

Forecasting of Banana Crop Productivity using Geospatial Approach: A Case Study of Anand District

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INTRODUCTION

- India is a well-diverse country with wide variety of agricultural products owing to its different climatic conditions.
- Banana ranks second amongst fruit consumption in India after mango due to its low price and high nutritive value.
- Anand is one of the important banana producing districts of Gujarat and contribute significantly in total banana production of the state.
- However, latest data of year 2022 shows that farmers are turning to other fruit crops because banana is a water-intensive crop and water levels across the state are declining.
- In addition to this, overall yield of banana is decreasing due to climate change and irregular precipitation and it is getting worse day by day.
- Accurate predictions of crop production are critical for developing effective strategies at the farm level.
- Availability of different type of spatial data makes it easy to carry out geospatial analysis and understand the impact of different ecological factors on the banana crop.
- This study utilized various parameters like Normalized Difference Water Index (NDWI), Land Surface Temperature (LST), Evapotranspiration (ET), Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), and Leaf Area Index (LAI) to forecast banana yield of Anand district.
- Modelling carried out using different techniques help in understanding the impact of various parameters on crop yield and generating the accurate models for the prediction.
- Therefore, this study attempts to utilize geospatial approach to forecast the banana crop yield of Anand district of Gujarat using mathematical modelling.

STUDY AREA

- Anand is primarily an agricultural district of Gujarat State of India (Figure 1).
- As per climatological data of nearest Indian Meteorological Department (IMD) Station at Ahmedabad the summers are generally hot and winters are cool.
- Mean maximum temperature ranges between 28.4°C during January to about 41.8°C during May and the mean minimum temperatures vary between 11.7°C during January and 27°C during June.
- Long-term average annual rainfall for Ahmedabad IMD station is 799.6 mm.
- Most of the rainfall is received during south-west monsoon between June and September (Yadav, 2013).
- Banana is one of the key crops grown in the district in terms of its value.
- The planting season of banana varies between Mid-February to first week of March.
- More than 10,000 Ha land is under banana cultivation and since it is an annual crop and needs more investment, even scale of finance for banana cultivation is reasonably high.

