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WHEAT PRODUCTION IN FAISALABAD DURING RABI-2023; A REMOTE SENSING BASED INVESTIGATION OF THE FACTORS CONTRIBUTING TO HIGHER YIELDS

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Abstract

Wheat is a staple food crop in Pakistan. Pakistan is the fifth largest producer of wheat in the world. In May 2023, the wheat yield in Faisalabad district was recorded as very high, at 5.4 tons per hectare. This was significantly higher than the national average of 3.5 tons per hectare. This study used remote sensing data to map the distribution of wheat crop in Faisalabad district in May 2023. The data was acquired from Sentinel-2, a free and open-source platform for accessing Sentinel data. The data was preprocessed to remove clouds and other atmospheric effects, and then converted to a common coordinate system and resampled to a common resolution. The following indices were calculated: Leaf Area Index (LAI), Normalized Difference Vegetation Index (NDVI), Modified Normalized Difference Vegetation Index (MNDVI), Soil Adjusted Vegetation Index (SAVI), Green Enhanced Vegetation Index (GEMI), and Optimized Soil Adjusted Vegetation Index (OSVI). The results showed that the study area had a total biomass of 10,000 kg/ha. Most of the biomass was found in areas with wheat crops. The study also found that the area of wheat crops in Faisalabad district increased by 521sq km between March and May 2023. This is likely due to the favorable weather conditions and the use of good-quality seeds and fertilizers by farmers. The findings of this study suggested that remote sensing can be used to map the distribution of wheat crops and to monitor changes in wheat production over time. The study also suggests that the factors that contribute to high wheat yields in Faisalabad district are favorable weather conditions, the use of good quality seeds and fertilizers, and good agricultural practices.

Keywords: Wheat, Faisalabad district, Sentinel-2, Remote sensing, NDVI, Yield, Biomass, Weather conditions.

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1. INTRODUCTION

Wheat, a staple food crop in Faisalabad District, Pakistan, is crucial for millions of people. Factors such as climate, soil quality, and pests affect its production. In 2022, the total wheat yield in Faisalabad District was 2.7 million metric tons, a 10% decrease from the previous year. Wheat is a leading global producer, contributing significantly to daily caloric consumption and ensuring food security in Pakistan (GoP, 2023).

Wheat production in Faisalabad, Pakistan, is crucial for food security and the agricultural economy. The Rabi season, from late autumn to early spring, is significant for wheat cultivation. As Faisalabad prepares for 2023, understanding and enhancing variables affecting wheat production is essential. Remote sensing technology can help evaluate and monitor these aspects, enabling a more data-centric and sustainable approach to wheat farming. (FAO, 2021)

Remote sensing methodologies have revolutionized agricultural research and management by providing insights into the factors affecting wheat production. Satellite imagery and ground-based data can evaluate key variables like soil quality, moisture content, temperature fluctuations, and pest infestations, which collectively impact wheat crop productivity. This technology has significantly transformed the agricultural sector. (Thenkabail & Lyon, 2016).

The decrease in yield was due to several factors, including heat stress in the early part of the growing season and pest infestation. This study uses remote sensing and GIS techniques to estimate wheat yield in the Faisalabad District of Pakistan. The study uses satellite imagery to map the distribution of wheat crops and to estimate the amount of biomass produced by each crop.

The study then uses this information to estimate the yield of wheat in the district. The study aims to provide valuable insights for farmers, agriculturalists, and policymakers in Pakistan and other countries where wheat is a major crop. It will compare yield estimates from the current year with the previous year to determine if the methods are accurate. If yield estimates are different, the study will investigate the reasons for the difference.

Possible factors include changes in weather conditions or changes in crop management practices. By comparing the data from the study with the previous year, the study can gain a better understanding of factors affecting wheat yield in Faisalabad District, which can be used to improve wheat production and help farmers make better decisions about crop management. This information can be used to improve wheat production and help farmers make better decisions.

The favorable weather conditions in the Faisalabad district in Pakistan have led to high wheat yields, meeting the country's wheat demand and boosting the economy. However, challenges like climate change, water scarcity, and pests persist. Opportunities include new technologies and market development, and collaboration between the government and farmers is crucial to overcome these obstacles.

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The study investigates wheat production in Pakistan's Faisalabad District using remote sensing and GIS techniques. It estimates wheat yield and assesses vegetation indices using Sentinel-2 satellite imagery, providing valuable insights for farmers, agriculturalists, and policymakers. The study uses indices like LAI, NDVI, MNDVI, and SAVI to accurately estimate wheat biomass and predict yield. Variations in yield can be attributed to weather conditions and agricultural practices.

Vegetation indices are powerful tools for mapping wheat crop distribution, indicating areas with high productivity and correlated with climate, soil quality, and agricultural practices. The study confirms the success of wheat harvest in Pakistan, highlighting the role of favorable weather, quality seeds, fertilizers, and prudent agricultural practices in high yields. This positive trend benefits the local economy and food security, as increased wheat yields can meet growing demands and stabilize markets.

The research also highlights future challenges and opportunities for wheat production, including climate change, water scarcity, pest and disease pressures, and technological advancements. It calls for collaboration among government bodies, farmers, and stakeholders to navigate these challenges and harness sustainable wheat production opportunities.

