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Research Article

Impact of climate on agricultural production in England

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ABSTRACT

This study was conducted to determine the effects of climate change on agricultural production in England. In the study, some long-year average and some climate data were evaluated statistically on a monthly basis. In this study, temperature, precipitation, humidity, and rainy day data for a total of 31 years between 1991 and 2021 were used. Sunny day data were used as the average of 21 years of climate data between 1999 and 2019. As a result of this study, it was revealed that the long-year average of temperature (°C) was 10.77±4.9205, precipitation (mm) was 690.00±6.0076, humidity (%) 78.33±5.8827, rainy days: 94±0.5774 and sunny days (hour): 5.78±2.0564 in all months of the whole year from the research area in the North Sea to the east and south of England. According to studies, agricultural production is mostly affected by temperature, precipitation and humidity.

INTRODUCTION

Agriculture is one of the main sorts of land use in the United Kingdom (England, Scotland, Wales, Northern Ireland, and Northern Ireland). The climate is predicted to have a significant impact on agriculture and other important food production industries. Due to its scope and sensitivity to weather changes, agriculture is the sector most at risk because of global warming. As researchers mentioned earlier, temperature, rainfall, precipitation, and humidity changes have a big impact on crop potential and livestock production in the UK. Around 71-72% of UK land area produces food, fiber, and fuel, while the UK agriculture sector currently provides around 50% of the food consumed in this country [1, 2]. As well as in the UK, Cropland and agricultural land are split fairly evenly (wheat and barley are the most popular crops). In addition, the vulnerability of UK agriculture to climate change was highlighted by the UK Climate Change Risk Assessment (CCRA2) [3], possibly having an impact on more than just businesses and agricultural productivity. Additionally, a substantial amount of the UK's landscapes' layout, biodiversity, management, and cultural value are discussed [4].

According to studies and research, Agricultural and livestock productivity is negatively impacted by climate change caused by an increase in greenhouse gas concentration, which reduces crop yields, the nutritional quality of major cereals, and livestock productivity, putting food security in jeopardy [5-9]. In addition, climate change causes drought, which adversely affects agricultural lands and will ultimately lead to forced changes in land usage in the next few years [10,11].

The harmful effects of climate change are already being felt. In the form of rising temperatures, weather erraticness, altering agroecosystem boundaries, invasive plants and animals, and an increase in the frequency of extreme weather occurrences. Therefore, climate change is decreasing animal output, key cereals' nutritional value, and agricultural yields on farms. As well, numerous aspects of climate variability have an influence on agricultural production, like water, winds, temperature, rainfall, and relative humidity. It is anticipated that the annual mean temperature will increase by 3°C to 5°C by the end of this century [12]. Moreover, climate change originates from human activities such as energy consumption for cooling, heating, and industrial processes that have an effect on urban climate and change the climate characteristics in urban areas [13-16]. Furthermore, the interactions between atmospheric elements such as air temperature, precipitation, wind speed, relative humidity, pressure, evaporation, and air pollutants cause variations in climate characteristics. Besides, as a result of urbanization, urban climate characteristics are negatively affected by urban air quality related to an increase in air pollutants because of anthropogenic activities [17-19]. Furthermore, large-scale atmospheric oscillations lead to variations in climate and are associated with climate variables [20].

According to climatology, the most important weather variables to consider when describing a region's climate are its temperature, rainfall, and relative humidity. No account of the weather and climate can be complete without mentioning the current temperature, rainfall, and relative humidity tendency, especially in relation to how they are distributed over time\space [21,22]. The location's temperature, rainfall, and relative humidity conditions provide a working environment for all natural phenomena, including those that are physical, physiological, and ecological. The bulk of bio-climate indices are therefore based on three variables: temperature, precipitation, and relative humidity [23,24]. After reviewing previous articles, the objective of this study is to check the Impact of Climate change on Agricultural Production in England. This study was carried out within the scope of statistical evaluation of some climate parameters averaged over many years in England on a monthly basis. In the study, the effects of climate change on agricultural production were revealed.