MAP OF THE STUDY AREA

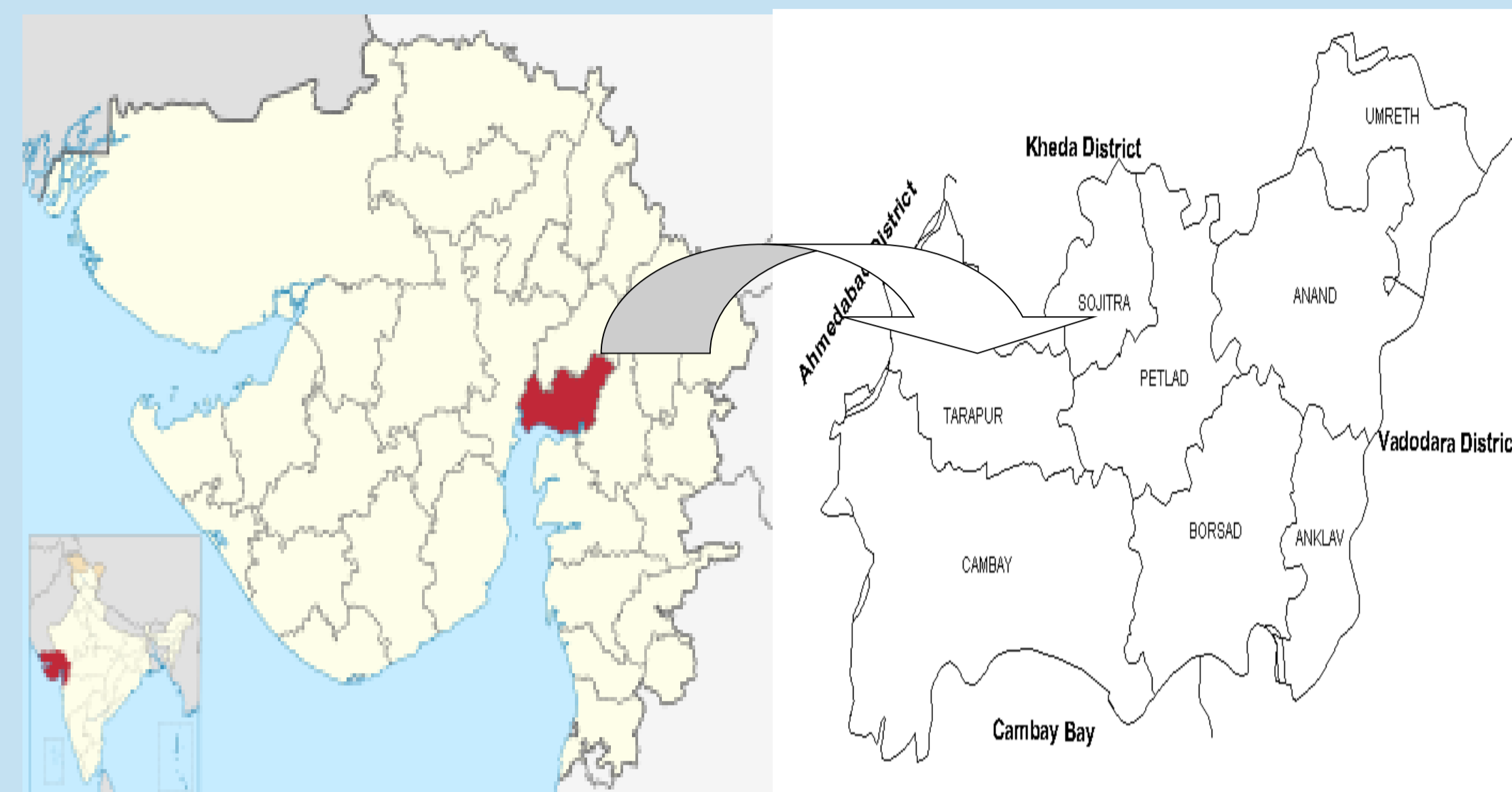


Figure 1

METHODOLOGY

- Banana crop yield forecasting needs different parameters to be assessed to understand their impact on yield.
- Field study was carried out in Anand district to locate banana fields and Ground Control Points (GCP) were collected.
- Total 11 different fields were identified which covered the different parts of the district.
- Sentinel 2 data was utilized to derive various indices like NDVI, EVI and NDWI.
- LAI was derived from EVI using the following formula:
$$LAI = (3.618 * EVI - 0.118)$$
- LST was also derived using Landsat dataset after processing using ERDAS 9.1.
- ET data was also extracted from Landsat dataset. Daily values from January 2018 to December 2021 were averaged out monthly post which values were extracted corresponding to GCPs using ENVI 5.1 software.
- Various statistical methods like regression, T-test, etc. were utilized to understand the impact of different parameters on yield of Banana and to forecast the yield.

