Perceptions and Experiences of Precision Agricultural Technology Adopters: A Multi-Case Study of Farmers in Taiwan and the USA

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ABSTRACT

Global agriculture faces numerous challenges, including climate change, poverty, an aging workforce, and resource depletion, which threaten food security. Precision Agricultural Technologies (PATs) can help in addressing these challenges. However, despite their benefits, the adoption of PATs varies significantly across regions, with notable gaps in understanding the factors influencing adoption rates, particularly in diverse cultural contexts. Previous studies have explored PAT adoption, focusing on drivers and barriers, but there is a lack of in-depth analysis of how cultural differences impact adoption decisions and outcomes. This qualitative case study fills this gap by examining the perceptions and experiences of PAT adopters in Taiwan and the USA through interviews with 21 adopters. The findings reveal that PAT adopters experienced improved efficiency, wealth, sustainability, and well-being in both countries. In addition, the study found that factors influencing PAT adoption include perceived relative advantage, dealer support, and ease of use of PATs. However, challenges such as high initial costs and limited data expertise were identified. The study recommends that policymakers and technology providers address these challenges and conduct further research on the Return on Investment (ROI) for PAT adopters to facilitate more effective resource allocation. By understanding these dynamics, stakeholders can help farmers use PATs to improve agricultural resilience and sustainability.

Keywords: Precision agricultural technology, adopters, perceptions and experiences, Taiwan, United States,

INTRODUCTION

The purpose of any agricultural innovation is to address the challenges facing the agricultural sector such as climate change, population growth, resource scarcity and to ensure sustainable and resilient food systems (Chang & Tsai, 2015; United Nations, Food and Agriculture Organization [FAO] – Pan American Health Organization [PAHO], 2017). To meet these objectives, farmers must adopt and use new agricultural innovations such as Precision Agriculture Technologies [PAT] to increase efficiency, productivity, and sustainability in food production (FAO-PAHO, 2017). Precision agriculture (PA) involves integrating technologies like the Internet of Things (IoT), Artificial Intelligence (AI), and data analytics into farming. It has emerged as a transformative approach to the challenges in the agricultural sector (Food and Fertilizer Technology Center for the Asian Pacific Region [FFTC], 2020; Wang, 2023).

While PATs' adoption has accelerated in large-scale agricultural systems such as those in the United States, their acceptance and use remain inconsistent in regions like Taiwan, where fragmented smallholder farms and aging demographics complicate implementation (FFTC, 2020). These disparities necessitate exploring farmers' perceptions and experiences with PATs, especially factors that shape farmers' decisions to adopt or not to adopt PATs. Despite extensive research on PA's technical feasibility, comparative studies examining contextual differences in adoption drivers across diverse regions remain scarce. This study addresses this gap by applying Venkatesh et al.'s (2003) Unified Theory of Acceptance and Use of Technology (UTAUT) to analyze the perceptions and experiences of PAT adopters in two regions with contrasting agricultural landscapes, Taiwan and the U.S.

The urgency of PAT adoption is underscored by its potential to optimize resource use, reduce environmental impact, and enhance yield predictability through tools such as GPS-guided machinery, remote sensing, and

automated irrigation systems (Yatribi, 2020). In the USA, PA adoption is often driven by economies of scale and robust institutional support, with large farms leveraging technology to streamline operations (Venkatesh et al., 2003). Conversely, Taiwan's agricultural sector, which is dominated by small landholdings and an aging workforce, has prioritized PA through state-led initiatives like the Smart Agriculture Project (2017) and Productivity 4.0 (Council of Agriculture, Taiwan, 2017). However, structural barriers hinder widespread adoption, such as high upfront costs, limited technical literacy, and perceptual challenges like skepticism about return on investment [ROI] (FFTC, 2020). These contrasting contexts provide a unique lens to examine how UTAUT's core constructs of performance expectancy, effort expectancy, social influence, and facilitating conditions operate across different cultural regions.

