Standard Operating Procedure (SOP) for Breeding Data Collection

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1. Introduction

Accurate, timely, and standardized data collection is critical to the success of modern plant breeding programs. The Enterprise Breeding System (EBS) provides a centralized digital platform for managing breeding workflows, including trial design, phenotypic data collection, and integration with genotypic and environmental data.

Electronic data collection using EBS and compatible tools such as Field Book ensures:
- Improved data accuracy and integrity
- Reduced transcription errors
- Real-time data availability
- Improved traceability and auditability
- Standardized workflows across breeding programs

This SOP establishes standardized procedures for collecting, validating, synchronizing, and managing phenotypic data in breeding programs in compliance with EBS workflows and institutional data quality standards. All breeding trials data must be collected digitally and aligned with the approved crop trait ontology in EBS. Standardization ensures interoperability, reproducibility, and reliable decision-making across IITA locations and partner institutions.

2. Purpose

The purpose of this SOP is to establish standardized procedures for collecting phenotypic data, synchronizing data between Field Book and EBS using BrAPI, validating and approving data, and ensuring data quality, integrity, traceability, and compliance with breeding data management standards.

3. Scope

This SOP applies to all breeding trials conducted under institutional breeding programs using EBS. It covers trial preparation, electronic data collection, BrAPI synchronization, validation, and data approval. This SOP applies to:
- Field Technicians
- Data Managers
- Data Officers
- Breeders
- Research Supervisors

This SOP does NOT apply to:
- Manual paper-based data collection (unless used as emergency backup)

- Genotypic data processing (covered under separate SOP)
- Environmental sensor data collection or laboratory workflows

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4.   Definition of terms

Enterprise Breeding System (EBS):

A centralized breeding data management platform used for managing breeding workflows, trial design, and phenotypic and genotypic data.

Field Book: A mobile application used for electronic field data collection and synchronization with breeding databases via BrAPI.

Phenotypic Data: Observable plant traits such as yield, plant height, disease severity, etc.

Trial: A structured experiment evaluating genotypes under defined environmental and experimental conditions.

Observation Unit: A plot, plant, or experimental unit where data is collected.

Trait: A measurable plant characteristic.

BrAPI (Breeding API): A standardized interface for exchanging breeding data between systems.

Data Synchronization: The process of transferring data between Field Book and EBS.

Data Collection: The process of measuring, observing, estimating, and recording plant characteristics using android device and Field Book app and also the validation and storage of trait data.

Data Quality Control is upheld through a semi-automated, standardized process designed to ensure both accuracy and reliability of the collected data.

SOP: Standard Operating Procedures

5.   Roles and Responsibilities

All staff involved in implementing breeding activities in the crop improvement programs at IITA must use the Breeding Data Collection SOP. The program leaders must approve any alteration to the procedures unless they are exceptionally necessary. The individuals responsible for each section of the Data Collection SOP in the breeding data cycle are listed below.

Breeding Program Lead

- Ensure compliance with this SOP
- Approve trial designs and trait lists
- Oversee implementation of electronic data collection

Data Officer

- Create and manage trials in EBS
- Prepare Field Book files for data collection
- Import and validate collected data

Data Manager/Officer

- Ensure proper trait configuration
- Ensure tablets are well configured for BrAPI
- Maintain data integrity
- Backstopped data officers and technicians

Breeder
- Define traits and scoring protocols
- Verify accuracy and completeness of collected data
- Review and approve data in EBS

Field Technician
- Collect field data using Field Book
- Ensure accurate and complete data collection
- Synchronize data as required

National Collaborator/Breeder (NC/B): Responsible for coordinating the data collection of trials sent from the IITA breeding programs in the target agro-ecologies and locations.

Research Supervisor is responsible for collecting quality data for the location or station under their assignment.

6.   Procedures

Phenotypic Data Collection Using Enterprise Breeding System (EBS)

This procedure describes the standardized workflow for collecting, validating, and synchronizing phenotypic data using the Enterprise Breeding System (EBS) and Field Book application. EBS provides flexible tools for collecting and managing phenotypic and trial data across breeding experiments. Data can be captured through multiple interfaces depending on the working environment of the breeding team.

