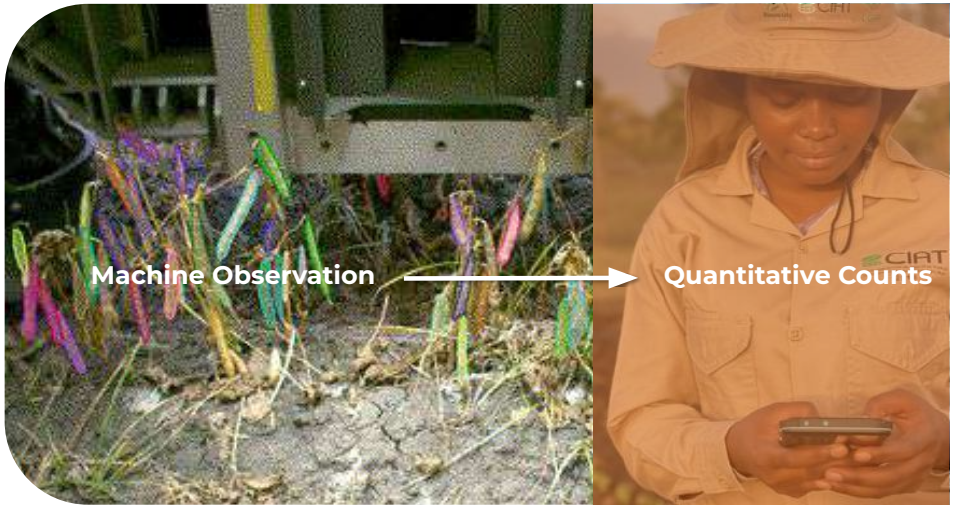
Digitization & Artificial Intelligence



Alliance Bioversity & CIAT

CGIAR

ARTEMIS

Gates Foundation

IITA Transforming African Agriculture

Colorado State University

LSE The London School of Economics and Political Science

in collaboration with

CIP International Potato Center

CIMMYT

Google Research

TARI

20%

OF WORLD'S CROPLAND SHOWS DECLINING PRODUCTIVITY DUE TO HUMAN-INDUCED DEGRADATION

DEGRADED SOILS EMIT SIGNIFICANT GREENHOUSE GASES, WORSENING CLIMATE CHANGE

70%

MORE FOOD NEEDED BY 2050, BUT EACH

1°C ↑ = 5% ↓

IN CROP PRODUCTIVITY

BBC Sign in Home News Sport Reel Worklife

NEWS

Home | War in Ukraine | Coronavirus | Climate | Video | World | US & Canada | UK | Business | Tech

Science

Faster pace of climate change is 'scary', former chief scientist says

Article | Open access | Published: 04 July 2023

Risks of synchronized low yields are underestimated in climate and crop model projections

Kai Kornhuber, Corey Lesk, Carl F. Schleussner, Jonas Jägermeyr, Peter Pfleiderer & Radley M. Horton

Nature Communications **14**, Article number: 3528 (2023) | Cite this article

60k Accesses | **24** Citations | **2485** Altmetric | Metrics

Article | Open access | Published: 22 January 2015

Climate variation explains a third of global crop yield variability

Deepak K. Ray, James S. Gerber, Graham K. MacDonald & Paul C. West

Nature Communications **6**, Article number: 5989 (2015) | Cite this article

79k Accesses | **1689** Citations | **161** Altmetric | Metrics

Article | Open access | Published: 02 July 2025

Climate change impacts on crop yields across temperature rise thresholds and climate zones

