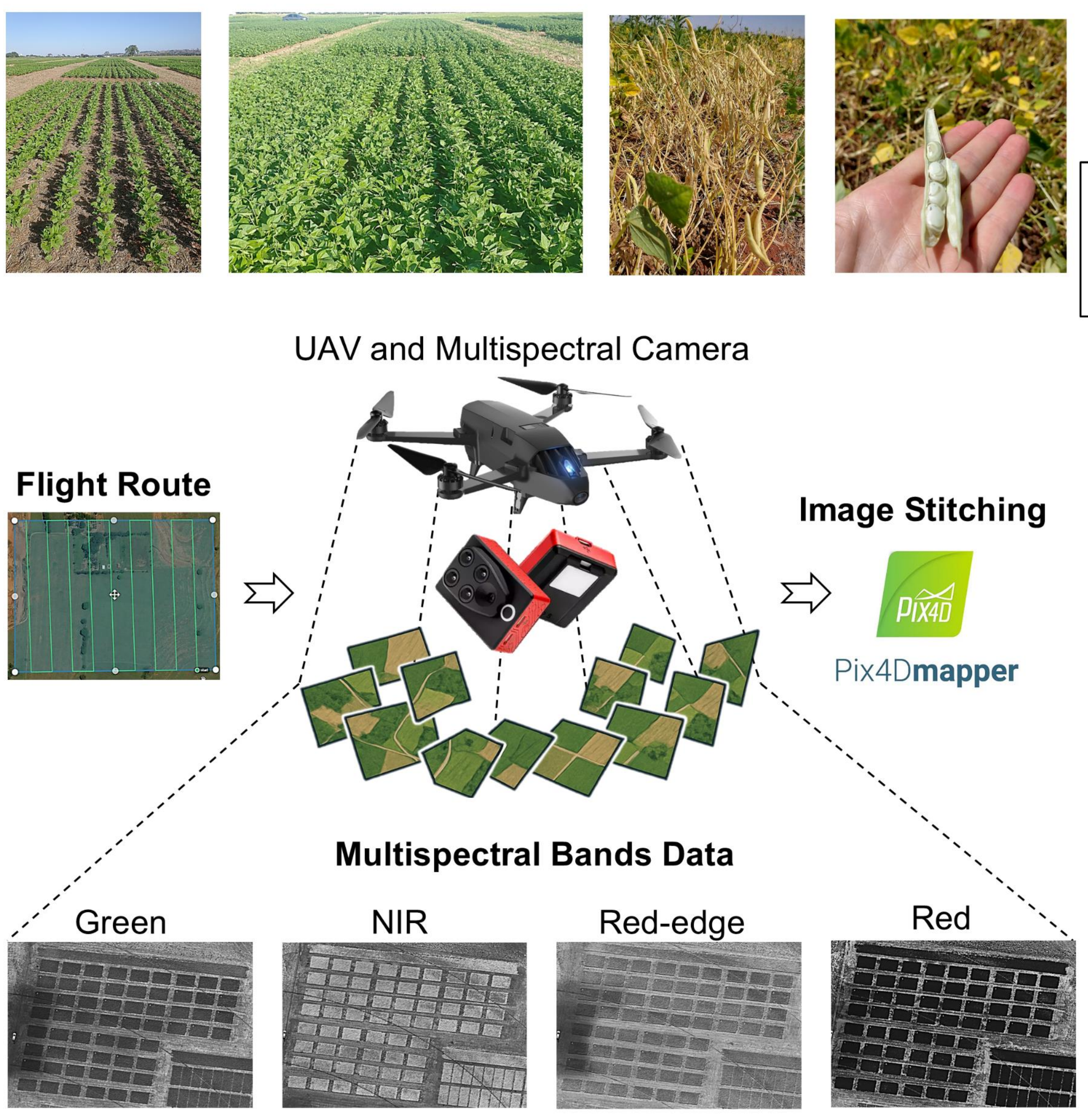
Optimizing nitrogen estimates in common bean canopies throughout key growth stages via spectral and textural data from unmanned aerial vehicle (UAV) multispectral imagery