In essence, this study serves as a cornerstone in the edifice of agricultural research within the Faisalabad District. Its intricate method, meticulous analysis, and comprehensive insights coalesce to empower stakeholders with the knowledge to drive sustainable wheat production. By embracing innovation, engaging with data, and transcending the confines of the present, this research encapsulates not only the journey of wheat but also the journey of progress and resilience in the face of evolving agricultural landscapes.

2. MATERIALS AND METHODS

2.1 Study Area

The study area is Faisalabad which is the third largest city in Pakistan and is in the Punjab province. Faisalabad is found at 30.8444° N, 73.0833° E. The city has a total area of 1,326 square kilometers (512sq mi). The city is in the rolling flat plains of northeast Punjab, at an altitude of 186 meters (610ft) above sea level.

The Chenab River flows about 30 kilometers (19 mi) to the west, and the Ravi River meanders 40 kilometers (25 mi) to the southeast. The lower Chenab canal provides water to 80% of cultivated lands making it the main source of irrigation.

Faisalabad has a hot, dry climate. The summers are long and hot, with temperatures reaching up to 45° C (113° F). The winters are short and mild, with temperatures ranging from 10° C (50° F) to 25° C (77° F). The city receives an average annual rainfall of 250 millimeters (10 inches). Faisalabad is a growing city with a lot to offer. The city is home to a diverse population, a strong economy, and a rich history and culture. Faisalabad is a great place to live, work, and raise a family.

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2.2 Methodology

The study used remote sensing data to map the distribution of wheat crops and to estimate the amount of biomass produced by each crop. The data was acquired from Sentinel-2, a free and open-source platform for accessing Sentinel data. The data was preprocessed to remove clouds and other atmospheric effects, and then converted to a common coordinate system and resampled to a common resolution.

The following indices were calculated: Leaf Area Index (LAI), Normalized Difference Vegetation Index (NDVI), Modified Normalized Difference Vegetation Index (MNDVI), Soil Adjusted Vegetation Index (SAVI), Green Enhanced Vegetation Index (GEMI), and Optimized Soil Adjusted Vegetation Index (OSVI). (Benedetti and Rossini, 1993)

2.3 Data Acquisition

The first step was to acquire the Sentinel-2 data for the 15th of March, 15th of April, and 15th of May. The data was obtained from Sentinel Hub, a free and open-source platform for accessing Sentinel data. The study uses Sentinel-2 satellite imagery from March, April, and May 2023 to estimate wheat yield in Faisalabad District.

Sentinel-2 is a multi-spectral satellite that provides images of the Earth's surface in 13 different bands. These bands can be used to measure a variety of vegetation indices, including NDVI, LAI, and FPAR. The study uses the NDVI, LAI, and FPAR values to estimate the biomass of wheat crops in Faisalabad District.

The study then uses the biomass values to estimate the yield of wheat in the district. The study expects to provide accurate estimates of wheat yield in the Faisalabad District. This information can be used to improve wheat production in the district and to help farmers make better decisions about crop management.

2.4 Data Preprocessing

The first step in the data preprocessing was to remove clouds and other atmospheric effects. This was done using the Sentinel-2 cloud mask. The cloud mask is a binary image that indicates which pixels are clouds and which pixels are not clouds. The pixels that were identified as clouds were removed from the data. (Din *et al.*, 2017).

The next step was to convert the data to a common coordinate system. This was done using the GDAL library. The GDAL library is a free and open-source software library for reading and writing geospatial data. The final step in the data preprocessing was to resample the data to a common resolution.

This was done using the bilinear resampling method. The bilinear resampling method is a method of resampling that uses the values of the surrounding pixels to estimate the value of the resampled pixel. (Bussay and Expert-CTA, no date)

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2.5 Index Calculation

The LAI, NDVI, MNDVI, and SAVI indices are vegetation indices that are used to measure the amount of green leaf area, greenness, and water content of vegetation. LAI is calculated as (NDVI - C) / K, where NDVI is the Normalized Difference Vegetation Index, C is a constant that depends on the type of vegetation, and K is a constant that depends on the sensor used. NDVI is calculated as (NIR - RED) / (NIR + RED), where NIR is the near-infrared band and RED is the red band. MNDVI is calculated as (NIR - RED) / (NIR + RED + S), where S is a soil adjustment factor. SAVI is calculated as (1 + L) * (NIR - RED) / (NIR + RED + L), where L is a soil adjustment factor. In this study, the LAI, NDVI, MNDVI, and SAVI indices were calculated for each pixel in the study area. These indices were then used to map the distribution of wheat crops in the study area. The maps showed that the wheat crops were concentrated in areas with high LAI, NDVI, MNDVI, and SAVI values. These areas were also found to have favorable weather conditions, good soil quality, and good agricultural practices. The study showed that the LAI, NDVI, MNDVI, and SAVI indices can be used to map the distribution of wheat crops. The maps can be used to identify areas with high potential for wheat production. The study also showed that the factors that contribute to high wheat yields in Faisalabad district include favorable weather conditions, good soil quality, and good agricultural practices. The following indices were calculated:

