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Climate Responsive Land Governance and Disaster Resilience: Safeguarding Land Rights

Precision Agriculture in Nepal: Multiphase Evaluation of Wheat Genotypes Using Multispectral UAV Imageries

Binod Prasad Bhatta, Gorakh Nath Pandey, Mamta Kadel, Sadikshya Adhikari, Manoj Kumar Bhat, Sujan Sapkota, Shreejan Pokharel (Nepal), Shangharsha Thapa (Sweden),

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Introduction

- Rapid population growth and limited land resources are worsening food self-sufficiency challenges (UNFPA, 2017; Liu et al., 2023).
- Climate change, marked by shifting rainfall patterns and extreme weather events, is reducing crop yields (Malla, 2009; Qadir et al., 2019).
- Traditional farming methods often lack real-time data, leading to inefficient resource use and yield loss (Neupane & Baysal-Gurel, 2021), while modern technology adoption is key for better yields.

Problem Statement

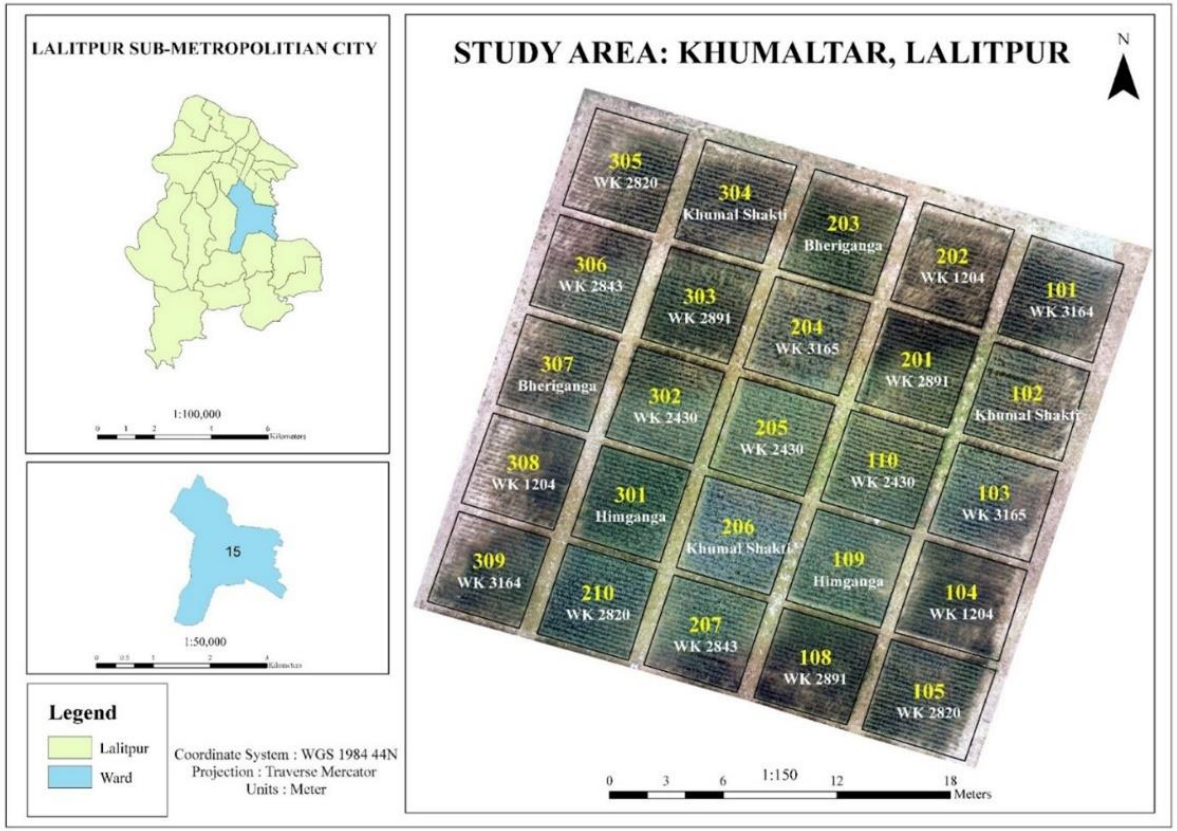
- The National Biotechnology Research Centre (NBRC) has received complaints about distributed wheat varieties being affected by diseases like stem rust, leaf rust etc. .
- Modern technology is yet to be used for evaluating the best-performing wheat varieties before their distribution to farmers.

