Breedbase: a digital ecosystem for plant breeding

AgBio seminar, December 2019

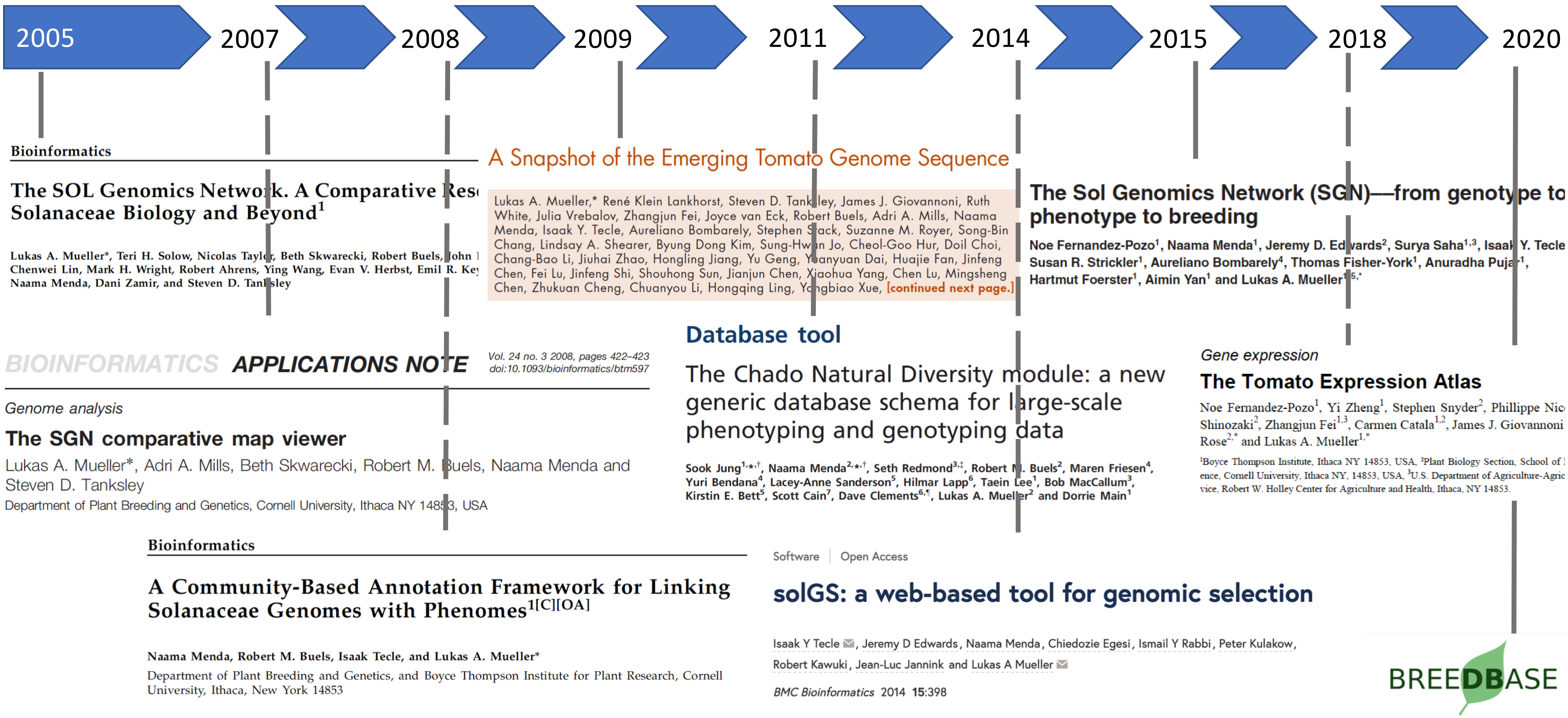
Guillaume Bauchet, Bryan Ellerbrock, David Lyon, Naama Menda, Nicolas Morales, Mirella Flores, Alex C. Ogbonna, Adrian Powell, Titima Tantikanjana and Isaak Y Tecle