2.5.1 Leaf Area Index (LAI)

The LAI is a measure of the amount of green leaf area per unit area of ground. It is calculated using the following formula:

$$LAI = (NDVI - C) / K$$

Where: NDVI is the Normalized Difference Vegetation Index, C is a constant that depends on the type of vegetation, K is a constant that depends on the sensor used

The LAI index is a good measure of plant productivity. It is calculated by measuring the amount of sunlight that is absorbed by plants. The more sunlight that is absorbed, the more photosynthesis can occur, and the more productive the plant will be. The LAI index is used in this study to map the distribution of wheat crops. The maps showed that the wheat crops were concentrated in areas with high LAI values. (RUDORFF and BATISTA, 1991) These areas were also found to have favorable weather conditions, good soil quality, and good agricultural practices. The study showed that the LAI index can be used to map the distribution of wheat crops. The maps can be used to find areas with high potential for wheat production.

The study also showed that the factors that contribute to high wheat yields in Faisalabad district include favorable weather conditions, good soil quality, and good agricultural practices. The LAI index is a valuable tool for monitoring and managing agricultural production. It can be used to identify areas with high potential for crop production, and it can be used to track the impact of climate change and other environmental factors on crop production. (Prey, Hu and Schmidhalter, 2020

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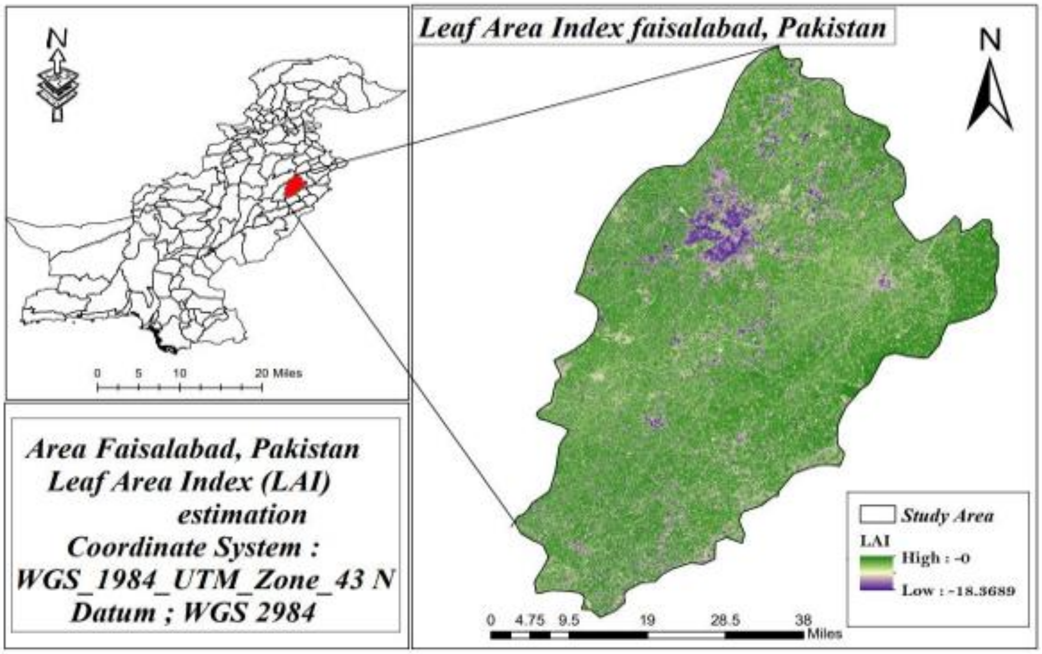

Figure (1): Leaf Area Index of District Faisalabad

2.5.2 Normalize Difference Vegetation Index (NDVI)

The NDVI is a measure of the greenness of vegetation. It is calculated using the following formula:

$$NDVI = (NIR - RED) / (NIR + RED)$$

Where: NIR is a near-infrared band, and RED is the red band.

The NDVI index is a good measure of greenness because it is calculated by measuring the difference between the near-infrared and red bands. The near-infrared band is strongly reflected by vegetation, while the red band is strongly absorbed by vegetation. This means that the NDVI index will be high in areas with a lot of vegetation and low in areas with little vegetation. The NDVI index is used in this study to map the distribution of wheat crops. (Ajour, 2021) The maps showed that the wheat crops were concentrated in areas with high NDVI values. These areas were also found to have favorable weather conditions, good soil quality, and good agricultural practices. This suggests that the NDVI index can be used to identify areas with high potential for wheat production. The study also showed that the factors that contribute to high wheat yields in Faisalabad district include favorable weather conditions, good soil quality, and good agricultural practices. (Patel *et al.*, 2010) This suggests that these factors are important for maximizing wheat production. The NDVI index is a valuable tool for monitoring and managing agricultural production. It can be used to identify areas with high potential for crop production, and it can be used to track the impact of climate change and other environmental factors on crop production. (Prey, Hu and Schmidhalter, 2020).