Objective

The objective of the study was:

- To identify the best-performing genotypes among ten distinct wheat varieties using UAV-derived vegetation indices, chlorophyll content measurements, plant height and grain yield data.

Study Area


LALITPUR SUB-METROPOLITIAN CITY
1:100,000
15
1:50,000
Legend
Lalitpur
Ward
Coordinate System : WGS 1984 44N
Projection : Traverse Mercator
Units : Meter
STUDY AREA: KHUMALTAR, LALITPUR
N
305 WK 2820
304 Khumal Shakti
203 Bheriganga
202 WK 1204
101 WK 3164
306 WK 2843
303 WK 2891
204 WK 3165
201 WK 2891
102 Khumal Shakti
307 Bheriganga
302 WK 2430
205 WK 2430
110 WK 2430
103 WK 3165
308 WK 1204
301 Himganga
206 Khumal Shakti
109 Himganga
104 WK 1204
309 WK 3164
210 WK 2820
207 WK 2843
108 WK 2891
105 WK 2820
0 3 6 1:150 12 18 Meters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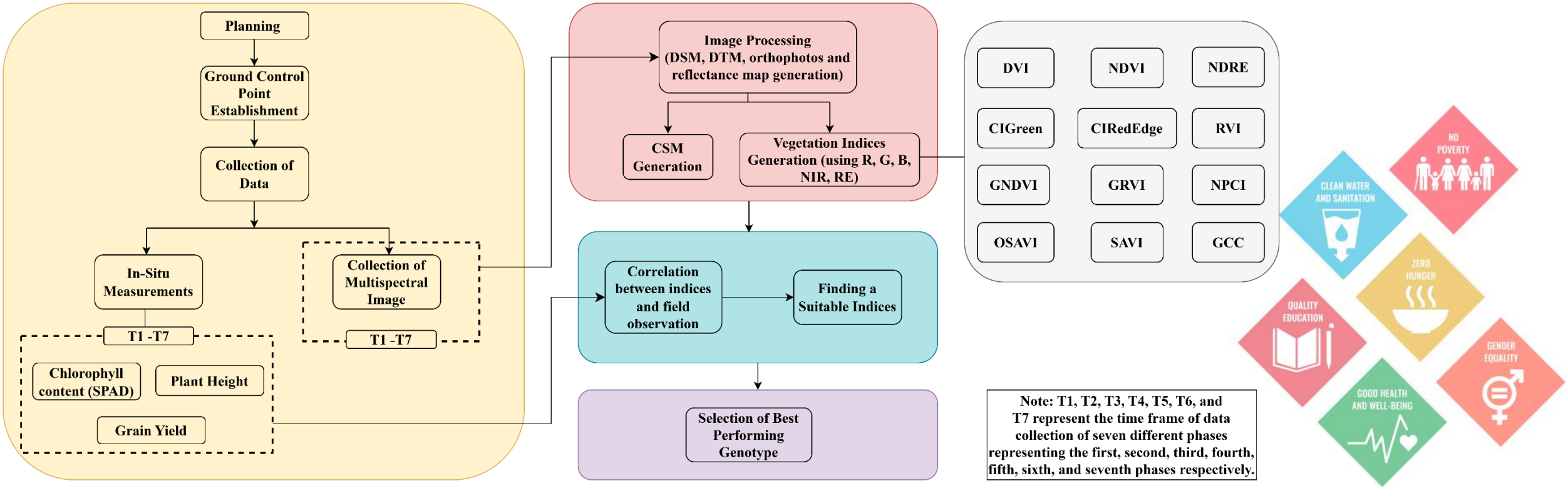
Methodology

