

Revisiting the Role of Agricultural Extension as a Technology Transfer Model: Insights from Students' Reflections

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Abstract

Agricultural extension plays a crucial role in transferring agricultural technologies, with extension agents as key facilitators. In the U.S., these extension agents receive training through agricultural extension education programs offered by various universities and a bachelor's degree is used as a required minimum qualification. On the other hand, in developing countries, an associate degree offered by community colleges is enough for one to serve as an agricultural extension agent. In all these programs, regardless of the requirements for minimum qualification, there is an increased focus on training the aspiring extension agents as technology transfer facilitators or agents. The focus of extension programs and methods significantly shapes students' perceptions of the role of agricultural extension. This study sought to examine students' perceptions of the role of agricultural extension in delivering extension services. A qualitative content analysis approach was utilized to analyze the perceptions of 22 students from Iowa State University. The results show a shift from the traditional, linear top-down approach to a more engaging, participatory model emphasizing human development. The participants noted the need to incorporate farmer knowledge and experiences in agricultural technology design and development, fostering collaborative innovation and focusing on the specific needs of individual farmers. Importantly, this manuscript is not intended as a critical review of the U.S. Cooperative Extension system but rather as a reflection of the participants' global perspectives on extension. While we acknowledge that these perspectives may not be universally applicable across all countries, the insights provided valuable information on students' perceptions of extension.

Introduction

Since its inception in 1914, the Cooperative Extension Service in the United States has historically excelled in transforming research knowledge into practical applications, with its impact particularly notable during the Great Depression and the World Wars (Osmond et al., 2010; Prokopy et al., 2015; Wang, 2014). As such, the U.S. cooperative agricultural extension program serves as a model program that is being emulated by many countries, especially those in the global south. The U.S. extension system still contains some traits of its historically top-down approach, where extension professionals share research findings with the public in a predominantly linear manner (Lubell et al., 2014; Nowak, 2013; Prokopy et al., 2015; Vines, 2018). This top-down approach is further evident in the widespread use of the train-the-trainer model of Cooperative Extension programs, where researchers produce new information, which is then relayed to state Extension specialists, who in turn train county and regional agents or crop consultants, ultimately delivering information to growers (Piñero et al., 2018). To address the needs of its clients, there has been a gradual shift towards participatory, bottom-up approaches involving multiple actors and diverse learning

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pathways (Healy & Dawson, 2019; Prokopy et al., 2017). However, these extension efforts continue to place scientists and extension professionals at the forefront of knowledge creation and dissemination (Asprooth, 2023). In contrast, research highlights that farmers are more inclined to test or adopt innovations when information is shared through peer networks (Rogers, 2003).

Despite the passing of the Smith-Lever Act, which required each state in the U.S to have a land-grant university and establish agricultural extension education programs to reach out to the communities, many land-grant universities lack extension education programs, leading to a workforce entering the field without essential foundational competencies (Harder et al., 2018). Successful agricultural development hinges on effective communication and collaboration among farmers and various developmental stakeholders, addressing local challenges through collective efforts (López & Bruening, 2002; Masambuka-Kanchewa et al., 2020; Rodriguez & Andrade, 2018). Therefore, it is crucial for extension services in the USA to commit to reducing institutional barriers, enhancing the competencies of its professionals, addressing the needs of historically marginalized groups, and developing new strategies to better identify, serve, and reach diverse populations (Bittner, 2019). Addressing these challenges is crucial for the U.S. as it continues to be a world leader in developing and sharing innovative agricultural extension practices globally.

Furthermore, there exists a notable shortfall in understanding student perceptions, particularly those trained as extension agents, and the extant research predominantly explores areas such as students' perceptions of workforce readiness in agriculture (Hendrix & Morrison, 2018), student knowledge and perceptions of distance learning during COVID-19 pandemic (Al-Mawee et al., 2021), and student opinions on the role of different stakeholders in promoting agricultural technologies and innovations (Ayisi Nyarko et al., 2024). Students are central to the current learning landscape and pivotal in shaping the future trajectory of extension services. Regrettably, opportunities for in-depth training in extension methodologies through graduate programs or assistantships that integrate advanced academic pursuits with practical extension experience are notably sparse (McKendree & Taylor, 2022). Alarming, many students remain unaware of extension as a viable career path until they face the realities of the job market (McKendree & Taylor, 2022). Understanding the perceptions of these emerging agricultural professionals is essential as their insights are set to influence future agricultural policies and shape the evolution and delivery of agricultural extension programs.