The UTAUT framework, widely applied in organizational and consumer technology adoption studies, posits that acceptance of technology hinges on four factors: performance expectancy (perceived benefits), effort expectancy (ease of use), social influence (peer/community norms), and facilitating conditions (institutional support) (Venkatesh et al., 2003). While UTAUT has been validated in sectors like healthcare and education, its application in agriculture, particularly in cross-cultural comparison, is limited. For instance, performance expectancy in the U.S. may emphasize yield optimization, while in Taiwan, labor reduction and operational efficiency might dominate (FFTC, 2020). Similarly, social influence in Taiwan's communal farming communities could differ markedly from the corporate agribusiness networks in the U.S. (Yatribi, 2020).

Previous studies on PAT adoption have often prioritized technical metrics over human-centered factors, such as trust in technology or cultural attitudes toward innovation (Yatribi, 2020). Comparative analyses of how regional disparities influence UTAUT constructs are notably lacking. For example, Taiwan's top-down, policy-driven adoption strategies contrast with the U.S.'s market-led diffusion, suggesting divergent roles for facilitating conditions and social influence (Trade.gov, 2020). This study bridges these gaps by addressing three questions: (1) How do the PAT adopters perceive the technology in Taiwan and the USA? (2) What are the experiences of PAT adopters in Taiwan and the USA? (3) How do UTAUT's core constructs shape PAT adoption in Taiwan and the USA.?

This multi-case study contributes to agricultural technology literature by contextualizing the UTAUT model within regional frameworks, offering actionable insights for policymakers and technology developers. For Taiwan, findings may inform strategies to align PAT solutions with smallholder needs, while U.S. stakeholders can refine outreach to large-scale producers. This study advances a nuanced understanding of technology adoption in heterogeneous agricultural systems by exploring the perceptions and experiences of PAT adopters in different cultures.

Purpose

The purpose of this qualitative study is to explore and gain insights into the viewpoints of farmers who have integrated PAT within their agricultural practices, drawing a comparative analysis between the contexts of Taiwan and the USA. Through a qualitative lens, this study seeks to offer a comprehensive exploration of the diverse cultural, technological, and contextual dynamics that shape the adoption, utilization, and outcomes of precision agricultural technology in these two distinct geographical settings. The results are expected to offer valuable insights into the multifaceted relationship between technology adoption and agricultural advancement. The study was driven by the following research questions:

(1) How do the PAT adopters perceive the technology in Taiwan and the USA?
(2) What are the experiences of PAT adopters in Taiwan and the USA?
(3) How do UTAUT's core constructs shape PAT adoption in Taiwan and the USA.?

METHODS

The study employed an instrumental multiple-case study research design (Eisenhardt, 1989). The design was considered suitable for exploring the perceptions and experiences of PAT adopters since case studies allow the researcher to gain an in-depth understanding of the phenomenon under investigation, and the information can be collected from several sources over for some time (Carless, 1998). In addition, the design helps to explore

complex issues, answer "how" and "why" questions, and draw on multiple approaches (Rashid et al., 2019; Yin, 2018). The central phenomenon addressed was the perceptions and experiences of PAT adopters and the factors that influence the adoption of PAT. The study included 21 PAT adopters from Taiwan and the United States, selected through purposive sampling (Patton, 1990; Silverman, 2011) and snowball sampling (Etikan et al., 2016). Participants had to be willing residents of either Taiwan or the USA and must utilize at least two PAT technologies. Initial participants were identified through connections in the precision agriculture community, with U.S. participants located in Lubbock County, West Texas, and Taiwanese participants were identified through the connections of extensionists. Subsequently, participants were asked for recommendations to include additional farmers embracing precision agricultural technologies.