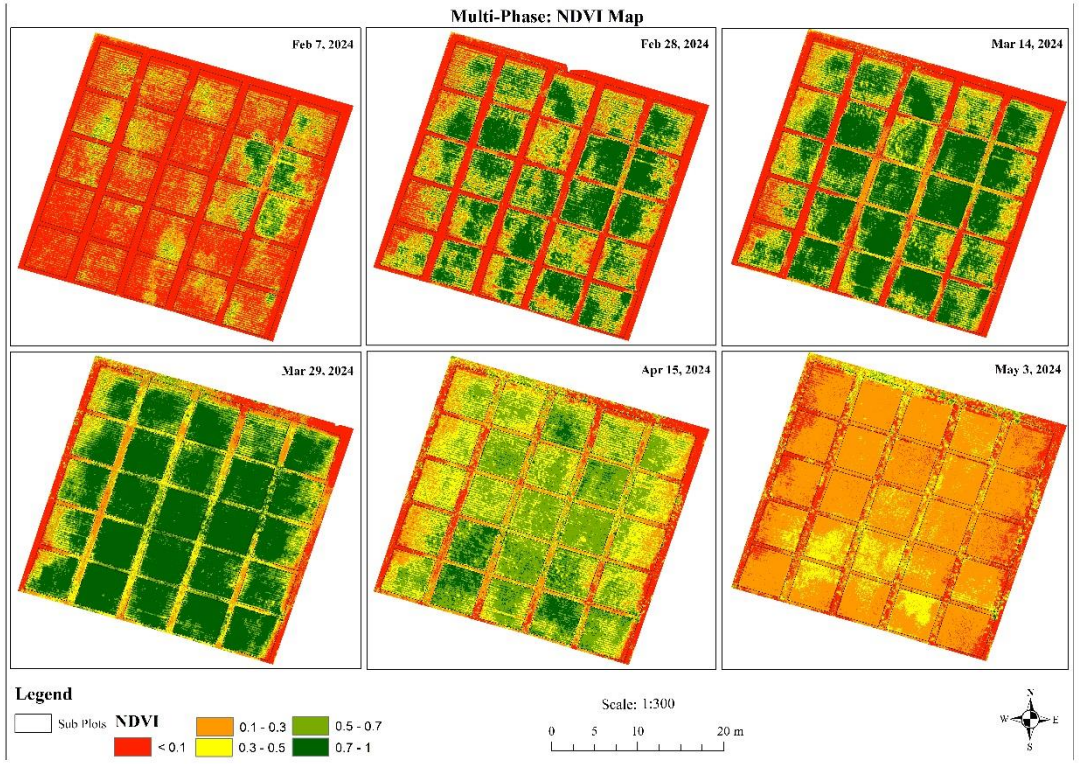


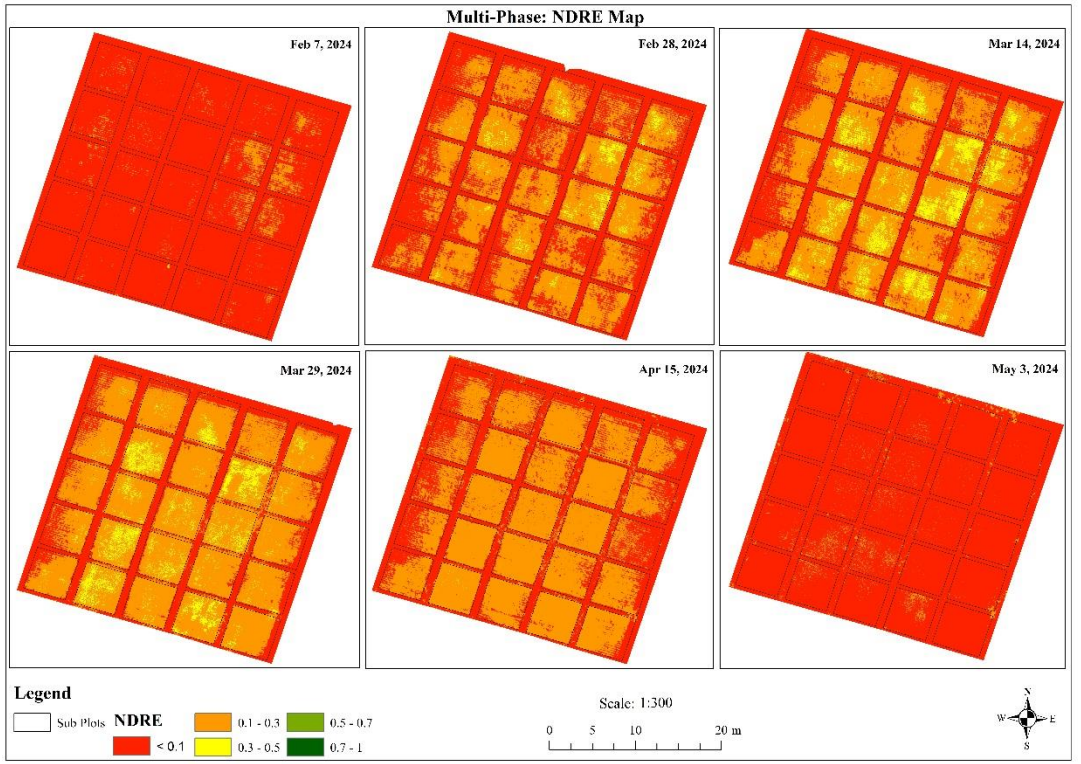
Note: T1, T2, T3, T4, T5, T6, and T7 represent the time frame of data collection of seven different phases representing the first, second, third, fourth, fifth, sixth, and seventh phases respectively.

