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Estimating Leaf Area Index of Wheat using UAV-Hyperspectral Remote Sensing and Machine Learning

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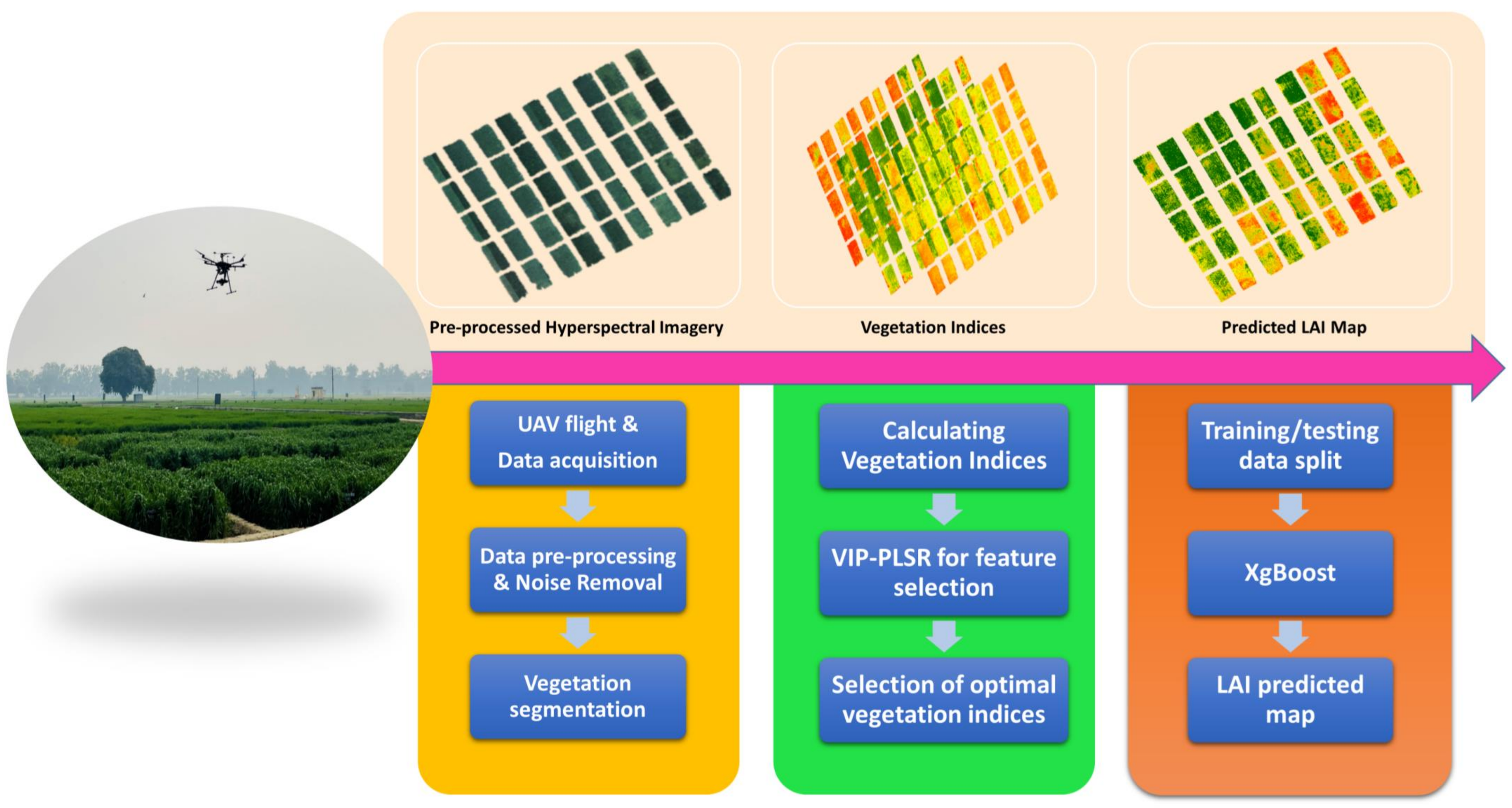
INTRODUCTION & AIM

