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Rice Leading the Prominent Crop Production Using NDVI at Khairpur Nathan Shah

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Keywords: Rice, Cash Crops, Dadu, Droughts, Floods

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Title

Rice Leading the Prominent Crop Production Using NDVI at Khairpur Nathan Shah

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Contents

Abstract

Rice is the basic cereal crop after wheat; it is a major revenue generator in cash crops around the Khairpur Nathan Shah region. It is one of the rice cultivator regions in the Dadu zone, which is considered a prominent crop for its local economy. Climate change has a major effect on agriculture in the KN Shah area, also enforcing vulnerable conditions due to droughts and floods that have negative effects on production and seasonal cultivation. For assessing the rice crop, community-based survey data were collected along with remote sensing, using the GIS tool, through the Indicate the month of June and July 2022 crop data. It was used for the Normalized Difference Vegetation Index (NDVI) classification. The result demonstrated 0.16-0.34 values in rice in the month of June, while 0.26-0.54 values in July.

Keywords:

Rice, Cash Crops, Dadu, Droughts, Floods

Introduction

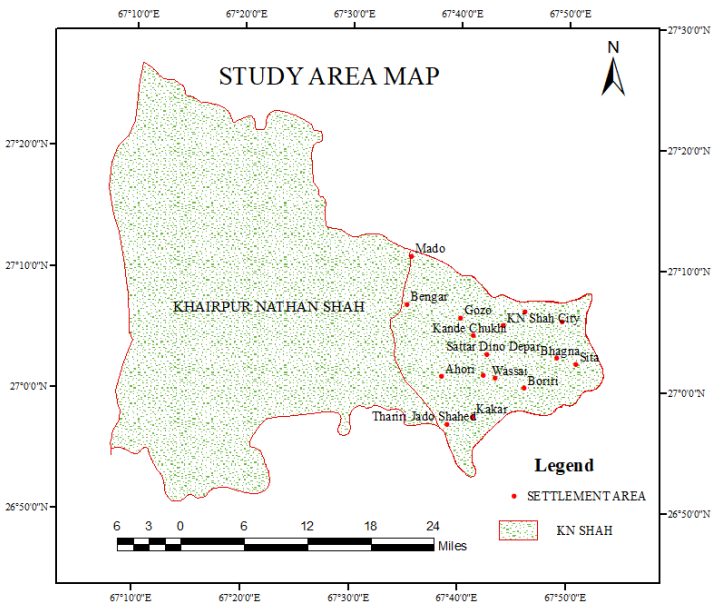
Agriculture has remained the backbone of humans from ancient times and has been the major economic source for the population over the globe (Revelle, 1976). Besides lumbering, hunting, and gathering, it is one of the oldest and most significant primary activities that sustain human life by providing food, fiber, and raw materials for industries. The increase in global population has a major impact on agricultural resources, which are leading challenges in food security, land management, and sustainable production(Alston & Pardey, 2014). In developing countries like Pakistan, an agriculture input not only support a large extent of the population, but they also contributes significant portion of GDP to the national economy(Azam & Shafique, 2017). It plays a vital role in livelihoods, input, employment, and the development of cities or regional economies. However, with the changing climatic conditions, uneven rainfall patterns, and increasing population density, the sustainability of agriculture system is becoming a serious concern(Hertel & Rosch, 2010). whereas climate change significantly affects the production of agriculture because it causes decreased rainfall in this region, which directly

affects production. However, flood damage to the infrastructure of irrigation led to an impact on agricultural production (Meghwar, S and, et al, 2020). It is another warning to raise temperature unevenly, leading to a shift in rainfall pattern in the range of 250-500 mm annually. This changing pattern inconsistently occurred since the last century, and it continues to affect monsoon weather with the amount of annual rainfall. This phenomenon is also caused by extensive flooding (Meghwar, S et al, 2019). Climate change-induced drought activities led to escalating agricultural catastrophe in the region. This is predominantly disturbing the Rabi and Kharif crops in all countries, especially in this region. Which are the main crops in the country. Therefore, it is forecasted crops may be decreased 8 to 10 percentage in production by 2040 (meghwar,S and et al, 2019).