Bao-Linh Tran, Wei-Chun Tseng & Chi-Chung Chen

Scientific Reports **15**, Article number: 23424 (2025) | Cite this article

14k Accesses | **22** Citations | **25** Altmetric | Metrics

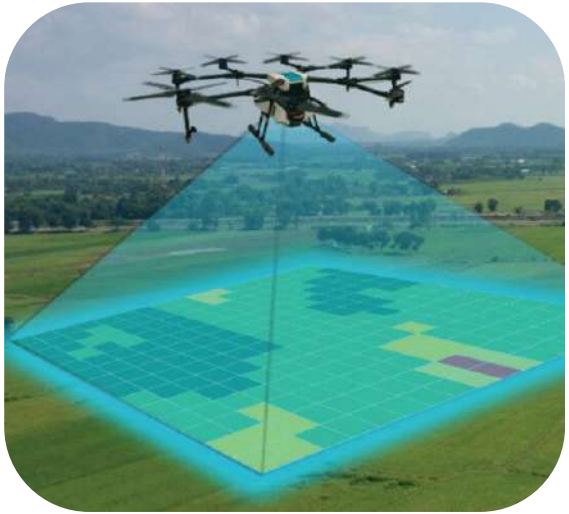
The results indicated that warmer temperatures are detrimental to crop yields across countries, with negative impacts exacerbated when temperature increase exceeds threshold values. For instance, for wheat, a 1 °C temperature increase would result in a 6.1% yield loss when the temperature rise is below 2.38 °C; however, when it exceeds 2.38 °C, yield loss would rise to 8.2% per 1 °C warming.

- Plant Breeding: developing better varieties
- Genebanks: store variety samples
- Adoption: getting better seeds to farmers
- Policy: science-based recommendations
- Landscapes: sustainable food systems
- Sustainable farming: increase productivity

Evaluating Variety (seed) Performance at Scale

Traditional Phenotyping with Pen & Paper

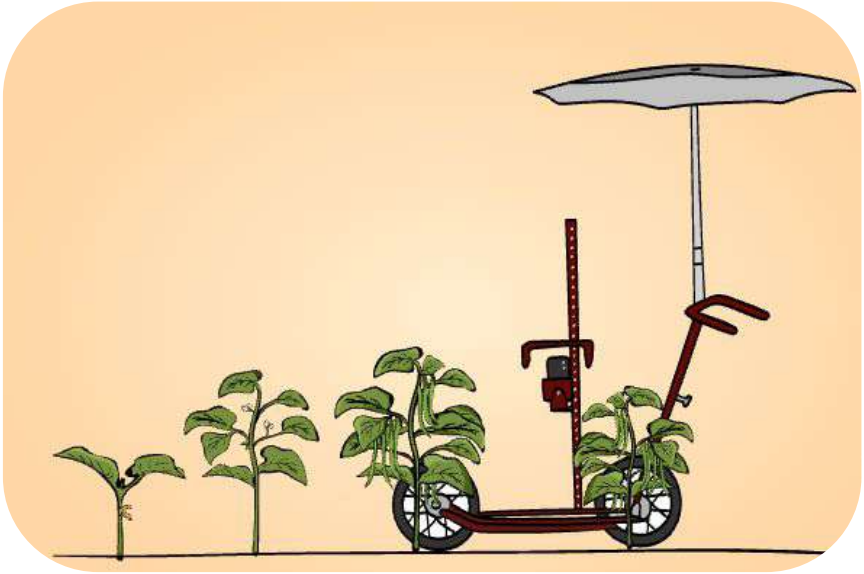
Few sites = limited representativeness



High tech ≠ accessible everywhere

How can AI help?