The Data Collection tool supports both online and offline data capture, allowing breeders, technicians, and data managers to record observations efficiently while maintaining data quality and traceability within the system.

6.1 Data Collection Workflows in EBS

EBS supports three primary data collection workflows:
- Web-based Data Collection
- Mobile Application Data Collection
- FieldBook-based Data Collection

Each option serves different operational needs depending on connectivity, field conditions, and user preferences.

1. Web-Based Data Collection

The **web version of the Data Collection tool** is typically used in the office or in locations with reliable internet connectivity.

Using the web interface, users can:

- Enter **phenotypic observations directly into EBS**.
- Review and validate **trial data at different stages**:
    - Pre-harvest
    - Harvest
    - Post-harvest
- Perform **data quality checks** to detect missing or inconsistent values.
- Monitor **data collection progress across sites and experiments**.
- Edit or correct **trial metadata and management information**.
- Upload datasets collected offline using compatible templates.
- Validate and approve datasets before analysis.

This interface is particularly useful for **data managers and breeders performing data review and curation**.

2. Mobile Application Data Collection via BrAPI

The **EBS mobile application** is designed for **in-field data collection** where internet connectivity may be limited.

The mobile application allows users to:

- Collect **phenotypic data directly in the field**.
- Work **offline**, with data automatically synchronized once internet connectivity is restored.
- Record observations **plot-by-plot** using predefined trait lists.
- Reduce manual transcription errors by **digitizing field observations immediately**.
- Capture **timestamps and metadata** associated with field observations.

This option is particularly useful for **technicians and field staff responsible for routine trait measurements**.

3. FieldBook-Based Data Collection

FieldBook is an external mobile application widely used for field-based phenotypic data collection. It integrates with EBS to allow seamless data exchange.

Using FieldBook:

- Data collectors can **download experiment layouts and associated trait list from EBS**.
- Phenotypic observations can be **recorded offline in the field**.

- The collected data can then be **exported and uploaded back into EBS**.
- Data managers can perform **validation and curation within EBS before final storage and analysis**.

FieldBook is commonly used when:
- Large field trials are being evaluated.
- Teams are already familiar with FieldBook workflows.
- Offline data collection is required.

6.2 Data Collection Stages in EBS

EBS organizes phenotypic data collection into **three stages**:

1. Pre-Harvest

Data collected before harvest, such as:
- Plant stand count and vigor
- Flowering time
- Pest/Disease scores
- Plant height

2. Harvest

Data recorded during harvest, including:
- Yield related traits
- Biomass
- Pod or grain characteristics

3. Post-Harvest

Data collected after harvest, including:
- Grain quality
- Moisture content
- Laboratory measurements

Best Practices

To ensure effective data collection in EBS:
- Always confirm that **experiment metadata is complete** before data collection begins.
- Use **standardized trait lists** defined in EBS.
- Validate datasets before uploading them into the system.
- Record observations at the **appropriate data collection stage**.
- Perform **data quality checks before analysis or reporting**.

6.3 Pre-Data Collection Requirements

6.3.1 Before field data collection:

- Trial must be created with the status 'planted' in EBS.
- The experiment/occurrence metadata especially planting date, is complete before data collection begins.
- Trait list must be verified against the crop ontology and loaded to EBS.
- Field layout and trait list must be exported from EBS and loaded to Field Book app or synchronized via BrAPI.
- The data collection devices (tablets) must be fully charged and tested.

6.3.2 Trial Creation

The Data Officer shall:

1. Log into EBS.
2. Navigate to the Experiment Creation module under the Core Breeding domain.
3. Create a new breeding trial and define:
    - Trial name
    - Description and or objective
    - Stage
    - Season
    - Pipeline
    - Entries
    - Experimental design
    - Number of replications
    - Number of occurrences
    - Field layout
4. Assign checks and randomize entries.
5. Define observation units (plots).
6. Update planting, trait and plot protocols.