Results

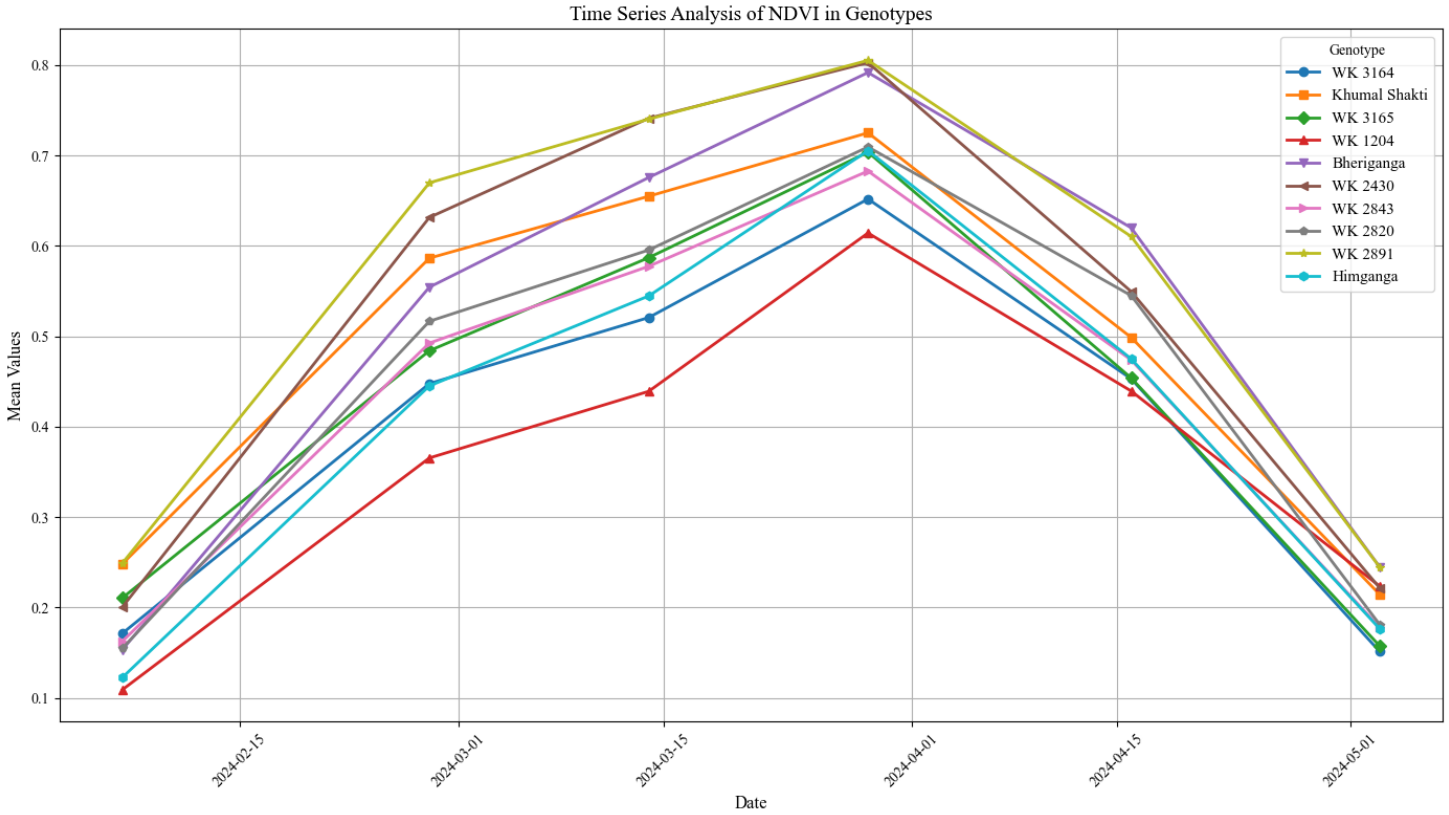
- Vegetation Indices Map (NDVI and NDRE)
- Time Series Analysis of NDVI and NDRE throughout the lifecycle of crop
- Relationship of VI's with SPAD (Chlorophyll Content)
- Relationship of NDVI and NDRE with the grain yield
- Growth Monitoring through Crop Surface Model

Vegetation Indices Map (NDVI and NDRE)

