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United States Department of Agriculture
Project Initiation

Project Data for Accession Number 1032997

Project Title

Labor, Efficiency, Automation, and Production: LEAP Nursery Crops Toward Sustainability

Project Details

Sponsoring Institution National Institute of Food and Agriculture	**Project Status** ACTIVE
Funding Source NIFA Non Formula	**Grant Year** 2024
Grant No. 2024-51181-43291	**Cumulative Award Amt.** $9,825,677.00
Proposal No. 2024-05427	**Multistate No.** (N/A)
Project Start Date Sep 01, 2024	**Project End Date** Aug 31, 2029
Program Code [SCRI] Specialty Crop Research Initiative	

Project Director

Lebude, A.

Recipient Organization

NORTH CAROLINA STATE UNIVERSITY
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Performing Department

(N/A)

Non Technical Summary

LEAP received USDA-SCRI planning grant 2020-51181-32137 and found that labor availability is the most critical sustainability challenge facing nursery crops producers, a labor-intensive industry that includes potting, pruning, staking, scouting, weeding, taking inventory, harvesting, and loading orders. Nursery crop production relies heavily on full-time workers augmented by seasonal employees. Scarce availability among both is limiting producers from facilitating rural prosperity and economic development. Despite the acknowledged advantages of automating repetitive tasks, overall adoption of innovations in nurseries is low due to few mechanisms designed specifically for nursery crops, and no reliable, consistent decision-making aids to determine economic feasibility. LEAP's long-term economic benefit is a sustainable US nursery industry that is more resilient to labor shortages and that drives economic growth of rural communities. LEAP's trans-disciplinary team will 1) Develop new automation and evaluate existing automated nursery technologies that improve labor efficiency; 2) Evaluate socioeconomic impacts of automation and develop

decision-making tools to inform adoption strategies that optimize the limited available labor; 3) Develop a route to accelerate automation adoption for growers by mapping diffusion of current innovations through their information-sharing networks; 4) Assess consumer preference and willingness to pay for impacts to economic, environmental, or worker health benefits by augmenting tasks with automation; and 5) Educate stakeholders with LEAP resources to increase awareness and accelerate adoption of automated nursery technologies. LEAP's outcomes will strengthen private land stewardship and rural economies by accelerating automation adoption, improving worker experiences, attracting available labor, and creating higher skilled positions thereby maximizing sustainbaility of US nurseries.

Animal Health Component

Animal Health Component: 0%

Research Effort Categories

Basic	50%
Applied	30%
Developmental	20%

Classification

Knowledge Area (KA)	Subject of Investigation (SOI)	Field of Science (FOS)	Percent
111	2110	1060	10%
803	2110	1060	10%
211	2110	1060	10%
402	2110	2020	40%
601	2110	3010	20%
204	2110	1060	10%

Knowledge Area

[111] Conservation and Efficient Use of Water

[803] Sociological and Technological Change Affecting Individuals, Families, and Communities

[211] Insects, Mites, and Other Arthropods Affecting Plants

[402] Engineering Systems and Equipment

[601] Economics of Agricultural Production and Farm Management

[204] Plant Product Quality and Utility (Preharvest)

Subject Of Investigation

[2110] Ornamental trees and shrubs

Field Of Science

[1060] Biology (whole systems)

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[2020] Engineering

[3010] Economics

Keywords

robotics feasibility laser invention nursery crops employee health wellness engagement producer

Goals / Objectives

Our goal is to develop new automation and through better understanding of diffusion of innovation stimulate adoption of existing technologies to study their effects on the remaining system components, including consumer preference at the retail level and the effect of labor retention and re-allocation as a buffer against ongoing labor scarcity. The teams created for this project will work collaboratively with the advisory board, stakeholders, producers, county and regional Extension staff, and allied industries to accelerate the diffusion and impact of automation adoption through nurseries and their workers to illustrate technology's inherent effect on output, labor efficiency and productivity, revenue, rural economics, and nursery sustainability.