The researchers employed semi-structured interviews as the primary data collection method, chosen for its ability to provide in-depth information (Denzin & Lincoln, 2017; Kvale, 1996), balance structure and flexibility (Mack et al., 2005), and encourage participant involvement (Fontana & Frey, 1994). Interviews are particularly useful for discussing sensitive topics, allowing participants to control the discussion's pace and depth (Seidman, 2013) and ensuring reliable and valid data through follow-up questions (Creswell, 2013). A predesigned, piloted interview protocol with twelve major guiding questions and probing questions was used (Creswell & Poth, 2018). The interviews ranged from 45 to 50 minutes in length and were conducted through WhatsApp video calls, LINE audio calls, and face-to-face from March 2023 to April 2023. According to Miles et al. (2020), data analysis of qualitative research is "the process of bringing order, structure, and meaning to the mass of collected data" (p. 3). They argue that qualitative research requires more than merely "reading and summarizing" the data to be rigorous and systematic. The data from the participants' interviews and researchers' memos were read several times to gain a deeper understanding of the data and to identify patterns and themes that may not be immediately apparent (Saldaña, 2016). After the multiple reading process, preliminary ideas emerged that led to open coding, which helped to identify concepts in the data. This was followed by axial coding that organized the concepts into categories and sub-categories, and then, finally, selective coding to identify the core categories and the central themes of the research questions.

To enhance trustworthiness and transferability, we conducted member checking to increase credibility (Creswell, 2013; Patton, 2002). Similarly, the data sources were triangulated, and the researchers reviewed the findings with their advisors to ensure they accurately reflected participant reality. In addition, we applied inter-rater reliability (Miles & Huberman, 1994). A comparison of codes showed consistency despite the researchers using different synonyms. For instance, Increased economy, economic prosperity, and economic health. The researchers also continuously examined and tracked data, which led to the confirmation of the data. To enhance confirmability, the researchers used the transcribed data and the researcher's memos. For reflexivity, the researchers positioned themselves within the inquiry to avoid bias (Creswell & Poth, 2018). Furthermore, the researchers attempted to address the issue of transferability by providing dense, detailed descriptions of the participants and their settings.

FINDINGS

The participants from the two countries reported a high level of satisfaction and optimism with PATs. They generally held positive perceptions about the adoption and use of PAT. Quotes from Taiwan participants are denoted as PT, while US participants are denoted as PU. For instance, a participant from the USA [PU2] said, "I can't imagine life without it." Similarly, a participant from Taiwan [PT4] said, "The autopilot is more accurate, user-friendly, and interesting. It makes my life less stressful and less boring". All the participants agreed that PAT was the technology of the future. PU9 said, "It's still going to advance, but who knows to where?". PT6 said, "It will be a trend in the future". The participants recognized PAT's potential benefits in optimizing resource use, enhancing decision-making, improving efficiency, increasing productivity, enhancing wellness, boosting economic wealth, and promoting environmental sustainability. Six themes emerged from the analysis: (a) increased efficiency, (b) economic wealth, (c) environmental sustainability, (d) wellness, (e) cross-cultural perspectives, and (f) barriers and facilitators to PAT adoption and use.

Theme #1- Increased Efficiency

Most participants indicated that PAT increased efficiency in their farming operations and increased productivity. They believe that technology such as GPS guidance systems, yield monitors, and variable rate irrigation/variable

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rate fertilizer can help them make better decisions and optimize their resource use. This leads to increased efficiency, reduced wastage of inputs, and high crop yields. Improved farming efficiency benefits farmers financially and contributes to food security and the well-being of communities due to food stability. PT1 said, "By accurately controlling the input and output and even adjusting the input to make it more efficient, it is quite critical for us."

PU9 also quipped, "I think it's helped our efficiency tremendously. And it's helped us reduce cost, labor costs, fuel costs, and time. We can do things faster, more timely, and it's just made us we're way more efficient." Participants reported that the implementation of PAT helped them reduce labor, fuel, and time expenses. They were able to complete tasks more quickly and precisely, resulting in an overall increase in the efficiency of their farming operations. These positive experiences strengthen their satisfaction and support for the use of PAT technologies.