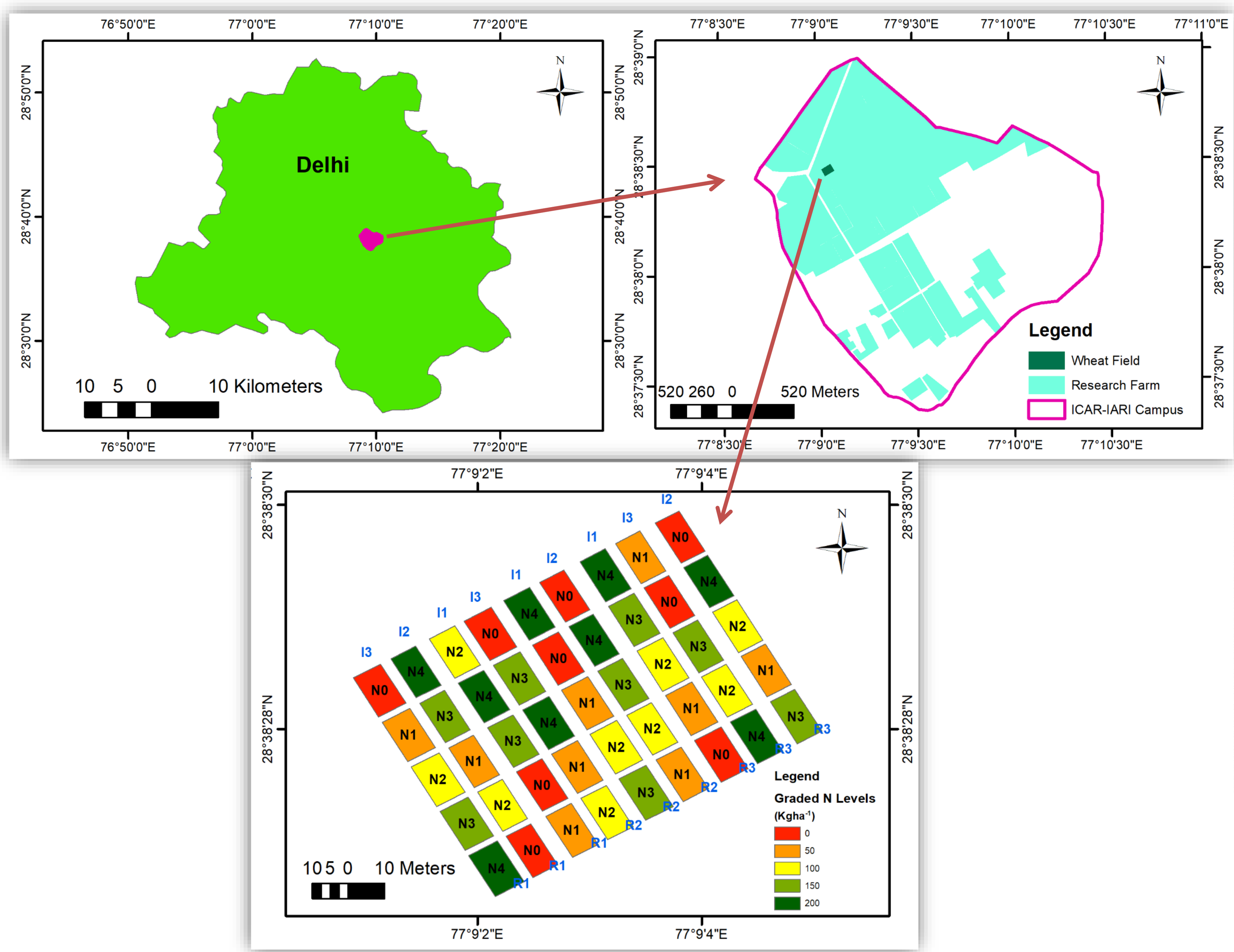
Hyperspectral remote sensing using Unmanned Aerial Vehicles (UAVs) provides accurate, near real-time, and large-scale spatial estimation of the Leaf area index (LAI), a very important crop variable used for monitoring crop growth. The objective of the present study is to estimate wheat LAI using high-resolution UAV-borne hyperspectral data with a spectral range of 400-1000nm and a spatial resolution of 4cm.

METHOD

A total of twenty-seven hyperspectral vegetation indices were computed. The PLS (Partial Least Squares) regression combined with the VIP (Variable Importance in the Projection) scores were used for selecting the optimum indices as feature vectors to the Extreme Gradient Boosting (Xgboost) model for predicting LAI.