Lukas Mueller lab

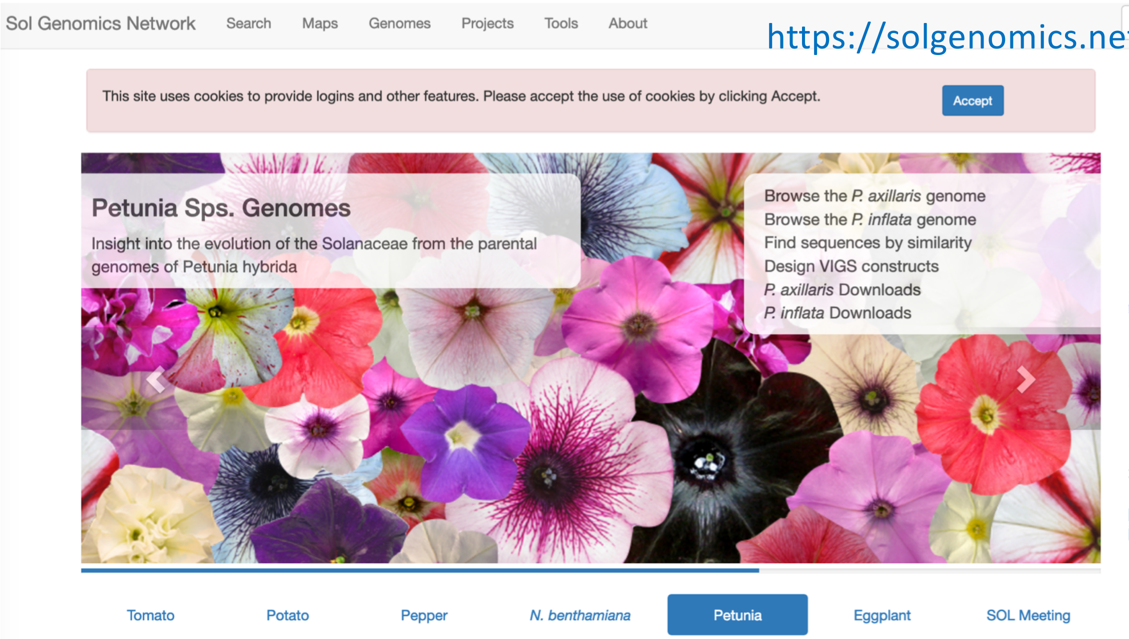
BREEDBASE

BTI Discovery & Innovation in the Life Sciences
BOYCE THOMPSON INSTITUTE

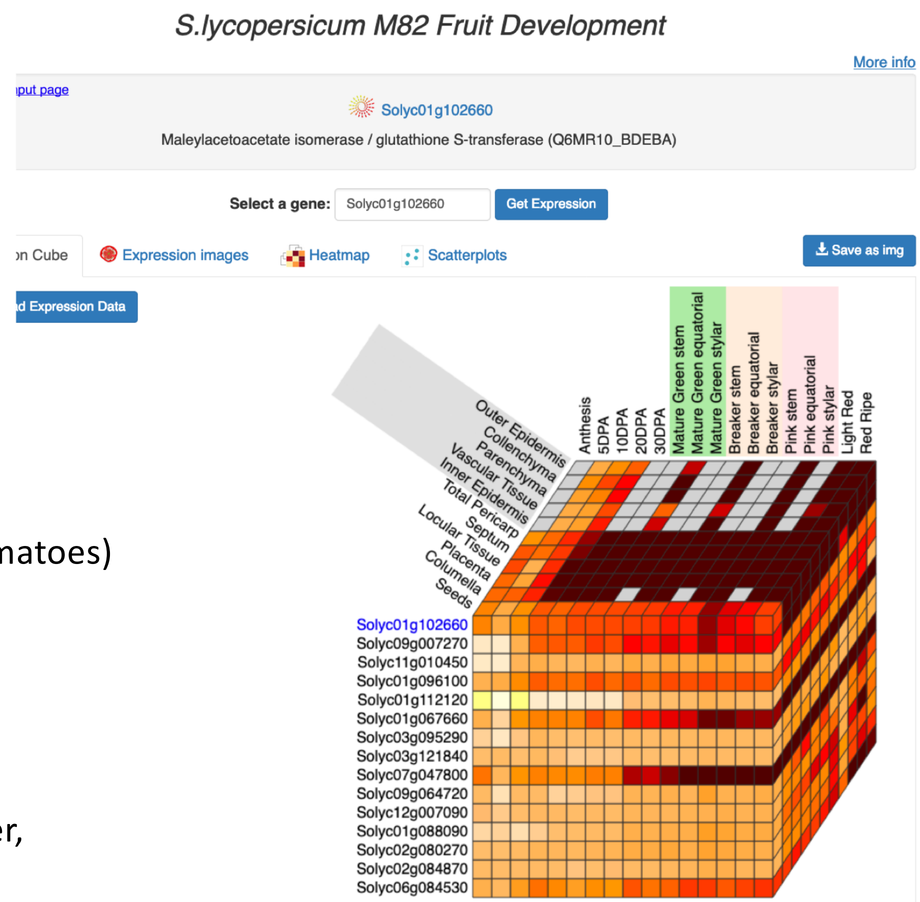
From Solgenomics…



https://solgenomics.net/



http://tea.sgn.cornell.edu/



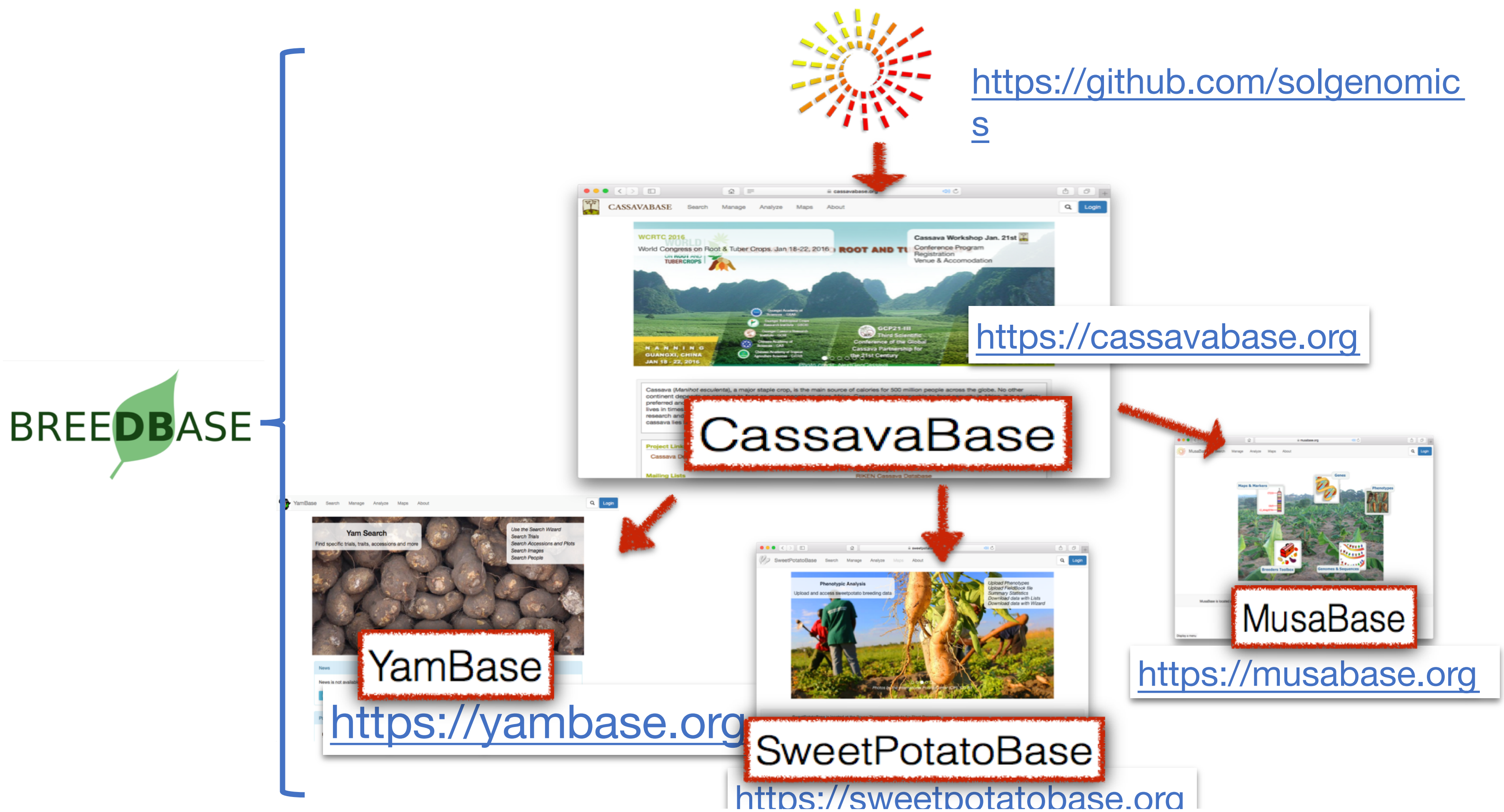
Data:

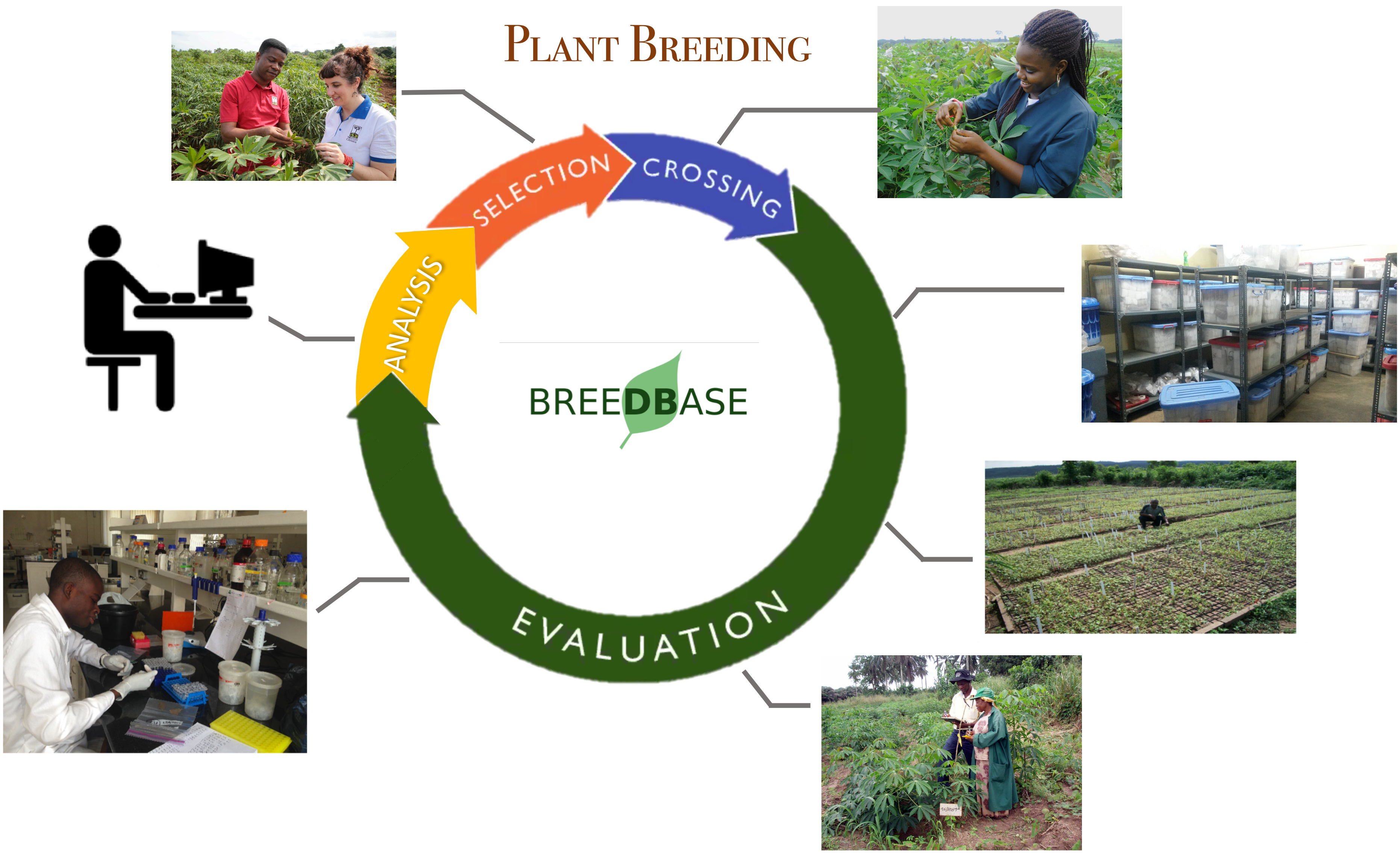
5 reference genomes (tomato, potato, eggplant, pepper, wild tomatoes)
6 draft genomes (tobacco, petunia, wild tomato)
16 genetic maps
500+ re-sequenced genomes