Theme #2 – Economic Wealth

Most PAT users reported greater farm production, increased revenue from the sale of agricultural products, and increased input savings because of using the PAT. They believe that by adopting efficient farming technologies, they have improved their economic viability, profitability, and savings from the precise application of fertilizers, insecticides, and irrigation water. All the above points lead to an improved economy. For instance, PT10 said, "One of the advantages of precision agriculture is that you can use the data you collect to achieve a balance between yield and quality." PU6 discussed the economic benefits of PAT, "I feel that some of my labor costs are greatly reduced as I can irrigate and spray remotely because the technology also integrates some big data."

When asked to approximate the amount saved since adopting PAT, the PU3 said:

Yeah, it's pretty hard to put a number on it because an operator can work longer hours. The operator is not fatigued from trying to monitor everything, so that's hard to put a number on. But one thing I can tell you is our autopilot technology, for planting our seed and our pesticide application. Yeah, it's saved us 5% on our costs.

When asked to mention any other source(s) for savings because of adopting PAT, PU2 said:

Minimizing overlap. That's a big one. And that's another one of those that it's the first time you go to the field with that technology, that piece of equipment. You see it instantly. There's no question. Yes, this just saves me money.

However, some participants reported negligible increases in productivity and income. For instance, PT5 said that "I have not seen any huge differences looking from an output perspective." While PU11 said, "The yield and quality haven't changed that much, but it's on a positive trend." In summary, most participants recognized the potential of PAT to reduce farming costs by optimizing input applications, minimizing fuel consumption, and reducing labor requirements. These cost-saving benefits, along with the increased efficiency enabled by PAT, were seen as contributors to improving income and overall profitability for farmers.

Theme #3 – Enhanced Environmental Sustainability

PAT was perceived to have positive environmental impacts by participants in both Taiwan and the US. In Taiwan, participants recognized environmental benefits, particularly in rational fertilization and pesticide application. They noted PAT's role in the precise and optimized use of fertilizers and pesticides, minimizing waste. Leveraging big data for optimal chemical application was highlighted as effective for environmental protection. Similarly, US participants mentioned PAT's environmental improvements, such as increased efficiency in tractor usage and larger implements, leading to reduced emissions. They emphasized PAT's role in precise chemical

application, preventing overuse, and reducing environmental impact. Efficient water resource utilization through PAT's irrigation systems was also noted as beneficial for both the environment and participants. In support of the above, PT2 said:

Looking at the concept of rational fertilization, it is equivalent to saying how much and when we should apply fertilizer, and we have a very precise amount of how much to apply. That will avoid the waste of our water and fertilizer, so it must be helpful to the environment.

Similarly, PU5 said:

The technology uses the exact amount of chemicals and like I said, one of the earliest spray controllers we got in the 1980s made us aware of how much we were overapplying certain chemicals. I think environmentally [there's] no question about it.

In summary, the participants acknowledged the positive influence of PAT on the environment. The utilization of PAT enabled them to be more environmentally friendly by minimizing the wastage of fertilizers and pesticides, optimizing resource use, and conserving water. They believed that adopting PAT technologies contributed to a positive impact on the environment, improving sustainability and conserving natural resources. As a result, the farmers end up having a healthy ecosystem to support their farming activities.

Theme #4 - Enhanced Wellness

The adoption and use of PAT were also found to enhance wellness as observed among participants from Taiwan and the US. The usefulness and convenience of adopting PATs saved participants' time, and hence, they had more flexibility in terms of time management. PT1 mentioned, "We can directly add the fertilizer along with the irrigation line. Originally, it took me three days to do the work, and now it only takes three hours to complete it." This reduction in labor-intensive activities contributed to improved wellness by reducing physical strength and allowing farmers to allocate their time more efficiently. Similarly, PU6 mentioned, "Maybe reducing some labor and driver fatigue. When you can use the autopilot stuff, you're just not nearly as tired at the end of the day, you're more alert or safe, you know things like that." The use of autopilot features and technology allowed for reduced labor and driver fatigue. By utilizing autopilot systems, farmers experienced less tiredness and increased alertness, thereby enhancing safety and overall well-being.