Refer to the EBS User Guides for step-by-step instructions on Breeding Trial Creation:

https://ebsproject.atlassian.net/servicedesk/customer/portal/2/article/29135736643

6.3.3 Trait Configuration in EBS

The Data Manager and Breeder shall configure the crop specific traits in EBS and create a list for common traits shared with all members of the program.

Refer to the Annex in section 8 to see the common traits for maize and legumes.

6.3.4 Export Trial to Field Book for Data Collection

The Data manager/Office shall:
1. Export the trial/occurrence layout file (csv) and trait list(trt) from EBS Experiment Manager for each data collection device (tablet).
2. Verify that export includes:
   - Plot ID
   - Plot Number
   - Germplasm name
   - Replication
   - Block number
   - Trait list
3. Transfer files to the Field Book app installed on the tablets.
4. **Control Point**: Do NOT modify plot IDs, trait headers or germplasm names in the downloaded field layout file and trait list.

6.4 Data Collection and Upload to EBS

The Field Technician whiles in the field

- Ensure all data is captured accurately using the Field Book App for the right plot.

- Double-check entries against physical measurements or estimations to prevent errors.

- Ensure that no blank values are present for any trait.

- Use NA to indicate not available or not applicable value in a plot where necessary.

- If using BrAPI, synchronize the data to EBS by tapping on Export after the trait(s) data collection is 100% captured. Note: Internet connectivity is required for a successful sync.

- Export the completed trait data collected and send the file to and notify the data manager/officer if you're not using BrAPI.

Refer to EBS guides on data collection for step-by-step guide:
https://ebsproject.atlassian.net/wiki/spaces/EUG/pages/29386178646/Data+Collection

6.5 Field Book and EBS Synchronization Using BrAPI

6.5.1 Purpose

This procedure describes the standardized process for synchronizing breeding experiment data between Field Book and the Enterprise Breeding System (EBS) using the Breeding API (BrAPI). This ensures secure, accurate, and efficient transfer of trial metadata and phenotypic observations between field devices and the central breeding database.
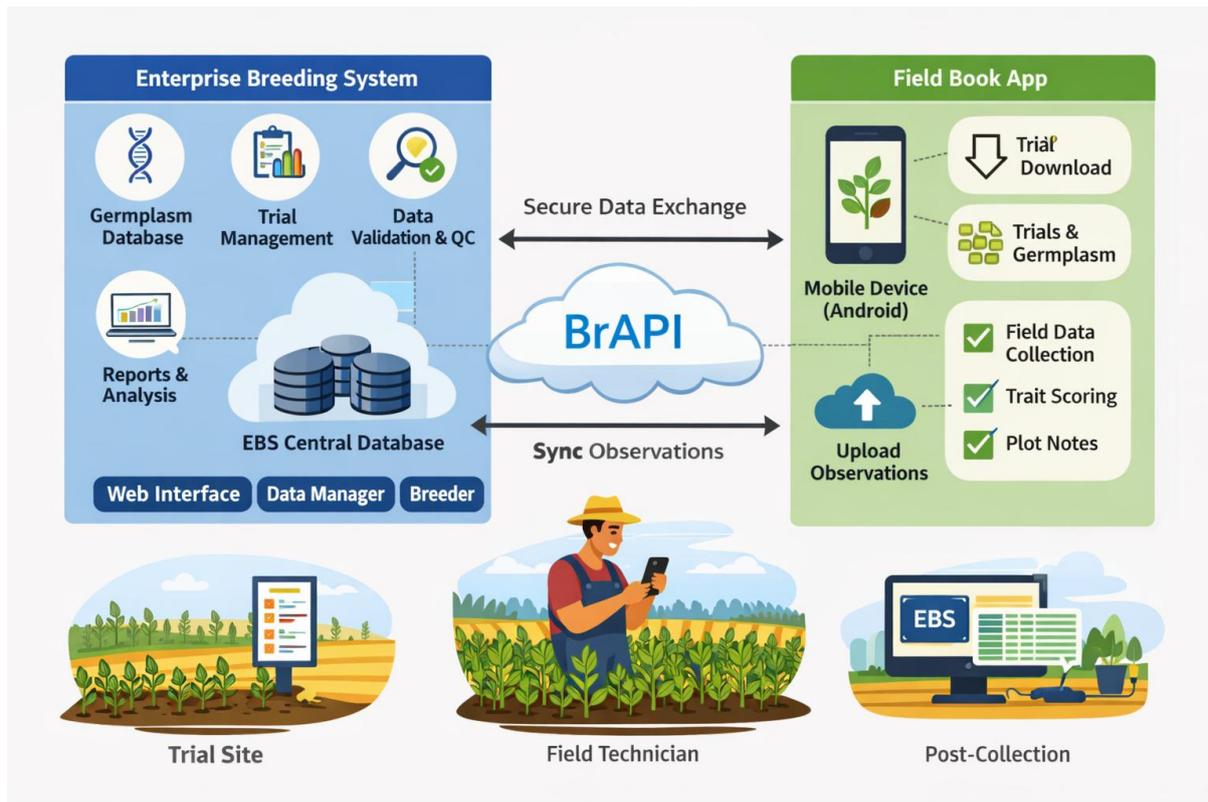
6.5.2 Prerequisites

