Leveraging Vision Language Models for Specialized Agricultural Tasks

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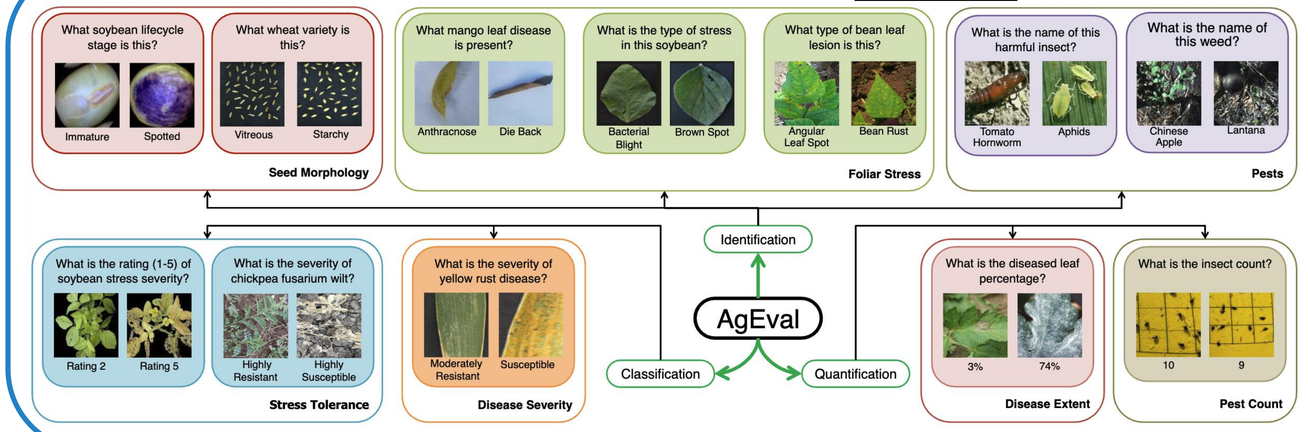
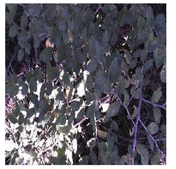
Introduction

- **Current Challenges:**
  - Each agricultural AI model requires thousands of expert-annotated images.
  - Expert annotation is expensive and creates development bottlenecks.
- **Evaluates state-of-the-art multimodal LLMs on plant stress phenotyping tasks.**
  - SOTA: GPT-4o, Claude 3.5 Sonnet, Gemini 1.5 Pro.
  - Budget Friendly: Claude 3 Haiku, and Gemini 1.5 Flash
- **12 diverse tasks:**
  - Diversity: Seed quality, foliar stress, pests, disease severity, and stress tolerance
  - Span: Identification, Classification and Quantification.

Benchmark





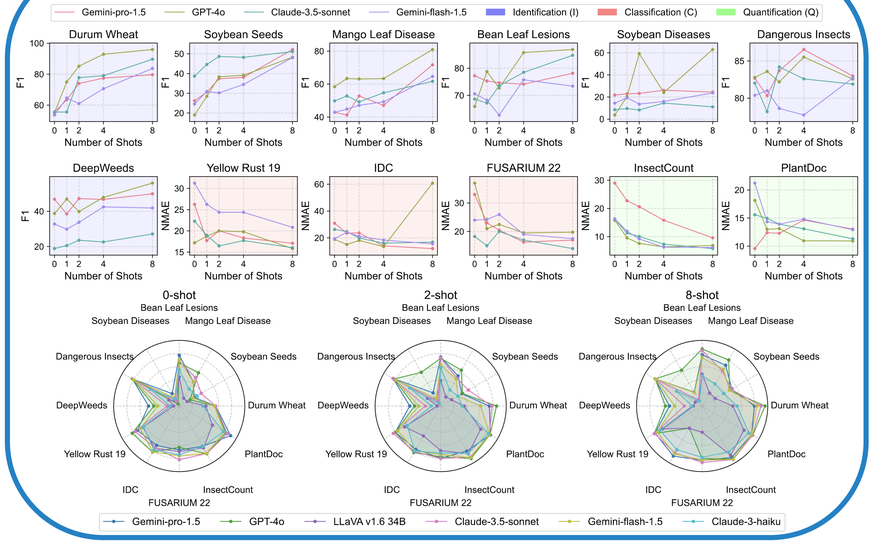
Category	Subcategory	Task
Identification (I)	Invasive Species	DeepWeeds

Ground Truth: Chinee apple

Predictions:

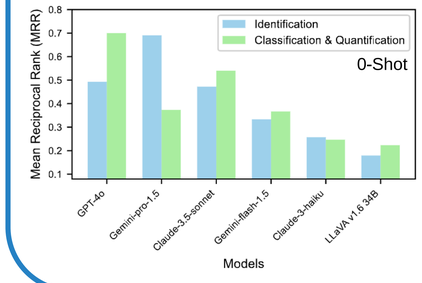
Model Name	0 shot	8 shot
Gemini-pro-1.5	Chinee apple	Chinee apple
GPT-4o	Chinee apple	Chinee apple
LLaVA v1.6 34B	Parthenium	Parkinsonia
Claude-3.5-sonnet	Lantana	Lantana
Gemini-flash-1.5	Prickly acacia	Chinee apple
Claude-3-haiku	Parthenium	Parthenium

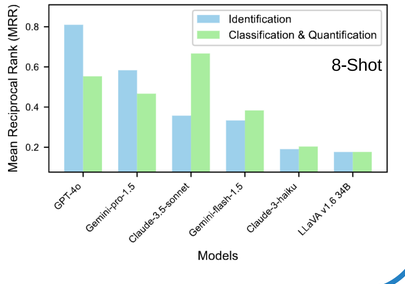
Analysis



Results

- Zero-Shot: Gemini-pro-1.5 leads in zero-shot identification (MRR 0.69), GPT-4o in classification/quantification (MRR 0.70).
- GPT-4o shows superior adaptability, with F1 score increasing from 46.24% to 73.37% in 8-shot identification.
- Bullseye examples (same category) improve F1 scores by 15.38% on average.
- Coefficient of Variation (CV) 26.02% (GPT-4o) to 58.03% (Claude-3-haiku). Subject matter expertise.





Conclusion

- Introduced comprehensive benchmark for agricultural multimodal LLM evaluation.
- Evaluated zero-shot and few-shot performance across diverse agricultural tasks.
- Analyzed example relevance impact and intra-task variability in LLMs.
- Established baselines for future research in agricultural AI applications.

Future work

- Expand scope of Benchmark.
- Increase shot counts for further analysis.
- Adapted Few Shot Learning for smart selection of input examples provided to Improve performance.