Tools:

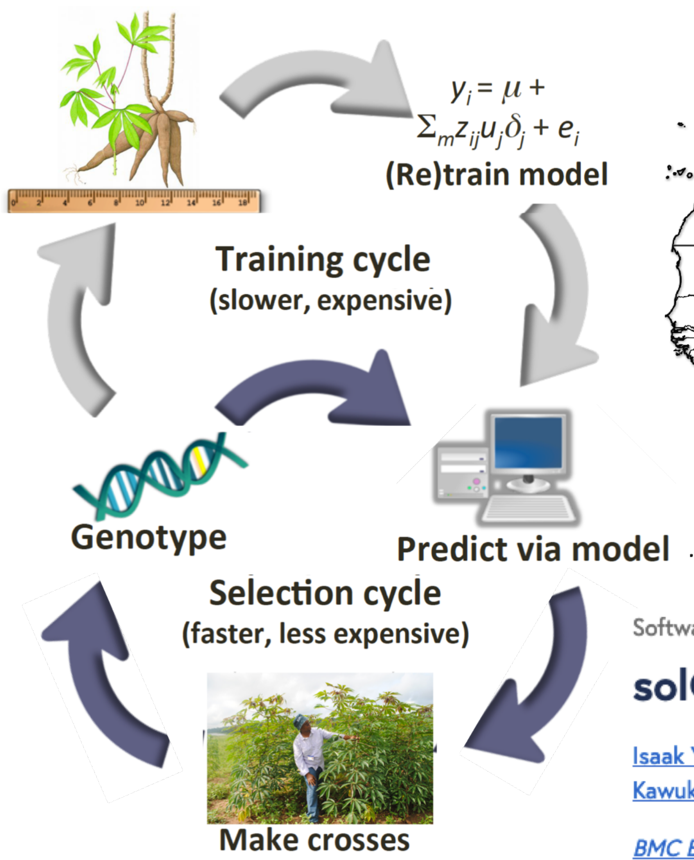
BLAST, Comparative maps, Expression Atlas, Jbrowse, Motif finder, Pathway tools, Phylo tree browser, QTL tools, VIGS, WebApollo

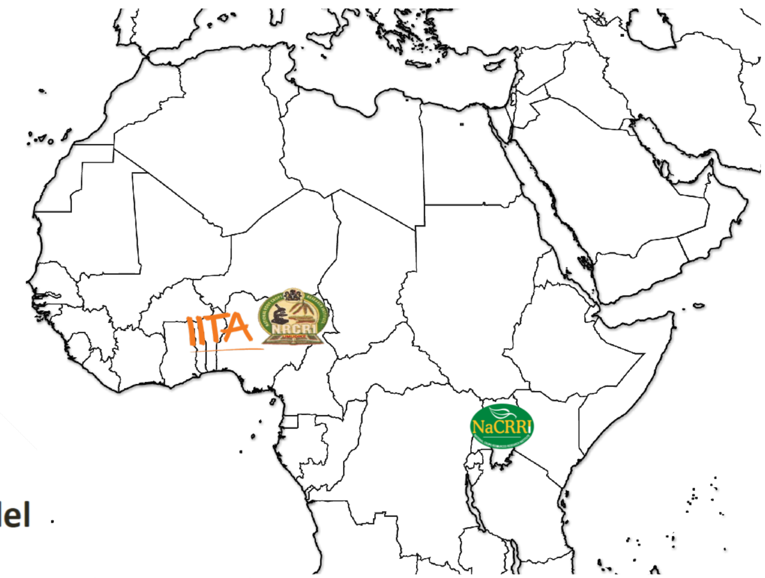
...to Breedbase




Plant Breeding
Selection
Crossing
Analysis
Evaluation
BREEDBASE

NEXTGEN CASSAVA





Software | Open Access | Published: 14 December 2014

solGS: a web-based tool for genomic selection

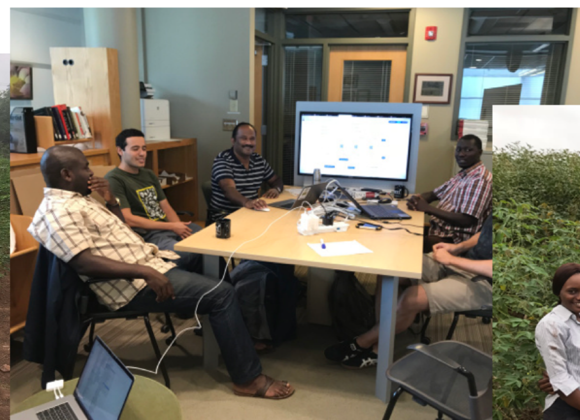
Isaak Y Tecle, Jeremy D Edwards, Naama Menda, Chiedozie Egesi, Ismail Y Rabbi, Peter Kulakow, Robert Kawuki, Jean-Luc Jannink & Lukas A Mueller