Agriculture is one of the prominent factors in terms of employment opportunity in Asian countries, where Pakistan provides 44 percent of the population(Aslam, 2016). Pakistan lies on most agro-ecological regions and climatic zones which have highly favorable for agriculture in all seasons.(Ahmad et al., 2019; Anwar Hussain & Bangash, 2017) Agriculture is dependent on the irrigation system of Pakistan which accounts 80 percent of the total area irrigated(Nasreen & Ashraf, 2020).In terms of GDP contribution Wheat, rice cotton and sugarcane with contribution of 6.5 percent are among the major crops in Pakistan,whereas minor crops (i.e. names of crops) 2.3 percent shares in Pakistan's economy(Ashiq Hussain & Ajmair, 2016; Khurshid, Qayyum, & Shera, 2021; Shar, Jiskani, & Qi, 2021). Due to natural disasterslike flood, Pakistan's economy has badly affected(Manzoor et al., 2022). Wheat in agriculture sector contributed 14.4 as a value added in agriculture. In terms of wheat producing Pakistan stands in 10th number(Shahzad et al., 2022). While rice is staple food and also cash crop which contributed in agriculture sector more than 3.1 percent value added in agriculture(Seck, Diagne, Mohanty, & Wopereis, 2012). After the wheat it is 2nd staple for country's population and also major source of foreign exchange as an earning product(Abbas, Sheikh, Shahbaz, & Afzaal, 2007). Cotton is considered as 4th largest produce and 3rd largest consumer over the globe(Ashraf, Sangi, Hassan, &Luqman, 2018; Khan et al., 2020). It is major cash crop in Pakistan almost it contributes 8.2 percent in value added in agriculture and 2 percent in GDP, and it earns from foreign exchange 55 percent the means of earning(Khurshid et al., 2021). Sugarcane is major constitute for the industries(Afghan, Khan, Verma, & Nikpay, 2024) that have high value in the cash crop which have adverse effect in the Pakistan's economy(Iqbal & Iqbal, 2014). It is 2nd most cash crop in Pakistan which contributes in agriculture as a 3.6 percent in value added in agriculture(Ali, Mustafa, & Shahbazi, 2013). Over the globe Pakistan is 5th largest producer of sugarcane(Qureshi & Afghan, 2020).

Figure 1

Study Area Map Khairpur Nathan Shah



Geography of Khairpur Nathan Shah

Khairpur Nathan Shah is one of the important taluka of District Dadu in Sindh Province, Pakistan.The location of this taluka is 26'50" 10 North latitude and 67'10"00 east longitude the total population of the taluka is 334,477, and it covers an area of 2,583 square kilometers (PBS, 2023). The majority of the population, about 262,064 individuals, lives in rural areas where agriculture is the principal source of income and livelihood. The taluka comprises three major physiographic units: the piedmont region, the Kachha (low-lying flood-prone area), and the riverine plains. Each of these zonesfounds change in terms of the fertility due to topographic and soil characteristics, these characteristics impact on the production level in agricultural. Most of the eastern parts of the taluka which is prominent for rice cropparticularly fertile due to water availability of the Indus River, which allowingmajor parts cultivation and supporting different crops. So, thatthe study is conducted on that part of the taluka; eastern part of this fertile land consists in KN shah approximately 969.10 square kilometers and that piece of land which is irrigated through the canals like Rice and Dadu.

In Khairpur Nathan Shah Agricultural practices are sodiverse, and numerous cropping seasons are practiced throughout the year. The Main crops of this area are Rice, cotton, Wheat, and sugarcane thatsupport the community and local economy of the study area. These crops are not enough for population needs but support the local agricultural market of Sindh Province. In district DaduKN Shah Talukais only taluka that is major contributor of rice production.Climate of the KN Shahis hot and arid, very low precipitation with low humidity, with the mean annual rainfall rages upto 10 to 150 mm.however, monsoon is one of the major contributor in terms of rainfall.

Research Methodology

The study reveals by the combined process Real time ground data with the Remote sensed data to validate the results of seasonal growth of rice crop in the taluka Khairpur Nathan Shah. To ensure the accuracy questionnaire were set and applied in the field as a survey data collection. While satellite images were acquired and analysis through software, to representation of the rice..

