Embracing Automation in Agriculture: A Workforce Development Strategy for the Future of Farming

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Workforce Readiness Challenge

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Author Note

Data collection and sources were based from the Arm Institute (RoboticsCareer.org). Portions of the findings are presented from other sources. It is important to note that this article is presented by high school students with minimum Research Paper knowledge, please give grace upon citations and reference formatting. Any concerns regarding this article should be addressed to Team 39110A at Germantown High School, Madison, Mississippi.

Abstract

The agricultural industry is undergoing a significant transformation driven by the integration of robotics, artificial intelligence (AI), and automation. As we look to meet the growing global demand for food while addressing problems like labor shortages and resource scarcity, our company is committed to automating key processes in the farming industry. The transition to automation presents both challenges and opportunities for the workforce.

The smart agriculture market, including precision farming, livestock monitoring, and smart greenhouses, is valued at $22 billion globally, with an expected yearly expansion of 13.7%. Meanwhile, the agricultural robot market—which reduces workload and human errors—is valued at $11 billion and is projected to grow even faster, at a 20% yearly rate. More than half of the crops, including corn, cotton, rice, sorghum, soybeans, and winter wheat, produced in the United States have been cultivated using advanced automated guidance technology (Greason, 2024), totaling nearly 334 million tonnes.[1]

This white paper outlines our strategic approach to automating important agricultural processes, developing a skilled workforce through training and professional development, and implementing a recruitment strategy aimed at attracting the next generation of skilled workers. Additionally, we will present a cost-saving outlook highlighting the financial benefits of automation in agriculture. By leveraging resources such as RoboticsCareer.org and Automate.org, we will ensure that our workforce evolves alongside technology, empowering both current and future employees to succeed in the newly automated agricultural industry.

[1] 334000 kilograms

Method

1. The Need for Automation in Agriculture

Agriculture serves as one of the most essential industries in the global economy; however, the industry faces increasing pressure to improve productivity, reduce environmental impacts, and address labor shortages. The rapidly growing global population, combined with climate change and diminishing resources, makes it clear that traditional farming models are unsustainable. As a result, automation has emerged as a key solution to these challenges.

From autonomous tractors to robotic harvesters and drones for crop monitoring, automation has the potential to revolutionize the way we produce food. However, to shift toward an automated agricultural system, it will require a transformation of the workforce. While automation promises efficiency gains and increased productivity, it also demands employees with new skills to manage, operate, and maintain automated systems. The ARM Institute has been providing valuable resources to help define these competencies and identify training and recruitment strategies to ensure workforce qualities and demands for the future (RoboticsCareer.org, 2000s).

2. Identifying the Agricultural Process: Robotic Harvesting and Automated Crop Management

The first step in our automation strategy is to implement robotic harvesting and automated crop management. This process will involve replacing traditional manual labor in harvesting tasks such as fruit and vegetable picking. These robots are designed to use sensors and cameras to detect when crops are ready to be picked (Bernier, 2023). Because harvesting robots are stationary, they are often paired with a mobile unit or a robotic transport unit[2] (RTU).

[2] Industrial machines used to automatically move materials between workstations.

Other automated applications aiding the agricultural industry include weeding robots, seeding and planting robots, and fertilizing robots. These robots autonomously navigate through fields and perform specific tasks to increase productivity and reduce human errors. Precision agriculture also reduces the environmental impact of the industry by promoting healthier food systems and reducing the use of chemical pesticides by 50% and fertilizers by 20% (Greason, 2024).

3. **Competency Mapping for Employee Success**

Automation will replace many manual tasks in harvesting and handpicking crops, leading to a decrease in demand for seasonal labor and workforce jobs. Every year, fewer people are seeking employment in agriculture. Over the last 10 years, more than 2.5 million employees have left the agriculture industry globally. By 2030, a 3% annual decline in management and worker positions is expected (Petruk, 2024). Labor shortages have already resulted in extreme economic losses due to increased food waste and exacerbated food insecurity. More than $73 million worth of food was wasted on farms in 2022, including $27 million in fruits and vegetables (Petruk, 2024).

However, with automation, new roles will be created, including robotic systems operators, maintenance technicians, data analysts, and automation engineers. This shift will foster new employment opportunities in the growing tech-driven agricultural sector and boost economic growth. These new positions will require workers to have a deeper understanding of both agriculture and advanced technologies. To ensure that our workforce is ready for this transition, it is critical to define the competencies[3] required for the emerging roles. We will partner with the ARM Institute and map competencies with RoboticsCareer.org. Additionally, partnerships with universities and technical institutions will be pursued.

[3] The knowledge, skills, abilities, and behaviors that contribute to individual and organizational performance.

