PHENOAPPS

Open-source Android Apps for Phenotyping

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Abstract

Plant breeding and genetics research is an inherently data-driven enterprise. Typical experiments and breeding nurseries can contain thousands of unique entries and programs will often evaluate tens of thousands of plots each year. Due to temporal and economic limitations, many phenotypes that could prove useful for selection are neglected or collected only on a subset of lines. To operate a modern breeding program efficiently, electronic data capture and management is essential. Many research programs, however, continue to function by scribing and transcribing much, if not all, of their data. This places heavy burdens on human resources, decreases data integrity, and limits future utilization of data. We have developed several open-source apps to increase the speed and robustness of data collection in plant breeding programs. All of our apps run on consumer-grade Android phones and tablets, decreasing the cost to breeders and creating a viable solution for research programs in developing countries. By utilizing a modern mobile operating system, it becomes simple to receive feedback, add requested features, and publish updates. In creating these PhenoApps, we attempt to decrease both technological and cost barriers that hinder adoption of electronic data management in breeding programs. With our open-source, accessible solutions, the vision of one handheld per breeder can become a reality for plant breeding and genetics programs around the world and will enable the transformational capacity essential to achieve a contemporary green revolution.

Field Book[1]

Field Book is used to collect phenotypic data in the field or greenhouse.
- Data can be collected on a trait or entry basis
- Different layouts are used for different traits to optimize data entry
- Traits can be managed directly within the app
- More than 7500 downloads

The main data collection screen (top left). Black arrows move between plots and green arrows change traits. The data entry area, on the bottom half of the screen, changes layout depending on the type of trait being collected. Fields (top center) and traits (top right) can be managed within the app. Different traits utilize different layouts (bottom).