Smartphone + Computer Vision + Pushcart -> More locations, Faster

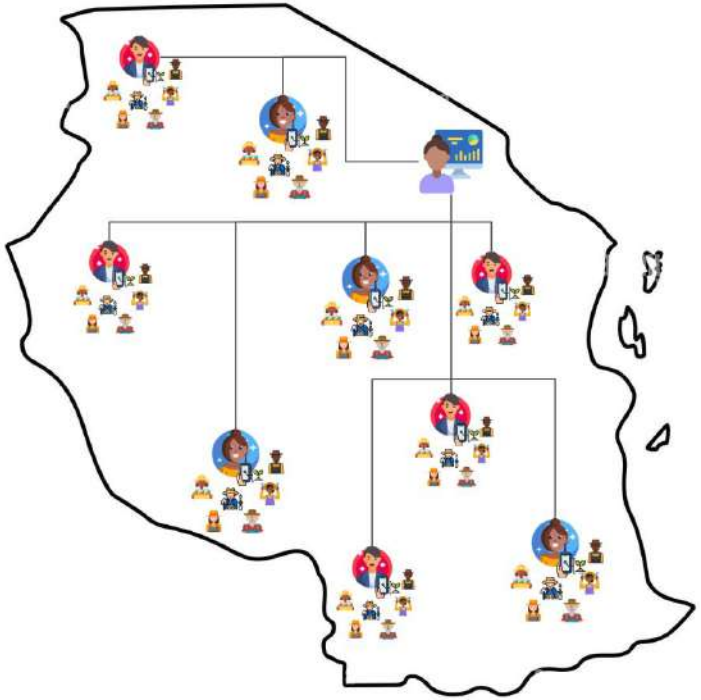


Standardized Imaging in 60 seconds

Scalable Across Sites

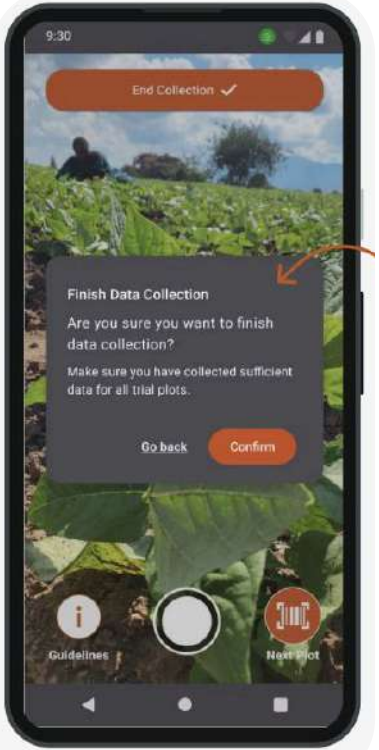
How can AI help?