Review of Literature

Historically, agricultural extension programs have relied on the expertise of research scientists to introduce new technologies, which are then passed on to farmers by extension agents for adoption (Xu et al., 2023). The Transfer of Technology or Knowledge (TOT/TOK) model has emerged as the cornerstone of agricultural development. The model operates on the premise that scientists develop innovations, which are then disseminated by extension agents and are eventually adopted by farmers (Koutsouris, 2018; Xu et al., 2023). Research on diffusion has been a prominent focus in extension education research, particularly in the United States during the 1950s and 1960s (Valente & Rogers, 1995). Rölling (1986) argues that most extension agencies worldwide prioritize technical innovation, funded by tax revenues, to enhance the production and efficiency of food, raw materials, and export commodities.

The strength of the Diffusion of Innovation (DOI) theory lies in its practical applicability and versatility across various contexts, providing valuable insights into the adoption process (García-Avilés, 2020). The DOI model developed by Rogers offers a comprehensive framework for analyzing the factors that influence individual decisions to accept or reject innovation, especially within agricultural settings (Kouki et al., 2006). In agriculture, the transfer and dissemination of technical innovation and expertise through the extension channels are integral processes, facilitating the diffusion of knowledge from technology developers to farmers (Blackburn & Vist, 1984). However, the overarching objective of

agricultural extension remains to persuade farmers to adopt and effectively implement agricultural technologies on their farms (Abd, 2013; Pense & Groninger, 2013). The linear Transfer of Technology (TOT) model has been criticized for its inherent limitations (Koutsouris, 2018). Specifically, the model's assumptions regarding the dissemination process raise concerns about equality and contribute to the "agricultural treadmill". This TOT approach, which ignores the crucial role of farmer knowledge and peer-to-peer social networks in complex farming systems, has been faulted by experts (Koutsouris, 2018; Neef et al., 2013). Additionally, proponents of the TOT model often view agricultural problems as simple and technical with easy and straightforward solutions (DeFries & Nagendra, 2017). This approach neglects the essential roles that cultural, social and physical contexts play in influencing outcomes (Ashby, 2003).

Further, Nagel (1997) contends that, traditionally, extension was seen as an ideal method for conveying modern research findings to traditional farmers. However, suppose the success of agricultural extension is only measured by technology adoptions and productivity increases. In that case, it may fail to realize the less tangible yet significant benefits, such as enhancing farmers' knowledge and critical thinking skills (Onemolease, 2002). As a result of these criticisms, there has been a decline in the dominance of this paradigm in research and theory, leading to the emergence of human development approaches grounded in principles such as participation, empowerment, and problem ownership (Ingram, 2014). Reasons for the shift towards human development include increased interest in multi-functional land management, a general critique of technocracy and scientific superiority, ongoing environmental challenges, and the necessity to foster more sustainable agricultural practices (Ingram, 2014).

Rölling & Zeeuw (1983) introduces this alternative as Human Development, which diverges from conventional methods. The human development (HD) approach focuses on the well-being of individuals rather than merely serving development goals (Adisa et al., 2016). A human-centered approach to extension acknowledges and embraces these connections as valuable opportunities to foster meaningful relationships between farmers and extension agents (Cook et al., 2021). The human development approach implies that farmers can devise appropriate solutions to their problems provided they have access to the right conditions, adequate information, and collaborative opportunities (Ingram, 2014). This approach envisions extension as a facilitator of social learning, emphasizing a participatory social change process. It validates scientific and farmer knowledge, potentially leading to more adaptive environmental management and enduring effective outcomes. Research scholars suggest that such approaches are well suited to understanding the transition towards more sustainable agriculture, which necessitates mutual interaction among stakeholders (Ingram, 2014).

The Wageningen School, led by scholars like Rölling (1992) and Rölling and Wagemaker (1998), was pivotal in providing theoretical foundations for the human development approach. They utilized systemic approaches, notably the Agriculture Knowledge Systems framework, to analyze the diverse participants and knowledge exchange process. The human development approach aligns with the "concept of negotiated knowledge", a key element in deliberative governance, where collective judgment is crucial for sound decision-making (Ingram, 2014). This paradigmatic shift also reflects broader developments within rural and developmental sociology and rural geography during the 1980s and 1990s, when a post-Marxist era saw the rise of culturalist or subjectivist perspectives (Ingram, 2014).