Numeric · Disease · Categorical · Percent · Date · Counter · Boolean · Multicat · Location · Photo
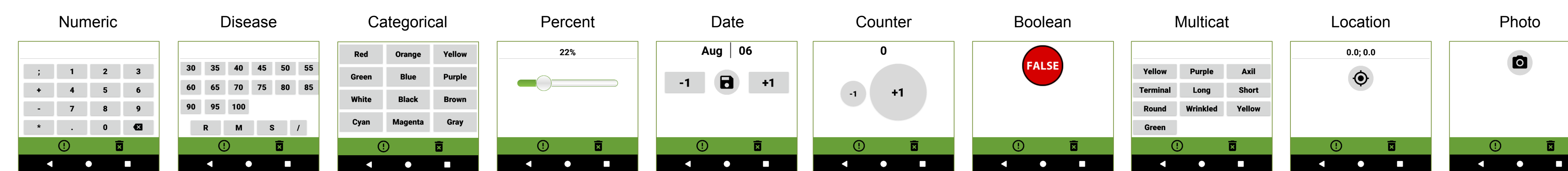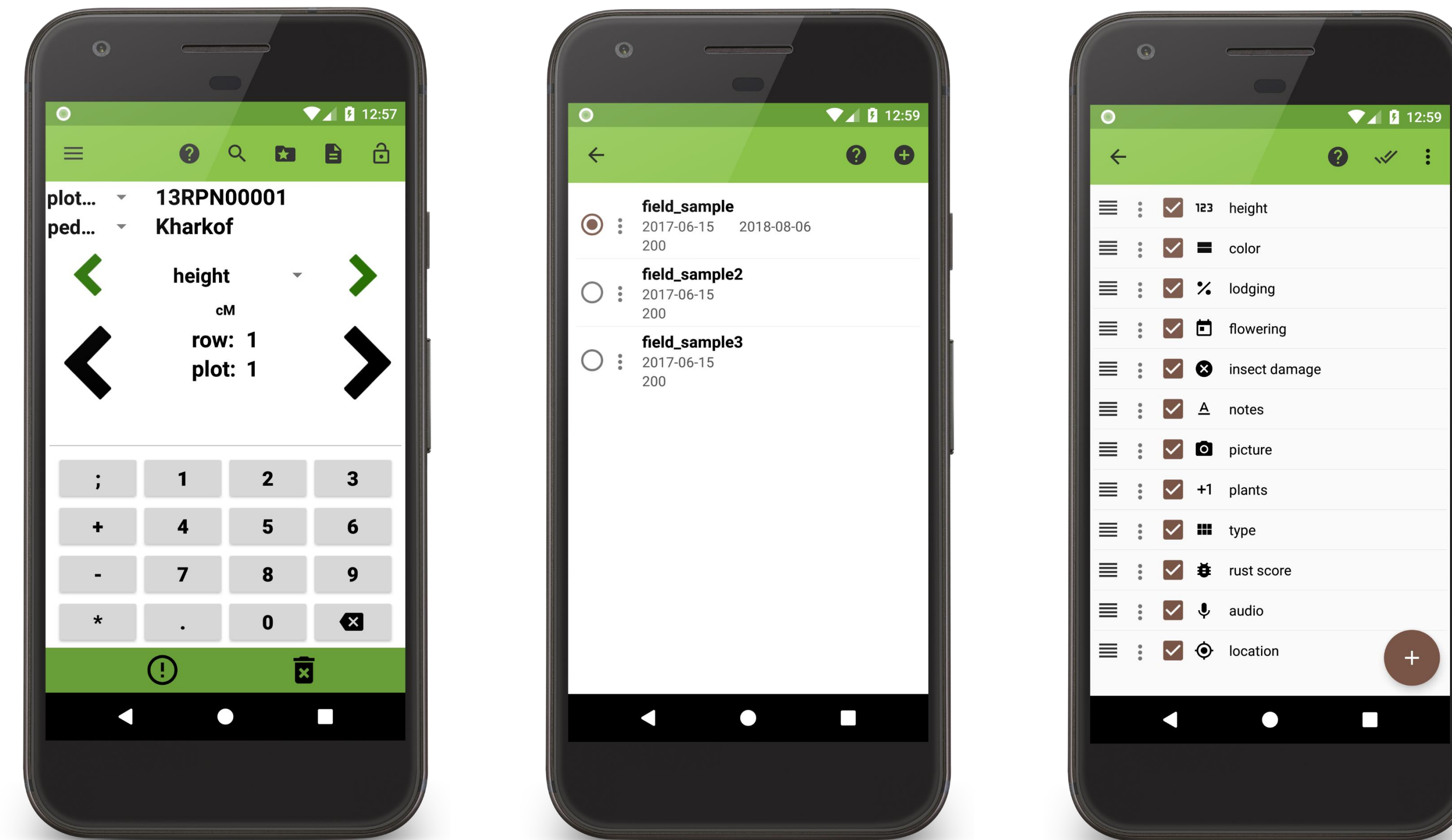
Coordinate

Coordinate organizes data being collected into grids. Grids are created from templates and can be grouped into projects. Templates be customized to include:
- Metadata fields (e.g. Person, Date, etc.)
- Row/column naming (e.g. alphabetic or numeric)
- Exclude cells from being collected