Smartphones + Locations + Natural Language Processing -> Farmer Feedback

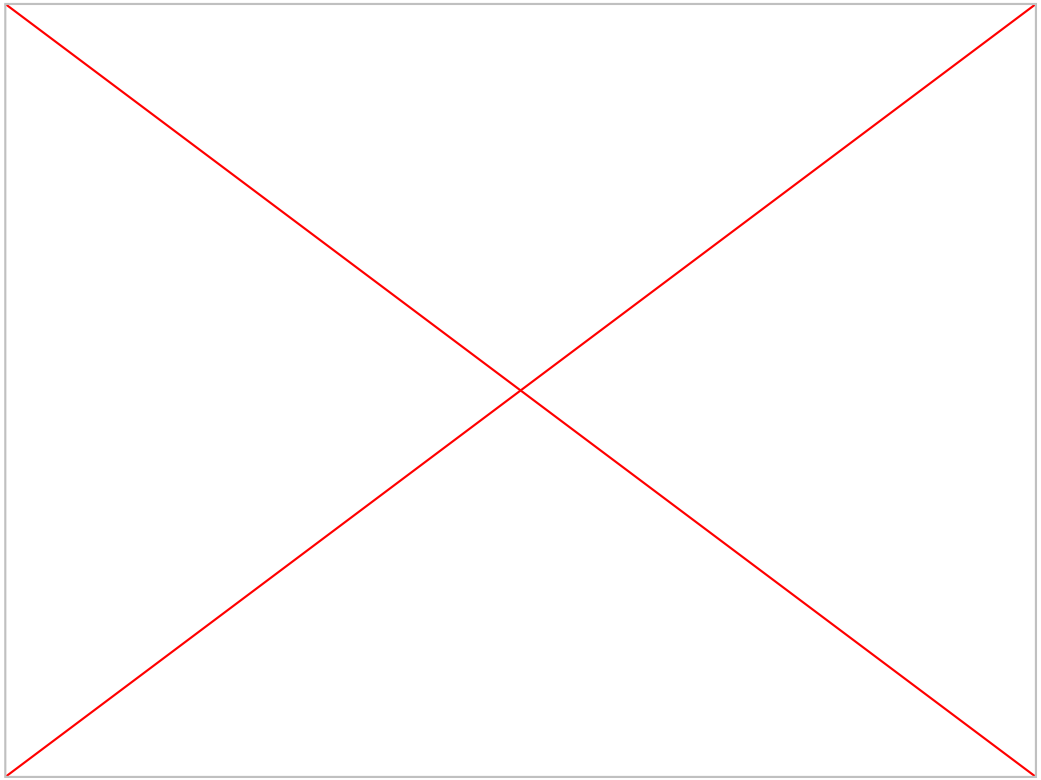


Plot registration

Data capture - camera



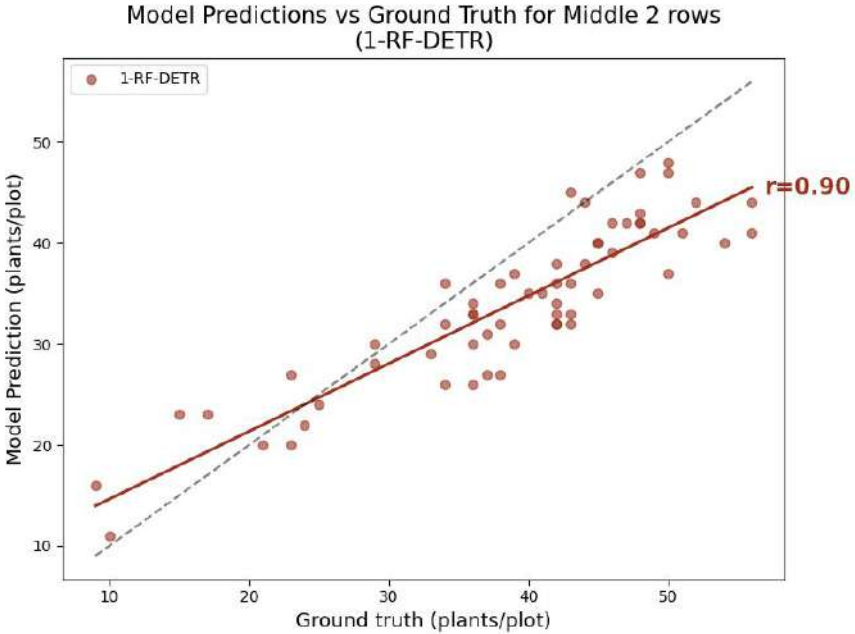
End collection



Annotation of a common bean plant image using instance segmentation. This enables tasks like counting flowers, counting plants, in an image, etc.