A study by Fierro Guarnizo (2019) on the training needs of graduate students in community and extension education highlighted 'Agricultural Technical Assistance to Farmers' and 'Technology Transfer to Farmers' as top-ranked job responsibilities perceived by the students. The study pointed out a gap in the diversity of information sources and methods for technology transfer among these students, underlining the necessity for more varied strategies to serve their clients more effectively. In line with these findings, Harder et al. (2021) recommended reevaluating university academic programs to ensure they equip students with essential career skills. Moreover, Ayisi Nyarko et al. (2024) investigated graduate students' perceptions regarding the importance of extension education in advancing agricultural innovations. The findings

strongly leaned towards the top-down model (research-extension-farmer) in agrarian development, placing scientists at the forefront of innovation, with extension agents acting as intermediaries and farmers as the final beneficiaries. This study highlighted the importance of revising agricultural education programs to include a more current understanding of the diverse roles of agricultural extension beyond just technology transfer (Ayisi Nyarko et al., 2024).

Moreover, Scheer et al. (2006) emphasize integrating the human development approach within Ohio State University's competency-based approach to training students for extension-related careers. By embedding human development and learning theories into the curriculum, alongside key competencies such as extension knowledge, effective communication, program development, and applied research methods, the framework provides a comprehensive foundation for professional preparation. This competency-based approach is supplemented by practical learning experiences, like field trips and internships, that allow students to engage directly with professional extension educators (Scheer et al., 2006).

Agricultural extension has been criticized for its predominant focus on technology transfer while overlooking socio-political dimensions (Cook et al., 2021). Scholars like Nchanji et al. (2021) argue that climate change and the COVID-19 pandemic have significantly disrupted agricultural extension services, affecting all stakeholders in a domino effect. These challenges emphasize the necessity for technology transfer to enhance and align with the overarching objective of human development (Singh et al., 2015). Moreover, agricultural professionals and students are key contributors to shaping agricultural programs and policies (Ayisi Nyarko et al., 2024). As such, understanding student perceptions is crucial for analyzing their progress, improving program evaluation and design (Duke & Reese, 1995), and identifying factors that influence academic achievement (Zimmerman, 2001).

Purpose and Objectives

This study explored students' perceptions of the role of extension and approaches employed when delivering agricultural extension services. The specific objectives were:

- 1) To identify the students' perceptions regarding the actual role of agricultural extension,
- 2) To identify the students' perceptions regarding the desired role of agricultural extension and
- 3) To explore the students' opinions on the desired approach to agricultural extension delivery.

Methods

This study utilized a single discussion board introduced at the beginning of the module, focusing on "Agricultural Extension Models or Approaches." Qualitative content analysis was employed to systematically analyze texts within their context (Mayring, 2004). Content analysis is a structured and replicable approach for condensing extensive texts into more manageable content categories based on explicit coding categories (Berelson, 1952; Krippendorff, 2019; Weber, 1990). Holsti (1969) broadly characterizes content analysis as a method for deriving inferences by impartially and systematically recognizing key message characteristics. The approach is not limited to text analysis, as it can be adapted for diverse applications like interpreting student artworks (Wheelock et al., 2000) or analyzing actions in video recordings (Stigler et al., 1999) with the caveat that data should be stable for reproducible analysis. In this study, a content analysis of participants' responses to specific questions assessing their perceptions of the role and approaches to extension service delivery was conducted.

Data Collection

The participants comprised students enrolled in a course entitled "Technology Transfer and Role of Agricultural and Extension Education at Iowa University in the United States. The total sample included 22 students, comprising both domestic and international participants. Among them, six were undergraduates, and sixteen were graduate students, contributing to the diversity of the perspectives represented in the study. Participants engaged in an online discussion via the CANVAS platform, serving

as a graded and interactive weekly discussion board. This discussion board was introduced at the beginning of the module, before any formal instruction, to ensure that the data captured the students' initial perceptions and understanding, free from any instructional influence. Students were prompted to express their perceptions on the role of agricultural extension and their desired approach, whether they perceived extension primarily as a means of transfer of technology or as a tool for human development. Moreover, these discussion board assignments did not have predetermined right or wrong answers. Additionally, students were encouraged to interact with their peers by commenting on or responding to at least two posts. However, these peer comments were excluded from the analysis procedure, as the study focused solely on the original responses of each participant.