Data Collection

The data was collected as from primary source in the form of questionnaire and survey was carried out across various rice sowing locations within the KN Shah. The questionnaire were designed open-ended questions,which focused on the rice cultivation practices, includingdetails about the before sowing period, after sowing, growth stages, and harvesting cycle.Farmers were interviewed directly so that the information regarding crops and their initial and final sowing periods, crop conditions, and local practical period.Survey helped in identifying actual conditions of ricecrop and extent of vegetation growth during study period.To compare the field data, satellite imageries were obtained from United States Geological Survey (USGS) platform. However, the data was collected from the various locations in the study area in the year of 2022, and month of June and July toto check validation of key sowing and early growth stages of crop.

GIS and Remote Sensing Methods

USGS Landsat satellitedata were selected for classificationof data was taken from satellite of Landsat-8 in the year of 2022 in the month of June 25th, while June 2022 and Landsat satellite 9 data were also acquired from the same year of month of July on 19threspectively.The acquired satellite images were processed and analyzed using ArcGIS 10.8. The analysis was carried out through the Normalized Difference Vegetation Index (NDVI), which is a standard method to quantify vegetation health and density. NDVI utilizes the Near-Infrared (NIR) and Red (R) spectral bands and calculated using the following formula:

NDVI=NIR–R/NIR+R.

Where Normalized difference vegetation index (NDVI)is technique that used to quantify the plants and vegetation's health to measure plants greenness, actual it is reflectance of light. Near-Infrared (NIR) band is essential in the NDVI calculation, by this band reflects healthy vegetation strongly reflects NIR light while absorbing red light. Red (R)Band it measures the amount of red light reflected. Band 4 is used in in R band its values are 0.64 - 0.67 µm with 30 m while band 5 is

used as NIR its values are 0.85 - 0.88 µm 30 m in the Landsat 8 data.

In the NDVI generally value that are negative like -1.0 indicates cloud and water, and other values which are near zero (0) which indicates bare soil, most positive values in NDVI indication such vegetation, ranging 0.1-0.5 indicates sparse vegetation while 0.6 and above are the dense vegetations.

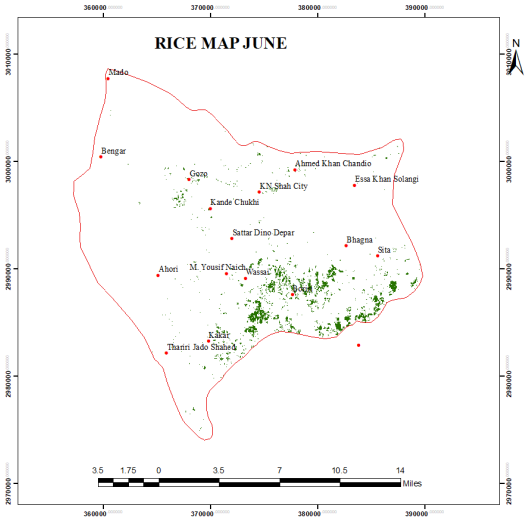
Result

NDVI is most powerful techniques that enables the accurate information about the vegetation index, however the KN Shah taluka is rich in rice cultivation in district Dadu, on the basis of ground reality, the information relate with the Remote sensing and GIS techniques were applied, NDVI analysis throughout the period of initial and final sowing period which were from 15 June to 19 of July, in accordance with the official calendar which were published on Sindh Agriculture website. NDVI were classified in six (6) classes to identify the rice crop which were marked by surveyed locations. Data were sort through the NDVI values 0.1 to 0.5 ranges as sparse vegetation which wasconsidered as rice,in the months of June and July.

As seen in map (FIGURE.2) above the south-eastern part of the study area was more rice cultivation practice took placed. In the month of June rice cultivation activity is high (Figure.2).

Figure 2

Rice Crop in June of Study area



The map showing the rice crop in the month of July which is probably some extent of rice has cultivated in July (FIGURE.3).