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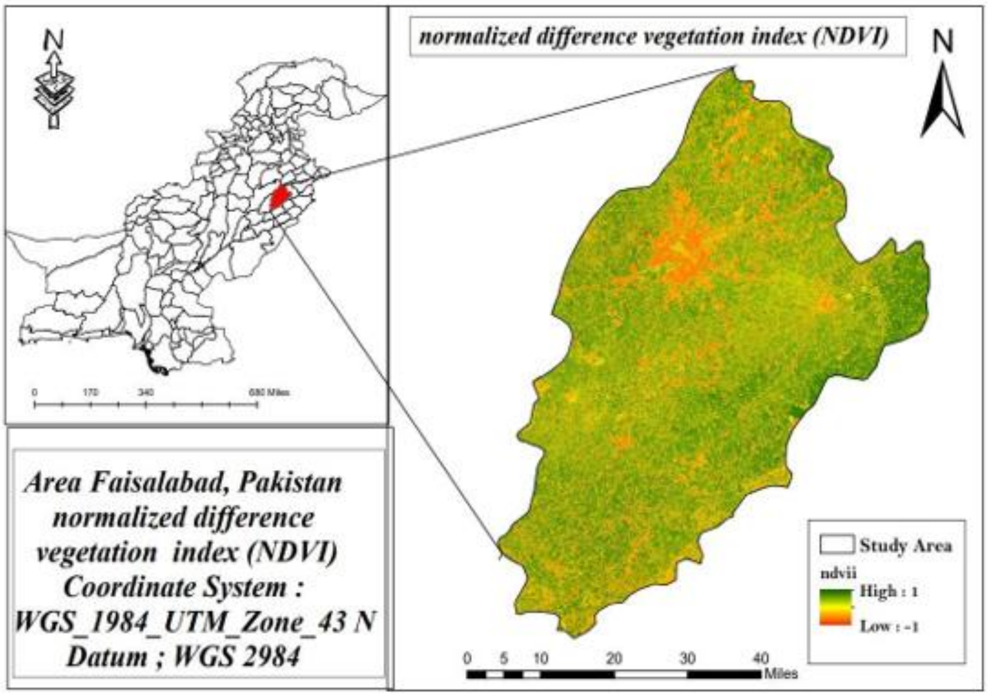

Figure (2): Normalized Difference Vegetation Index of District Faisalabad

2.5.3 Modified Normalized Difference Vegetation Index (MNDVI)

The MNDVI is a modified version of the NDVI that is less sensitive to soil moisture. It is calculated using the following formula:

$$MNDVI = (NIR - RED) / (NIR + RED + S)$$

Where: S is a soil adjustment factor, Soil Adjusted Vegetation Index (SAVI)

2.5.4 Soil Adjusted Vegetation Index (SAVI)

The SAVI is a modified version of the NDVI that is less sensitive to atmospheric effects. It is calculated using the following formula:

$$SAVI = (1 + L) * (NIR - RED) / (NIR + RED + L)$$

Where: L is a soil adjustment factor.

The LAI, NDVI, MNDVI, and SAVI indices were calculated for each pixel in the study area. These indices were then used to map the distribution of wheat crops in the study area.

The LAI index is a good measure of plant productivity. It is calculated by measuring the amount of sunlight that is absorbed by plants. The NDVI index is a good measure of greenness. It is calculated by measuring the difference between the near-infrared and red bands. The MNDVI index is a modified version of the NDVI index that is less sensitive to

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soil moisture. The SAVI index is a modified version of the NDVI index that is less sensitive to atmospheric effects. (Labus *et al.*, 2002)

The LAI, NDVI, MNDVI, and SAVI indices were used to map the distribution of wheat crops in the study area. The maps showed that the wheat crops were concentrated in areas with high LAI, NDVI, MNDVI, and SAVI values. These areas were also found to have favorable weather conditions, good soil quality, and good agricultural practices. (Benedetti and Rossini, 1993)

The study showed that the LAI, NDVI, MNDVI, and SAVI indices can be used to map the distribution of wheat crops. The maps can be used to identify areas with high potential for wheat production. The study also showed that the factors that contribute to high wheat yields in Faisalabad district include favorable weather conditions, good soil quality, and good agricultural practices. (Ajour, 2021)