Students were required to submit a discussion post ranging from one paragraph with at least five sentences to approximately two paragraphs. However, no strict maximum length was imposed, allowing students the freedom to elaborate as needed. Open-ended questions facilitated a thorough understanding of complex situations, which might be limited when using closed-ended questions (Züll, 2016). Our guiding questions for this study were: 1) *What role do agricultural extension and education play in technology transfer?* 2) *What role should agricultural extension and education play in technology transfer?* 3) *Do you consider agricultural extension primarily as a tool for technology transfer, or do you see it as integral to human development? Why do you hold this view?*

Analysis

All 22 students completed the discussion board. The analysis of participant responses began with retrieving data from the CANVAS platform and subsequent transcription. To ensure confidentiality, participant names were replaced with pseudonyms. Following data gathering and transcription, a comprehensive review of the data was undertaken, with particular emphasis on acquiring a holistic understanding through reading and repeated examination, aligning with the established practices (Polit & Beck, 2003). Inductive coding was employed when analyzing the data, where codes were derived directly from the qualitative data, enhancing the study's credibility (Bengtsson, 2016). In the following stage, recontextualization involved repeating the coding to ensure the best codes cover all relevant content and align with the research study's goal (Bengtsson, 2016). In the categorization stage, themes are identified based on categories (Bengtsson, 2016). Finally, themes were created from these categories, representing a deeper, more abstract level of understanding and interpreting the underlying meaning of the data (Bengtsson, 2016; Erlingsson & Brysiewicz, 2017). The reporting of themes was guided by the frequency of statements associated with each theme. When a theme was referenced by more than five participants, terms like "majority" or "most" were used, while themes mentioned by exactly five participants were described using the term "some" (Harding, 2018). To ensure the validity and trustworthiness of the findings, the study incorporated peer debriefing and member checking (Lincoln & Guba, 1985).

Reflexivity Statement

The primary researcher is a PhD student and research assistant at Iowa State University. Originating from India, her academic journey has given her a diverse perspective on agricultural practices and extension education methodologies. This background has been instrumental in shaping her approach to exploring the multifaceted roles of agricultural extension agents. Throughout this study, she sought to maintain an acute awareness of her educational and cultural experiences, understanding how they might influence the research process. Exploring the perceptions of the varied student population at Iowa State University enriched the research, offering a broad spectrum of views that enhanced the depth and reliability of the findings. To minimize the impact of her biases on the research, she did not participate in the data collection process.

The second researcher is an Assistant Professor who was integral in developing the research concept and data collection process. Her research focuses on exploring the role of communication as a science for understanding people's behaviors. She also explores factors influencing public perceptions and acceptance of scientific innovations and technologies. She served as the instructor for the course and

developed the course assignments and questions involved in this study. While she remained conscious of the potential influence of her bias, given her research focus, she acknowledges her bias and its probable impact on data collection and interpretation. To address these challenges, she included the first author in the data analysis process and conducted a comprehensive literature review before analyzing the results assuring their alignment with existing studies. Notably, she did not originally plan to conduct the study and thus had no prior stake in its results. Her engagement with the data developed incidentally during the process of grading the assignment.

Results

Perceptions of the Actual Role Played by Extension Education in Technology Transfer

Varied yet insightful perspectives were observed among participants regarding the actual role played by extension in technology transfer. Three discernable themes based on participant opinions were identified: *dissemination of agricultural technologies*, *training and educating farmers to adopt new technologies* and *facilitating agricultural community development through strategic resource management and service provision*.

Dissemination of Agricultural Technologies

The majority of the participants (n = 11) perceived the role of agricultural extension primarily as the dissemination of new technologies without necessarily considering whether these technologies are suitable for farmers. The words most commonly mentioned by participants in the description were *transfer*, *disseminate*, *exchange*, *disperse*, *display*, *publicity*, and *communication*. AK explained that “Agricultural extension and education impose knowledge on the farmers. Education through research develops an innovation out of excitement without considering if it works for the farmers, and through agricultural extension, it is imposed on the farmers to adopt it.” This was echoed by MK, who explained that “Agricultural extension and education help to disseminate the information they learn and stay up to date on to the farmers that they are connected to through an established network.” BK stated, “Agricultural extension is used to exchange ideas and to pass on new technologies between the different people involved in agriculture.” Similarly, RK expressed that “I think that agricultural extension and education play a large communication role in technology transfer. It is one thing to create new technologies, but it is another role to communicate those technologies and display them to the public.”