Figure 3

Rice crop in July of the study

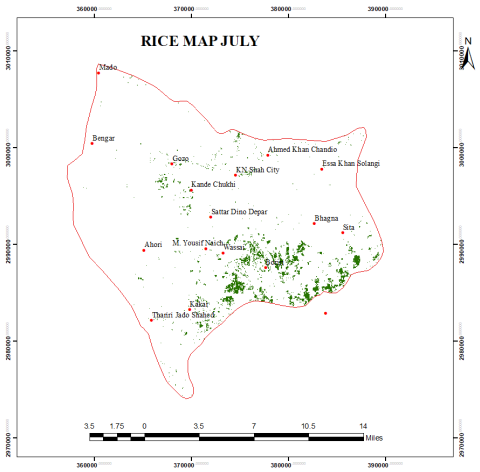


Figure 4

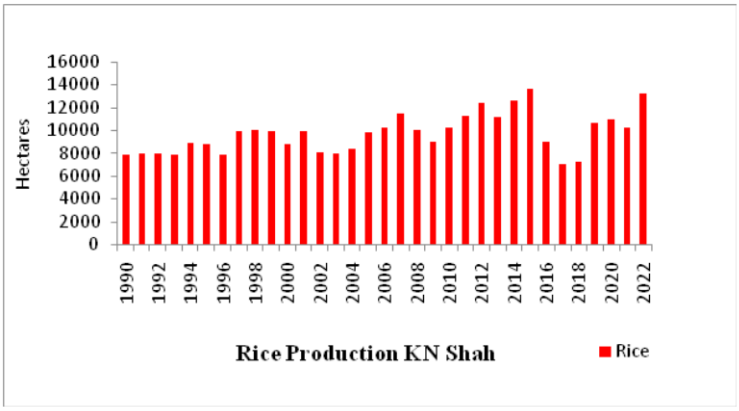


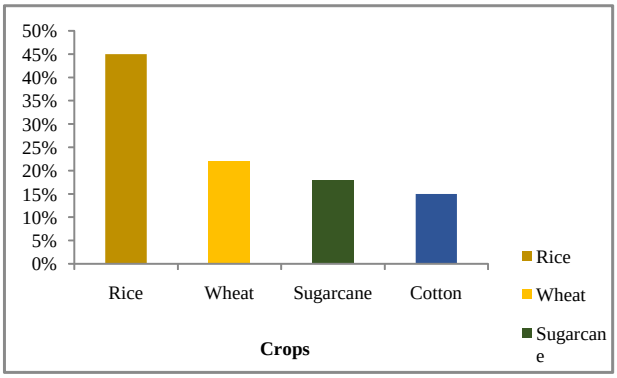
Figure.4 RICE CROP IN FROM 1990 TO 2022 OF STUDY AREA

From the 1990 to 2022 the rice data reveals that the fluctuation. However, most of the years have increase gradually, the reflecting the influence of climatic conditions and irrigation availability,. From 1990 to 1995 Rice production of the rice remainsmoderately stable, which ranges approximately 7,500 to 8,500 hectares, and this period indicates normal rice conditions.From 1996 to 2001 A gradual increases is observed, with production reaching around 9,500–10,000 hectares. This rise may be attributed to improved irrigation supply, favorable monsoon rainfall, and expansion of cultivated area. From the year of2002 to 2004 somedecline occurred in rice,where production nearly to 8,000 hectares, which was possibly due to flood disturbances, water logging, or climatic variability in the study area, And from the year of 2005 to 2015shows. a noteworthy upward trend in rice production peaking up to 13,500 to 14,000 hectares around, while from the year of 2014 to 2015. Increase in the ricesuggeststhatenhanced flood-based soil fertility, better water availability and quality. From the year of 2016 to 2018Amajor declinewhich is noticeable, mostly around 2017 to 2018, where production of rice area dropped nearly 7,000 hectares.From the year of2019 to 2022Rice productionsimprovedstronglyand reached up toapproximately 13,000 hectares by 2022, which indicatingimprovement inrice cultivation practices, and adaptive strategies by farmers (Figure.4).

Wheat, Rice, Cotton and Sugarcane is major crops in KN shah but most prominent crop in this region as compare to high productive in other crops is rice. Due to water availability and favorable climatic conditions rice is major cultivated crop. This crop dominated and making largest agriculture inputs in this region (FIGURE.5).