Introduction

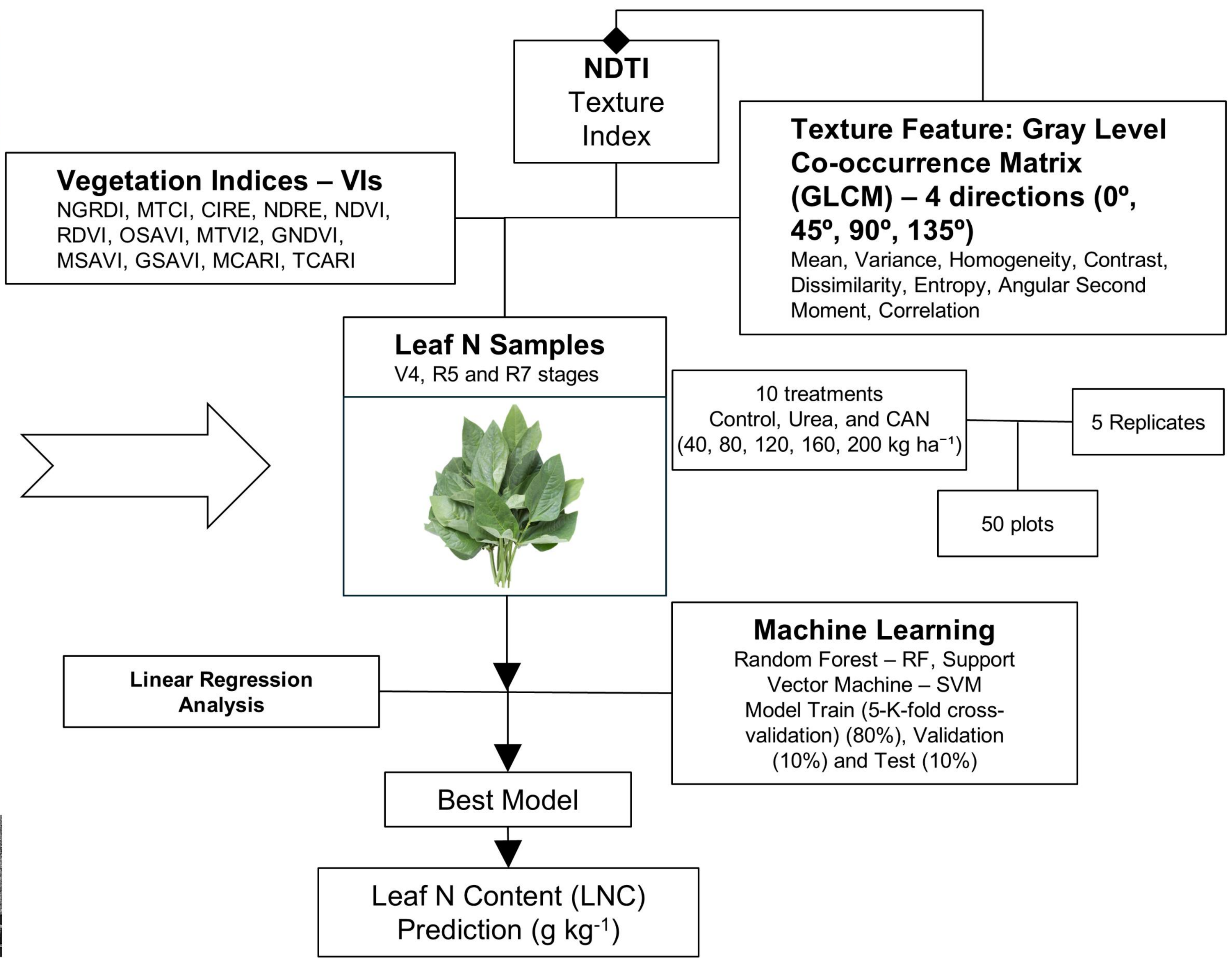
Methods

This study evaluates the integration of multispectral and texture data from UAV imagery to estimate leaf nitrogen content (LNC) in common bean across different growth stages.