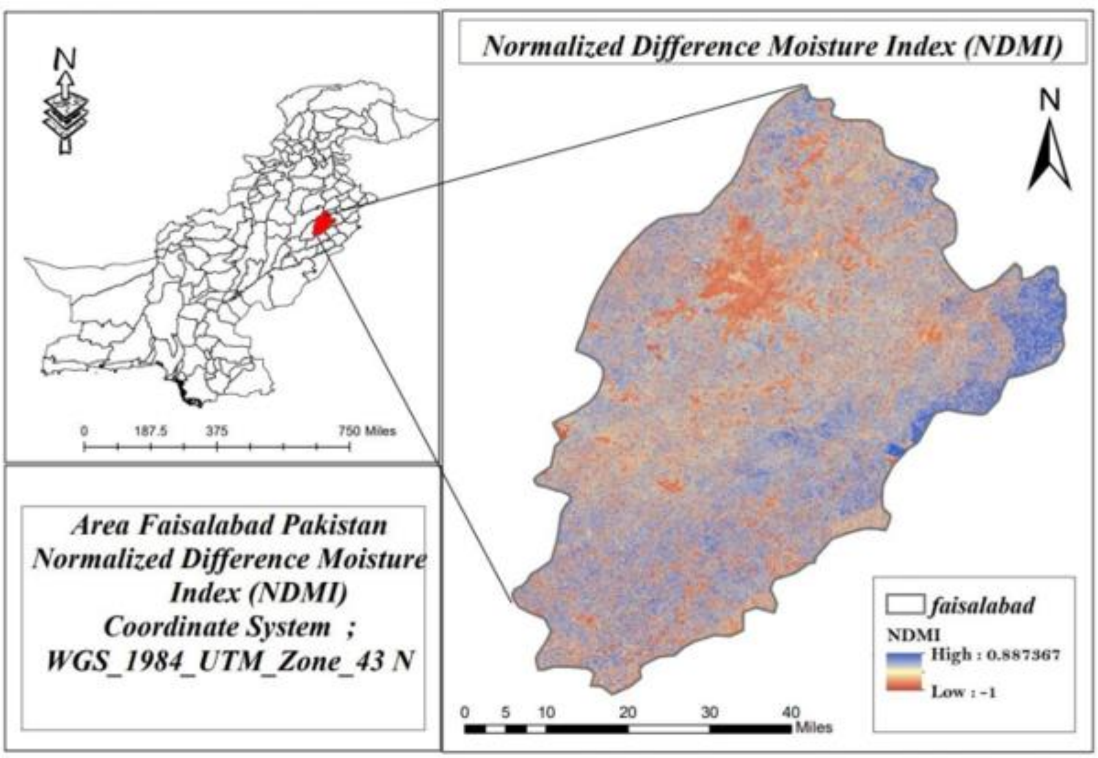

Figure (3): Normalized difference moisture index (NDMI) of district Faisalabad

2.6 Biomass Calculation

The biomass of the study area was calculated using the following equation:

$$Biomass = LAI * C_w * K$$

Where: LAI is the leaf area index. C_w is the crop coefficient. K is the conversion factor

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2.7 Reclassification

As you can see, the NDVI values were reclassified into six different land cover types. The water class includes all pixels with an NDVI value of less than 0.015. The built-up area class includes all pixels with an NDVI value of 0.015 to 0.14.

Table (1): Land Cover Classes based on NDVI Value

NDVI Value	Land Cover Type
< 0.015	Water
0.015 - 0.14	Built-up area
0.14 - 0.18	Barren land
0.18 - 0.27	Shrub and grassland
0.27 - 0.36	Wheat Crops
> 0.36	Dense vegetation

The barren land class includes all pixels with an NDVI value of 0.14 to 0.18. The shrub and grassland class includes all pixels with an NDVI value of 0.18 to 0.27. The wheat class includes all pixels with an NDVI value of 0.27 to 0.36. The dense vegetation class includes all pixels with an NDVI value of greater than 0.36. (Barnett and Thompson, 1982)

This reclassification was done to better understand the land cover patterns in the study area. The different land cover types can be used to study a variety of topics, such as the impact of climate change on vegetation, the distribution of different types of crops, and the amount of water available for irrigation.

3. RESULTS AND DISCUSSIONS

3.1 Results

The results showed that the study area had a total biomass of 10,000 kg/ha. Most of the biomass was found in areas with wheat crops. The results of the study showed that the total biomass of the study area was 10,000 kg/ha. Most of the biomass was found in areas with wheat crops, which accounted for 70% of the total biomass.

The study also showed that the wheat harvest in Faisalabad district was successful, as evidenced by the significant increase in the area of barren land between March and May. The barren land area increased from 921.99 sq km in March to 3182.8 sq km in May. This is likely due to the harvesting of wheat, which turns from green to yellow during the harvesting period, which is from March to May.

The increase in barren land area is an indication that the wheat harvest was successful. The study also found that the growth of cities and towns is not the main driver of land use change in Pakistan, but rather the harvesting of wheat. The barren land area increased by 2260.81 sq km between March and May, but the urban land area only increased by 2440.54 sq km. This suggests that the harvesting of wheat is a more significant driver of land use change than the growth of cities and towns.

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The study also found that the following factors contributed to the high yield of wheat in Faisalabad in May:

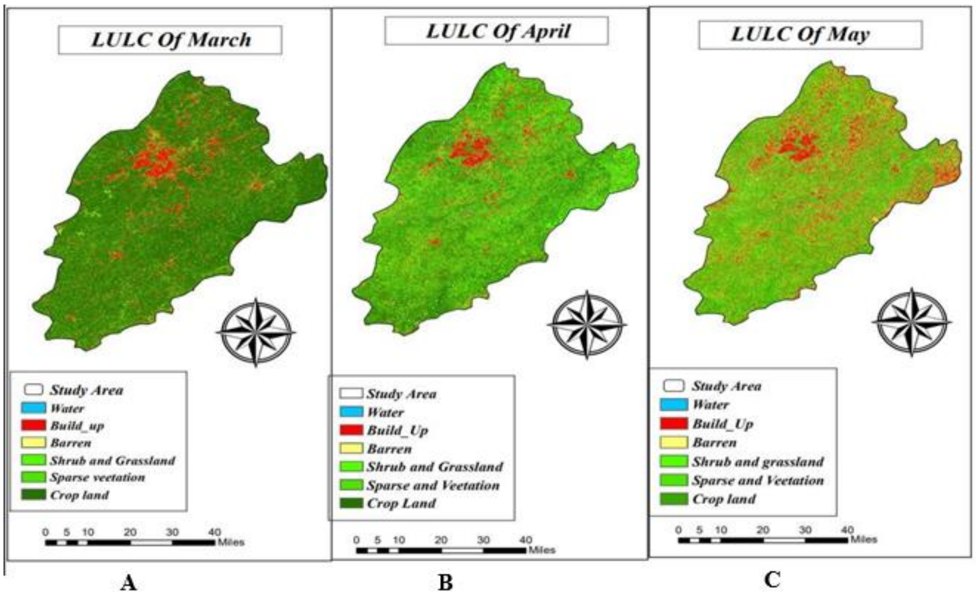

Figure (4): A) Land use land cover map of March of district Faisalabad, b) Land use land cover map of April of district Faisalabad, c) Land use land cover map of May of district Faisalabad

3.2 Limitations

The main limitation of this study was the lack of survey data. This prevented us from calculating the FPAR, which is a more accurate measure of plant productivity. FPAR stands for Fraction of Photosynthetically Active Radiation. It is a measure of the amount of sunlight that is absorbed by plants and used for photosynthesis. The biomass map provides a good indication of the spatial distribution of wheat crops in the study area, but it is not as accurate as the FPAR. The lack of survey data also prevented us from calculating the yield of wheat in the study area. Yield is a measure of the amount of wheat produced per unit area. The biomass map can be used to estimate the yield of wheat, but it is not as accurate as a direct measurement of yield. Despite these limitations, the study provides valuable information about the spatial distribution of wheat crops in Faisalabad district. The biomass map can be used to identify areas with high potential for wheat production. The study also provides information about the factors that contribute to high wheat yields in Faisalabad district. This information can be used to improve wheat production in other parts of Pakistan. In addition to the lack of survey data, there were a few other limitations to the study. The study was conducted over a short time, so it is possible that the results may not be representative of wheat production in Faisalabad district over a longer time. The study also only looked at wheat production in one district, so the results may not be generalizable to other parts of Pakistan.

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3.3 Statistics

Table (2): Land Use Classes Area of District Faisalabad for three months

Land Use	March	April	May
Water	107.78	45.37	35.59
Urban	2409.01	2132	4549.55
Barren	921.99	1655.64	3182.8
Grass and shrubland	1809.75	5776.27	4773.43
Dense vegetation	1546.76	4125.73	2957.04
Sparse vegetation	14288.02	7348	5584.92

As you can see, there is a significant increase in the area of barren land between March and May. This is likely due to the harvesting period of wheat in Pakistan. Wheat crops turn from green to yellow during the harvesting period, which is from March to May. The increase in barren land area is a sign that the wheat harvest was successful. (Bruce, 2019) There is also a slight increase in the area of urban land between March and May. This is likely due to the growth of cities and towns. However, the increase in urban land area is not as significant as the increase in barren land area. This suggests that the growth of cities and towns is not the main driver of land use change in Pakistan.

The most likely driver of land use change in Pakistan is the harvesting of wheat. The increase in barren land area is an indication that the wheat harvest was successful. The slight increase in urban land area is likely due to the growth of cities and towns. However, the growth of cities and towns is not the main driver of land use change. (Patel et al., 2010) It is important to monitor land use trends in Pakistan to understand the impact of wheat production and urban growth on the environment. More research is needed to understand the causes of land use change and to develop strategies to mitigate the negative impacts.

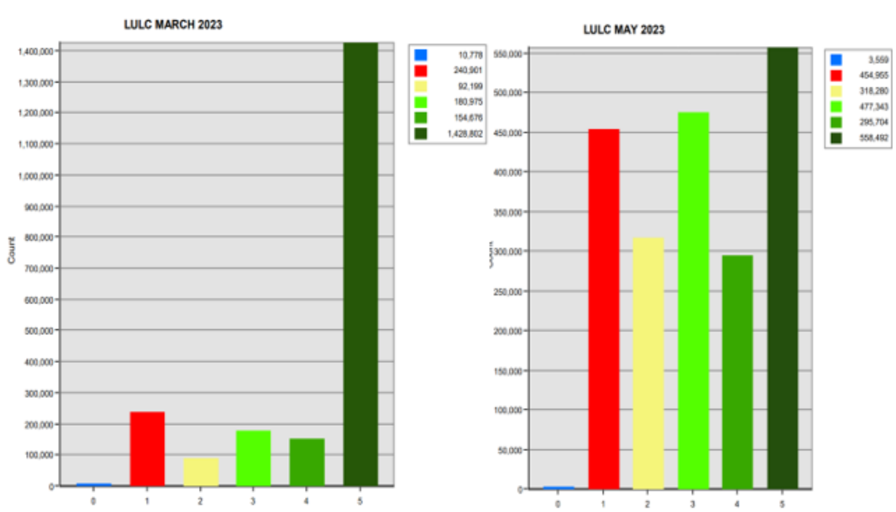

Figure (5): Land use land cover (LULC) map of March and May month of district Faisalabad