Before synchronization, ensure the following requirements are met:

System Requirements

- Field Book application installed on mobile device (Android recommended)
- Stable internet connection (Wi-Fi or mobile data)
- Active EBS user account with appropriate access permissions
- Valid EBS BrAPI endpoint URL or QR code
- Device authorized for synchronization

Data Requirements

- Trial must be created and published in EBS
- Traits must be fully configured in EBS and linked to trial occurrence
- Observation units (plots) must be defined
- Germplasm list must be complete

6.5.3 BrAPI Configuration in Field Book (One-Time Setup)

Field Technician or Data Manager shall configure BrAPI connection following the steps defined in the Manual: Guidelines and best practices for digital data collection and management of breeding trials using Field Book, BrAPI and EBS (https://hdl.handle.net/10568/175269)

6.5.4 Download Trial from EBS to Field Book via BrAPI

This step ensures Field Book receives the official trial structure directly from EBS.

Field Technician shall:

Step 1: Open Field Book

Step 2: Select:

Import → BrAPI → Select EBS Server

Step 3: Login using EBS credentials

Step 4: Select appropriate trial occurrence

Step 5: Click Download

System automatically downloads the Field Layout to the Field Tab in the app including the following details:

- Trial name
- Plot structure
- Germplasm entries
- Trait list
- Observation unit identifiers

Step 6: Verify downloaded trial

Confirm:

- Trial name is correct
- Number of plots matches as in EBS
- Trait list is complete

Control Point:

Do NOT modify plot IDs or germplasm names in Field Book.

6.5.5 Field Data Collection Using BrAPI-Synchronized Trial

Field Technician shall:

1. Open downloaded trial in Field Book
2. Collect the crop-specific trait data as defined in Section 6.2
3. Ensure:

- Accurate plot selection
- Correct trait scoring
- No placeholder values

Field Book automatically stores data locally until synchronization.

6.5.6 Upload Observations from Field Book to EBS via BrAPI

After field data collection:

Field Technician shall:

Step 1: Connect device to internet

Step 2: Open Field Book

Step 3: Select:

Export → BrAPI → Select EBS Server

Step 4: Select trial/occurrence

Step 5: Tab Export to submit the observations to EBS

Field Book uploads:

- Plot observations

- Trait values

- Timestamp

- User information

6.6 Data Quality Checks and Validation

To ensure high-quality breeding datasets, EBS provides several **data validation features**:

- Detection of **missing values**

- Identification of **outliers and suspicious values**

- Controlled vocabularies for **traits and metadata**

- Data correction and curation before analysis

These features help maintain **data integrity for breeding analysis and decision-making**.