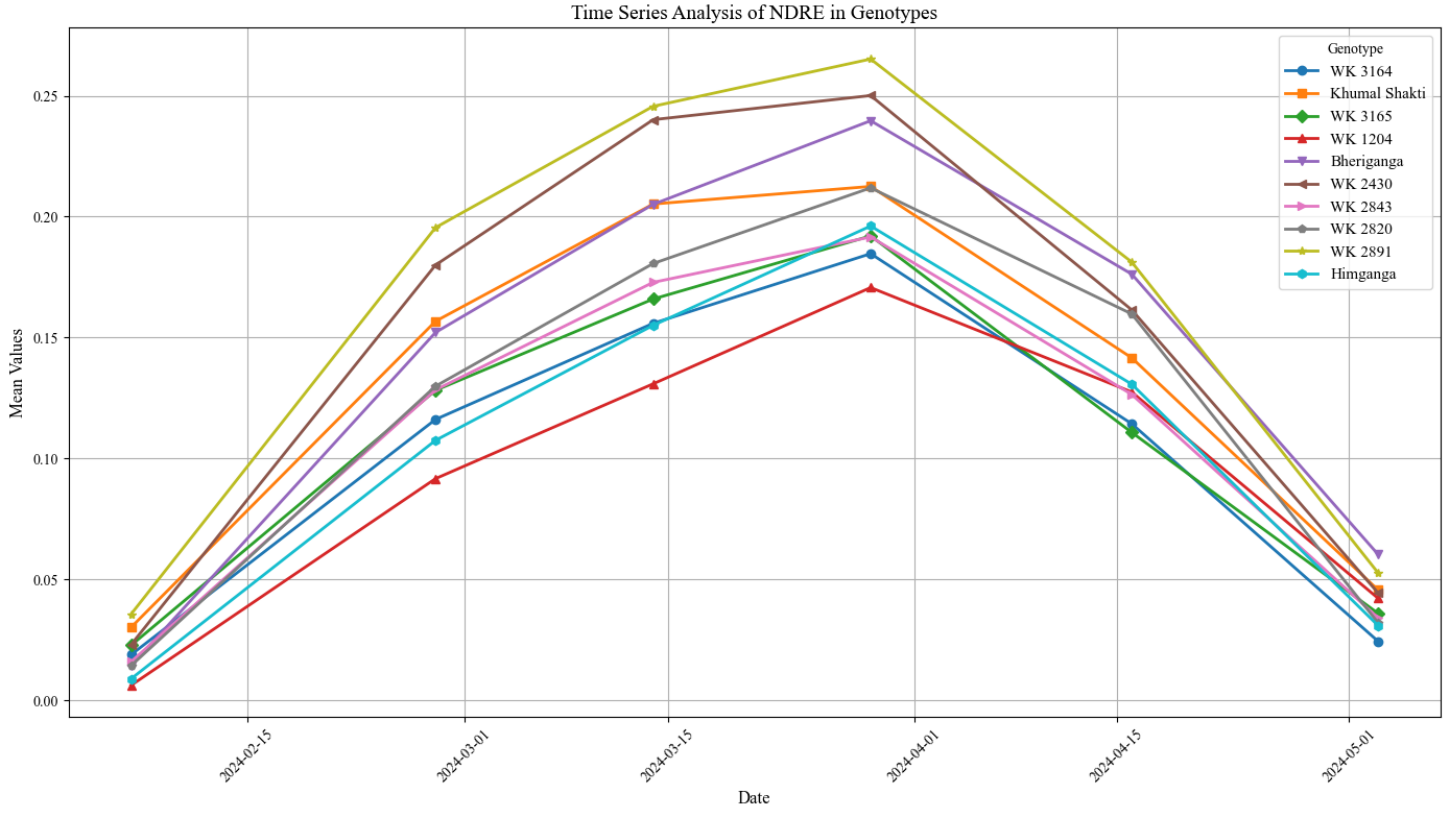




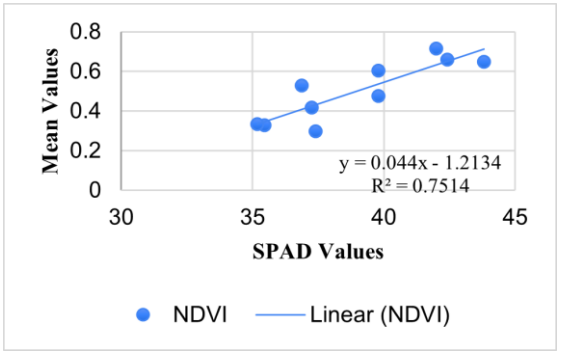
Time Series Analysis of NDVI Throuought the Lifefcycle of the crop