BMC Bioinformatics **15**, Article number: 398 (2014) | Cite this article

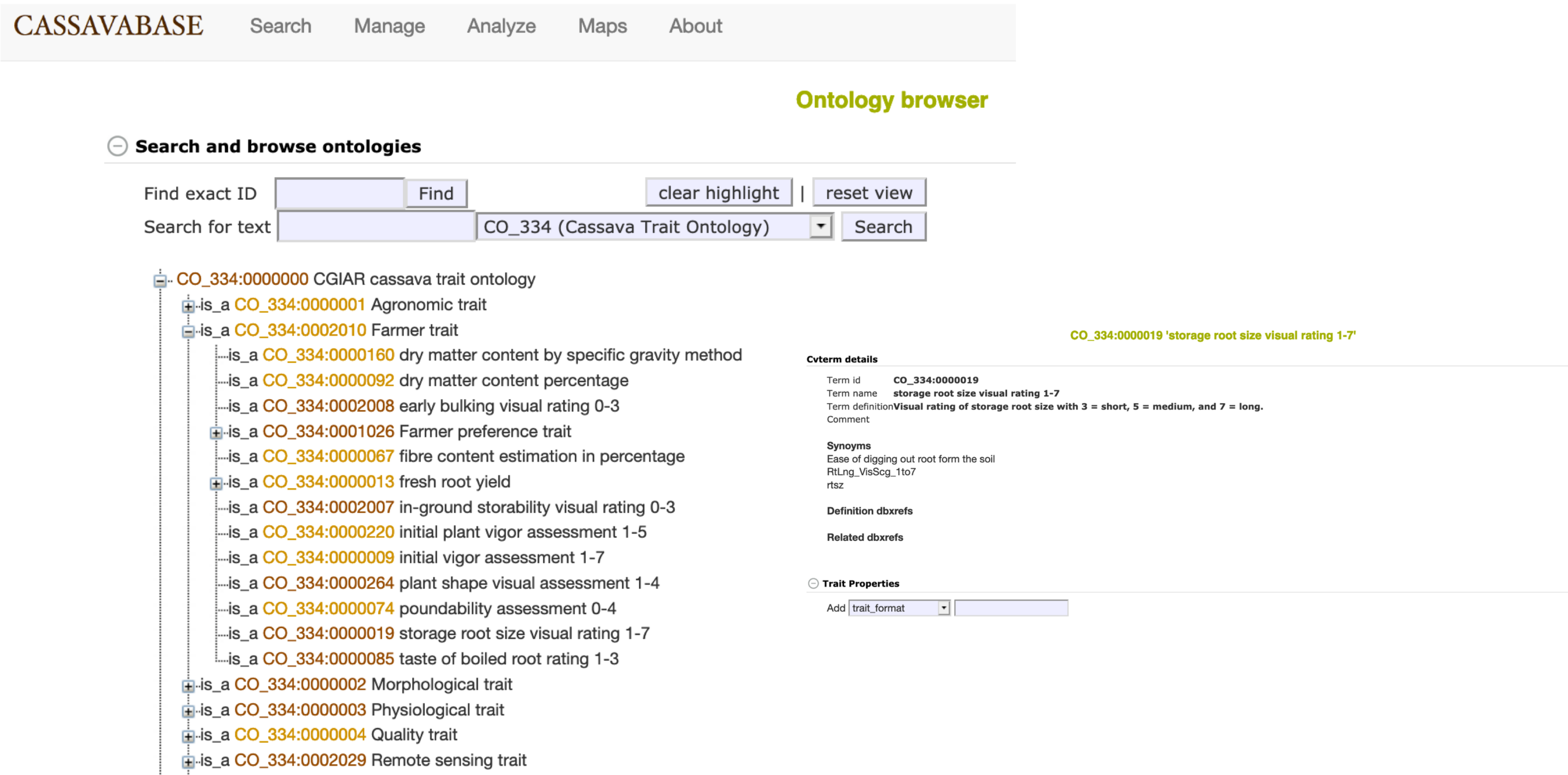
NEXTGEN CASSAVA

BREEDBASE (CASSAVABASE) ROLES

- Project’s data repository
- Contribute to harmonize data, standardize procedure
- Enhance collaboration across partners, build a crop community



Developing a common vocabulary: ontologies



Formats:

TD (Trait Dictionary) -

Q	R
Trait name	Trait class
Weight of commercial storage roots	Agronomic trait

OBO (Open Biomedical Ontology) -

name: Weight of commercial storage roots

is_a: Agronomic trait

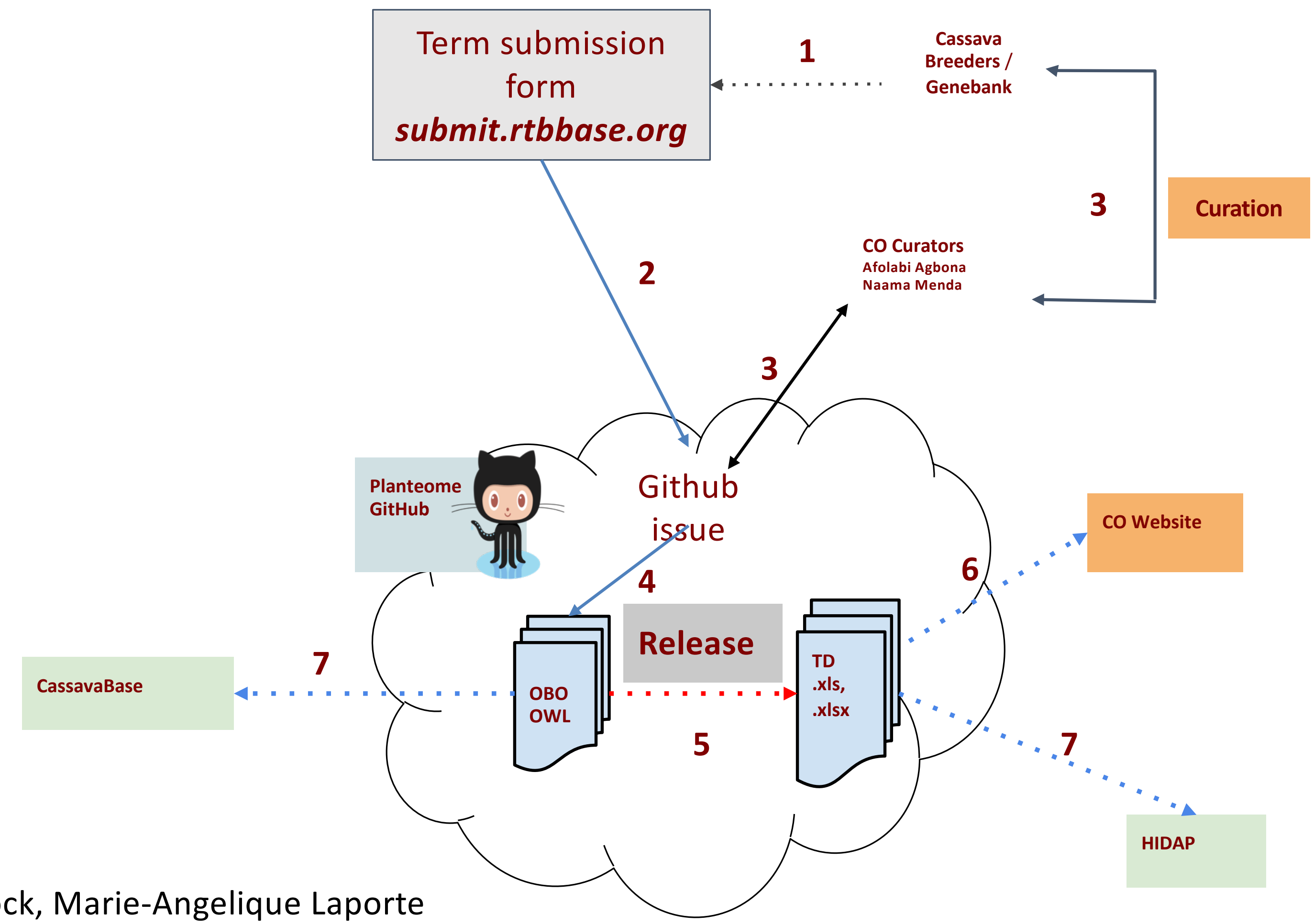
OWL (Web Ontology Language) -

Weight of commercial storage roots SubClassOf **Agronomic trait**

Tools:

OBO-Edit, Protege, Web Protege

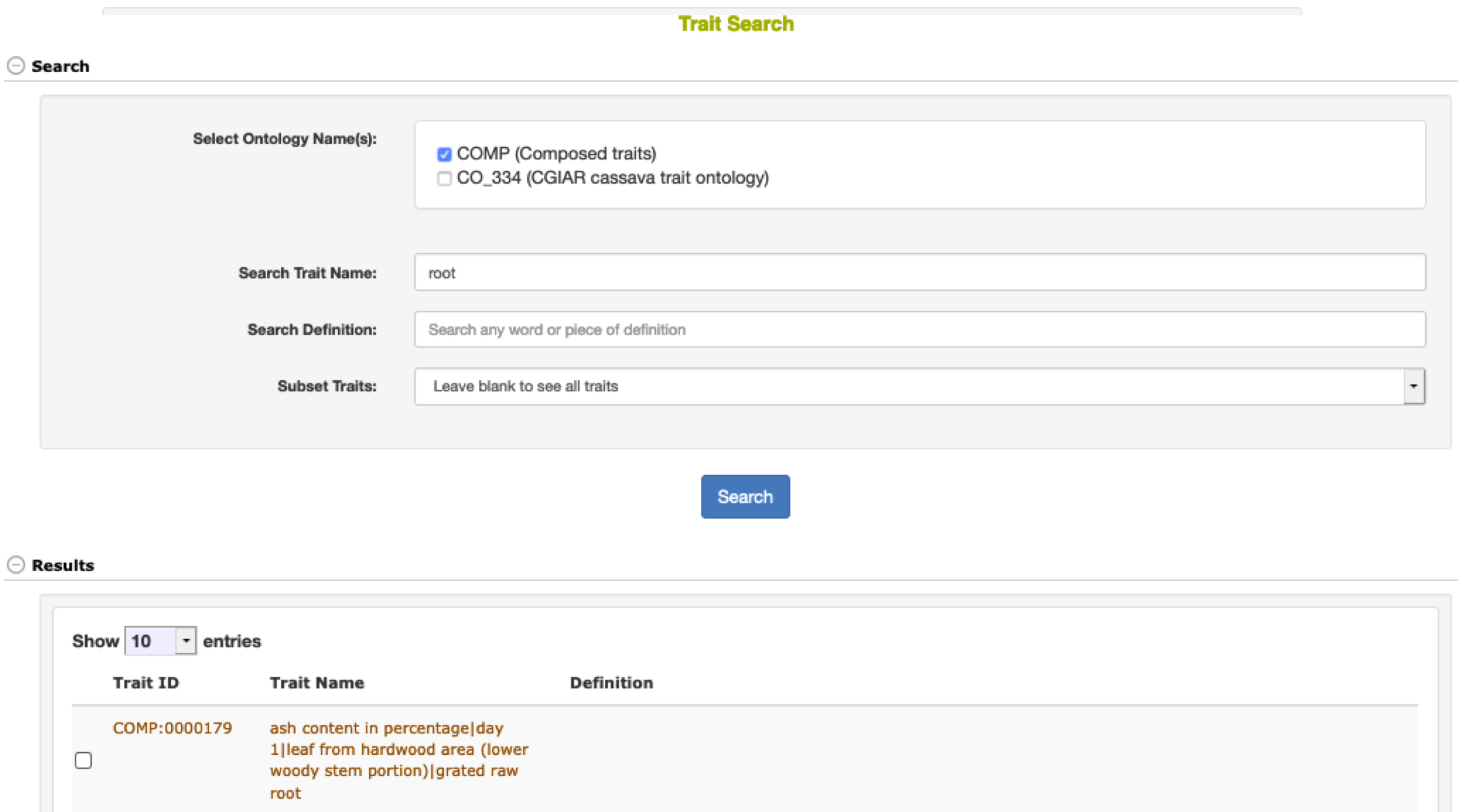
Ontology trait request



Credits: Bryan Ellebrock, Marie-Angelique Laporte

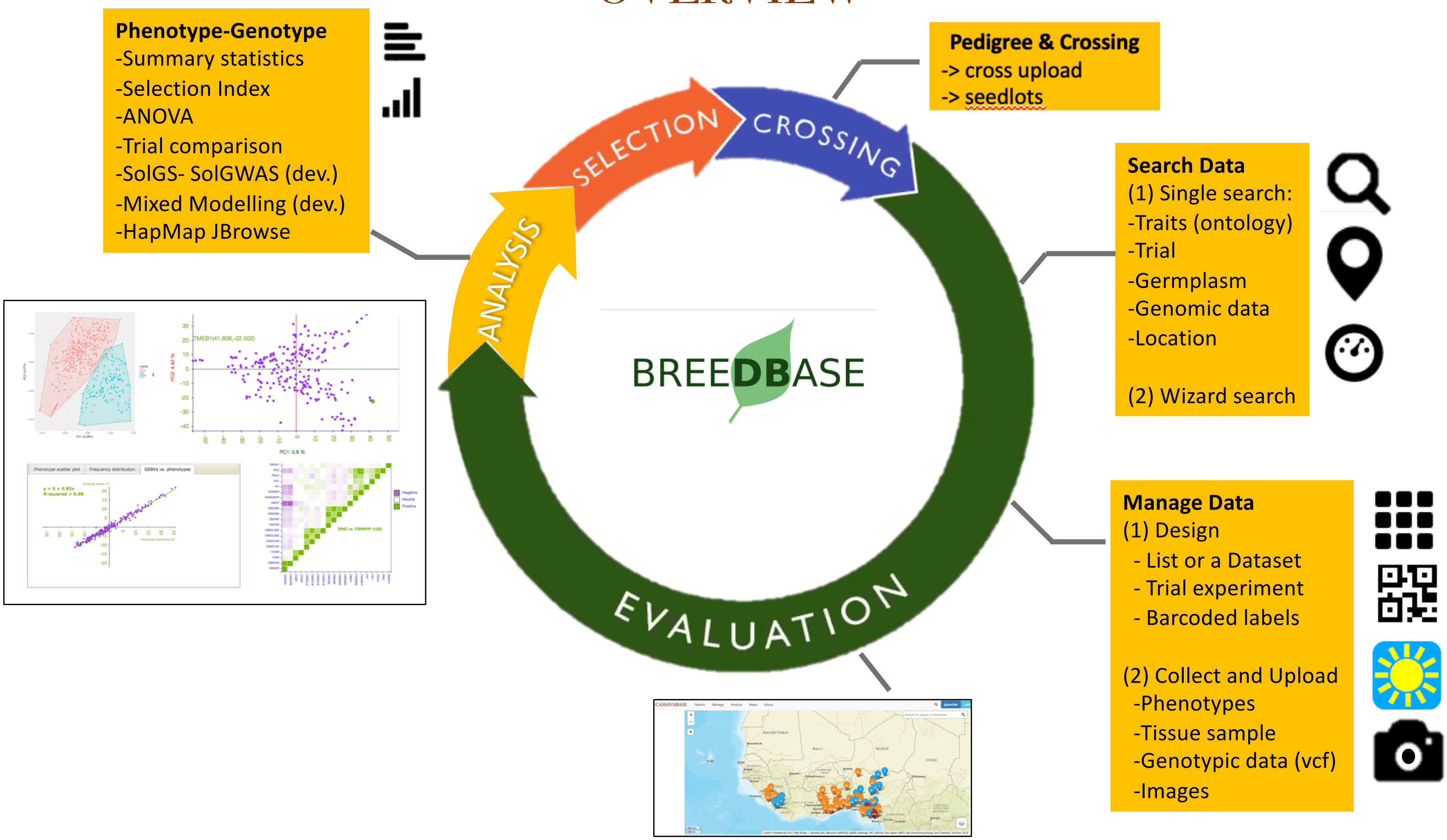
Ontology Post Composing

https://cassavabase.org/tools/compose/



Breedbase: system overview

OVERVIEW


Phenotype-Genotype
-Summary statistics
-Selection Index
-ANOVA
-Trial comparison
-SolGS- SolGWAS (dev.)
-Mixed Modelling (dev.)
-HapMap JBrowse
Pedigree & Crossing
-> cross upload
-> seedlots
SELECTION
CROSSING
ANALYSIS
EVALUATION
BREEDBASE
Search Data
(1) Single search:
-Traits (ontology)
-Trial
-Germplasm
-Genomic data
-Location
(2) Wizard search
Manage Data
(1) Design
- List or a Dataset
- Trial experiment
- Barcoded labels
(2) Collect and Upload
-Phenotypes
-Tissue sample
-Genotypic data (vcf)
-Images

WORKFLOWS

What are you interested in? For General Help

×

Upload Genotypes

Intro — Genotyping Project — Genotyping Protocol — Genotype Info — Confirm

1 2 3 4 5

This workflow will guide you through uploading genotypes into the database

Select a genotyping project on the next screen. This project can represent a series of genotyping plates sent to a genotyping facilty.