Figure 5

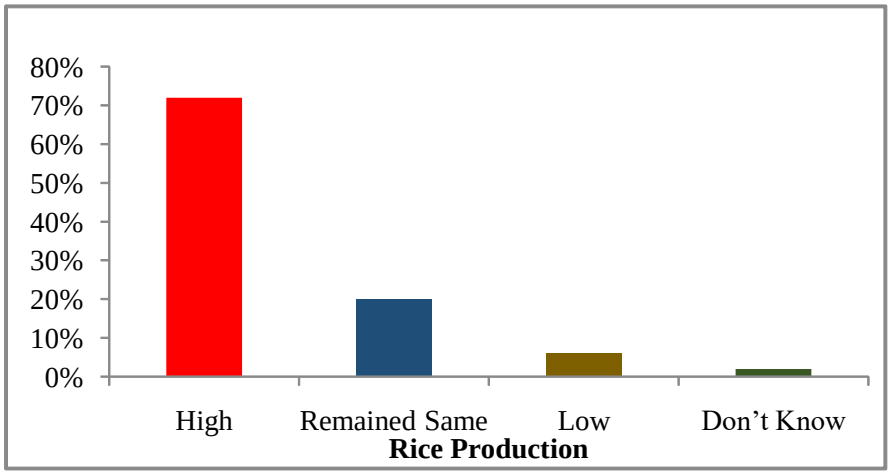
Major Crops of the study area



The question were asked from the interviewers most of the respondent have answered that production were high due to rainfall which gives an adequate water to rice and other crops that made it surplus and yield as compared to previously, some of them were respond that they have same production level, while other were as low and they don't know (FIGURE.6)

Figure 6

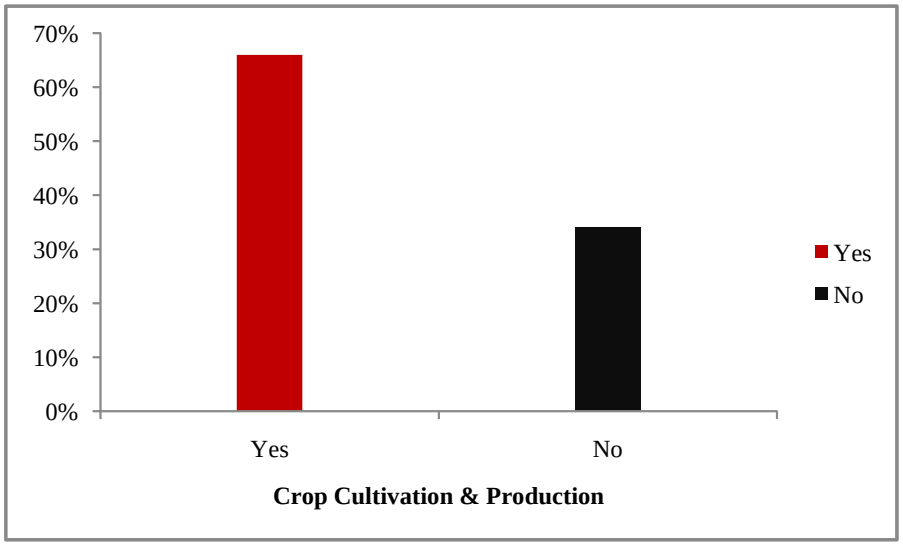
Production comparison the study area



During the field survey respondents were interviewed to understand their level of satisfaction with their practices and crop yields. The question aimed to assess whether farmers were satisfied with their current methods or if they feel they must need for improvement in cultivation techniques, irrigation, fertilizers, or crop varieties (FIGURE.7).

Figure 7

Crops cultivation and production of the study area



Conclusion

This study concluded that rice sowing and cultivation in Khairpur Nathan Shah Taluka of District Dadu has undergone significant temporal and spatial variations in 2022 and before due to climatic conditions and flood dynamics in recent decades. Rice is major cash crop in the KN Shah where fluctuations were observed throughout the study period and data were observed from the 1990 to 2022 and overall trend indicates a gradual increase in rice cultivation area that reflecting the adaptability of farmers and the study area's suitability for rice production.

The integration of Remote Sensing and GIS techniques, particularly in NDVI analysis has proved that the effective in identifying crop and mapping rice cultivation during sowing period from 15 June to 19 Jul. NDVI values ranging from 0.1 to 0.5 which has classified as sparse vegetation represented accurately and early-stage of rice crop and were validated through ground truth survey. For the Spatial analysis further revealed that the south-eastern part of the study area consistently supports higher rice cultivation that confirming the spatial variability in cropping practices within the taluka.

Higher rice production due to increase in rainfall and adequate water availability in the study area and is leading to improved yields compared to previous years.

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