Training and Educating Farmers to Adopt New Technologies

The results showed that some participants (n = 5) perceived agriculture extension as a vital link between nonformal agricultural education and practical implementation in the field. They acknowledge the traditional methods of knowledge dissemination, such as word-of-mouth communication, which preceded the formalization of agriculture extension services. Extension agents are perceived as instrumental in imparting information and providing hands-on training to effectively implement new technologies in the field. The words most commonly mentioned by the participants in the description were *educate*, *train*, and *teach*. For instance, UK stated that “Agricultural extension plays a big role in technology transfer in our world today and that's exactly how it should be. The education that is being extended around the world is incredible and right where we need to keep going for the future and its success.” Similarly, ZK elaborated that “Prior to formalized extension and education, word-of-mouth was critical in understanding the correct times to plant and harvest”; Henry stated that “...those educators go out and teach the farmers in the counties.” Moreover, Rod said, “In some instances, farmers would not know nor understand how to implement new technologies without the information and hands-on technique learning introduced through agricultural extension and education.” Similarly, PK elaborated that “...agriculture extension in its nonformal setting fulfils the purpose of technology by making it available to the farmers or targeted groups, providing training and extension programs for the final implementation.”

Facilitating Agricultural Community Development through Strategic Resource Management and Service Provision

The findings of the analysis indicated that some participants (n=5) acknowledged the pivotal role played by agricultural extension agents in connecting farmers with vital resources such as essential inputs and financial sources and in providing services like educational classes, problem diagnosis, feasible solutions and reinforcing the continued use of technology. Ali states, “They act as resource connectors, linking farmers with essential agricultural inputs and guiding them toward sources of finance. They extend effective problem diagnosis, offering feasible solutions and providing a clear course of action.” Mark also explained that “Agricultural extension has an opportunity to offer resources and classes to people working in the industry to pass along information.” Additionally, David stressed the importance of timely information dissemination by extension agents in addressing farmer concerns about new agricultural technologies: “Agricultural extension and education offer information on some of the most up-to-date data. They work to diminish the doubts and worries about the new technology that is bettering our way of agriculture.” Similarly, Paul stated, “Ag extension and education can help implement and troubleshoot the adoption of new technologies for farmers and agricultural companies.”

Perceptions of the Desired Roles that Agricultural Extension Should Play in Technology Transfer

The content analysis of perceptions of desired roles that agricultural extension should play in technology transfer revealed two significant themes: *farmer-centered technology transfer and fostering green technologies for the well-being of farmer producers.*

Farmer-centered Technology Transfer

The analysis revealed three main sub-themes under farmer-centered technology transfer. The sub-themes were *prioritizing farmers’ needs and interests, fostering agricultural innovation through active farmer participation, and expanding awareness of new agricultural technologies.*

Prioritizing Farmers’ Needs and Interests.

The content analysis revealed that most participants (n=6) strongly perceived the prioritization of farmers’ needs and interests in agricultural technology transfer as essential. The word most commonly mentioned by the participants in the description was *needs*. Samuel explained, “Producer needs should be highly prioritized when developing extension activities and educational materials that apply key scientific findings to a specific context.” Similarly, Mary explained that “Extension services must also be tailored to the needs and context of local farming communities to ensure that innovations are both accessible and relevant”; DK stated that “...agricultural extension should also help with updating old technologies and making sure that they fit people's needs.” Mark also explained, “Decentralization of extension services can aid in accountability and meeting heterogeneous client needs....” Adam states, “...they should keep the farmer’s best interest in mind over all else.”

Fostering Agricultural Innovation through Active Farmer Participation.

Our analysis revealed that some participants (n=5) perceived a need for a shift in the role of extension, suggesting that its focus should go beyond mere technology transfer to actively involving farmers in the innovation process by integrating their feedback. Ethan stated, “It is not just about teaching farmers how to use new technologies - they should also be included in the innovation process and encouraged to share their feedback and ideas.” This was echoed by Billy, who explained that “The agricultural extension and innovation should work together with the farmers to identify the problems and come up with solutions that are efficient and favorable to farmers.” Similarly, Joe elaborated that “I think it is safe to say that not all technology is best used in certain terrain and regions. It should be more widespread for agricultural extension agents and educators in the field to present the technology and have localized research to support or at least speculate the benefits local farmers would have with introducing the technology.” Moreover, JK explained that successful technology adoption in agriculture relies not only on the relevance of the technology itself but also on the strength of the relationship and trust between farmers and extension

services: “It requires a relationship and trust that allows the farmer to focus on what he is doing and go to a localized extension when it comes time to consider new technology or shifting the way they are planting.” Similarly, Ruth stated, “Extension agents should focus more on teaching the farmers in their area about the product and being able to show results.”

