Identifying Southeastern Extension Professionals' Precision Agriculture Competency Needs

Chin-Ling Lee, Ginger Orton, & D. Barry Croom
University of Georgia

cllee@uga.edu
University of Georgia
405 College Station Dr.
Athens, GA 30602
(706) 542-8913

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Introduction and Need for Research

The advancements in data-driven technologies have revolutionized the agricultural sector, offering innovative solutions to contemporary challenges (Rozenstein et al., 2024). Extension professionals who can provide expertise are essential for transferring such innovation knowledge from research to stakeholders (Ketterings, 2013). Precision agriculture (PA) technology supports human decisions based on data to increase food production quality and quantity (Erickson & Fausti, 2021), reduce chemical and other inputs (Storey et al., 2022), and lower environmental impacts of agricultural production (Finger et al., 2019), thus working toward Sustainable Development Goals (SDGs) related to climate change and feeding a growing population (Musa et al., 2022). PA adoption rates in the southeastern United States have fallen short of expectations, despite PA's positive sustainability outcomes and the large agricultural economy in this region (McFadden et al., 2023). Extension agents possess the regional expertise needed to facilitate local technology adoption and aid in the more widespread adoption of PA technology (Edge et al., 2017). However, PA technology changes at a fast pace, and Extension agents must stay prepared with current knowledge, skills, and abilities (KSAs) to effectively assist farmers with adoption efforts. There is a need for research to investigate what competencies Extension agents need to effectively disseminate PA knowledge (Lee et al., 2023). Therefore, this study sought to describe the PA competencies needed among Extension agents to ensure they possess sufficient KSAs to effectively engage farmers throughout the PA adoption process.

Conceptual Framework

We defined the necessary competencies in terms of knowledge, skills, and abilities (KSAs), following the frameworks of Ritzhaupt and Martin (2014) and Wang et al. (2005). These three components are interconnected and build on one another progressively. Knowledge addresses content-specific demands. Skills are developed through knowledge application and encompass both mental and physical capacities needed to complete a task. Ability, then, integrates knowledge and skills for task performance.

Methodology

We used a three-round Delphi approach to describe a consensus of key PA competencies among Extension experts in the southeast. Delphi studies seek to develop a consensus among topic experts through iterative rounds of data collection (Landeta, 2006). Panelists were identified through the Southern Association of Agricultural Experiment Station Directors (SAESD), and 43 members with expertise in PA were invited via email to participate. Fifteen participants first qualitatively described their preferred KSAs, and we inductively coded these responses into a 13-item list of competencies (Round 1). Next, these participants were sent the list of items and asked to rank their importance (Round 2) (n = 11). Finally, the original 15 participants were sent the aggregated list of rank items and asked to agree with the consensus or re-rank (Round 3) (n = 13). Data were analyzed between each round using Excel and SPSS.

Findings

The top 13 key competencies are presented in Table 1. The means represent the average ranking position; the lower mean represents a more prioritized ranking.

Table 1

Mean Rank Data from the Aggregated Ranks

Competency (K, S, A)	Round 2 Mean Rank	Round 3 Mean Rank	Change in Order
PA basic awareness (K)	4.56	1	0
Basic commodity awareness (K)	4.78	2	0
Collaboration (S)	6.22	3.08	0
Digital literacy (K)	6.33	4.23	0
Problem-solving (S)	6.33	5.92	+1
Communication (S)	6.44	5.85	-1
Innovativeness (S)	7	7.23	0
Data collection and analysis (A)	7.33	7.69	0
Strategy execution (S)	7.78	9.46	0
Data interpretation (A)	8.11	9.46	0
Facilitation (A)	8.22	10.77	0
Sustainability awareness (K)	8.33	12.23	+1
Equipment operation skill (S)	9.56	12.08	-1

Conclusions, Implications, and Recommendations

Our results indicated that southeast Extension agents need basic knowledge of PA principles, regional commodities, and digital technologies. Key skills included collaboration, problem-solving, and communication, which are fundamental components of more complex skills and abilities related to data handling and equipment operation. The findings reflect the foundational mission of Extension, which is to bring agriculture research to a point where knowledge can be rapidly transferred to the people who depend on it for their livelihoods (USDA, 2024). Therefore, to increase the adoption rate of PA, the knowledge diffusion of the related digital innovations must be based on the basic knowledge of PA and its corresponding commodity by the Extension agents (Ritzhaupt & Martin, 2014; Wang et al., 2005). Considering Extension agents possess regional expertise and may be familiar with local commodities, region- or commodity-based training should work to increase understanding of how PA technology can integrate into and benefit their locality. The skills of Extension agents in collecting, managing, and analyzing multiple digital forms may also play an increasingly important role in informing farmers' decisions as PA technology evolves (Finger et al., 2019). Emphasis should therefore be placed on supporting Extension agents to become digitally literate in PA once the foundational knowledge and skills are acquired. Future research should investigate the current PA competencies Extension agents possess across regions, and future professional development should focus on instilling the presented desired competencies among Extension agents.

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