Project Methods

Obj 1.1a ANDREW Autonomous Nursery Driving Robot for Eliminating Weeds. Evaluation: Build three prototypes in Y 1-3. Prototypes will be tested by LEAP and collaborators and at ETREC for payload. Tests will evaluate autonomy accuracy of navigation on multiple surfaces and precision spraying functions. After testing and AB feedback, we will pursue commercialization through technology transfer to Moss Robotics, Inc.Obj 1.1bPIPER a Pot-in-Pot (PNP) Extraction Robot. During Y 1-3, we will test PIPER's hardware in field conditions at ETREC and optimize the mobile platform using Farm-ng's Amiga. In Y 3-5, PIPER will incorporate the vision system for object I.D. and localization. Evaluation: PIPER will be tested in nurseries by randomly selecting rows and trees. The Phase-II design output is a prototype robotic platform that can navigate within row, I.D. and localize a target plant pot nested within a socket pot for harvest.Obj 1.1c TALI a terrestrial automatic laser-based inventory system. Evaluation: Accuracy of TALI will be validated with artificial objects and live trees at various travel speeds under both laboratory and field conditions. Field experiments every 2 weeks beginning in dormancy on 3 one-acre blocks, with or without bamboo and fiberglass stakes on 8 nurseries will test the standard nursery practice of manually counting and measuring height, canopy dimensions, and caliper.Obj 1.1d A-IPM Artificial Intelligence Pest Monitoring system for early detection of Japanese maple scale. Evaluation: The presence/absence success rate of the scouts and A-IPM will be compared using a generalized linear model fitted to a binomial distribution. Over on-farm tests with producers and commercialization collaborators (e.g., Moss.ai, Farm.ng, Clearpath Robotics™) we will identify a threshold for successful diagnosis of JMS infestation at different distances and densities of infestation.Obj 1.2.1&2&3Evaluate existing herbicide, fertilizer, and irrigation ANTs.Application technologies will be tested at 6-8 nurseries across FL, NC, TN and OR.Obj 2.1&2 Socioeconomics (SE) Increase the adoption of automation and technology (ANT) through the development of SE information and tools to help firms make informed decisions. Partial budget and scenario analysis valuation data will be collected from 21 nursery firms in key production areas using case studies, and evaluated and validated by a firm panel approach and personal interviews with stakeholders and Extension agents. Workers from 4 nursery operations with different levels of ANT will be surveyed to assess: 1) worker job satisfaction; 2) beliefs/experiences related to the replacement of tasks by ANTs' 3) beliefs/experiences related to changes in worker efficiency and productivity-related to ANT adoption; 4) beliefs/experience related to changes in worker health associated with ANT adoption; and 5) impacts of ANTs on family life and overall well-being. Changes in the number of workers employed on the farm over time, changes specifically related to the adoption of ANT systems and changes in worker availability will be collected. Eight semi-structured interviews (2 interviews x 4 operations, with workers at different managerial levels). Using qualitative analysis, we will assess the trade-off between changes in the number of workers employed and changes in workers' perceptions related to job satisfaction, wellness, and productivity. Interviews and discussions will be analyzed with NVivo qualitative analysis software.Obj 3A&B Behavioral Adoption (BA) Develop routes to ANT adoption for firms

and map growers' information-sharing networks that accelerate adoption. Use qualitative focus groups and quantitative survey methods, purposive sampling to recruit innovative individuals and use individual interviews to quantitatively capture perceptions associated with adoption of ANTs including relative advantage, compatibility, complexity, trialability, and observability, motivators and outcomes, barriers, and other social factors, including normative influences drawn from specific referent groups. Use social network analysis (SNA) to visually map a social system using UCINET to generate a matrix representing the flow of information about ANTs. Qualitative data will be analyzed using the constant comparative method to identify themes pertaining to adoption, multivariate analyses to identify which variables predict respondents' adoption or nonadoption of specific ANTs.Obj 4.1&2&3 Consumer Preference (CP) Assess consumer knowledge and preference for potential impacts of ANTs in nurseries. An online discrete choice experiment (DCE) will elicit preference and willingness to pay (WTP) estimates from 4800 people. DCE results will be analyzed using mixed logit models to determine how the attributes influence consumers' probability of choice and how perceptions impact their plant selections. Eye-tracking experiments will assess how ANT and employee well-being related information at the point-of-sale influences consumer purchasing behavior and WTP for nursery plants. Two national surveys will be guided by Grunig's Situational Theory of Publics to identify audience segmentations based off issue involvement and ANT knowledge. The Elaboration Likelihood Model of Persuasion will framework the second survey to identify how messaging influences consumers' attitudes and purchasing intent of plants produced with ANTs.Obj 5 Extension, Outreach and Science Communication (EX) Analysis of Results: Outreach activities and products are coordinated and evaluated by LEAP's Extension Management team and collaborators every four months, then presented to the AB at annual meetings. Descriptive statistics, e.g., downloads, site visits, will be recorded for print resources, videos, project websites, decision-aid tools, and publications. Where thorough data is collected (i.e., seminars, webinars, LLC, tours) a standardized evaluation tool developed by CI Warner will evaluate adoption through the Transtheoretical Model of Change as a non-linear series of stages in contrast to an all-or-nothing approach.5.1 Increase awareness and educate stakeholders about new ANTs to improve labor efficiency. LEAP will organize 10 field days and 6 to 8 tours over five years at multiple US locations and Europe to showcase ANTs in operation. CI Altland will organize an AI and Automation in Nursery Crops conference. Ivers will produce 60 minutes of video. 5.2 Develop digital and printed resource materials and case studies to inform grower decisions about ANT adoption. Resource materials, in-person illustrated presentations, hands-on trainings, and decision-aid tools will be developed in English and Spanish. The 21 case studies will use print and video to illustrate the adoption process and effect on management and employee engagement and wellbeing for nurseries of several sizes and segments. 5.3 Create the LEAP Learning Center (LLC). NC State CALS Online Academy will host the learning center and bestow a completion certificate credential to producers, extension agents, and students.5.4 Design, develop, and curate LEAP websites. https://www.nurseryleap.com/ will host outputs and a second website will educate consumers about impacts of ANTs on production practices, environmental stewardship, labor efficiency, employee well-being, plant quality.5.5 Create a social network for growers willing to share information and mentor other growers. Producers will mentor other growers considering ANT adoption and have completed the LLC.