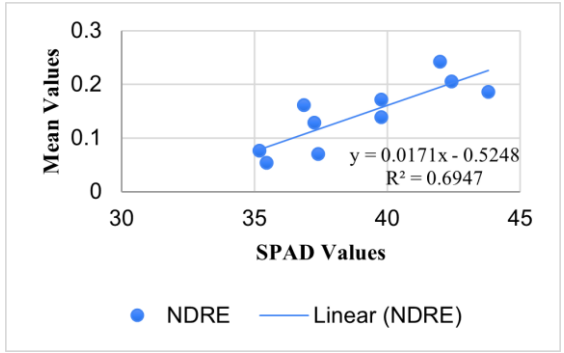


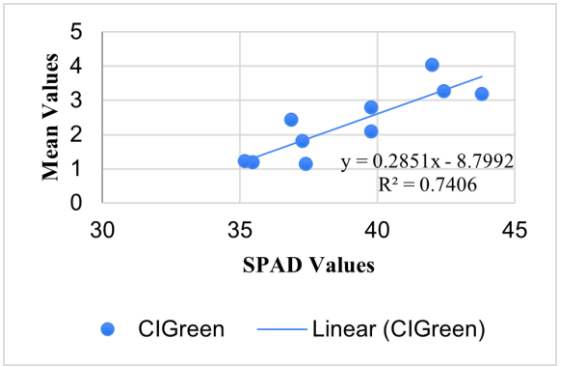
Time Series Analysis of NDRE Throuought the Lifefcycle of the crop

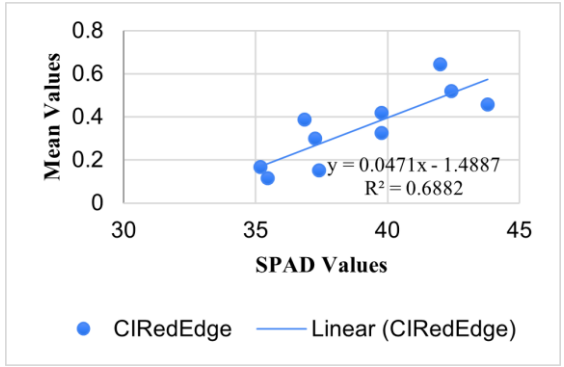


Relationship of VI's with SPAD (Chlorophyll Content)

