PDF%20Tar%C4%B1m%20%C3%9Cr%C3%BCnleri%20Piyasalar%C4%B1/2021-Ocak%20Tar%C4%B1m%20%C3%9Cr%C3%BCnleri%20Raporu/Bu%C4%9Fday,%20Ocak%202021,%20Tar%C4%B1m%20%C3%9Cr%C3%BCnleri%20Piyasa%20Raporu.pdf Access date: 03.04.2021.

TR2015-CC (2015). *Yeni Senaryolar ile Türkiye İklim Projeksiyonları ve İklim Değişikliği*, Meteoroloji Genel Müdürlüğü, Turkey: Ankara. https://www.mgm.gov.tr/FILES/iklim/iklim-degisikligi-projeksiyon2015.pdf Access date: 08.04.2021.

Trewin, R. (1999). Impacts of the Asian Crisis and the Political Economy on Agriculture's Role in Developing Economies. *Development Bulletin*, 49, Australia: Development Studies Network Ltd., pp. 5-8.

Tuğay, M.E. (2012). Türk Tarımında Bitkisel Üretimi Artırma Yolları. *Tarım Bilimleri Araştırma Dergisi,* 5 (1), 1-8.

TMO, (2020). 2019 yılı Hububat Sektör Raporu. https://www.tmo.gov.tr/Upload/Document/sektorraporlari/hububat2019.pdf Access date: 08.03.2021.

TGDF, (2020). Dış Ticaret Verileri. https://www.tgdf.org.tr/turkiye-gida-ve-icecek-sektorleri-dis-ticaret-verileri/ Access date: 08.03.2021.

TURKSTAT, (2008). T*urkish Statistical Institute- Crop Products Balance Sheets 2005/06-2006/07*. Turkish Statistical Institute Printing Division, Ankara.

TURKSTAT, (2021). *Turkish Statistical Institute Cereals and Crop Production Statistics*.

TURKSTAT, (2021a). *Turkish Statistical Institute Wheat Self-Sufficiency Bulletin.*

UPENN, (2008). University of Pennsylvania, School of Arts and Sciences, *Tutorial: Pearson's Chi-square Test for Independence*. https://www.ling.upenn.edu/~clight/chisquared.htm#:~:text=The%20Chi%2Dsquare%20test%20is,if%20the%20variables%20are%20independent. Access date: 03.04.2021.

USDA, (2021). *Agricultural Export Yearbook.* https://www.fas.usda.gov/sites/default/files/2022-04/Yearbook-2021-Final.pdf Access date: 08.06.2022.

UN, (1948). *The United Nations the Universal Declaration of Human Rights*.

WHO, (2019). *The State of Food Security and Nutrition in the World.* https://www.who.int/nutrition/publications/foodsecurity/state-food-security-nutrition-2019-en.pdf?ua=1 Access date: 08.03.2021.

WHO, (2021). *Coronavirus Disease (Covid-19) Dashboard*, https://covid19.who.int/ Access date: 23.02.2021.

Zhao, C., Liu, B., Piao, S., Wang, X., Lobell, D. B., Huang, Y., Huang, M., Yao, Y., Bassu, S., Ciais, P., Durand, J. L., Elliott, J., Ewert, F., Janssens, I. A., Li, T., Lin, E., Liu, Q., Martre, P., Müller, C., Peng, S., … & Asseng, S. (2017). Temperature Increase Reduces Global Yields of Major Crops in Four Independent Estimates. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(35), 9326–9331. https://doi.org/10.1073/pnas.1701762114.