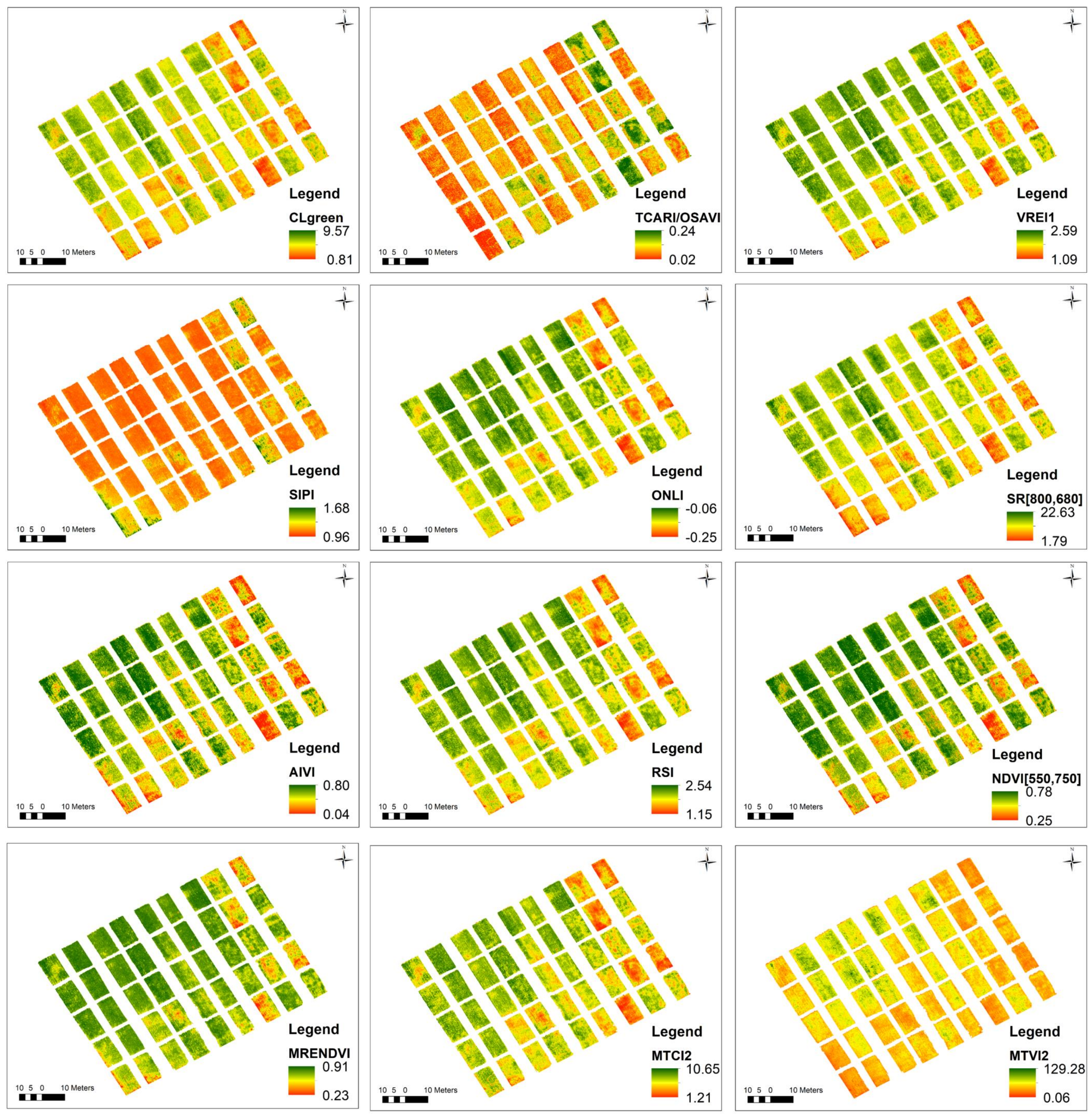
Workflow adopted for LAI mapping



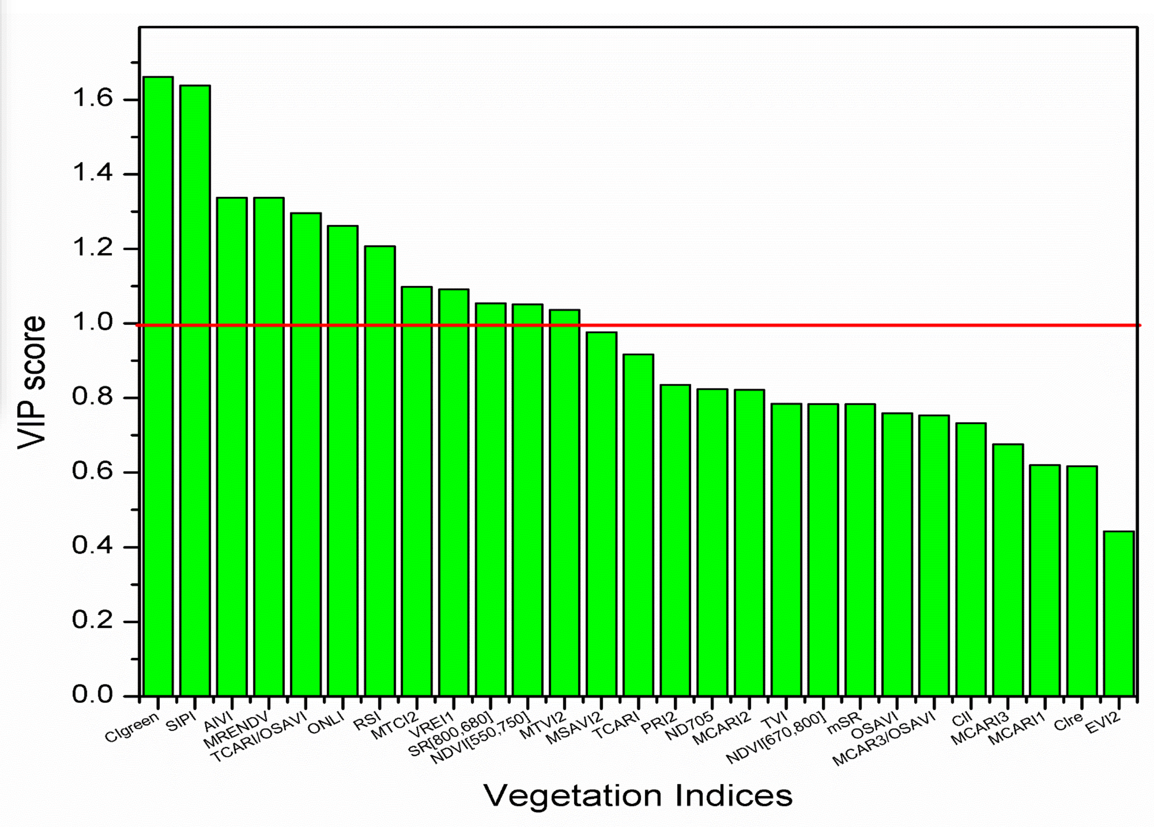
Study area location and Wheat experimentation

