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United States Department of Agriculture
Project Initiation

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Project Title

Social And Economic Impacts Of Agricultural Autonomy (A2) On Small Farms: Status And Recommendations

Project Details

Sponsoring Institution National Institute of Food and Agriculture	**Project Status** ACTIVE
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Performing Department

(N/A)

Non Technical Summary

The on-going trend of Agricultural autonomy (A2) is believed to have profound influence in improving agricultural productivity and shaping the future of agriculture. However, until recently most A2 technologies are designed to fit large-scale farms, while they tend to be technical and cost prohibitive to small farms. There has been growing concern that small farms may be negatively impacted and driven out of the market by the current A2 trend. This project aims to gain a detailed understanding of the needs, attitudes, and concerns that small farms have towards A2 technologies, investigate the potential social and economic impacts, and recommend strategies to improve the adoption of A2 in small farms. The proposed research in this project is closely related to the AFRI Program Area Priority of the implementation of autonomous technologies and systems within the agricultural production. It will first complete a comprehensive survey of the history and current development of A2 technologies. Particularly, small farms' challenges, attitudes, and adoption intentions will be documented through surveys, interviews, and focus groups.

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Based on the collected data, it will then estimate the potential impacts of emerging A2 technologies on small farms and related rural communties through cost-effectiveness simulation, stakeholders' opinion collection. Key factors that impact small farms' A2 adoption intentions will be identified. Finally, it will propose recommendations for the potential future directions of autonomous industry to benefit small farms by new products, better adoptions, and business model innovations.

Animal Health Component

Animal Health Component: 0%

Research Effort Categories

Basic	50%
Applied	25%
Developmental	25%

Classification

Knowledge Area (KA)	Subject of Investigation (SOI)	Field of Science (FOS)	Percent
803	7210	3010	100%

Knowledge Area

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

Subject Of Investigation

[7210] Remote sensing equipment and technology

Field Of Science

[3010] Economics

Keywords

adoption, small farms, agricultural Autonomy, future directions, social and economic impacts

Goals / Objectives

The overall goal of this project is to understand the current state of agricultural autonomy and assess the potential impacts this technological trend may have on small commercial farms and related rural communities, and ultimately to provide recommendations to the small farm community, equipment manufacturers and related businesses, and policy makers on how agricultural autonomy can potentially be a help and not a hindrance to small farming operations. We intend to accomplish the following three specific objectives:Evaluate the current state of A2 technologies, direction of development, and attitudes of small farms and other stakeholders involvedAssess the potential impacts of the emerging A2 technologies on small farms and related rural communities.Propose recommendations for potential future direction(s) of the A2 industry development to benefit small farms and all the other stakeholders involved.