RESULTS AND DISCUSSION

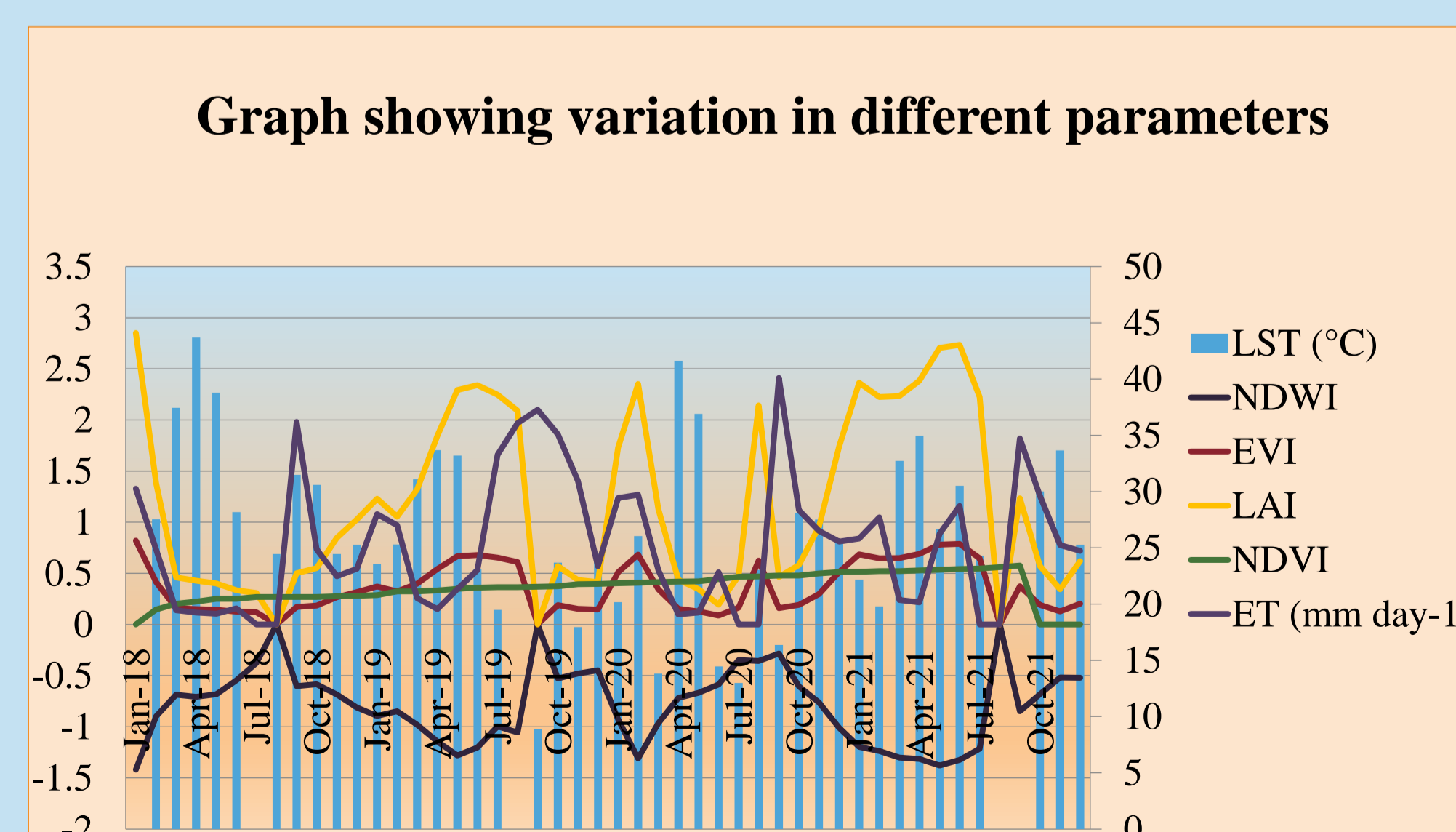


Figure 2: Graph showing variations in different parameters during the study period

RESULT AND DISCUSSION

- LST varied from 8 °C in winter to 43 °C in summer indicating the year round variations in temperature (Figure 2).
- NDWI was found to be varied from -1.41 to -0.28 indicating the variation in water regime of the agriculture fields.
- Low NDWI values were observed from January to June months corresponding to the dry season of the year.
- EVI varied from 0.09 to 0.82 during the study period. Correspondingly, LAI of the banana crop varied from 0.19 to 2.85 indicating the vigour of the crop. EVI and LAI were found to be high during the months of February to July months of the year representing plantation period of the banana crop.
- NDVI values were found to be varied from 0.14 to 0.58, wherein high values indicated the growing season of banana crop.
- ET varied from 0.1 to 2.41 mm day⁻¹ revealing its seasonal variation. It showed higher values during monsoon season indicating its role in crop growth.
- The regression analysis between different parameters revealed an interesting result. It was clear from the analysis that since R² was only 0.02, therefore LAI was not dependent on LST indicating that the temperature variations were having less impact on crop growth.
- The ET and LAI were also poorly related with each other with R² value as low as 0.01.
- However, the crop was dependent on NDVI as revealed by R² value of 0.64 when regressed with LAI.
- Regression analysis between NDWI and LAI showed that these two variables were highly dependent on each other with R² value as high as 0.76.
- This indicated that the growth of banana crop was highly influenced by NDWI and yield of the crop varied with varying values of NDWI. These results were also supported by T-test.
- Therefore, regression model derived using these two parameters were found to be significant for forecasting the banana yield (Figure 3).