MATERIALS AND METHODS

England, is the component of the present study, is in United Kingdom. To the west and north, it shares land boundaries with Wales and Scotland, respectively. The Celtic Sea is to the southwest, and the Irish Sea is to the northwest. The North Sea to the east and the English Channel to the south separate it from mainland Europe. The nation contains more than 100 smaller islands and takes up five-eighths of the North Atlantic island of Great Britain [25-27]. The study area includes the North Sea to the east and the English Channel to the south (Fig. 1).

Fig 1. The location of research area

As we know, the climate is not a constant phenomenon; it varies and fluctuates throughout time and between different locations. These adjustments can occasionally be made on a daily or seasonal basis and use the linear regression method to analyze the data. The following chart illustrates how the climate has changed in England in terms of temperature, precipitation, and relative humidity.

Analysis of climate data

Agriculture is the most vulnerable industry to climate change because of its scope and how sensitive it is to changes in the weather [28,29]. Temperature and rainfall changes have a big impact on the quantity of food grown [30]. Temperature, precipitation, and CO_2 fertilization all have different effects on different crops, places, and variables that change [31]. Warmer temperatures cut yield, but more rain is expected to make this less problematic. In this study, we focused on the Impact of Climate change on Agricultural Production in England. We calculated the obtained climate data through standard deviation and linear regression analysis [32]. In this study, temperature, precipitation, humidity, and rainy day data for a total of 31 years between 1991 and 2021 were used. Sunny day data were used as the average of 21 years of climate data between 1999 and 2019.

RESEARCH FINDINGS

In this study, the effects of climate change on agricultural production in England were examined. In this context, long-year average monthly total precipitation, temperature, rainy days and sunny days were evaluated statistically and the course of change on a monthly basis was revealed. The monthly change of some climatic values are statistically analyzed and given in below.

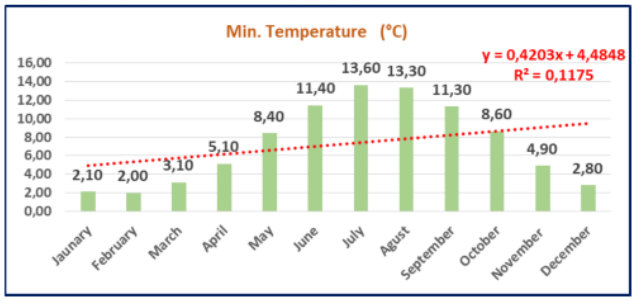

Fig 2. The distributions of Min. Temperature in England.

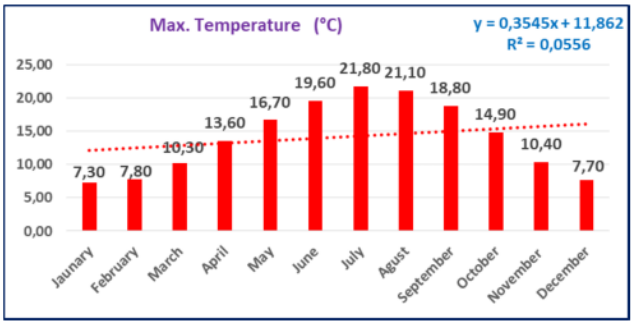

Fig 3. The distributions of Max. Temperature in England.

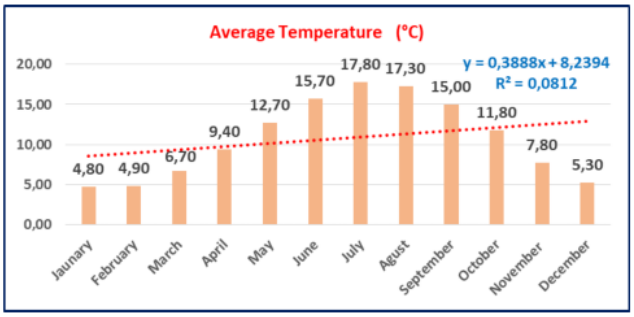

Fig 4. The distributions of Average Temperature in England.