Data Manager/Officer shall:

Step 1: Log into EBS

Step 2: Navigate to:

Data Collection → Select the uploaded dataset

Step 3: Verify uploaded data by performing basic QCs

Check for:

- Missing values

- Outliers and suspicious values

- Incorrect values

- Duplicate entries

- Synchronization errors

Step 4: Auto compute calculated traits if any

Step 5: Perform other data cleaning if necessary

Step 6: Commit and submit data for Breeder review

6.6.1 Breeder Review and Approval

Breeder shall:

- Review uploaded phenotypic data

- Confirm accuracy

- Approve dataset

6.6.2 Data Integrity and Security Requirements

The following rules must be followed:

- Do not edit plot identifiers
- Do not delete synchronized records without authorization
- Only authorized personnel may perform synchronization
- Maintain device security

6.7 Synchronization Frequency

Recommended synchronization frequency:

Stage	Frequency
During flowering	Daily or every visit
During maturity	Every data collection day
During harvest	Immediately after data collection
After harvest	Immediately after data collection
Final synchronization	Within 48 hours after post-harvest data collection

6.8 Error Handling and Troubleshooting

If synchronization fails:

Step 1: Verify internet connection

Step 2: Verify BrAPI credentials

Step 3: Restart Field Book application

Step 4: Retry synchronization

If problem persists: Contact your data manager or

Step 5: Export Field Book file with data manually

Step 6: Submit file to Data Manager for upload to EBS

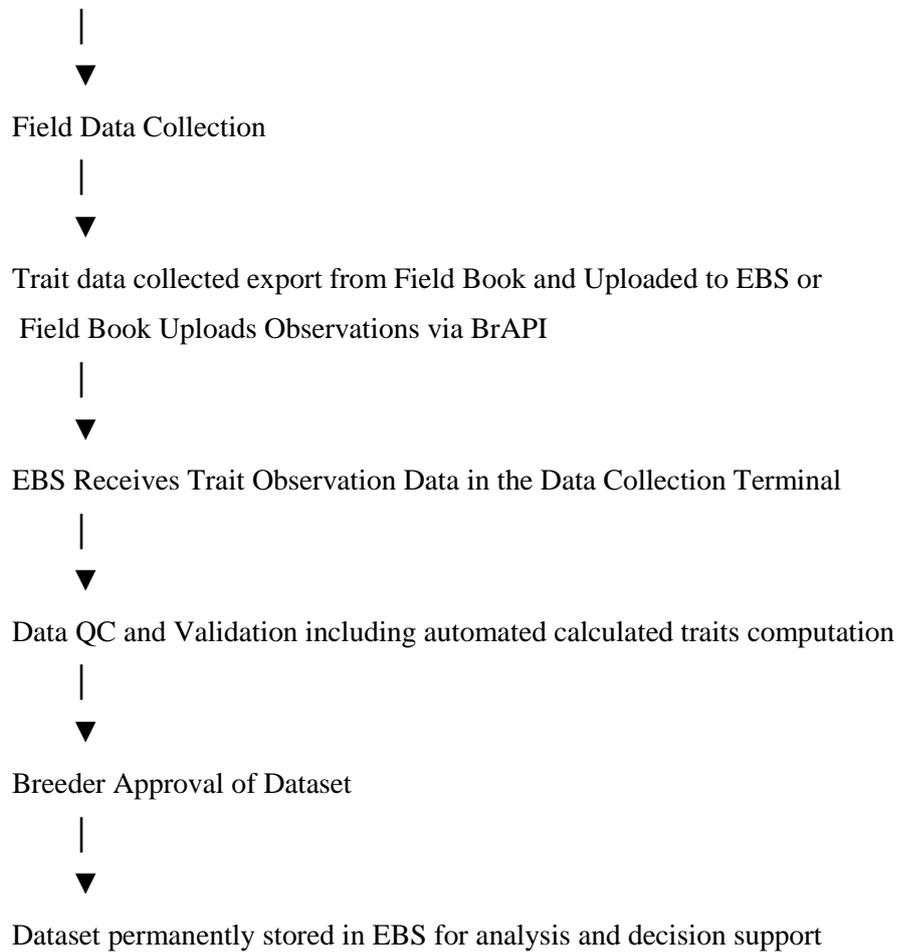*6.9 Synchronization Workflow Diagram*

EBS Trial Created

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Trial Metadata updated

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Trial Field Layout and Trait files downloaded to Field Book Connects to BrAPI