Participants also mentioned the convenience and time-saving aspects of PAT. They highlighted features such as remote monitoring and control, which allowed them to check the status of equipment or operations from a distance. This eliminated the need for frequent travel, saving both time and effort. By reducing the need for physical presence and enabling remote access and monitoring, PAT contributed to increased convenience and improved work-life balance for participants. PU8 stated, "There's a convenience factor there. It makes my life easier, and so I'm willing to pay for a little bit."

PU9 also said:

We used to have to be out at night baling hay. So, when my boys were eight up to when they got out of high school, you know, we were bouncing out of bed at midnight, one or two o'clock, and going to work for two or three hours, and everybody's running a tractor. Now that I went with the double baler rig, I could run more hours so that one guy could go out and do what the three of us were doing. And productivity increased, right, there was quite a bit. Just simply finding someone who would be willing to work weird hours, their wife might not be okay with this. And you don't want to cause marital issues, you know.

I would hate for anyone to get divorced over me asking them to work.

Theme #5 – Cross-Cultural Perspectives

According to participants' responses, cross-cultural perspectives also emerged as a theme in terms of adopting PAT. The adoption of PAT in Taiwan was more prevalent among small-scale farm holders due to land size; the adoption of self-driving equipment was uncommon, and older farmers were often hesitant to adopt novel technologies. The fragmented nature of farmland in Taiwan posed challenges for the adoption of PAT, particularly in outdoor farming. The scattered nature of farmland made it difficult to install facilities, and small landowners faced additional barriers. Despite these challenges, participants mentioned the existence of

agricultural groups, trade unions, and association platforms that facilitated information exchange and learning among farmers.
PT4 said:

The farmland in Taiwan is relatively scattered, so if outdoor farming agriculture wants to introduce precision agriculture equipment, this may be a problem. In addition, there are small landowners in Taiwan.

In the US, adoption of PAT was more prevalent among large-scale farming operations. Participants highlighted its usage in tractors, sensors, self-driving equipment, and spray controllers. Contrary to their Taiwanese counterparts, some older US farmers were early adopters, demonstrating a greater willingness to embrace new technologies. For information on PAT, US farmers relied on various sources such as dealers, the internet, social media, and publications. Online platforms like social media and farming groups were particularly valued for exchanging information and experiences.

PU6 stated:

Let's say 2008 to 2012, basically until up to the point where everybody had an iPhone and the Internet was readily accessible. You would learn it from the guy selling the stuff at the sales. Yup. But now that I have access, I don't want to hear what the salesman likes; I do all the research. I go to Trimble's website or something like that. Yes, Twitter, Facebook, you know, there are farming groups on Facebook for different GPS products and stuff, they're very constructive and helpful. But I would say that where the majority of my information comes from now is social media.

Both Taiwanese and US participants stressed the importance of independent research and networking. Farmer-to-farmer communication played a crucial role in disseminating PAT information, underlining the significance of observing successful practices from others.

PT2 said:

The government will promote the young farmers' association and then organize some activities. We will visit other people's farms and see how they use artificial intelligence to do farming. It is relatively difficult for the elderly to accept novel technologies and it is easier for the young farmers to absorb these new methods and new equipment, but the biggest problem is that we need to have available funds.

PU8 indicated:

Birds of a feather flock together. I mean, if you're a guy going to look for help on one of these forums or a Facebook group, then you're also likely to be the kind of person that doesn't mind offering help. So I've found the experience to be very positive. In fact, it's so much more positive, I would rather deal with that than I had my local dealers because the dealer has an agenda.

Theme #6: Barriers and Facilitators to the Adoption and Use of PAT

The final theme identified in the study relates to the barriers and facilitators to the adoption and use of PAT. While participants acknowledged the usefulness and benefits of PAT, they also mentioned several challenges that could potentially influence their decision to adopt and utilize these technologies on their farms. High initial costs posed a significant barrier, but dealers or companies often provided credit options to alleviate this issue. Software malfunction and the cumbersome update requirements were mentioned as another challenge. Participants expressed that software issues and the need for regular updates could sometimes be frustrating and time-consuming. Learning to use new software and keeping up with the rapid pace of technological advancements were also mentioned as barriers. Overall, acquiring specialized knowledge and skills to effectively utilize the big data collected by PAT was a challenge for some farmers.