The layout for Coordinate and two different grids in the process of being collected: a seed tray and a microtubule rack commonly used when collecting plant tissue.
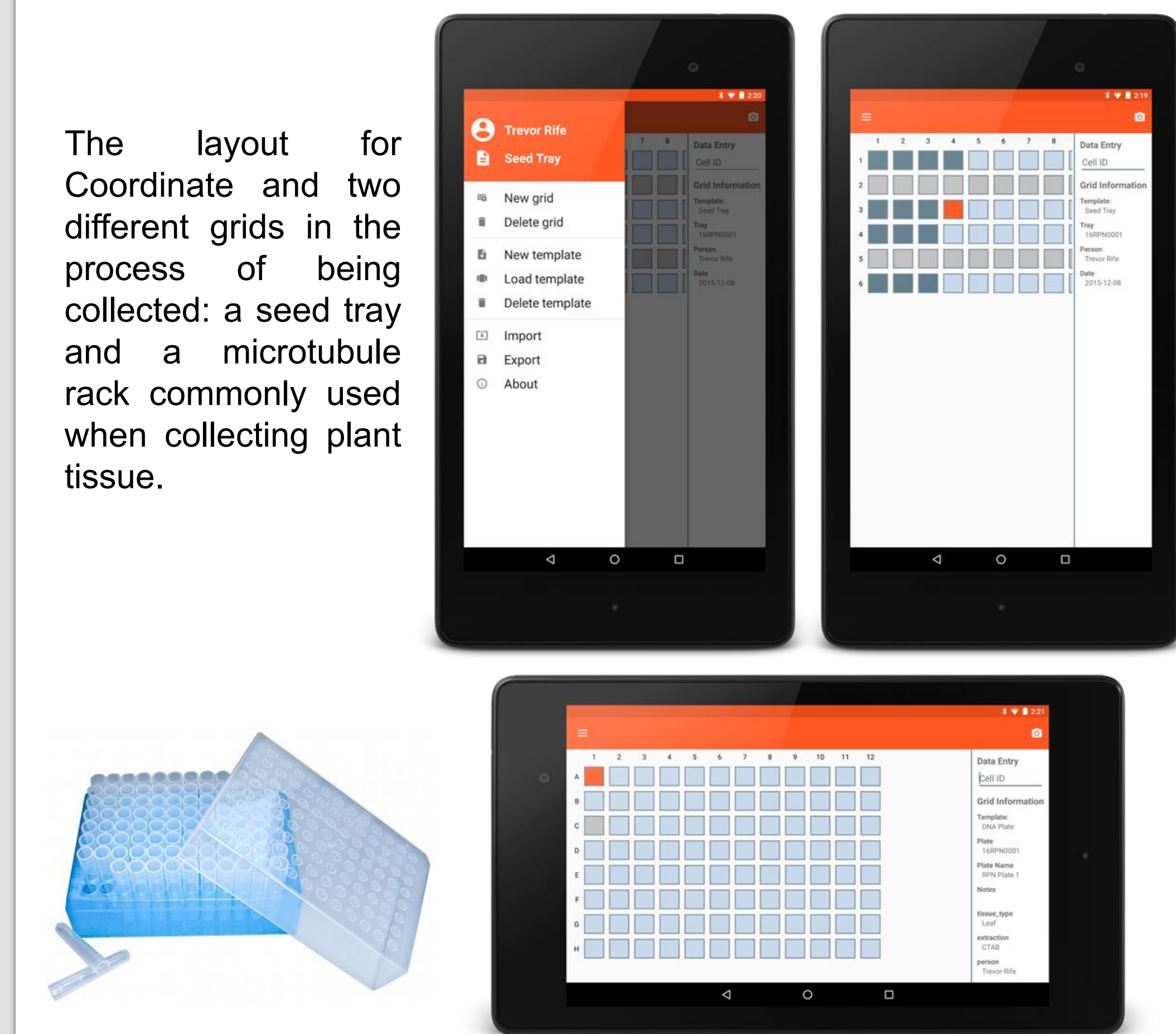
Inventory

**Inventory** pairs with a USB scale to simultaneously organize and weigh samples.
- Metadata also collected (timestamp, person)
- Can be used to collect weight data from harvest samples

Inventory connects directly with a USB scale to simultaneously collect weight data.

Verify

Verify imports a list of entries and uses sample barcodes to interact with the list via different modes:

- Default: show all data from imported file for each entry
- Order: requires samples to be scanned in order
- Filter: removes scanned items from the visible list
- Color: highlights scanned items in the list
- Pair: matches entries in the imported list
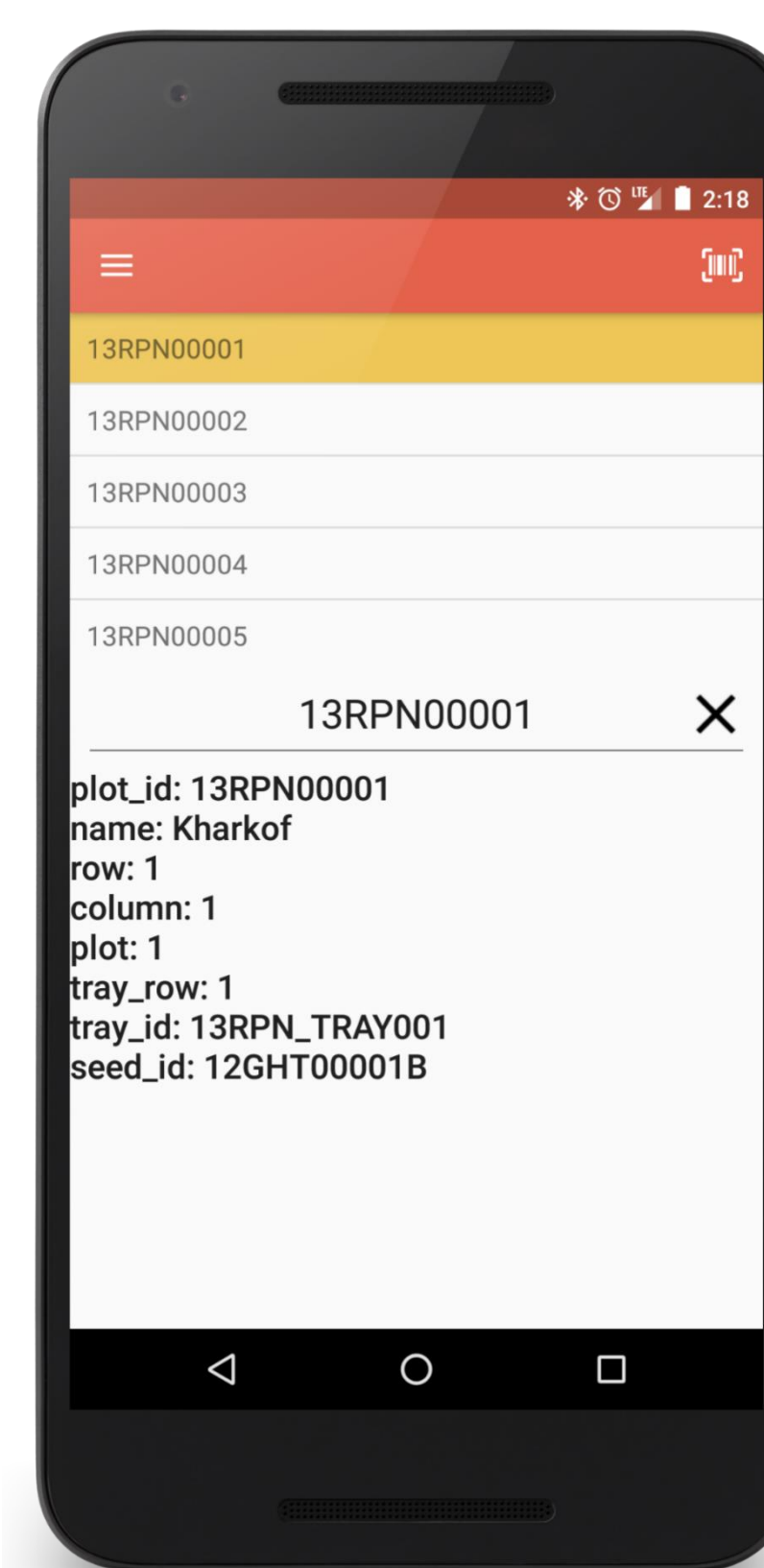
Intercross

Intercross is an upcoming app that will allow breeders to track and manage the crossing portion of their breeding program.