Competencies for Key Roles:

Robotics Technician: Knowledge of robotic arms, autonomous harvesters, and related agricultural machinery, along with troubleshooting and maintenance skills. Training and certifications in robotics maintenance and system diagnostics tailored for agricultural applications (RoboticsCareer.org, 2000s). Recommended course: Automation and Robotics Training, Horizon Science Academy Columbus, 1070 Morse Rd, Columbus Ohio 43229.

Agricultural Automation Specialist: Expertise in autonomous vehicles, robotic harvesters, irrigation systems, and drones. Ability to manage and operate these systems efficiently. In-house training and external certifications focusing on agricultural automation machinery (RoboticsCareer.org, 2000s). Recommended course: Agricultural Systems Technology, Iowa State University, 2321 Elings Hall, 605 Bissel Road, Ames, Iowa 50011.

Data Analyst: Proficiency in analyzing data from sensors, drones, and automated systems to interpret crop health data[4] and provide actionable insights. Partnering with the ARM Institute to find specialized courses in agricultural data analytics and AI-driven farming systems (RoboticsCareer.org, 2000s). Recommended Course: Automated Manufacturing Systems Technology, Fox Valley Technical College, 1825 N. Bluemound Drive, P.O. Box 2277, Appleton, Wisconsin 54912.

Agricultural Engineer: Expertise in designing and optimizing automated farming systems with a solid understanding of robotics, IoT[5], and data systems in agriculture. Collaboration with universities offering agricultural engineering and robotics programs (Shutske, Plaster, Pinzón, 2025).

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[4] Measures vegetation health by analyzing the difference between near-infrared and visible light reflected by plants.

[5] Internet of Things, refers to the collective network of connected devices and the technology that facilitates communication between devices and the cloud, as well as between the devices themselves.

Current employees will be trained alongside experienced robotics technicians to ensure hands-on experience with the new systems. Employees will also be encouraged to enroll in various of online courses for agricultural automation systems, robotics programming, and maintenance (RoboticsCareer.org, 2000s). After completing training, employees will be awarded certifications recognizing their competency in agricultural robotics, further enhancing their qualifications and job security.

4. **Comprehensive Employee Training Program**

The transition to a fully automated agricultural systems requires not only new roles but also significant upskilling of the current workforce. Our training program will ensure that all employees are equipped with the necessary skills to operate, maintain, and innovate within an automated system. The program is designed to be comprehensive, with clear objectives and step-by step processes, ensuring measurable outcomes for workforce readiness.

a. **Training Objectives:** We will equip employees with the skills to operate and maintain automated systems, support career growth, and ensure technological literacy.

b. **Training Phases,** *Figure 1.*:

Phase	Objectives	Key Activities
Phase 1: Orientation (0-6 Months)	Familiarize employees with the vision and adoption of automations in agriculture.	1. Introduction to Agricultural Automations 2. Technology Awareness Sessions 3. Safety Protocols
Phase 2: Skill Development	Build practical expertise in using and maintaining	1. Robotics System Training

(6-12 Months)	automated systems, focusing on specific roles.	2. Simulations and Virtual Training 3. Mentorship Program
Phase 3: Specialized Training (12-24 Months)	Objective: Develop expertise in areas like system diagnostics, data analytics, and machine applications.	1. Robotics Technician Training 2. Agricultural Automation Training 3. Data Analytics 4. Automation Engineering
Phase 4: Continuous Development (Ongoing)	Ensure employees stay up to date in technology advancements and improve agricultural automations skills.	1. Industry Certifications and Recertifications 2. Internal Knowledge Sharing 3. Advanced Learning Programs

c. **Measurable Outcomes and Evalution:** To ensure that the training program achieves its objectives, we will establish clear metrics to measure success. Employee certification rates will be tracked and kept on file for those who have completed certifications in robotics, automation, and agricultural systems technology. We will conduct quarterly skill assessments to evaluate employee proficiency in operating and maintaining automated systems. Long-term retention rates will be monitored among trained employees to ensure a return on investment and job satisfaction. Improvements will be measured by the performance and effectiveness of automated systems. Lastly, we will gather feedback from employees regarding the training and adjust future sessions to better meet their needs.

d. **Resources and Partnerships:** To support this training program, we will leverage outside resources and partnerships, such as

- **RoboticsCareer.org**: Certification and specialized courses in agricultural robotics and automation.
- **Technical Institutions:** Partnering with universities and technical colleges for access to cutting-edge research, training facilities, and professional instructors.
- **Industry Partnerships:** Collaborating with robotics manufacturers and tech companies to keep up to date with training contents and technological advancements.