RESULTS & DISCUSSION

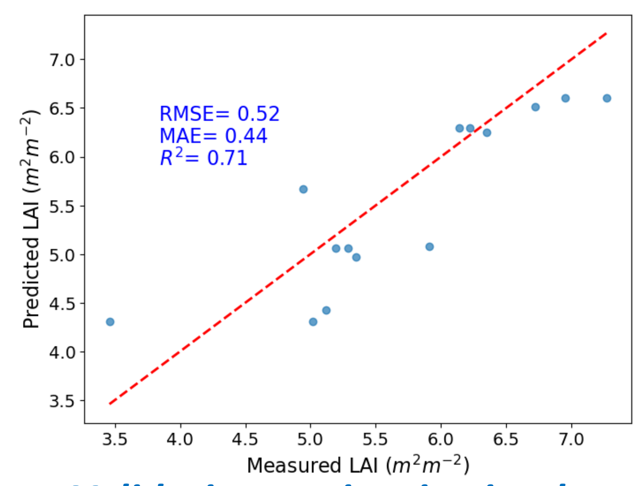
The twelve optimal vegetation indices with VIP scores above 1 were selected to develop the prediction model. On validated against the in-situ measured LAI values, the prediction model shows good accuracy with R^2 of 0.71, RMSE of 0.52, and MAE of 0.44. The model was used to generate a spatial map showing the variability of the LAI of wheat fields.



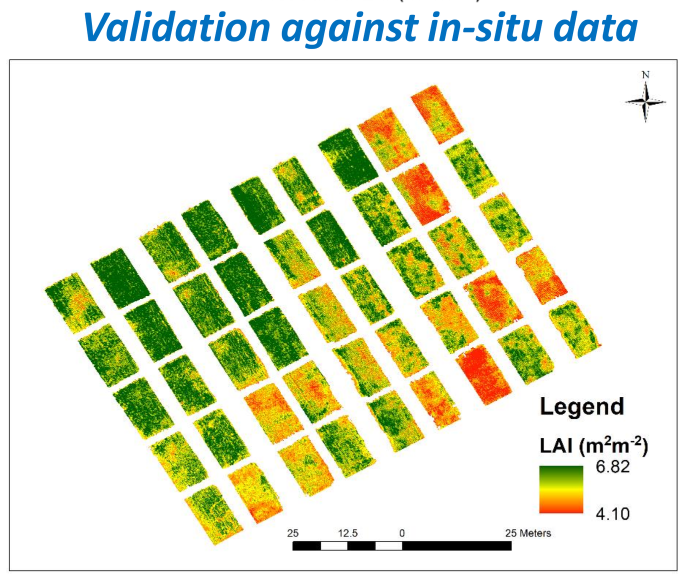
Maps of optimal vegetation indices obtained through VIP-PLSR



VIP scores obtained for optimal vegetation indices



Validation against in-situ data



Predicted LAI Map

CONCLUSION

Accurate mapping of LAI for wheat crops was achieved by integrating high-resolution UAV data and machine learning model. The results can be up-scaled to the farmers' s field for the operational delivery of LAI of crops to monitor crop growth and yielding prediction.

ACKNOWLEDGEMENT

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