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MDPI

An Evaluation of Machine Learning Algorithm Performance in Crop Recognition Using Remote Sensing: A Case Study in Southern Ukraine

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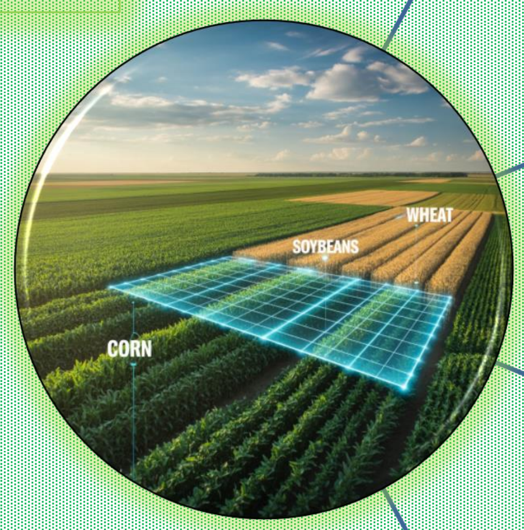
INTRODUCTION & AIM

Remote sensing-based crop recognition



Dynamic crop mapping
- perform near-real-time identification of crop types
- timely decision-making in agriculture

Land use monitoring
- track changes in land cover and farming practices
- develop sustainable land management strategies

Cropland structure analysis
- examine field patterns, sizes, and fragmentation
- reveal spatial drivers of agricultural productivity

Natural resources usage monitoring
- assess water and soil utilization efficiency
- ensure resource-saving farming practices

AIM

Remote sensing + Machine learning = **Automated crop recognition system**

METHOD

The study employed the **Normalized Difference Vegetation Index** (NDVI) derived from the **OneSoil** cloud-based crop monitoring platform to train and evaluate modern machine learning algorithms. Four major crops – **grain corn, wheat, sunflower, and soybean** – were considered, each represented under both irrigated and rainfed management, resulting in eight balanced classification classes. The **methodological workflow** of the study is illustrated **in the diagram below**.

NDVI and crop types data collection for the selected fields within the study area (Kherson & Mykolaiv regions, Southern Ukraine)

Retrieving NDVI values from OneSoil cloud platform (Sentinel-2 imagery)	Data generalization and calculation of average monthly NDVI values

↓

Preprocessing collected data

Augmentation	Normalization

↓

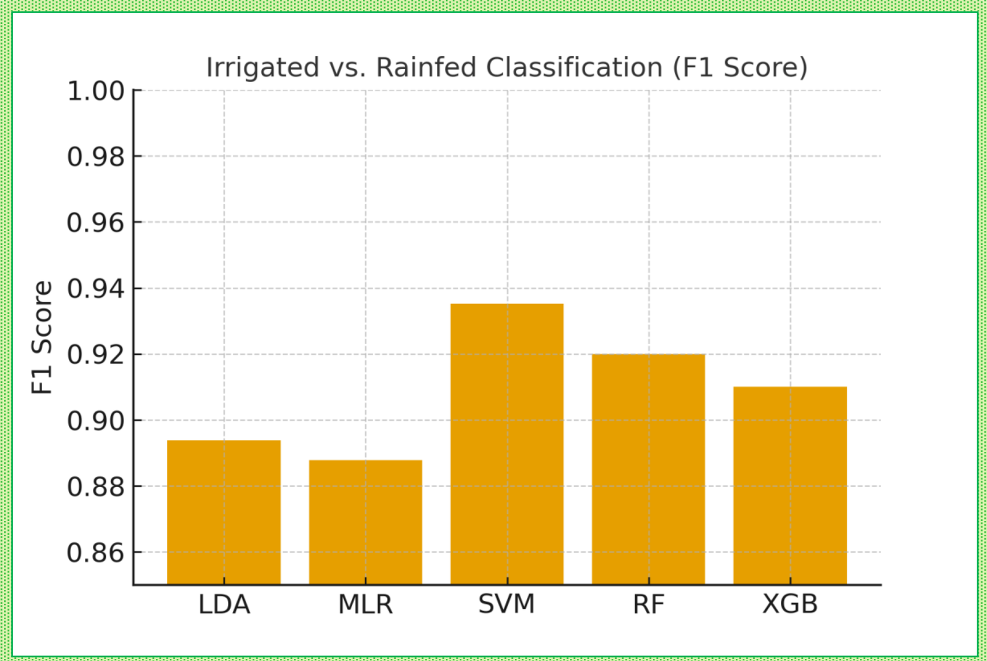
Machine learning implementation in Python 3 using LDA, MLR, SVM, RF and XGB algorithms for croplands classification

Irrigated vs. rainfed	Crop Types

↓

Statistical metrics evaluation, insights, general conclusions

RESULTS & DISCUSSION



Irrigated vs. Rainfed

All ML models performed well.