5. **Professional Development Resources**

In addition to core competencies, continuous professional development is important to ensure that employees stay up to date with the latest advancements in agricultural automation. This can be offered through online platforms (RoboticsCareer.org, 2000s) in agricultural technology, robotics, and engineering. Mentorship programs can be created within the company to bridge the knowledge gap between traditional farming practices and automation technologies. Specialized leadership training will also be provided for employees transitioning into managerial roles, such as overseeing automated systems or managing robotics teams.

6. **Recruitment Strategy to Attract New Talent**

As we integrate automation into our agricultural processes, it is essential to recruit new talent with the skills needed to operate and maintain advanced technologies. Our recruitment strategy will focus on the following components:

Recruitment Plan:

a. **University and Technical School Partnerships** (RoboticsCareer.org, 2000s):

- Universal Robots, California: on Education Robotics Training (Workforce Certificate)
- Lincoln Laboratory – MIT: on Autonomous Systems and Controls Co-op (Academic Credits)
- SWPA BotsIQ: on Robotics Technician Pre-Apprenticeship (Academic Credits, Apprenticeship)
- Indiana University Bloomington: on Data Science – Certificate (Certificate of Completion)
- Association for Advancing Automation: on A3 Certified Robot Integrator Program (Certificate of Completion)
- Cleveland Community College: on Automation Systems Certificate (Certificate of Completion)

b. **Clear Job Descriptions**: We will develop and provide detailed job description for automated roles such as roles listed in **Competency Mapping for Employee Success (3.),** specifying the technical skills and experience required for the job.

c. **Internships and Apprenticeships**: Internship programs will be launched for students from technical schools to gain hands-on experience with automated systems and potentially secure long-term employment within the company.

d. **Promoting Career Pathways**: We will emphasize career growth opportunities in automation, highlighting the tech-driven future of agriculture and the potential for advancement through continuous learning and certification programs.

7. **Cost-Saving Outlook for the Industry**

The shift toward automation in agriculture presents a significant opportunity for long-term cost savings and increased efficiency. The agricultural robot market size is projected to grow from $12.2

billion in 2024 to $139.4 billion by 2035 (Sharma, Rishav, 2024), representing a compound annual growth rate (CAGR) of 24.78%.

Agriculture Robot Market: Report Attributes/Market Segmentations, *Figure 2***.,** (Sharma, Rishav, 2024)

Key Report Attributes	**Details**
Historical Trend	Since 2019
Forecast Period	Till 2035
Current Market Size (2024)	$12.20 Billion
Markey Size Value by 2035	$139.42 Billion
CAGR (Till 2035)	24.72%
Type of Robot	Automated Harvesting Systems Driverless Tractors Milking Robots Unmanned Aerial Vehicles (UAVs) Other Robots
Type of Offering	Hardware Services Software
Type of Farming Environment	Indoor Outdoor
Type of Farm Products	Field Crops Fruits and Vegetables Livestock Others

Type of Application	Dairy and Livestock Management Field Farming Harvest Management Irrigation Management Pruning Management Soil Management Others
Type of Distribution Channel	Direct Sales Indirect Sales Leasing / Rental Model Robot-as-a-Service (RaaS)
Type of Farm Size	Small-scale Farms Medium-scale Farms Large-scale Farms
Geographical Regions	North America Europe Asia Latin America Middle East and North Africa Egypt Rest of the World Australia New Zealand Other countries

Leading Market Players	AGCO Abundant Robots AgEagle Aerial Systems AgJunction Auroras

While the initial cost of implementing robotic harvesters, drones, and autonomous vehicles may seem high, it is a crucial investment for future growth. The increase in focus and investment in agricultural machinery will continue to drive innovation within the sector (Sharma, Rishav, 2024). Furthermore, automation will reduce the need for seasonal labor, a significant cost in agriculture. Robotic systems can work around the clock, improving harvest efficiency and reducing labor costs.

Automated systems can also harvest crops faster and with greater precision, leading to higher yields and less waste. Additionally, automation allows for more efficient use of resources such as water, fertilizer, and pesticides, reducing waste and costs. The financial benefits from automation—lower labor costs, increased yield, and optimized resource use—will lead to a positive return on investment within 3 to 5 years.

Result

The automation of agriculture represents a transformative opportunity for the industry. By adopting advanced robotics and automation technologies, we can address labor shortages, improve productivity, and create a more sustainable farming environment. This paper has outlined a comprehensive strategy for developing the competencies needed in our workforce, attracting new talent, and achieving significant cost savings. Leveraging resources and partnerships from the ARM

Institute and RoboticsCareer.org, we are confident that our transition to automation will drive long-term success, ensuring that both our employees and our company are prepared for the future of farming.

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