Ideally the sample names in your VCF file will match sample names in genotyping plates in the database; however, the sample names in your file can also match accession names in the database.

Curently we support the VCF format for upload.

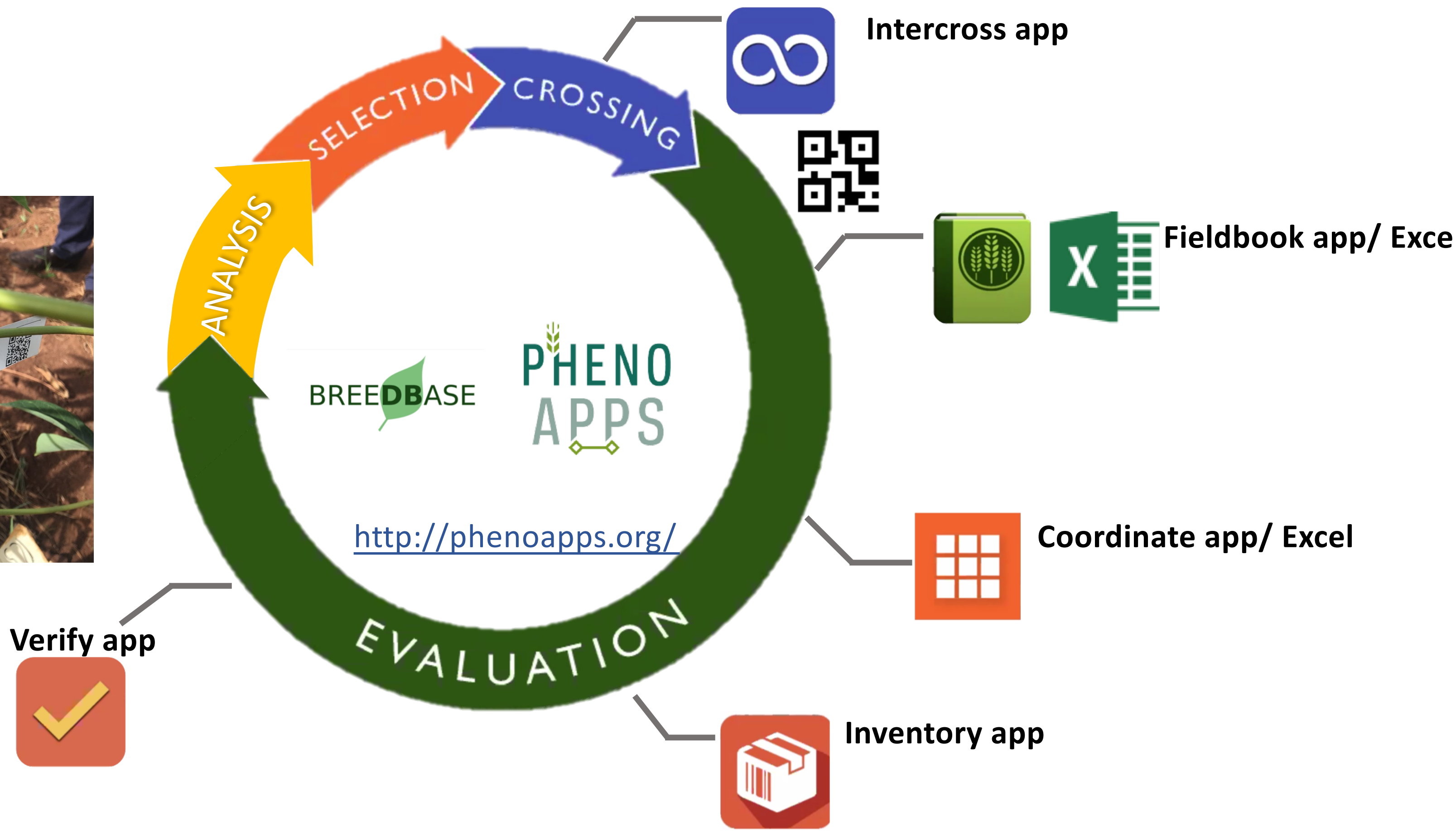
Go to Next Step

Print barcode labels for my experiment (for your plots or plants or tissue samples in the field, or for your 96 well plate and tissue samples) Go

Analyze phenotypic performance across trials Go

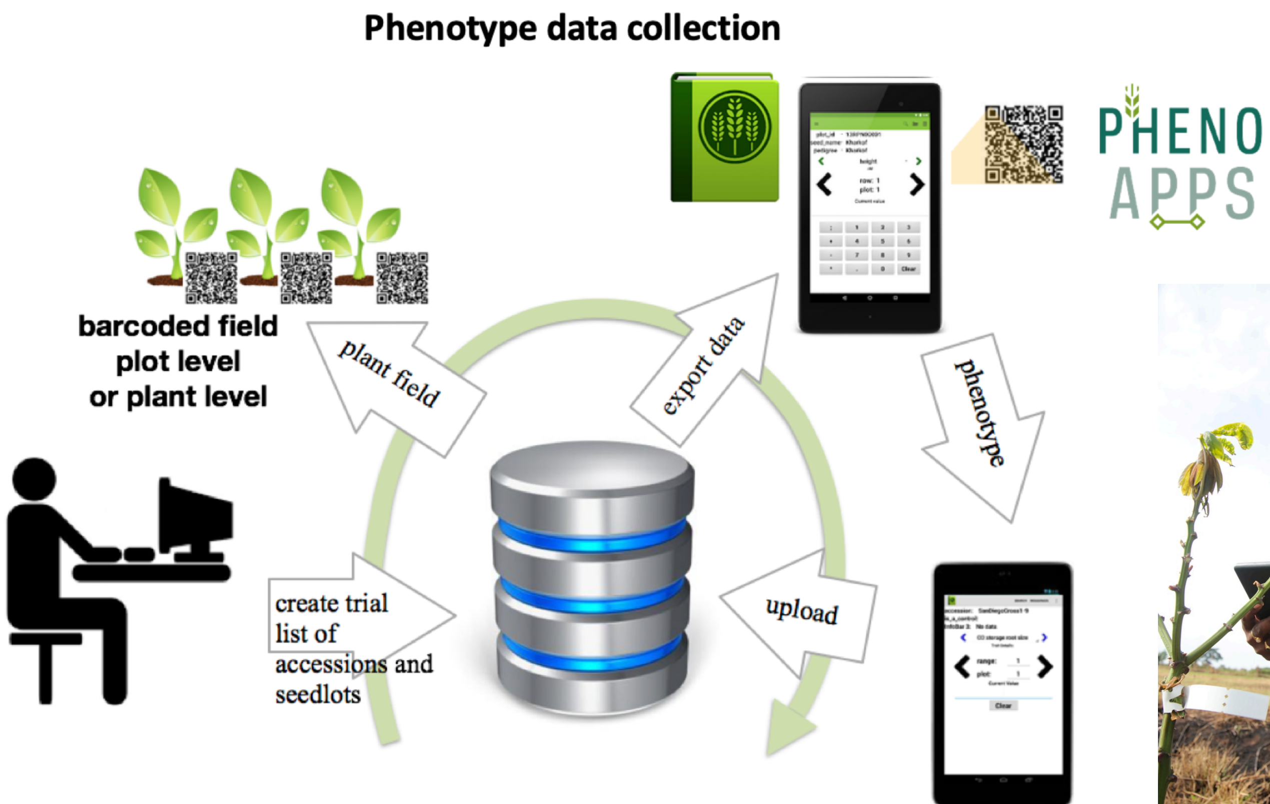
Breedbase – PhenoApps: field applications