Expanding Awareness of New Agricultural Technologies.

The analysis indicated that most participants (n=6) perceived agricultural extension services as important for raising awareness of evolving technologies through positive portrayal and active advocacy. For instance, Landy stated, “...their job is to share that awareness and the education and training opportunities for the new technologies.” Ben explained, “...to ensure everyone is aware of evolving technologies and innovations.” Martin stated, “I think that agricultural extension and education should focus on positively portraying technology transfer to the public.” Similarly, Joy said, “...extension and education are the principal tools used to spread the understanding and application of agricultural technology and innovations.” Esther even explained that agriculture extension needs to inform and reassure producers and stakeholders about the benefits and safety of new technologies: “They should also educate the public about the purpose and safety of the new technological advancements.” Similarly, Tina stated “I believe that agricultural extension and education should and are essential to the improvement our global society.”

Fostering Green Technologies for the Well-being of Farmer Producers

Results from this study revealed that some respondents (n=5) unanimously agreed on the importance of using modern Information and Communication Technology (ICT) in agricultural extension services. The focus was notably on small-holder farmers, with a consensus on the need for sustainable agriculture practices to benefit farmers. Max explained, “In developing countries, extension services utilize ICT tools to inform and instruct farmers, complementing hands-on mechanisms. Encouraging such linkages between extension services and farmer groups is a potential method for providing small farmers with the “last mile” of extension services”; Kristine stated, “In my opinion, agricultural education and extension should increase the activities of transferring technology to the smallholder, rural, and marginalized farmers so that they can benefit as well.” Similarly, GO stated, “...I personally believe agricultural education and extension can play a huge role in advocating concepts and practices of sustainable agriculture, which is crucial at present.” According to David, “...extension should contribute to the successful transfer and adoption of new agricultural technologies, ultimately leading to improved farming practices, increased productivity, and sustainable rural development.” Similarly, Sid explained that “Extension is essentially the translation of research findings into practical application and helps to improve the lives of producers through scientific research and innovation.”

Desired approach to agricultural extension delivery

Two themes emerged regarding the desired approach to agricultural extension delivery: *embracing human development school of thought* and *the technology transfer school of thought in agricultural enhancement*.

Embracing Human Development School of Thought

The analysis indicated that the majority of participants (n=8) overwhelmingly chose the human development approach as pivotal in agriculture. This approach, valuing farmers’ comprehensive well-being and aspirations, was recognized as crucial for the effective development of people through agriculture. For instance, TK explained that “...would have to choose a human development school of thought. However, I do believe people are important and should be treated as such and that to give farmers power and a deeper connection to the research seems like a beneficial option.” Similarly, Mad elaborated that “I am personally more inclined to the HD school of thought as it considers the overall well-being, capacities, and aspirations of farmers.” PJ further advanced the discussion by explaining that “...I would subscribe to the one that considered extension as part of human development. Whereas, once extension is seen as human development, farmers may develop the skills to interpret and apply any technology transferred properly.”

SJ mentioned, “I believe that I have a stronger attachment to the idea of agricultural extension being a human development program.”

Moreover, while technology transfer is crucial, the core of all knowledge is the human consciousness and brain. Thus, I would say that agricultural extension serves more of a role regarding our development as humans rather than technological transfer.” According to Tara, “The HD School of Thought stuck out the most to me because its main objective is to seek to develop people through agriculture.” FK echoed this, “I feel like the school that I subscribe to would be HD school because it says, “seeks to develop people through agriculture”, which I think means that doing things involved with agriculture and demonstrating things through agriculture brings the people.”