IMAGERY — ANNOTATIONS — MODELS — INFERENCE & TRAIT EXTRACTION

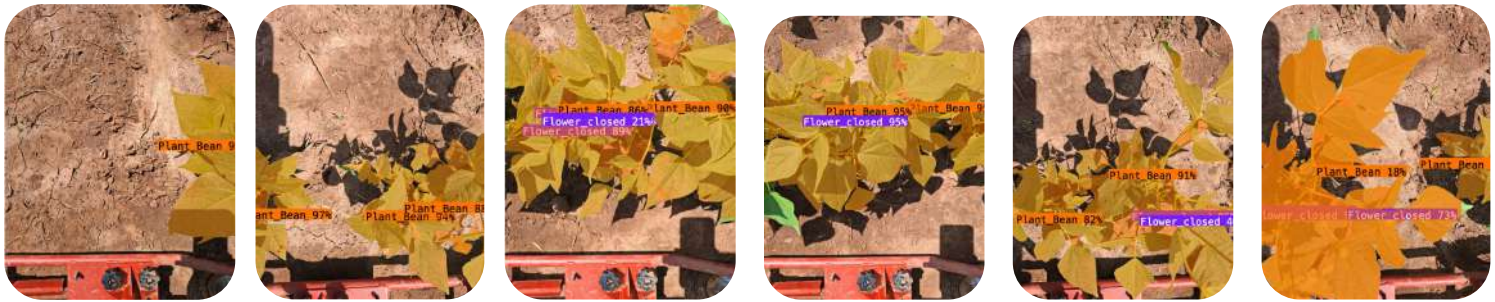
IMAGERY — ANNOTATIONS — MODELS — INFERENCE & TRAIT EXTRACTION



IMAGERY — ANNOTATIONS — MODELS — INFERENCE & TRAIT EXTRACTION

Row 2

Row 3



IMAGERY — ANNOTATIONS — MODELS — INFERENCE & TRAIT EXTRACTION

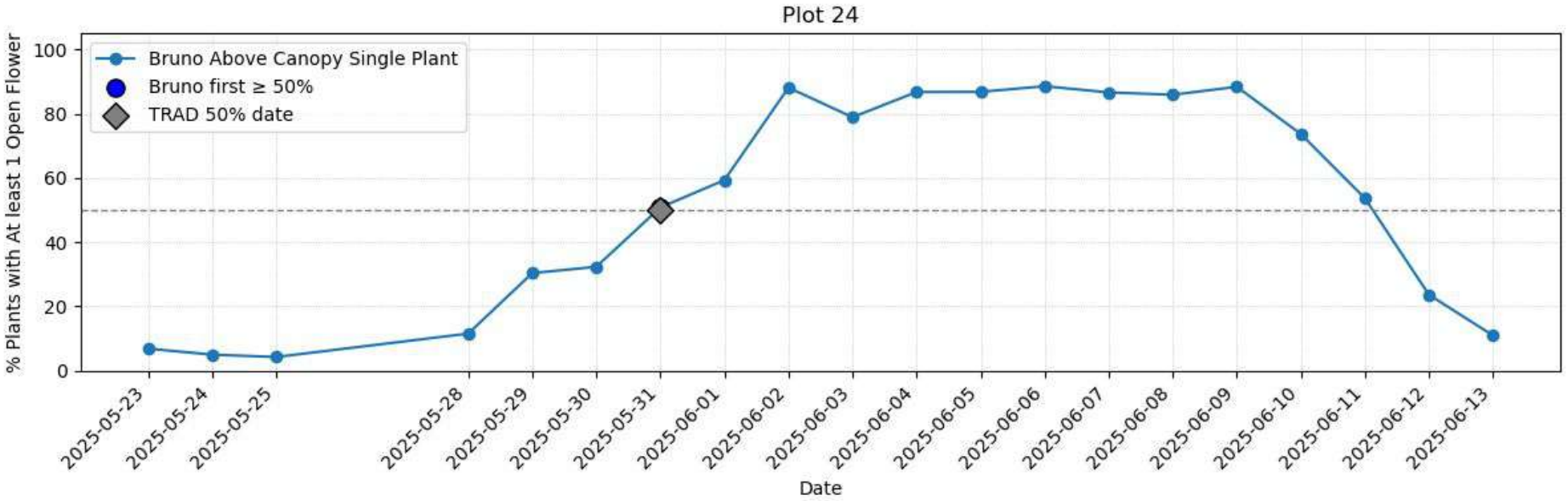


Image level to plot level

Averaging count across unique images

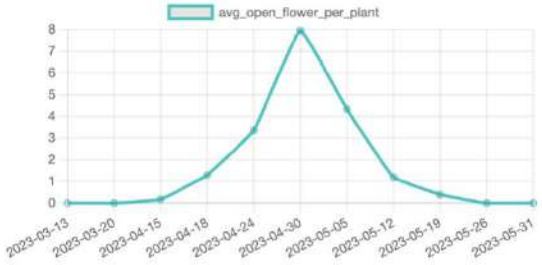
Row 2

Row 3

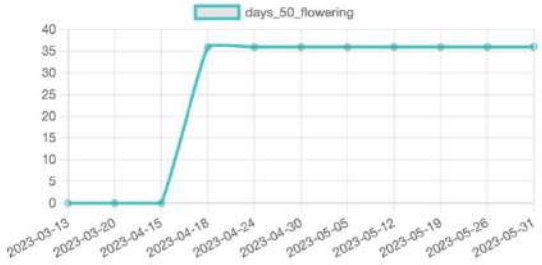
IMAGERY — ANNOTATIONS — MODELS — INFERENCE & TRAIT EXTRACTION

Plot: p16
Variety: Jesca
Replication: r3

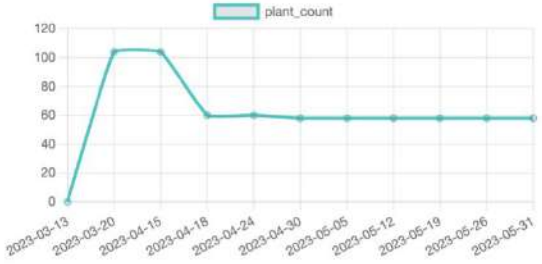
Average Open Flower Per Plant



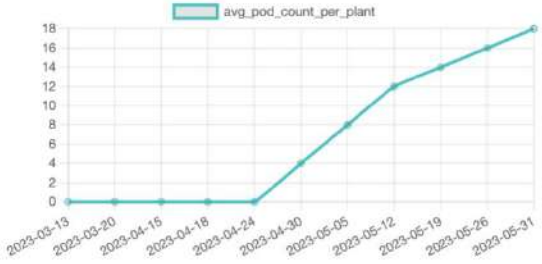
Days to 50% Flowering