Reaching the Field: PhenoApps

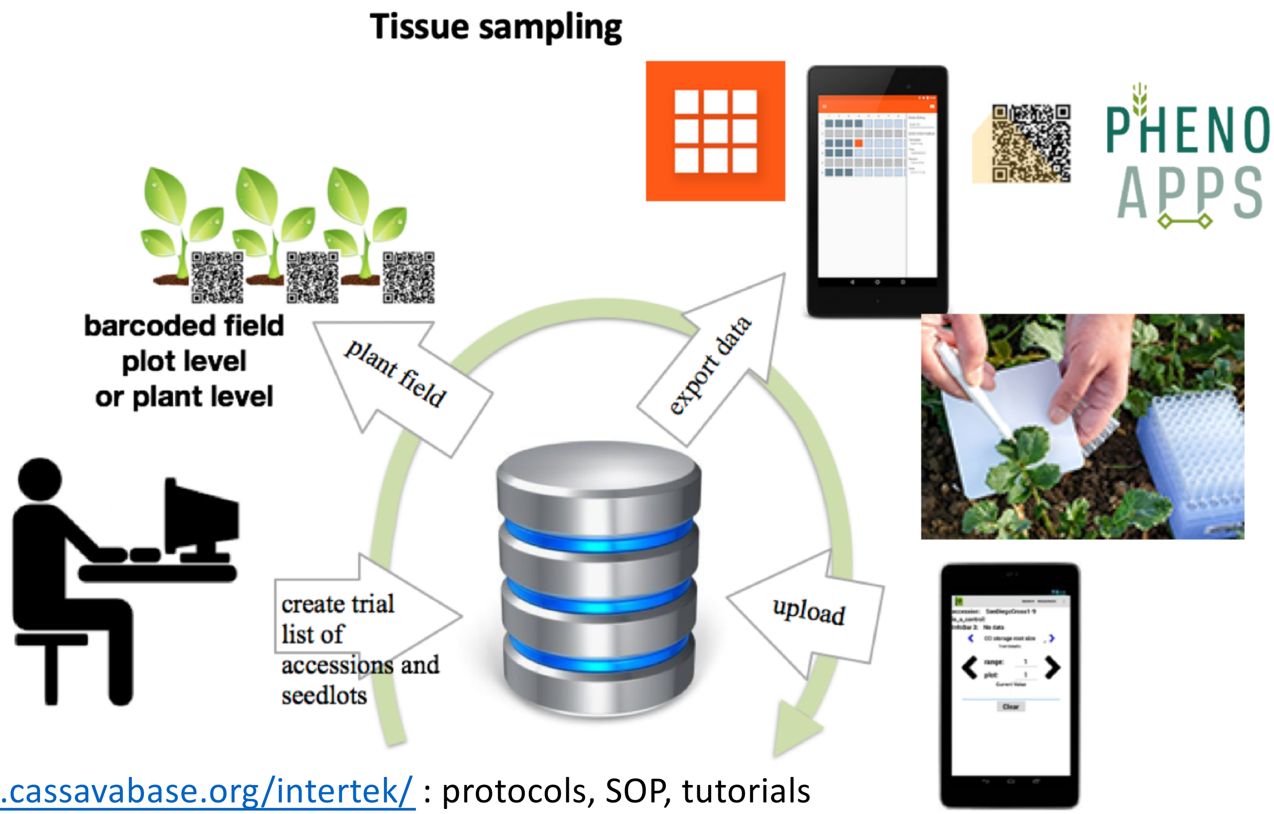


Credits: Trevor Rife, KSU

Phenotypic data collection workflow



Genotypic data collection workflow



ftp://ftp.cassavabase.org/intertek/ : protocols, SOP, tutorials

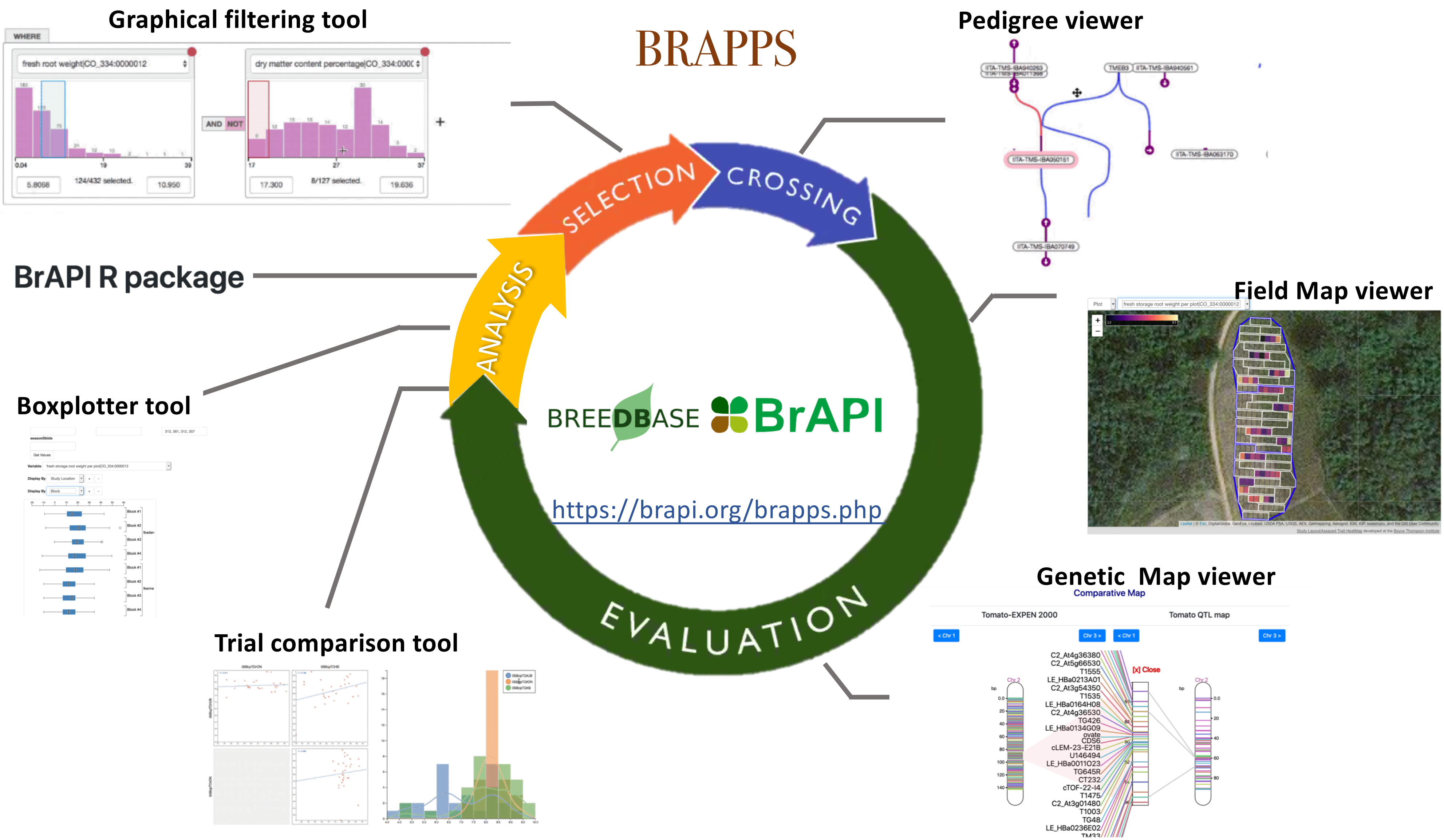
https://cassavabase.org/breeders/genotyping/ : tissue sampling upload interface