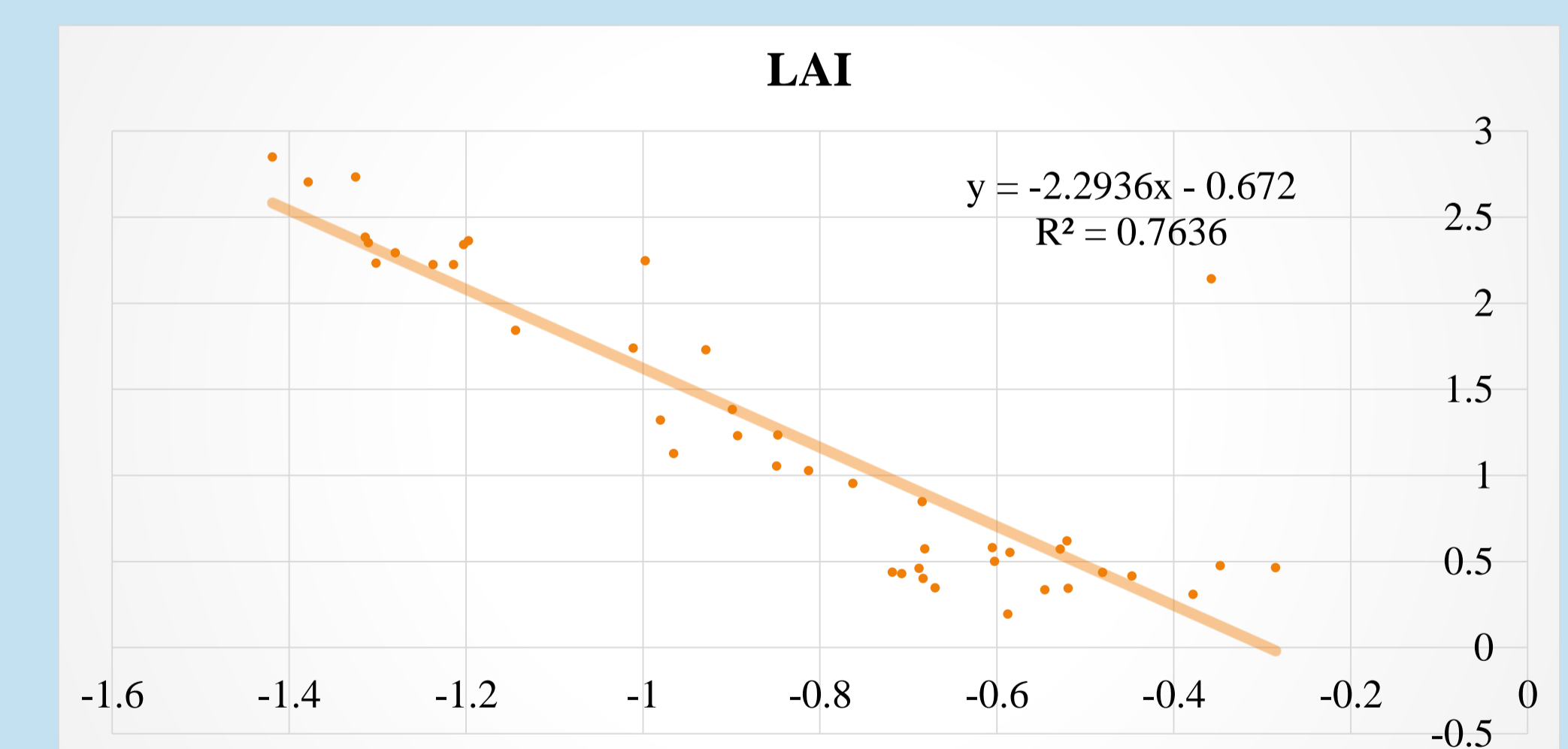


Figure 3: Chart showing regression equation for predicting Banana yield

CONCLUSION

Banana is a one of the most important fruit crop of India and at global level. Increased water stress due to unpredicted rainfall and competition for water resources is leading to reduced yield of the crop. This study attempted to generate banana crop productivity based on the various parameters derived using geospatial approach. Regression analysis revealed that banana crop is highly dependent on NDWI, i.e. ground water condition of the agriculture field as indicated by high R² values. Regression model derived using these parameters can be utilized to predict banana yield.