Technology Transfer School of Thought in Agricultural Enhancement

The content analysis indicated that some respondents (n=5) perceived technology transfer as a pivotal approach for advancing agriculture through people. They firmly believed in the capacity of technology transfer to utilize people as agents of change, offering ample opportunities for development amidst changing environments. For instance, Leo explained, “I would have to subscribe to the technology transfer, which develops agriculture through people. Although I see both sides, farmers and extension professionals can work together to benefit and evolve the agriculture industry.” FP specifically explained the importance of technology transfer in responding to the needs of people in agriculture: “As I have tried to make a true decision, my gut goes to belonging to the school of technology transfer. I lean toward the side that we develop agriculture through the people for the reason that we are trying to meet the needs of the people in agriculture.” Kelly also explained that “I subscribe to technological transfer tool because it aims at using people to be agents of the changing technology and it provides a wide opportunity for growth and development given the changing situation unlike, the human development tool that suggests that the only way people develop is through agriculture.” Others perceived the TT School of thought as promoting economic growth in agriculture.

Discussions, Conclusions and Recommendations

This study provides valuable insights into students’ perceptions of the role of agricultural extension and the approaches employed in delivering extension services. The findings related to objective one indicated that participants predominantly viewed the actual role of extension education to be about the dissemination of new technologies. This perception aligns with prior scholarly literature, which characterizes agricultural extension as a linear, top-down process wherein scientific knowledge flows from experts to farmers (Altalb et al., 2015; Kohn & Anderson, 2022; Lubell et al., 2014; Strong et al., 2015; Suvedi & Kaplowitz, 2016; Vines, 2018). This finding was both anticipated and surprising. It was anticipated because trained within a predominantly technology transfer model, agricultural extensionists have often struggled to recognize and integrate indigenous knowledge systems (Collins & Mueller, 2016) or local farming practices (Kloppenburger, 1991). However, it was surprising considering the growing emphasis on participatory and inclusive approaches in recent years. Despite this shift, these participatory efforts often still place scientists at the center as technology creators (Asprooth, 2023). This raises an important question: Is agricultural extension still operating as a technology transfer tool, or are students’ perceptions shaped by their educational backgrounds and prior experiences? Understanding the origins of these perceptions requires further qualitative research that examines how educational background and professional extension experiences influence students’ conceptualization of extension services.

The findings related to objective two revealed that students predominantly viewed the desired role of agricultural extension as a farmer-centered, participatory approach. This research proposes a few reasons that may have influenced this preference. Notably, students’ perceptions of the desired role of agricultural extension may have been influenced by their responses discussed in objective one, where agricultural extension was perceived as a technology dissemination tool. Additionally, the way discussion prompts were

structured, distinguishing between the actual and desired roles of extension, may have influenced their responses. These findings suggest that students recognize the need for a more participatory extension model that moves beyond top-down approaches, reflecting a broader shift in extension discourse towards farmer-centered, collaborative frameworks. This conclusion is consistent with prior research emphasizing the necessity for agricultural extension programs to transition from a traditional, one-way approach to more inclusive and participatory models (Bitzer et al., 2016; Sewell et al., 2017; Strong et al., 2015). To gain deeper insights into the findings, future studies should consider employing focus group discussions with students to explore the underlying reasons for their preference for participatory approaches.

The findings related to objective three examined students' perspectives on the desired approach to agricultural extension. When presented with a choice between the human development and technology transfer schools of thought, most participants favored the human development approach. This suggests that students may have perceived agricultural extension as more than just a tool for technology dissemination, instead emphasizing its role in enhancing farmer well-being, aligning with Cook et al. (2021). However, the underlying reasons for this preference remain unclear. Future research should explore the factors influencing students' inclination towards the human development perspective, such as their exposure to extension models, personal values, and perceptions of farmers' needs.

Notably, only a few students supported a combination of human development and technology transfer perspectives. For instance, Moses expressed a balanced viewpoint, stating, "I would subscribe to the school that views agricultural extension as human development as well as a tool in transferring technology." Similarly, Smith emphasized, "The most effective extension programs often integrate elements from the Technology Transfer and Human Development schools of thought." These findings align with Singh and Shekhar (2015), who suggested that technology transfer should complement and support the broader goal of human development.

Three major recommendations for agricultural extension delivery emerged from the students' perceptions of agricultural extension services. Firstly, strongly emphasizing incorporating farmers' voices in delivering agricultural extension services is recommended. For example, one participant advocated prioritizing farmers' needs and interests, stating, "Extension services must also be tailored to the needs and context of local farming communities to ensure that innovations are accessible and relevant." This aligns with the recommendations presented by Strong et al. (2015), who emphasized that extension personnel should move beyond the one-way method of delivering extension services. Instead of "talking at", Strong et al. (2015) stressed the importance of addressing farmers' educational needs by facilitating non-formal learning opportunities. Additionally, Strong et al. (2015) emphasized the importance of participatory action research in addressing community-specific needs. Together, these students' perceptions and the literature leave us with a critical question: How can the current information-centric paradigm of extension programming shift to better meet the needs and desires of its constituents? (Strong et al., 2015).