- Manage crossing blocks
- Track parental IDs and the generated cross IDs
- Collect metadata about the cross event
- Print cross labels with barcodes to portable label printer
- Pre-plan crosses and view progress
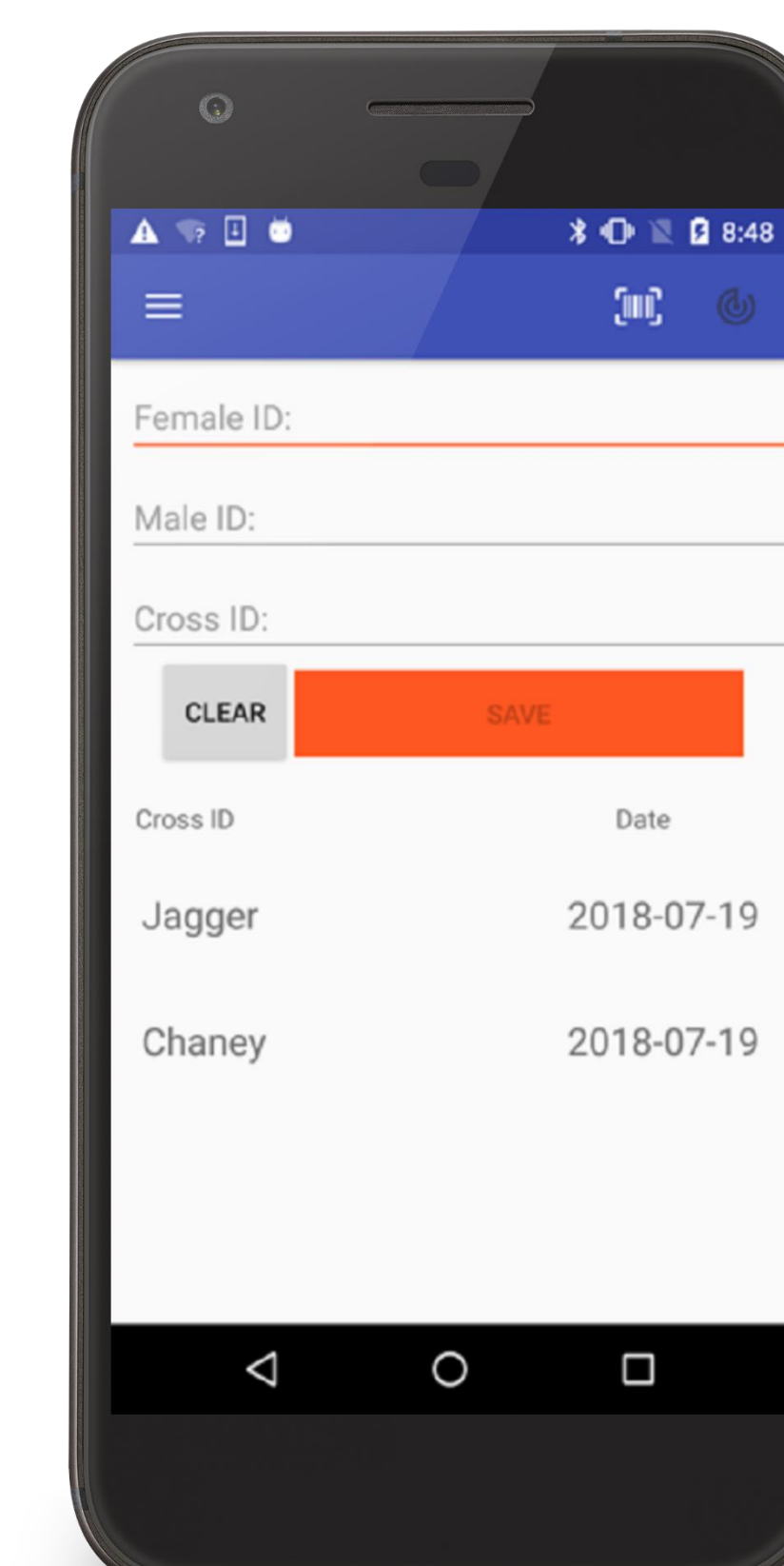
Perspective

Data collection is fundamental to plant breeding and genetics research. PhenoApps have been developed with user-friendly interfaces to increase the speed and accuracy of data collection. The ability to keep data organized will lead to further innovation and growth of plant breeding programs. Implementing electronic data capture into plant breeding programs will be critical to develop improved varieties necessary for a contemporary green revolution. These apps give every breeder access to a robust data collection tools that will enable significant gains in agricultural productivity.

References

1. Rife, T.W., and J.A. Poland. 2014. Field Book: An Open-Source Application for Field Data Collection on Android. Crop Sci. 54(4): 1624–1627.

Acknowledgements