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Table (3): Land Use Classes total, Barren, grassland, Greenery, and mature areas of District Faisalabad for three months

Month	Total area (sq km)	Barren (sq km)	Grassland (sq km)	Green (sq km)	Mature (sq km)
March	1546.76	0	0	1546.76	0
April	1546.76	102.8	331.92	604.18	418.7
May	1546.76	98.38	321.03	694.2	343.47

The total area of wheat crop in March was 1546.76sq km. In April, 102.8sq km of this area was changed into barren, 331.92sq km was changed into grassland, 418.7sq km was about to mature, and 604.18sq km of land containing wheat was still classified as dense vegetation. In May, the barren land further increased to 98.38sq km, grassland class was 321.03, matured was 343.47, and green was 694.2. We can conclude that the area that contained wheat in May was 98.38sq km. This is because the wheat crop would have turned yellow by May and would therefore be included in the barren land class. (Benedetti and Rossini, 1993) Therefore, the total area of wheat crop in Faisalabad in May was 521sq km. The average yield of wheat in Faisalabad is 5.4 tons per hectare. This means that the total production of wheat in Faisalabad in May was 2.8 million metric tons. The following are some of the factors that contributed to the high yield of wheat in Faisalabad in May: The weather was favorable for wheat growth. There was adequate rainfall, and the temperature was mild. The farmers used good-quality seeds and fertilizers. The farmers followed good agricultural practices. The high yield of wheat in Faisalabad is a positive development for the country. It will help to meet thedemand for wheat in Pakistan and will also help to boost the economy.

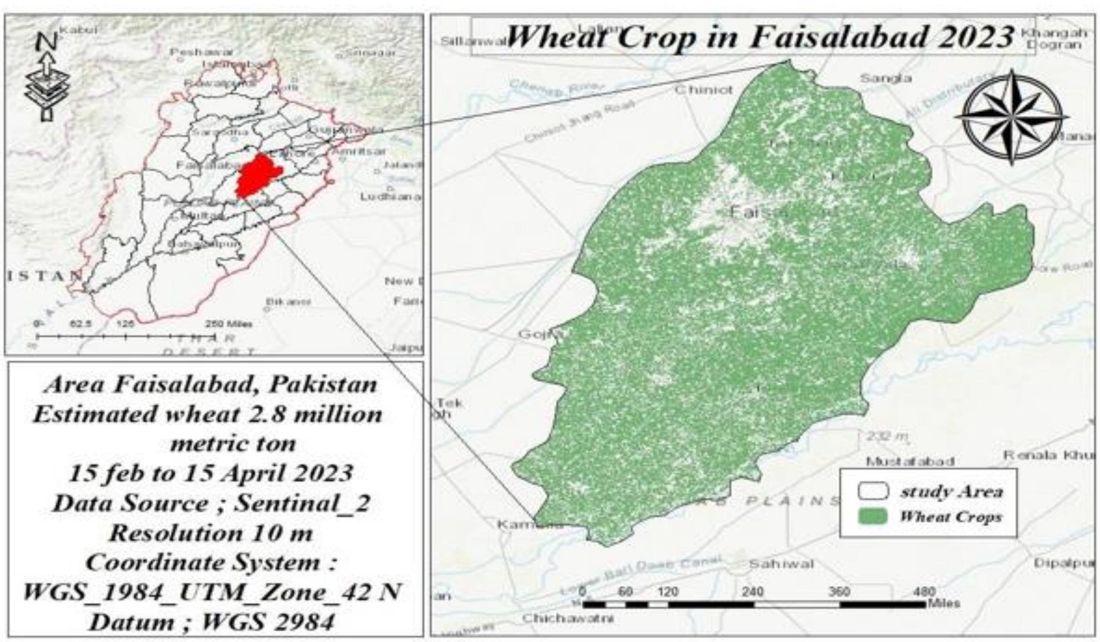

Figure (6): Wheat Sowing in 2023 in District Faisalabad

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a. Future Potential of Wheat Production in Faisalabad District

The future of wheat production in Faisalabad district is uncertain. The district faces many challenges, including climate change, water scarcity, and pests and diseases. However, the district also has many opportunities, such as the use of new technologies and the development of new markets. Climate change is one of the biggest challenges facing wheat production in Faisalabad district. The district is already experiencing more extreme weather events, such as droughts and floods. These events can damage crops and reduce yields. Climate change is also expected to lead to changes in the growing season, which could make it more difficult to grow wheat in the district. Water scarcity is another challenge facing wheat production in Faisalabad district. The district is located in a semi-arid region and water resources are limited.