SVM highest F1 Score (0.9352).

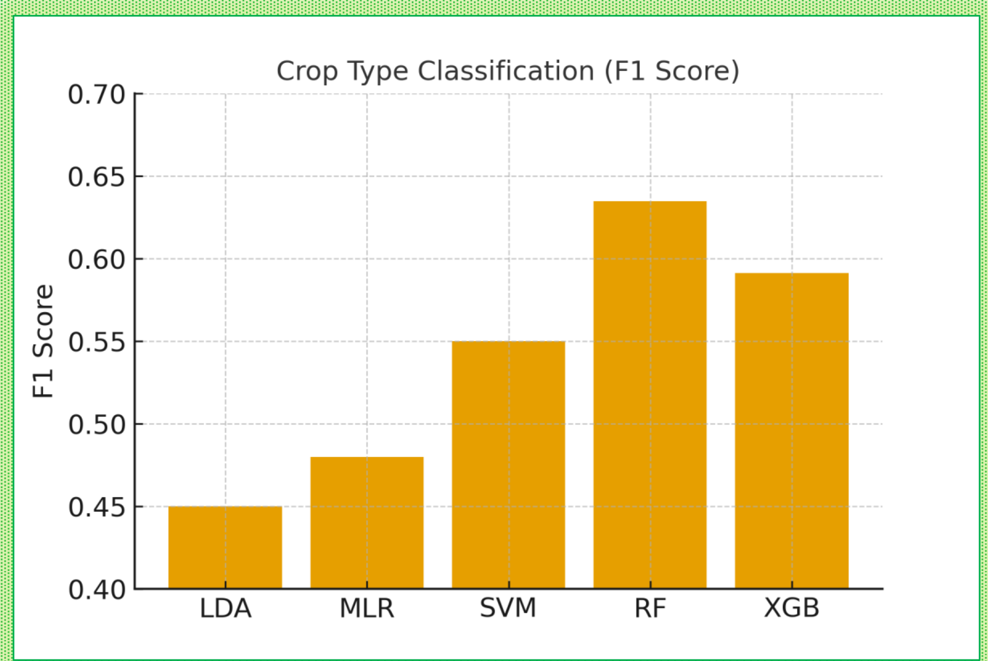
LDA & MLR lowest F1 Score (≈0.89).

Crop type recognition

Much harder (F1 < 0.60).

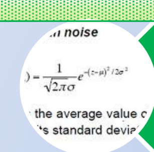
XGB best on original dataset (0.5911).

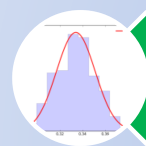
RF best on augmented (0.6346).



Data augmentation: Improved most models; shifted relative rankings.
Data normalization: No effects.

CONCLUSION


Gaussian noise augmentation is a promising enhancement


Data normalization has no benefits


SVM excels in distinguishing irrigated vs. rainfed fields


Crop type recognition remains challenging with monthly NDVI

FUTURE WORK / REFERENCES

Our future work will be directed mainly on:
- Increasing the size of datasets through wider geographical representation.
- Exploring higher temporal resolution NDVI and additional indices (EVI, NDMI).
- Investigating deep learning for crop type classification.
- Implementing the best models in practical software application for crop recognition.

Key References:

1. Lykhovyd, P., Vozhehova, R., Bidnyna, I., Shablia, O., Averchev, O., Avercheva, N., Kozyriev, V., Marchenko, T., Leliavska, L., Haydash, O., Hetman, M., & Piliarska, O. (2024). Supervised machine learning in crop recognition through remote sensing: A case study for Ukrainian croplands. Modern Phytomorphology, 18, 183–187.
2. Lykhovyd, P., Vozhehova, R., & Averchev, O. (2024). Using remote sensing normalised difference vegetation index to recognise irrigated croplands via Agroland Classifier application. Visnyk of V. N. Karazin Kharkiv National University, series "Geology. Geography. Ecology", (61), 223–233.