



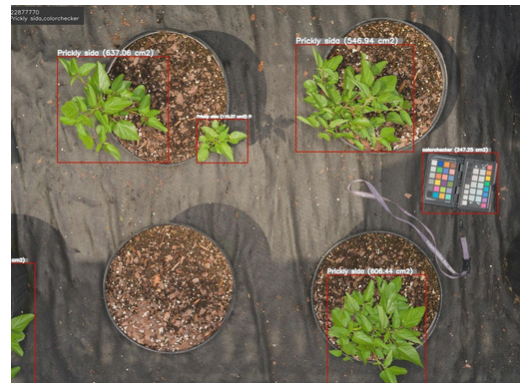
BenchBot

Building the Ag Image Repository to power the robotic revolution in U.S. agriculture

The Challenge: Agriculture is under pressure like never before. Farmers face mounting risks from water scarcity and flooding, pest resistance, and degraded soils, all while fewer producers manage more acres. To keep pace, they need affordable, site-specific precision technologies that boost productivity, cut input costs, and sustain rural economies. The digital agriculture revolution holds the solution—but one barrier stands in the way: **a shortage of large, open-source training datasets**. Agriculture is a million-and-one computer vision problems, and without data, AI cannot solve them. This training-data bottleneck is stalling the robotic revolution in agriculture.

Our Response: Public-sector scientists are bridging the gap. Distributed across the U.S. and embedded in every major cropping system, we are building the **National Plant Agricultural Image Repository (AgIR)**, an open, cloud-based bank of tens of

thousands of high-resolution, metadata-rich images of crops, cover crops, and weeds.



At the center is **BenchBot**, a modular, automated imaging system designed to rapidly generate pre-labeled, AI-ready datasets (left). These datasets flow directly into computer vision pipelines, streamlining annotation and enabling the development of customizable machine learning models for breeding, production research, and on-farm decision tools.

This expanding public resource is already powering affordable, scalable technologies that help farmers detect stress, respond to weeds and pests, and make real-time, data-driven management decisions. **Together, BenchBot and the Agricultural Image Repository are democratizing agricultural AI by making tools that were once proprietary and expensive accessible to all.**

BenchBot is an automated imaging platform that fuels the **Agricultural Image Repository** by capturing high-resolution plant images at scale. Built on a modular, open-source framework, BenchBot delivers a high-throughput, cost-effective way to generate **pre-labeled, AI-ready datasets**. These flow directly into computer vision pipelines for processing and semi-automatic annotation, streamlining the creation of customizable machine learning models for real-world applications. Currently, BenchBot is collecting thousands of images of agronomic crops, specialty crops, and weeds. Together, BenchBot and the Agricultural Image Repository form a growing public ecosystem of **free, cutting-edge AI solutions** to some of the most pressing challenges in U.S. agriculture—and the platform is open for new collaborators.

Learn more about DASH: digitalagsystemshub.org

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BenchBot Specifications

System Overview

BenchBot is more than equipment—it's a **customizable research platform** that brings high-throughput imaging directly to your site. Along with the machine, our team provides **site planning, installation, training, routine service, and troubleshooting** to keep your system running seamlessly. By hosting a BenchBot, you gain access to a **fully integrated pipeline** where high-resolution imagery is captured daily and securely delivered to USDA's **SCINet cluster** (and soon, a mirrored cloud environment for non-SCINet users).

Dataflow

At its core, BenchBot captures **daily, high-resolution imagery**. Because these files are large, a **high-bandwidth internet connection** is required at your site. Data transfers use **Globus**, a secure, high-speed platform trusted across the research community. Once uploaded, imagery will be stored within **SCINet**, USDA's powerful, high-performance computing (HPC) environment for large-scale data analysis. Optionally, data can also be synced to on-premises infrastructure or the cloud. This data can then be processed utilizing SCINet's HPC environment, on-premises servers, or cloud Virtual Machines.

Semi-Field Plot Requirements

Plot needs vary by crop, but some universal requirements include:

- Rectangular open area to fit pots with target plant species.
- Perimeter barrier to keep out animals and unauthorized people.
- The BenchBot pad dimensions can be customized (imaging area slightly smaller):
 - Gantry Width: 12 ft to 32 ft
 - Track Length: 60 ft to 200 ft
- Extra utility space in each direction.
- Irrigation system and appropriate drainage.
- Level, flat ground for BenchBot rails ($\leq 3^\circ$ slope in either direction).
- Most surfaces are acceptable if anchors and rebar can be installed.



Other Required Resources

- **Power:** 240v 30A single phase power source (single leg of 208V 3-phase is also acceptable).
- **Internet:** High-bandwidth internet access (a sustained upload speed of at least 100 megabits per second; ideally 1 gigabit per second).
- **Water:** Sufficient water source for your plants' irrigation needs.
- **Personnel:** Staff available for day-to-day operations.
- **Potting Infrastructure:** Black plastic pots with a peat, bark, and perlite-based potting soil. An added time-released fertilizer, such as osmocote, is ideal.
- **SCINet:** Accounts for users that need data access.