Breedbase - Breeding API

Reaching Developers and data sharing tools: BrAPI

- Breeding Application Programming Interface (API)
  - Language support: Brapi.R interface and Brapi.JS
- Data exchange
- New way for coding breeding applications (BrAPPs)
- BrAPPs run on any data backend that supports BrAPI

http://brapi.org/
https://github.com/CIP-RIU/brapi



BRAPPS
Graphical filtering tool
Pedigree viewer
BrAPI R package
Field Map viewer
Boxplotter tool
Genetic Map viewer
Comparative Map
Trial comparison tool
SELECTION
CROSSING
ANALYSIS
EVALUATION
BREEDBASE
BrAPI
https://brapi.org/brapps.php

Engaging communities

NaCRRI UGANDA

TARI + IITA TANZANIA

IITA + NRCRI NIGERIA

Embrapa, Cruz Das Almas, BRAZIL

Cassavabase data content
(as of June 2018)

<u>Germplasm:</u>
217,500 accessions
2,450 images
6366 pedigree

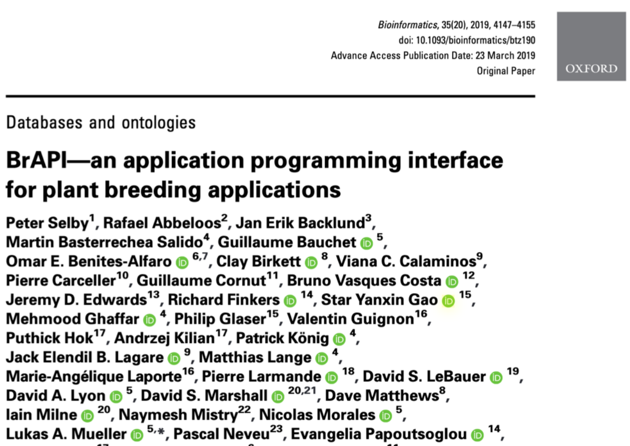
<u>Genotypes:</u>
53,000 genotypes
120 DNA plates

<u>Phenotypes:</u>
207 locations (10 countries)
2,690 field trials
488,000 field plots
71,000 tracked field plants
11,000,000 phenotypes

A DIGITAL ECOSYSTEM FOR BREEDING

2005

2019-2020



Bioinformatics, 35(20), 2019, 4147–4155
doi: 10.1093/bioinformatics/btz190
Advance Access Publication Date: 23 March 2019
Original Paper

OXFORD

Databases and ontologies

BrAPI—an application programming interface for plant breeding applications

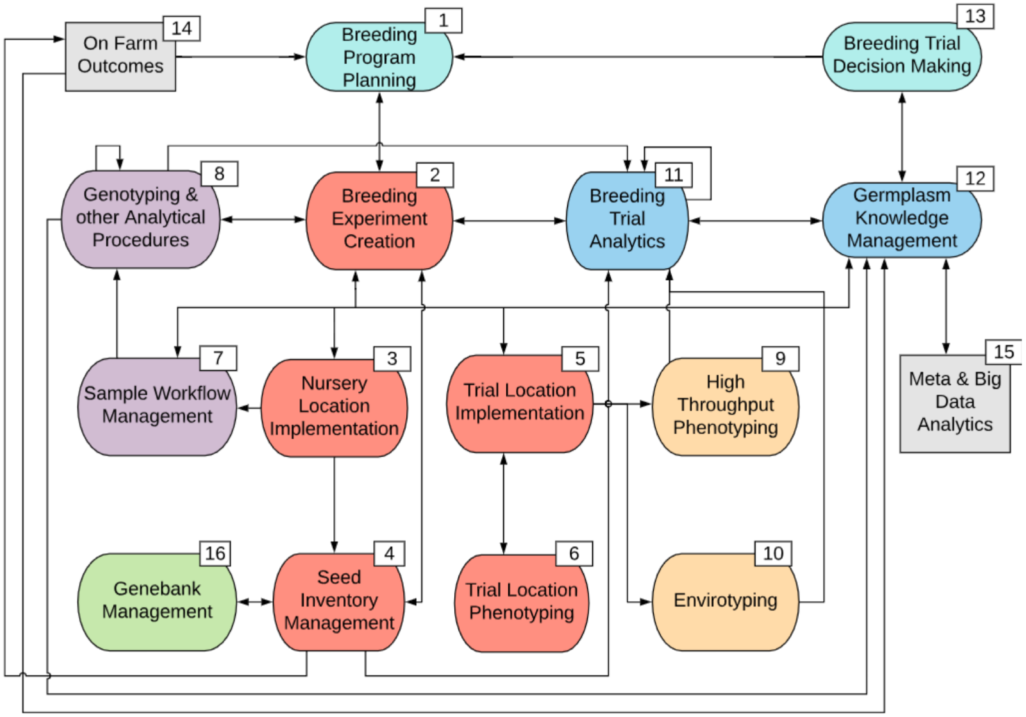
Peter Selby[1], Rafael Abbeloos[2], Jan Erik Backlund[3], Martin Basterrechea Salido[4], Guillaume Bauchet[5], Omar E. Benites-Alfaro[6,7], Clay Birkett[8], Viana C. Calaminos[9], Pierre Carceller[10], Guillaume Cornut[11], Bruno Vasques Costa[12], Jeremy D. Edwards[13], Richard Finkers[14], Star Yanxin Gao[15], Mehmood Ghaffar[4], Philip Glaser[15], Valentin Guignon[16], Puthick Hok[17], Andrzej Kilian[17], Patrick König[4], Jack Elendil B. Lagare[9], Matthias Lange[4], Marie-Angélique Laporte[16], Pierre Larmande[18], David S. LeBauer[19], David A. Lyon[5], David S. Marshall[20,21], Dave Matthews[8], Iain Milne[20], Naymesh Mistry[22], Nicolas Morales[5], Lukas A. Mueller[5,*], Pascal Neveu[23], Evangelia Papoutsoglou[14],

Image data analysis

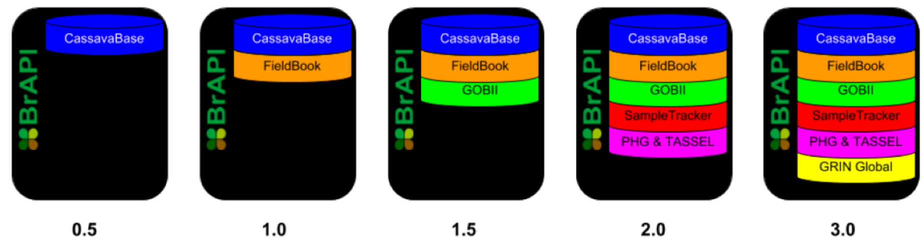
Near Infrared Spectra (NIRS) analysis

Marker QC

What future looks like?



Cobb et al 2019, TAG



BREEDING INSIGHT

https://www.breedinginsight.org/

Online Resources

Looking for code?

BrAPI code: https://brapi.org/

BrApps: https://brapi.org/brapps.php

Breedbase code: https://github.com/solgenomics

Breedbase Docker instance: https://hub.docker.com/u/breedbase

Looking for phenoApps?

PhenoApps: https://github.com/PhenoApps
https://www.youtube.com/playlist?list=PLs7Y2nGwfz4E5_gv1H6Y4imeWDkFJDhIn

Looking for database tutorials or ontology request?

Online manual and videos https://solgenomics.github.io/sgn/
Request new traits: http://submit.rtbbase.org/
Slides: http://www.slideshare.net/solgenomics

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Thank you!

USDA ARS
United States Department of Agriculture
Agricultural Research Service

BILL & MELINDA GATES foundation

UKaid
from the British people

Embrapa

WEST AFRICA CENTRE FOR CROP IMPROVEMENT
WACCI

MAKERERE UNIVERSITY

LZARDI
Lake Zone Agricultural Research & Development Institute

Cornell University

University of Hawai'i

BTI
Boyce Thompson Institute for Plant Research

DFID Department for International Development

IITA Transforming African Agriculture 50 1967 - 2017

NaCRRI
National Crops Resources Research Institute

CIAT

NATIONAL ROOT CROPS RESEARCH INSTITUTE