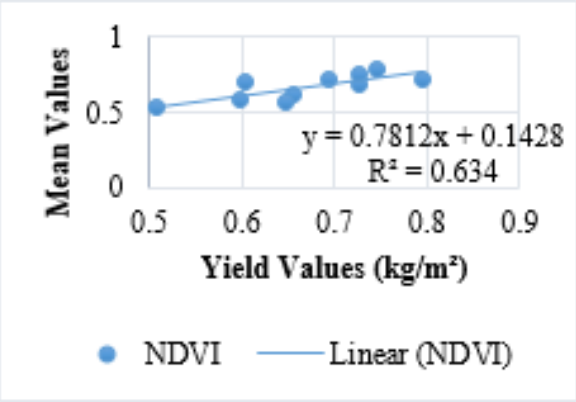


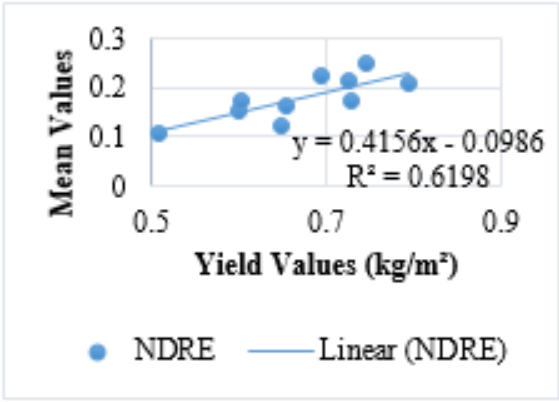




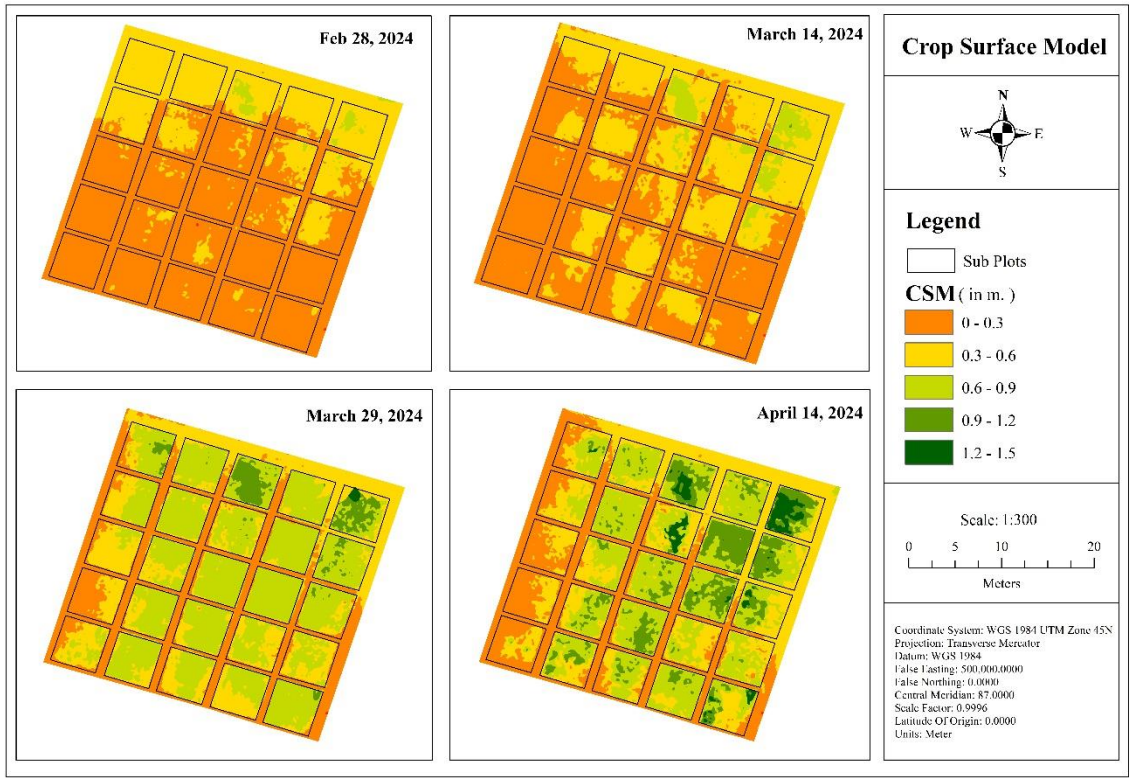


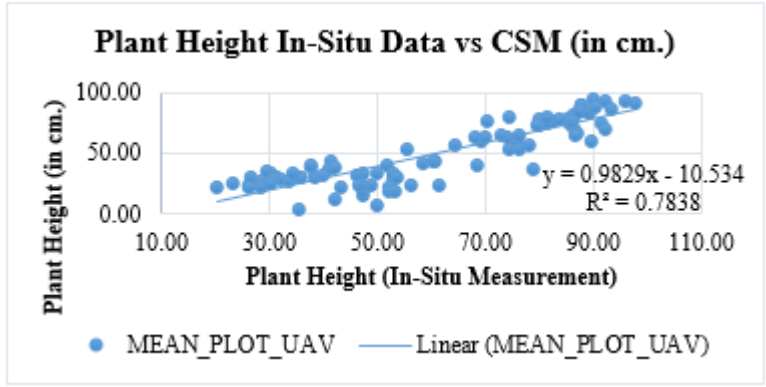
Relationship of NDVI and NDRE with Grain Yield





Crop Surface Model





Conclusion

- Strong correlations of the vegetation indices (NDVI an NDRE) with SPAD readings and grain yields, along with strong correlation of plant height with CSM shows that Multispectral UAV imageries are a valuable tool for monitoring crop health.
- **WK 2891 and WK 2430** were best performing genotypes meanwhile **Himganga and WK 1204** had the lowest performing genotypes.

Limitations and Recommendations

Limitations

- While we conducted a multi-temporal analysis, we couldn't collect data at specific intervals that align with key phenological stages of wheat.
- Data collection was often hindered by less optimal weather conditions.

Recommendations

- Strong Ensure data collection aligns with key wheat growth stages, especially early vegetative and reproductive stages.
- Schedule UAV flights on clear, calm days at noon for optimal sun angle and image quality.

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