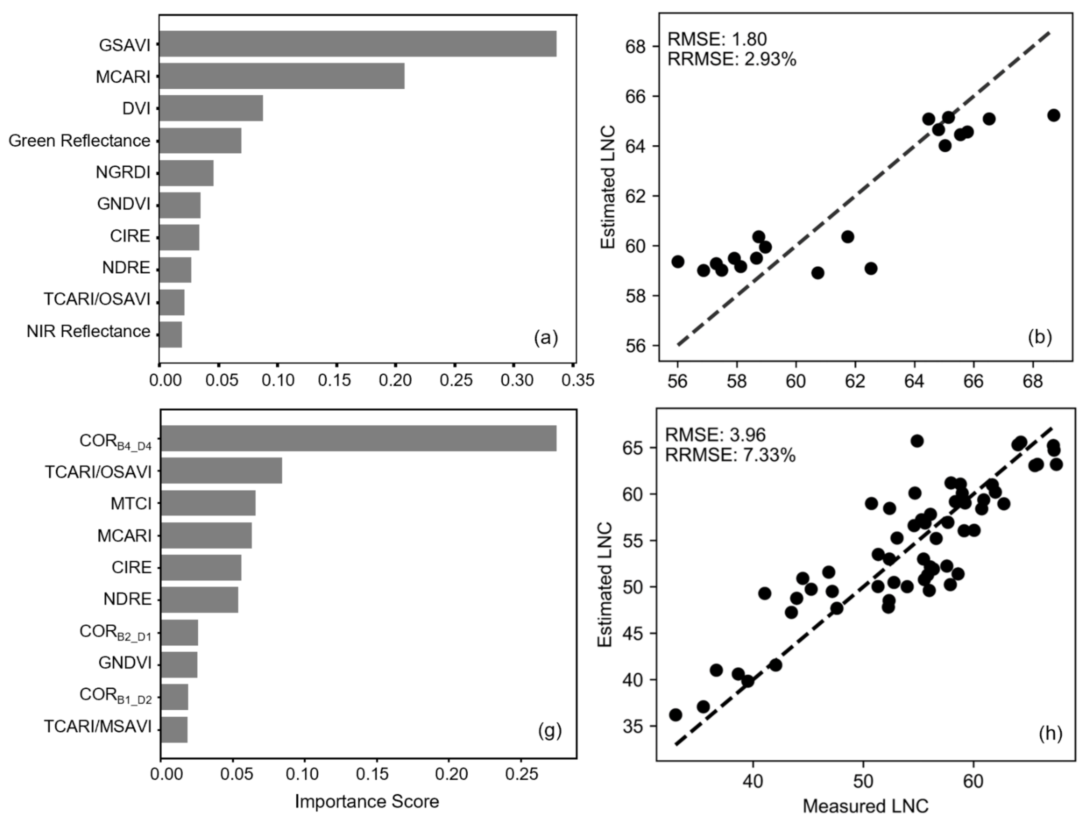
Data Collection and Pre-processing



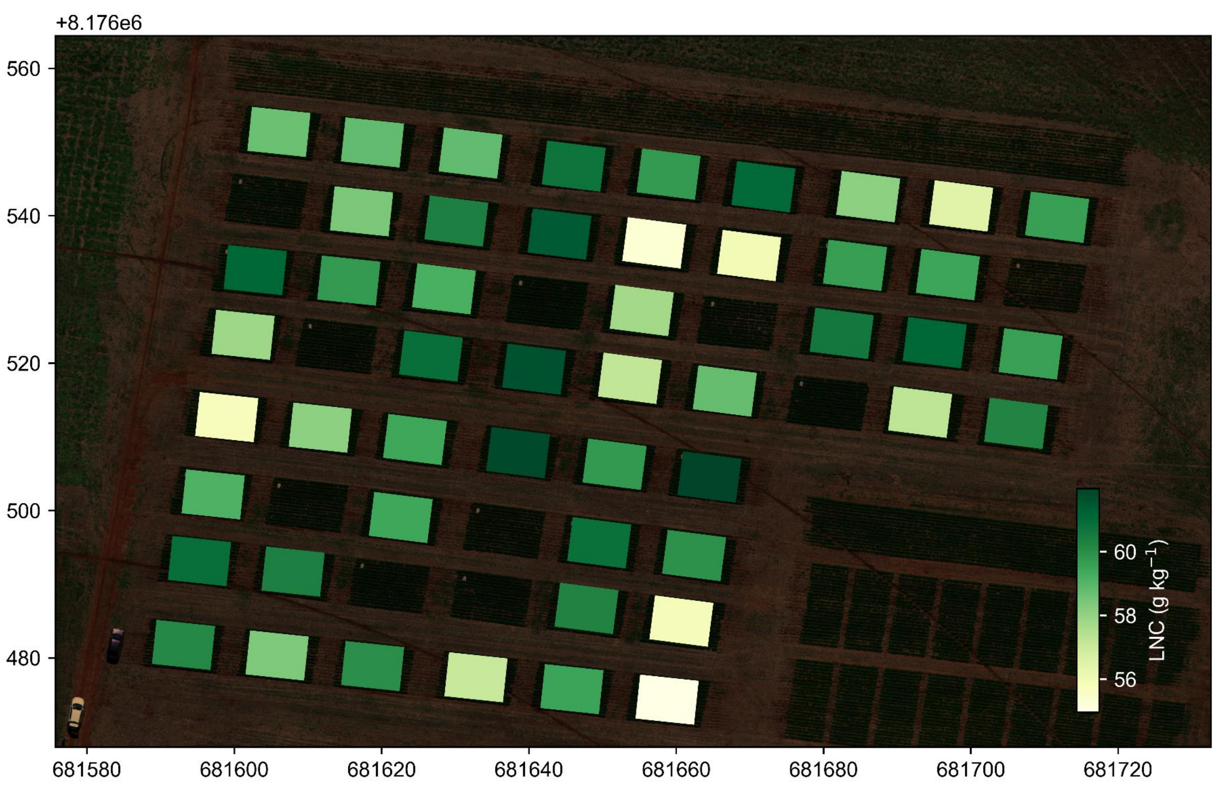
Model Construction



Results and discussion



Top ten features importance and the relationship between the leaf N content – LNC (g kg^{-1}) estimated vs. the LNC measured by VIs and texture metrics using (a, b) support vector machine (SVM) model at V4; and (g, h) random forest (RF) model over the three stages (entire season). The dashed lines indicate 1:1.



Prediction map over the 2021/2022 crop season indicating the leaf N content (LNC) related to every plot in the UAV-based image for the V4 common bean growth stage. The model used for inference was the support vector machine (SVM) and only the top 10 features.

Conclusion

- While individual metrics showed limited predictive power, the integration of data sources significantly enhanced estimation accuracy;
- Best model varies for each/entire stage;
- Our findings provide practical guidance for nitrogen management;
- Our models were developed using data from a single location over two seasons; thus, broader validation is needed across diverse environmental conditions and cultivars.

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REFERENCES

- Fu, Z., Yu, S., Zhang, J., Xi, H., Gao, Y., Lu, R., et al. (2022). Combining UAV multispectral imagery and ecological factors to estimate leaf nitrogen and grain protein content of wheat. European Journal of Agronomy. https://doi.org/10.1016/j.eja.2021.126405
- Zheng, H., Ma, J., Zhou, M., Li, D., Yao, X., Cao, W., et al. (2020). Enhancing the nitrogen signals of rice canopies across critical growth stages through the integration of textural and spectral information from unmanned aerial vehicle (UAV) multispectral imagery. Remote Sensing. https://doi.org/10.3390/rs12060957

ACKNOWLEDGEMENTS

The authors thank the Coordination of Superior Level Staff Improvement of Brasil (CAPES, Finance Code 001), Embrapa Rice and Beans team for providing field support and the Federal University of Goiás/LAPIG/Pro-Vant for providing the aerial platforms and multispectral sensors.

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LATIN AMERICAN & CARIBBEAN
Soil Carbon Research Symposium

Rio de Janeiro, RJ, Brazil
June 25-28, 2025

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