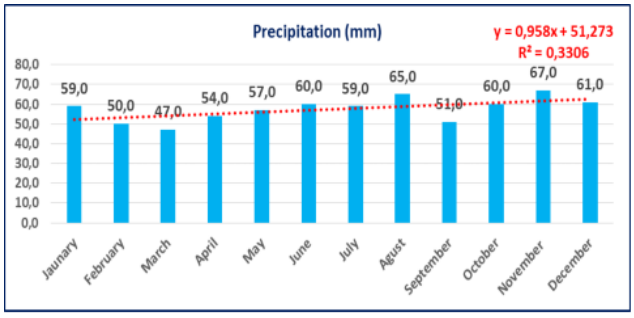

Fig 5. The distributions of Precipitation in England.

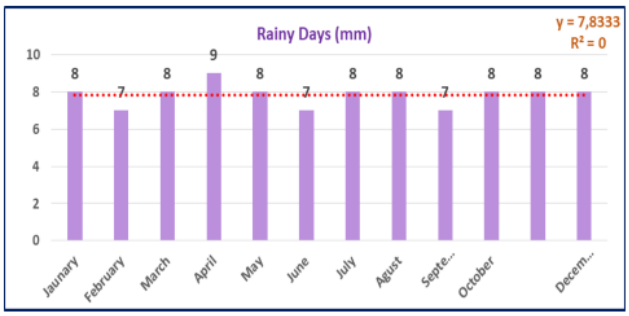

Fig 6. The distributions of Rainy Days in England.

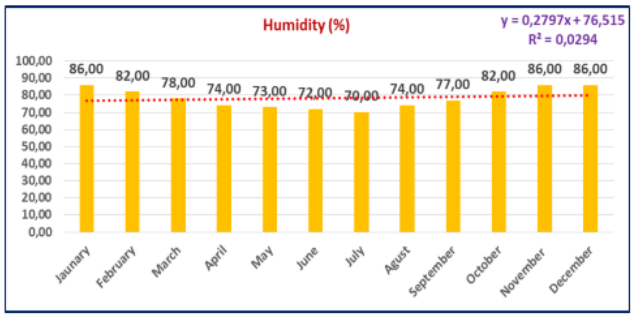

Fig 7. The distributions of Humidity in England.

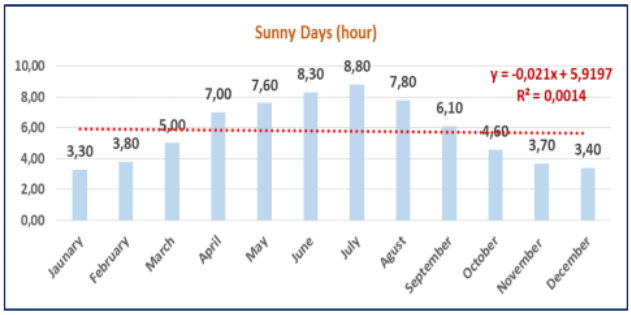

Fig 8. The distributions of Sunny Days in England.

Table 1. The average and standart deviation of some climate data.

Climate Parameters	Average	Standard deviation
Min. Temperature (°C)	7.22	4.4204
Max. Temperature (°C)	14.17	5.4209
Average Temperature (°C)	10.77	4.9205
Precipitation (mm) (Total)	690.00	6.0076
Humidity (%)	78.33	5.8827
Rainy Days (Total)	94	0.5774
Sunny Days (hour)	5.78	2.0564

Although the UK's weather is unpredictable, it is rarely extreme. In summer, the most common temperature in England across the UK is a daily high of 14 degrees Celsius (56°F) and a low of 6 °C (43 °F) [33,34]. Figures 2, 3 and 4 show the climatic variability data, including the minimum temperature (°C), maximum temperature (°C) and average Temperature (°C) of the whole year.

