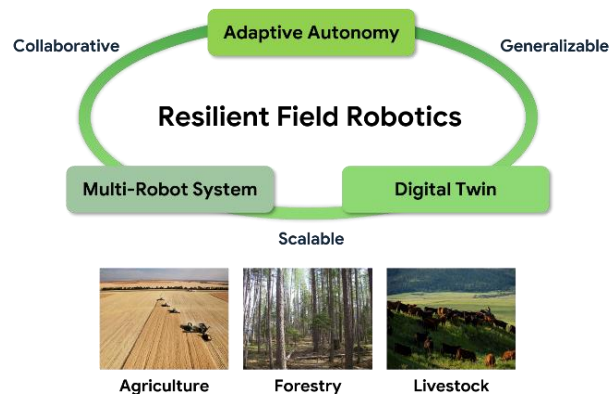


# Field Automation, Robotics, & Machinery (FARM) Laboratory

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The research vision of the FARM Lab is **to develop generalizable, collaborative, and scalable robot autonomy to solve critical global agricultural challenges** like labor shortages, resource constraints, and climate-resilient food production. Looking forward, this core robotic technology will be extended to broader field robotics applications, including forestry and livestock automation.

According to the “Critical and Emerging Technology List Update” by the U.S. National Science and Technology Council, agricultural and robotics technologies are recognized as critical and emerging areas, highlighting their importance for national technological leadership and security. Traditionally, heavy machinery has been widely utilized for farming, but these conventional platforms face challenges in improving efficiency and sustainability under the constraints of finite resources such as water, energy, and agrochemicals. Therefore, precision agriculture requires a paradigm shift, and intelligent robotic technology has emerged as a key solution to drive this transformation.



- 1. Adaptive Autonomy:** Although the state-of-the-art robotic technologies have been widely used in various applications, current autonomy stacks struggle to deploy successfully in agricultural environments with cluttered vegetation and dynamic crop motion. To address this, the FARM Lab focuses on developing an advanced autonomy stack (e.g., localization, mapping, navigation, perception, path planning, and manipulation) leveraging multi-modal sensor fusion to adapt across diverse crop environments.
- 2. Multi-Robot System:** Effectively monitoring and managing large-scale agricultural fields exceeds the capacity of any single robotic platform. The deployment of heterogeneous multi-robot systems is inevitable for scalable farm management. The FARM Lab designs multi-platform robotic swarm systems capable of large-area, multi-scale sensing, where UAVs capture high-resolution aerial data while ground robots execute precise, micro-level tasks in the areas of interest.
- 3. Digital Twin Design:** Agricultural research traditionally has seasonal constraints for field testing. To overcome these temporal limitations and facilitate continuous, off-season research, the FARM Lab builds high-fidelity physics-informed simulation environments calibrated with real-world field data. This digital twin framework enables robust robot learning and reliable sim-to-real transfer.