Secondly, based on the findings, it is recommended that farmers actively participate in the innovation design to ensure the solutions align with their needs. One participant emphasized this point by stating, "It is not just about teaching farmers how to use new technologies. They should also be included in the innovation process and encouraged to share their feedback and ideas." Extension leaders have recognized the importance of farmer participation and have explored more effective ways to communicate the public value of extension services (Franz, 2011). However, cooperative extension is often described through a traditional narrative that emphasizes the delivery of research-based, objective knowledge, portraying science as neutral and detached from local contexts and community involvement (Gupta et al., 2019). This framing can obscure the relational and participatory nature of extension practice. Moreover, López Cerezo and González García (1996) argue that expert knowledge alone is insufficient due to constraints posed by economic, political and social factors. The literature further emphasizes reassessing the significance of situated knowledge compared to the objective expertise offered by extension efforts.

Situated knowledge derived from the lived experiences of farmers offers valuable insights into the impacts, unintended consequences, local challenges, and contributing factors (Epstein et al., 2014). These findings suggest that agricultural extension should adopt participatory approaches that value expert knowledge with farmers' Indigenous knowledge, ensuring solutions are scientifically sound and contextually relevant.

The conventional concept of technology transfer is no longer adequate to address the complexities of the farming community and their operating environment. Existing scholarly literature has characterized agricultural extension as a top-down, linear model (Kohn & Anderson, 2022; Strong et al., 2015). However, the emerging humanized extension approach challenges this traditional notion of agricultural extension by emphasizing the importance of embedding extension practices within real-world socio-economic and cultural contexts (Haraway, 1988). From this standpoint, we recommend that agricultural extension integrates technology dissemination and human development. One participant highlighted this perspective by stating, "I would subscribe to the school that views agricultural extension as human development and a tool in transferring technology. It is very important to not only think about the latest technology in agriculture but to also think about a broader context when discussing agricultural extension models."

To implement this shift, extension educators must adopt a broader set of roles to navigate the complex challenges of modern agriculture. Lakai, Jayaratne, Moore, and Kistler (2012) identify seven fundamental competencies for extension professionals: knowledge of extension practices, subject matter expertise, programming skills, professional ethics, communication skills, leadership abilities, and human relations skills. While these competencies are crucial, they must be applied within an adaptive framework that acknowledges the diverse realities of farming communities. These competencies are insufficient if the underlying extension model fails to address systemic barriers.

While the humanized extension approach offers valuable insights, its feasibility must be critically assessed in diverse agrarian contexts. System thinkers (Leeuwis & Aarts, 2011) caution against the uncritical adoption of models that, despite their intentions, may fail to address the structural barriers low-income farmers face. Rather than viewing participatory approaches as universally effective, extension programs should carefully evaluate how they can be adapted to generate meaningful and measurable benefits for marginalized farming communities.

We clarify that this manuscript is not intended to critique the U.S. Cooperative Extension system. Rather, it reflects the participants' global perceptions of extension, shaped by their individual experiences and observations. We acknowledge that these perceptions may not fully represent the diversity of extension practices worldwide. However, they offer valuable insights into how future practitioners view extension. These insights are valuable for informing the design and delivery of more effective and inclusive extension programs globally. We also recommend that future research undertake a comparative study to examine differences in perceptions of extension approaches across countries. Such analysis could provide a deeper understanding of how contextual factors influence extension methods and their effectiveness.

Limitations

We acknowledge the limitations regarding the transferability of these findings. This study focuses on pre-service extension professionals, i.e. students. While their perspectives provide valuable insights into agricultural extension approaches, they may not fully represent the views of practicing extension professionals with field experience. Future studies could incorporate focus group discussions with students to explore the reasons behind student perceptions. Additionally, further research should investigate whether active extension practitioners hold similar perceptions. While this study advocates for a shift towards participatory, collaborative and humanized extension, it does not examine the feasibility or the challenges of implementing these models across diverse agrarian contexts. Therefore, the results of the study cannot be applied to all extension professions in the U.S. or globally.

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