When we look at the standard deviation of the average temperature, the minimum temperature and the maximum temperature are practically equal. But Rainy Days and Sunny Hours have low value. The highest temperature was 17.80 °C recorded in June, while the lowest temperature was 4.80°C recorded in January, which constitutes the coldest month in the area. The area's temperature condition climbs from March to July and declines until January, according to the annual temperature cycle. This variation in the annual temperature of the area is a result of the earth's rotation, the sun's angle, precipitation, and the geography of England.

Fig. 8 and Fig. 4 represent that sunny days and temperatures have lower values as compared to all other variables, which means these variables have very little variability in all months of the whole year. While Figure 5 represents precipitation that varied so much because it has the highest value of standard deviation, the second-most crucial meteorological factor for the stability of local water supplies and agricultural operations is rainfall. In addition, it is a crucial factor in regulating the temperature and other aspects of the weather.

The variability of crop production with rainfall makes it clear that rainfall was the primary factor, and the carrying capacity of the grazing area in head of stock per square kilometer emphasizes this fact. Additionally, it impacts the rate of evapotranspiration from vegetation and soil, as well as crop output and atmospheric moisture content. The amount of rainfall has a direct impact on the size and growth of plants. It came to the conclusion that the actual values of climatic variables are drastically altering as a result of climatic change.

Crop and livestock productivity are impacted by climate change brought on by an increase in greenhouse gas concentration, either negatively or positively. According to some research, a change in the climatic regime may affect these climate resources, making some forms of production less feasible while permitting others. While this is happening, higher atmospheric carbon dioxide levels may result in higher production of some crops (including grass, wheat, and soy barley) [4,9,35-38].

According to Arnell and Freeman's [4] report, the times newspaper ran a news piece in August 2020 with the headline "Climate forces farms to start growing soya. The Worst harvest of wheat in decades" was the result of a wet winter and dry summer, but some farmers had started planting soy and barley, which require greater temperatures than are generally anticipated in the UK. As well, the production of barley is currently highly self-sufficient in the United Kingdom [38]. It means the productivity of some crops may increase when atmospheric carbon dioxide (CO_2) concentrations rise [4].

However, some excessive changes that occurred during the growing season may cause production to be lost or diminished. For instance, crops and livestock might be stressed by drought or high temperatures during vulnerable times. On the other high temperatures may prevent plants from growing and harm livestock [39]. The number of days between May 1 and June 15 when the highest temperature is over 32 °C during the anthesis (flowering and seed setting) stage of wheat is calculated as a heat-stress indicator. They found that every day during anthesis when the temperature exceeds 32 °C, grain yield falls by at least 10%. Crops can be harmed by hail (now uncommon in the UK), excessive rain, and flooding. High temperatures hasten the growth and development stages of crops, which may result in lower yields [4,40].

CONCLUSION AND RECOMMENDATIONS

Crop and livestock productivity are impacted by climate change brought on by an increase in greenhouse gas concentrations and Global warming. As well as temperature, precipitation, humidity, Rainy days, and Sunny hours, these are the factors that are directly related to the climate. As researchers show, temperature, precipitation, and CO_2 fertilization all have different effects on different crops, places, and things that change.

According to research in UK counties, these factors can have negative or positive effects on a change in the climatic regime. It was also

concluded that some factors may affect these weather resources, making some forms of production less feasible while permitting others, like higher levels of atmospheric carbon dioxide and high temperatures, which may result in more production of some crops, including grass, wheat, soy, and barley. As a result, this perfectly captures the possible impact of global average temperature change on agriculture in the UK, including adjustments to the capacity for the cultivation of crops and animals.

Studies on climate change around the world show an increasing trend in recent years with global warming. In these studies, the negative effects of global warming and its damage to agricultural production have come to the fore [41-47].

In this research, the effects of climate change (temperature rises) on agricultural production in England were examined. It is thought that the results obtained will be an example for similar studies.

AUTHOR CONTRIBUTIONS

M. Cüneyt BAĞDATLI- experimental design and statistical analysis. İlknur UÇAK – writing and literature review. Rowida KHALILY - Writing.

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