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▼

Field Data Collection

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▼

Trait data collected export from Field Book and Uploaded to EBS or
Field Book Uploads Observations via BrAPI

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▼

EBS Receives Trait Observation Data in the Data Collection Terminal

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▼

Data QC and Validation including automated calculated traits computation

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▼

Breeder Approval of Dataset

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▼

Dataset permanently stored in EBS for analysis and decision support

EBS Data Flow
From Trial Creation to Decision Support

Trial Creation → Data Collection → Data QA / QC → Data Analysis → Decision Support

Trial Setup | Field & Lab Data | Validation & Curation | Reports & Decisions

Audit Trail and Traceability

EBS automatically records:

- Users who uploaded data or committed to the system
- Date and time of uploads and commits
- Changes made to dataset and by who

7. References

Excellence in Breeding – EBS User guides - User guides - Digital Solutions

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8.Annex

Summary of Maize Traits for EBS

Trait Name	Trait Abbrev	Unit	Data Type
Plant Stand	PLST	Count (plants/plot)	Integer
Plant Height	PHT	cm	Numeric
Ear Height	EHT	cm	Numeric
Days to Anthesis	DYANTH	Days	Integer
Days to Silking	DYSK	Days	Integer
Anthesis–Silking Interval	ASI	Days	Numeric (Calculated)
Husk Cover	HUSK	1–5 Scale	Ordinal
Ear Aspect	EASP	1–5 Scale	Ordinal
Plant Aspect	PASP	1–5 Scale	Ordinal
Maize Streak Virus	MSV	1–9 Scale	Ordinal
Rust Severity	RUST	1–9 Scale	Ordinal
Northern Corn Leaf Blight	NCLB	1–9 Scale	Ordinal
Days to Maturity	DYMAT	Days	Integer
Root Lodging	RL / RLRAT	Count or %	Numeric
Stalk Lodging	SL / SLRAT	Count or %	Numeric
Plants Harvested	PHARV	Count	Integer
100-Seed Weight	SW100	g	Numeric
Curvularia Severity	CURV	1–9 Scale	Ordinal
Gray Leaf Spot	GLS	1–9 Scale	Ordinal
Ears Harvested	EHARV	Count	Integer

Heat Stress Trial Traits

Trait Name	Trait Abbrev	Unit	Data Type
Tassel Blasting Severity	TBLS	1–9 Scale	Ordinal
Leaf Rolling	LR	1–9 Scale	Ordinal
Leaf Firing	LFIR	1–9 Scale	Ordinal
Barren Plants	BARR	Count or %	Numeric

Striga Trial Traits

Trait Name	Trait Abbrev	Unit	Data Type
Striga Damage Rating (8 WAP)	STRR1	Rating (plants)	Integer
Striga Damage Rating (10 WAP)	STRR2	Rating (plants)	Integer
Striga Count (8 WAP)	STRC1	Count	Integer
Striga Count (10 WAP)	STRC2	Count	Integer

Fall Armyworm Trial Traits

Trait Name	Trait Abbrev	Unit	Data Type
Ear Damage Rating	FAEAR	1–9 Scale	Ordinal
Leaf Damage Rating	FALDR	1–9 Scale	Ordinal

Stem Borer Trial Traits

Trait Name	Trait Abbrev	Unit	Data Type
Ear Damage (Borer)	SBED	Count	Integer
Stem Borer Rating	SBR	1–9 Scale	Ordinal
Stem Tunnelling	STUN	% Stem Length	Numeric
Leaf Feeding Damage	LFD	1–9 Scale	Ordinal
Dead Heart	DH	Count	Integer
Stalk Breakage	STBK	Count	Integer