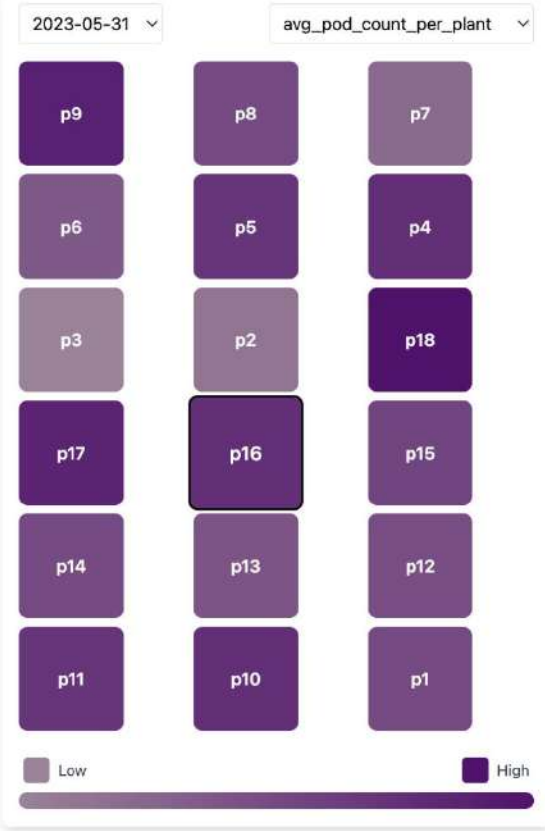


Plant Count



Pod Count





IMAGERY

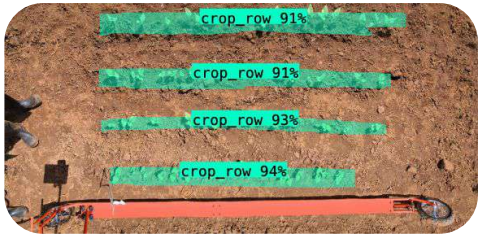
Mount smartphones to a pushcart

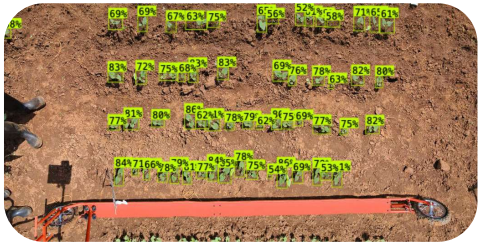
ANNOTATIONS

Region/area of each plant part

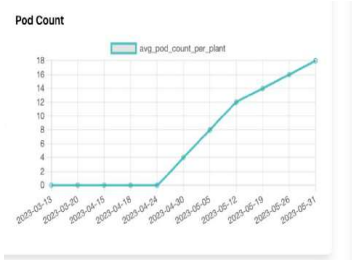
Count whole plant

MODELS





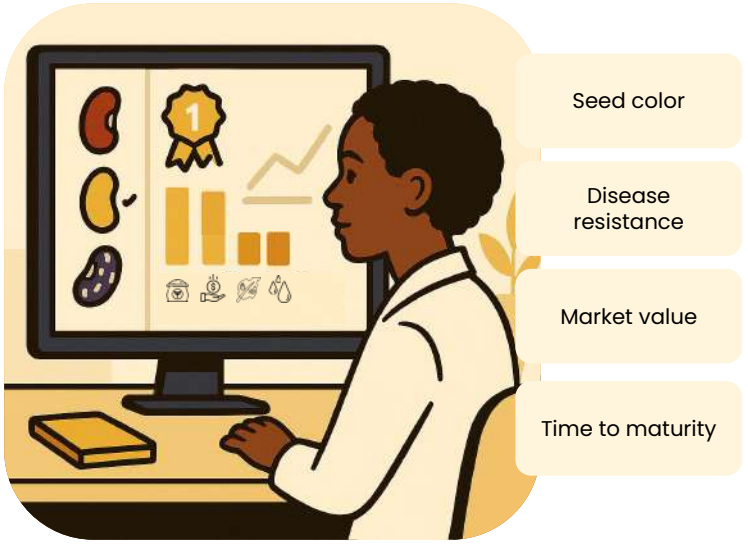
INFERENCE & TRAIT EXTRACTION



Average number of pods/plant for a plot

Product Preference

Need: Varieties adapted to climatic conditions, environment and needs.



Solution: understand market (farmer preferences) and segments

LLM –Powered Data Processing

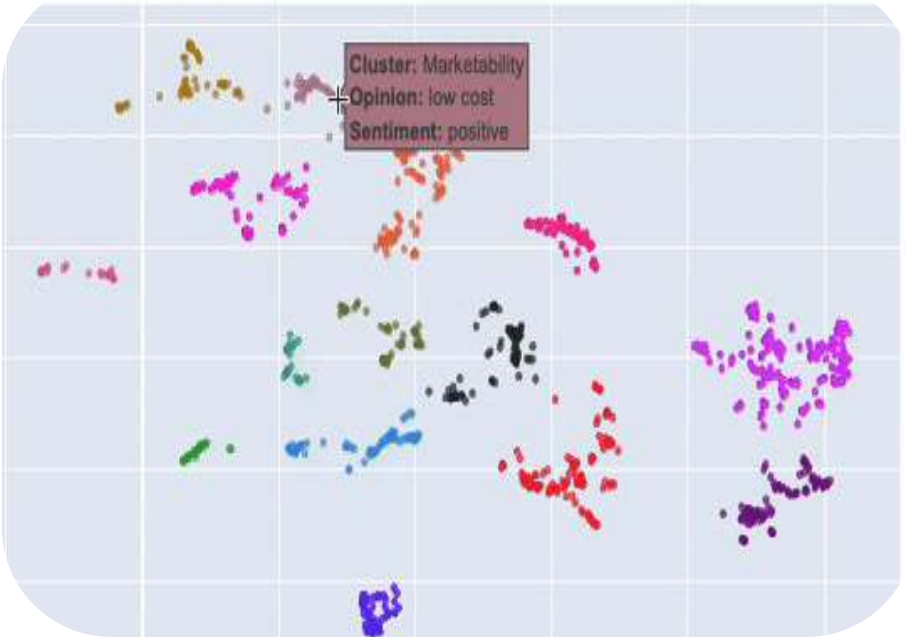
Question: What do you like about variety A? What do you dislike?

Answer: I like Variety A because it has really large leaves and the leaves also taste nice. However, i didn't like that the pods matured unevenly.

Enhance target-use understanding

1. **Trait Discovery:** What traits do farmers notice
2. **Trait Prioritization:** Which traits are most important to different groups
3. **Variety Evaluation:** How do trial varieties perform along farmer-relevant metrics

Trait Discovery



Topic Cluster

- Pod Structure
- Flowering
- Yield
- Branching Architecture
- Germination & Seed Quality
- Taste & Cooking Quality
- Climate & Soil Tolerance
- General Satisfaction
- Plant Vigor & Height
- Plant Stress Symptoms
- Grain Quality & Appearance
- Marketability
- Pest & Disease Resistance
- Maturity Time
- Vine Structure