Project Methods

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Methods for Objective 1:1.1 A comprehensive review of academic publications, popular press, industrial reports, and other literature will be conducted to describe the current state of A2 technologies and the development directions. A special focus will be on small farms. The cost information of the technologies will receive close attention. The interviews with the A2 industry personnel (e.g., manufacturers, dealers) would focus on product development, sales, and marketing, and they may include open-ended questions. These interviews would be performed either in-person or virtually. The research team will explore existing surveys/tools and modify them to fit this research objective. All surveys that the research team develops are expected to be validated so that they can be used for future research efforts.1.2 We will review and perform an analysis of literature related to the history of both farmers' adoption of mechanization and their adoption of precision agriculture. We will use the information gained as historical experience and draw parallels between those transitions and the current one to inform our analyses regarding the adoption of A2 technologies. We intend to conduct a meta-review of literature and the transitions that have occurred historically in agriculture, along with the economic and social implications of each of these transitions.1.3 In years 1 and 2, small farms' opinions about A2 will be gathered through observations, surveys, and interviews with farmers. The observational studies and interviews with farmers will be conducted in-person when possible. The selection of farmers will be performed in collaboration with county extension agents from the MSU Extension Service. Specific data gathering mechanisms include observational studies of current farming practices in small and possibly large farms, surveys (e.g., researcher developed, technology acceptance model (TAM), diffusion of innovation theory-based), and interviews with the different stakeholders (e.g., farm owners, managers, and laborers). As a second source of data, Co-PI Bethel also has access to several types of social media data (e.g., Twitter, Facebook, YouTube, and others) through her center affiliations. This data can be analyzed to determine sentiment, needs, challenges, and attitudes of farmers.Methods for Objective 2:2.1 We first examine the potential economic impacts of A2 on small farms' financial status. Since few small farms have actually adopted A2, the economic analysis will be performed through simulation studies to evaluate the hypothetical farming profit changes if A2 were adopted. The profitability change evaluation is analyzed using a more comprehensive whole-farm profitability simulation following the method of Knight and Malcolm (2009) and Lowenberg-DeBoer et al. (2019) to simulate the entire farm's costs and revenues with A2 adoption. In particular, we will thoroughly interview one or a few farms as the case-study farms. Key parameters such as labor savings or productivity increases by A2 technology will be obtained from either manufacturers' prototype testing data or from our own on-farm trials if possible.2.2 To examine and identify perceived social impacts of A2 on small farms and rural communities, we will conduct interviews and focus groups with members from the following groups: small farm owners, A2 manufacturers and dealers, agricultural service providers, and farm workers. We will explore questions centered around the development and eventual implementation of A2. To examine the perceived social impacts of A2, we also will contemplate diverse possible social contexts or scenarios such as whether small-farm-friendly A2 technologies (e.g., smaller, cheaper, easier to operate) were more available or whether the government subsidize small farms to make the current A2 technologies affordable. Qualitative data generated from the interviews and focus groups will enable us to identify salient themes as well as opportunities and challenges for farmers and stakeholders involved in the development and use of A2 technologies.2.3 This research will identify the major barriers to adoption through quantitative analysis of the survey and interview data collected in sub-objectives 1.3 and 2.2. Farmers' intentions will be gathered from interview questions. We will create a similar structure to Pierpaoli et al. (2013) to describe and quantify the effects of various factors impacting small farmers' intentions for A2 adoption. Some open-ended questions will also be asked in the survey and interviews to collect any other factors impacting adoption. The mathematical relationship between adoption intensions and the impacting factors will be estimated through both econometrics and machine learning models.3.1 The research team will synthesize the data collected from the different stakeholders as well as follow-on analyses to propose recommendations for industry to engage in efforts for research and development, product commercialization, and distribution that focus on small farms while also open profitable business opportunities for equipment manufacturers. Furthermore, input from small farm stakeholders regarding A2 technologies will likely inform equipment manufacturers regarding new designs, new equipment, and new systems they may not have heretofore considered. The information synthesis process will focus not only on identifying common issues among small farms that would provide a confirmation for a particular idea, but it will also focus on unconventional and potentially visionary ideas proffered by individuals or small groups of knowledgeable and

insightful growers.3.2 Through the surveys, interviews, and focus groups covering small farmers and industry, farmers will be asked to consider equipment and technological concepts that they were not aware existed or could exist in the future. Their innovative ideas proactively shared and reactive responses to concepts they were previously unaware of will be recorded, compiled, analyzed, and synthesized with a view to identifying synergies between small farm constraints and practices and the advantages of A2 technologies. The information synthesis process will focus on identifying common challenges among small farms that would provide a confirmation for a particular idea, and also on unconventional and potentially visionary ideas from individuals or small groups of growers. Furthermore, the specific adoption choices can be integrated into the profitability simulation models in sub-objective 2.1, and generate accurate assessment of economic feasibility under different scenarios such as purchase prices, equipment sizes, government policies, or weather conditions.3.2 We propose to thoroughly review the business model innovations for small businesses' autonomy adoption in other industries, such as warehousing and distribution, manufacturing, health and medicine, transportation, and other leading industries in automation usage. Three innovations are most popular and will receive our main attention: (1) equipment rental, (2) cost sharing, and (3) Robotics-as-a-Service (RaaS). In addition, based on the financial status simulation analysis tool created by this project, we can also further assess the economic feasibility of those business models for small farms' different A2 adoptions. Finally, in the focus groups conducted in sub-objectives 1.3 and 2.2, the research team will try bringing together the farming communities with industry members to discuss new A2 technologies in development. The research team will explore the effectiveness of this type of farmer-industry communication meetings, assess the costs and feasibility to hold those meetings, and promote the meetings to be held in larger scales and higher frequencies to get small farmers more involved in A2 development process.