UAV-based disease and pest detection using AI: Time to reconsider our approach?

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1. INTRODUCTION

- Uncrewed Aerial Vehicles (UAVs) with RGB, multispectral, or hyperspectral sensors are widely used in agricultural research.
- Machine Learning (ML) and Deep Learning (DL) models are commonly applied to UAV imagery for automated disease or pest detection.
- Many **studies report high accuracies** for disease or pest detection, but their evaluation methods for model performance differ greatly.

Objective

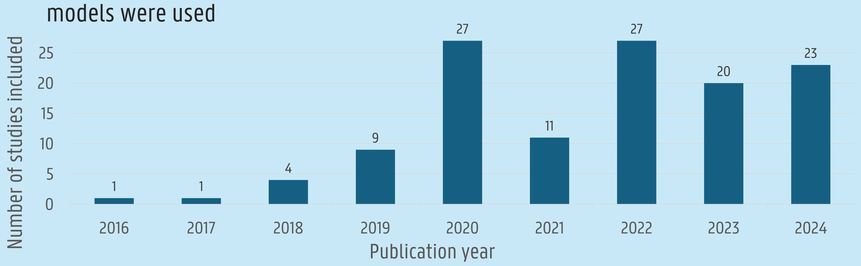
Systematic literature review of studies training ML/DL models on UAV data for disease or pest detection, with special focus on how datasets are split for model training and testing.

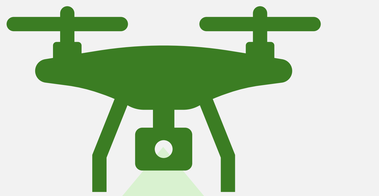
2. METHODS

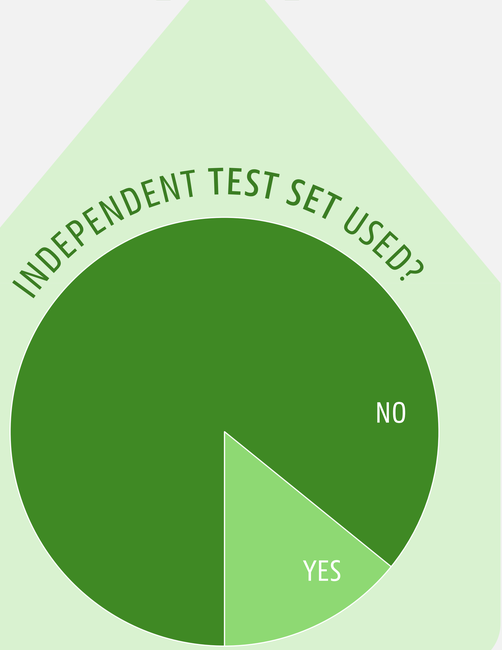
- Systematic review following the PRISMA protocol
- Web of Science search terms: drone or UAV AND "machine learning" or "deep learning" AND disease detection
- Studies included in review: 121
- Studies excluded: did not use UAV-mounted RGB, multi- or hyperspectral sensors; did not give sufficient info about model training or testing
- Review looked at: type of sensor, number of fields and number of flights (days), how the data were split into training and test set, which ML/DL models were used

What is an independent test set?
A dataset that the ML/DL model has not been trained on;
i.e., a dataset (field) that the model has not "seen" during the training stage.

The importance of untrained data
It tests whether a model will give good predictions on unseen, real-world data and helps detect overfitting on trial conditions.





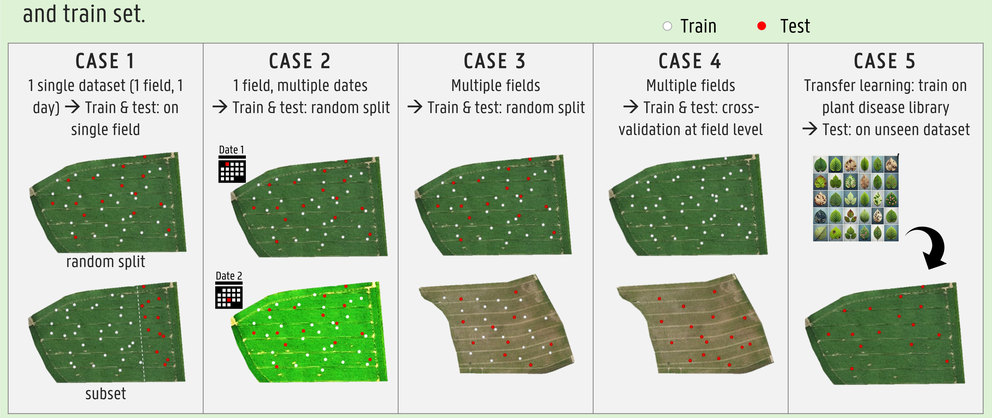


RECOMMENDATIONS

- Include independent datasets for model testing
- Make datasets publicly available
  ⟶ transfer learning on varied datasets
- Prioritise the use of independent test sets during the review process for publication

3. RESULTS

Studies were categorised in 5 cases, according to how dataset was constructed and split into test and train set.



No independent test set → Model is **not generalisable**
= cannot be applied by other researchers on a new dataset

Studies using a truly independent test set: 11 RGB & 5 multi/hyperspectral

- 46% of studies only used one single dataset (one field, one day) to train and test a model
- 70% of studies used one single field to collect data and train and test a model

→ Especially studies using multi- or hyperspectral sensors did not collect an independent dataset

- **86% of studies did not use an independent test set** for evaluation of the trained model
- **No studies tested whether the ML/DL model was disease- or pest-specific**

4. CONCLUSION

This review highlights a critical limitation in the robustness and generalisation capacity of current AI-approaches to crop disease and pest detection with UAVs.

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