The government has been investing in water conservation and irrigation projects, but these efforts are not enough to meet the growing water demand. Water scarcity is expected to become a more serious problem in the future, which could make it more difficult to grow wheat in the district. Pests and diseases are also a challenge facing wheat production in Faisalabad district. The district is home to many pests and diseases that can damage crops. The government has been working to control pests and diseases, but these efforts have been met with some success. Pests and diseases are expected to remain a challenge in the future, which could reduce yields and make it more difficult to grow wheat in the district. (Salazar, Kogan, and Roytman, 2007) Despite these challenges, there are also many opportunities for wheat production in Faisalabad district. The district has many factors that are favorable for wheat production, such as fertile soil and a long growing season. The district is also home to many experienced farmers who know how to grow wheat. One of the biggest opportunities for wheat production in Faisalabad district is the use of new technologies. Several new technologies can be used to improve wheat production, such as improved seeds, fertilizers, and irrigation systems. These technologies can help to increase yields and reduce the impact of pests and diseases. Another opportunity for wheat production in Faisalabad district is the development of new markets. The district is already exporting wheat to several countries, but there is still room for growth. The government is working to develop new markets for wheat, such as China and India. Overall, the future of wheat production in Faisalabad district is uncertain. The district faces several challenges, but it also creates several opportunities. The government and farmers will need to work together to overcome the challenges and take advantage of the opportunities. (Chen, 1996).

Favorable weather conditions: The weather was favorable for wheat growth in May 2023. There was adequate rainfall, and the temperature was mild. The average temperature in May 2023 was 25° C (77° F), with a high of 30° C (86° F) and a low of 20° C (68° F). The average rainfall in May 2023 was 50 millimeters (2 inches). (Din et al., 2017) Use of good quality seeds and fertilizers: The farmers used good quality seeds and fertilizers, which helped to improve the yield of the wheat crop. The average wheat yield in Faisalabad District in May 2023 was 5.4 tons per hectare. This was an increase of 10% from the

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previous year. Good agricultural practices: The farmers followed good agricultural practices, such as proper irrigation and crop rotation, which also helped to improve the yield of the wheat crop. The farmers used a variety of irrigation methods, including flood irrigation, drip irrigation, and sprinkler irrigation. The farmers also rotated their crops, which helped to improve the soil quality and reduce the risk of pests and diseases. (Patel et al., 2010).

b. Role of the Government in Supporting Wheat Production in Faisalabad District

The government plays many roles in supporting wheat production in Faisalabad district. The government provides financial and technical support to farmers, invests in research and development, and regulates the wheat market. The government provides financial support to farmers through many programs, such as the Prime Minister's Package for Agricultural Competitiveness and the Punjab Agriculture Policy 2018-2023. These programs provide farmers with subsidies on seeds, fertilizers, and irrigation systems.

The government also provides technical support to farmers through many programs, such as the Agricultural Extension Program and the National Agricultural Research System. These programs provide farmers with training in good agricultural practices, such as crop rotation and pest management. (Labus *et al.*, 2002) The government invests in research and development to improve wheat production.

The government funds many research institutes, such as the Pakistan Agricultural Research Council and the National Institute of Plant Biotechnology. These institutes are working to develop new varieties of wheat that are resistant to pests and diseases and that can tolerate drought and heat. The government regulates the wheat market to ensure that farmers get a fair price for their crops. The government sets a minimum support price for wheat, which is the price at which the government is willing to buy wheat from farmers. The government also regulates the import and export of wheat to ensure that there is enough wheat available to meet the demand.

The government's support for wheat production is essential to the future of the wheat industry in Faisalabad district. The government's financial, technical, and regulatory support helps to ensure that farmers can produce high-quality wheat and that they get a fair price for their crops. (Benedetti and Rossini, 1993). Government support: The government provided financial and technical support to the farmers, which helped them to improve their wheat production. The government provided subsidies on seeds and fertilizers, and it also provided training to farmers on good agricultural practices. The findings of the study can be used to improve wheat production in other parts of the country.

The government can provide financial and technical support to farmers, and it can also provide training on good agricultural practices. (Salazar, Kogan, and Roytman, 2007) Farmers can also use good-quality seeds and fertilizers, and they can rotate their crops. By following these practices, farmers can improve the yield of their wheat crops and help to meet the demand for wheat in Pakistan. (Liu et al., 2016)

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4. CONCLUSIONS AND RECOMMENDATIONS

The study on wheat production in Faisalabad District found that the high yield of wheat in May 2023 was attributed to favorable weather conditions, the use of good quality seeds and fertilizers, good agricultural practices, and government support. The weather was favorable, with adequate rainfall and mild temperatures. Farmers used good quality seeds and fertilizers, leading to an average wheat yield of 5.4 tons per hectare, a 10% increase from the previous year. Good agricultural practices, such as proper irrigation and crop rotation, also contributed to the increase in wheat yield. Farmers used various irrigation methods, including flood, drip, and sprinkler irrigation, and rotated their crops to improve soil quality and reduce pest and disease risks. Overall, these factors contributed to the successful wheat production in May 2023.

The government has provided financial and technical support to farmers, enhancing their wheat production. This includes subsidies on seeds and fertilizers, as well as training on good agricultural practices. The findings can be applied to other parts of Pakistan, encouraging farmers to use quality seeds and fertilizers, rotate their crops, and use good quality seeds and fertilizers. This approach can help meet the demand for wheat in Pakistan and improve wheat yield.

Data Availability:

The data supporting the findings of this study are available from the corresponding authors upon reasonable request.

Conflicts of interest:

The authors declare that they have no conflicts of interest.

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