Soybean common traits for EBS:

Trait Name	Trait Abbrev	Unit	Data Type
Planting Date	DATE_PLANT	Date	Date
Days to 50% Flowering	DAYS_TO_FLOWERING	Days	Numeric
Flower Color	FLWCOL_EST_SCALE	Category	Text
Nodulation Score	NODULATION_SCORE	Scale (1–5)	Numeric
Days to Maturity	DAYS_TO_MATURITY	Days	Numeric
Plant Height	PLANT_HEIGHT	cm	Numeric
Pod Clearance	POD_CLEARANCE_CM	cm	Numeric
Lodging Score	LODG_EST_1TO5	Scale (1–5)	Numeric
Shattering Score	SHATTERING	Scale (1–5)	Numeric
Pubescence Color	PUBCOL_EST_1TO4	Category	Text
Pod Color	PODCOL_EST_1TO4	Category	Text
Number of Plants Harvested	PLNTHVST_COUNT_PLANT	Count	Numeric
100 Seed Weight	SEEDWEIGHT_100	g	Numeric
Plot Yield	AYLD_CONT	g	Numeric
Hilum Color	HILUM_COLOR	Category	Text
Moisture	MOIS	%	Numeric

Cowpea Traits Summary for EBS: Refer to Cowpea Data Collection SOP via https://hdl.handle.net/10568/175267 on how these traits are captured.

1. Seedling Stage Traits

Trait Name	Trait Abbrev	Unit	Data Type
Number of Hills	NHILL	Count (hills/plot)	Integer
Stand Count at Emergence	STDE	Count (plants/plot)	Integer

2. Vegetative Stage Traits

Trait Name	Trait Abbrev	Unit	Data Type
Aphid Population Rating	APHID	1–9 Scale	Ordinal
Cowpea Virus Severity	VIRUS	1–5 Scale	Ordinal

3. Flowering and Podding Stage Traits

Trait Name	Trait Abbrev	Unit	Data Type
Number of Days to First Flower	NDFF	Days	Integer
Days to 50% Flowering	D50FLOW	Days	Integer
Days to First Pod Maturity	D1PODM	Days	Integer
Days to 95% Pod Maturity	D95MAT	Days	Integer
Development Type	DEVTYPE	Categorical (1–2)	Ordinal
Pod Load Score	PODLOAD	1–3 Scale	Ordinal
Thrips Damage Rating	THRIPS	1–9 Scale	Ordinal
Thrips Population	THRPOP	Count	Integer

4. Disease Resistance Traits

Trait Name	Trait Abbrev	Unit	Data Type
Bacterial Blight Severity	BBLIGHT	1–5 Scale	Ordinal
Leaf Smut Severity	LSMUT	1–5 Scale	Ordinal
Cowpea Scab Severity	SCAB	1–5 Scale	Ordinal
Other Fungal Diseases Severity	OFD	1–5 Scale	Ordinal

5. Maturity and Yield Traits

Trait Name	Trait Abbrev	Unit	Data Type
Stand Count at Harvest	STDH	Count (plants/plot)	Integer
Pod Dry Weight	PODWT	g	Numeric
Seed Weight	SDWT	g	Numeric
100 Seed Weight	SDWT100	g	Numeric
Fodder Weight	FODWT	kg or g	Numeric

6. Insect Pest Traits (Post-Flowering)

Trait Name	Trait Abbrev	Unit	Data Type
Maruca Pod Damage	MARUCA	1–9 Scale	Ordinal
Pod Sucking Bug Damage	PSBDMG	1–9 Scale	Ordinal
Pod Sucking Bug Population	PSBPOP	1–9 Scale or Count	Ordinal

7. Parasitic Weed Traits

Trait Name	Trait Abbrev	Unit	Data Type
Striga Presence	STRIGA	0–1 Scale	Binary
Striga Infested Plants	STRCNT	Count	Integer
Alectra Presence	ALECTRA	0–1 Scale	Binary
Alectra Infested Plants	ALECTCNT	Count	Integer

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