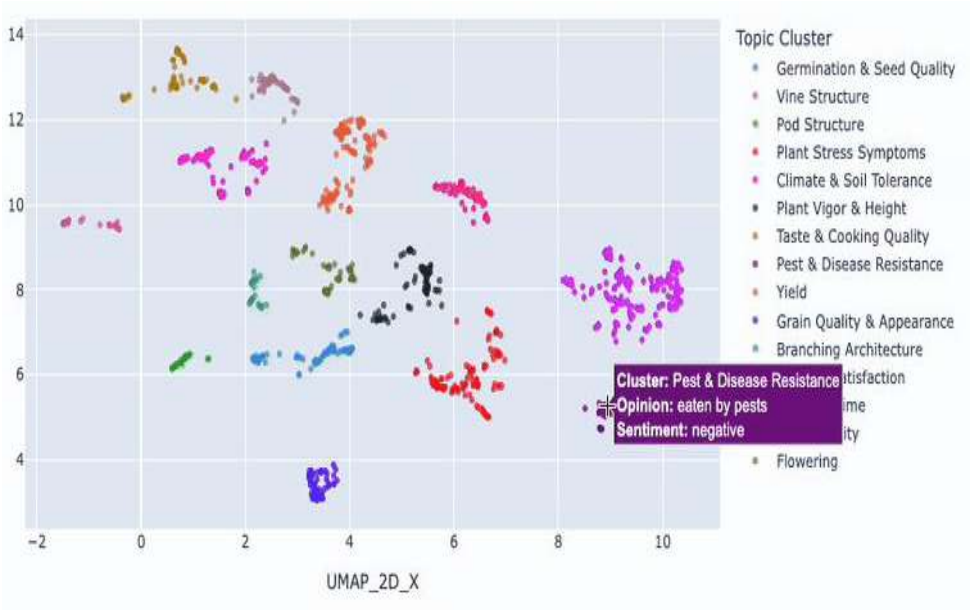
AUDIO — TRANSCRIPTION — ANNOTATION — MODELS

> 5000
Audios collected & transcribed

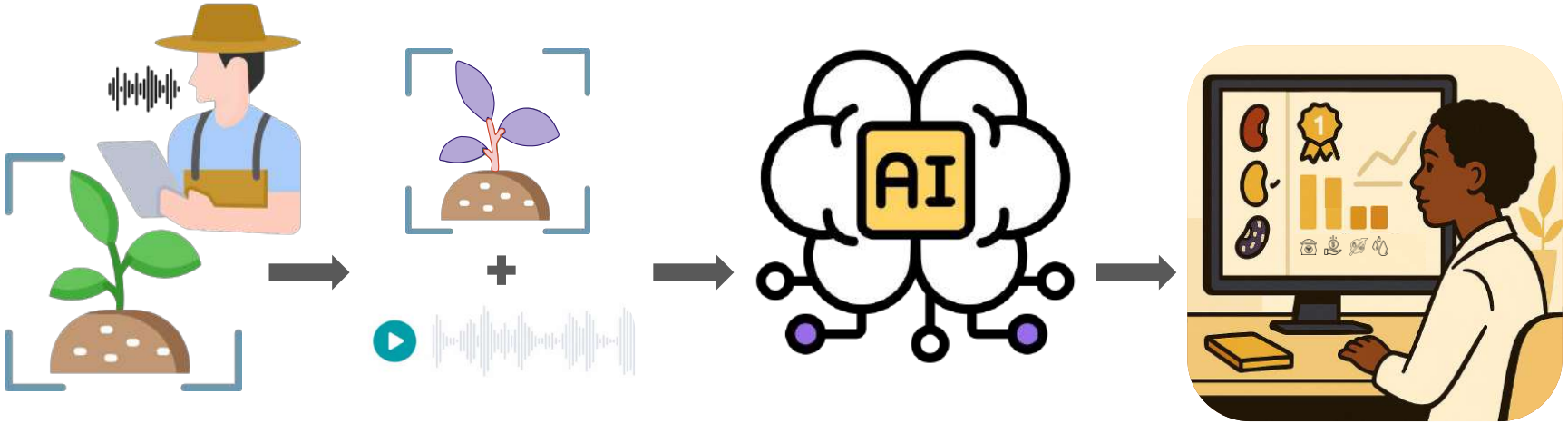
> 4000
Transcribed audios annotated

11
New trait categories

90
New nuanced traits



Transferable Pipeline



Data Collection at Scale

Annotate diverse, useful images the right way

Ethical & powerful model development

Accurate, timely decisions backed by data

Multi-Modal Analytics

Conversational Data

7B Images

Imagery

On Station & On Farm

Artemis FM

Multi-Modal Analysis

Breeding Decisions

Research at Google

Alliance Bioversity & CIAT