PU3 stated, "Normally, if you need finances, we usually go with the dealer because we've had a history of repayment ability and all that." PU2 said, "There are some companies whose headquarters are good, and you can call them and they may be 1000 miles away, but they're just really good and helpful." In short, US

participants acknowledged both the advantages and challenges of adopting PAT. Challenges included high initial costs, software issues, learning curves, and keeping up with advancements. However, participants noted that support from dealers, available credit options, and assistance from companies helped them overcome these obstacles and effectively implement PAT on their farms.

DISCUSSION, CONCLUSION, AND IMPLICATIONS

Discussion

The study aimed to explore the perceptions and experiences of precision agriculture technology (PAT) adopters in Taiwan and the United States, focusing on the factors influencing adoption and the contextual differences between these regions. The findings indicate that performance expectancy, particularly in economic efficiency and yield optimization, and effort expectancy, such as ease of use, are central motivators for PAT adoption. These results are consistent with the Unified Theory of Acceptance and Use of Technology (UTAUT) framework, which posits that PAT's perceived benefits and ease of use are important drivers of technology acceptance (Venkatesh et al., 2003). Similarly, the results align with the findings by DeLay et al. (2021) and Thompson et al. (2018), who observed that adoption of PAT may be influenced by economic efficiency, yield optimization, and ease of use of the technology by the farmer. Moreover, participants frequently emphasized cost savings and labor reduction, which aligns with previous research by Boehlje and Langemeier (2021) and Yatribi (2020), suggesting that PAT can reduce input overlap and operational expenses.

However, the study also revealed variability in return on investment (ROI), with some farmers reporting negligible improvements in yield or income. This finding contrasts with more optimistic reports in the literature that highlight systemic profitability gains from PAT adoption (Agri Planting, 2024; Yatribi, 2020). The discrepancy suggests that the economic benefits of PAT may be contingent upon complementary investments in data literacy and supporting infrastructure (Cleary, 2017). Furthermore, fragmented or partial adoption, without holistic integration, may lead to suboptimal outcomes, echoing concerns raised by Jones et al. (2014) regarding the need for comprehensive system integration.

From the results, environmental sustainability emerged as another significant theme, with participants noting benefits such as reduced chemical use and improved water conservation. These perceptions are supported by global analyses indicating that PAT can lower resource inputs by 20–40% (FFTC, 2020). Nevertheless, some scholars have criticized PAT as primarily a climate adaptation tool rather than a mitigation strategy, highlighting the need for standardized metrics to quantify ecological impacts (DeSmog, 2020). While adopters perceived reductions in emissions and waste, the broader scalability of these environmental benefits may be limited by persistent barriers such as data interoperability and rural connectivity gaps (Sela, 2025).

Cross-cultural differences in adoption patterns were evident, reflecting structural disparities between Taiwan’s smallholder-dominated sector and the large-scale operations typical of the U.S. In Taiwan, government-led initiatives and farmer associations played a prominent role in knowledge dissemination, whereas U.S. farmers relied more on dealer networks and social media. These findings are consistent with previous studies emphasizing the importance of social influence and institutional support in technology diffusion (DeLay et al., 2021; Khaspuria et al., 2024; McFadden et al., 2023). However, skepticism among older farmers in both regions underscores ongoing generational divides in technological literacy, a barrier that may be exacerbated by the rapid pace of technological change (Agri Planting, 2024; Cleary, 2017).

Conclusions, Implications, and Limitations

This study demonstrates that PAT adoption is shaped by a complex interplay of economic, environmental, and sociocultural factors, as mediated by UTAUT constructs. The results suggest that economic viability is primarily determined by perceived efficiency gains, such as labor and fuel cost reductions, rather than direct increases in yield. While environmental benefits are achievable, there is a need for standardized metrics to validate these claims and justify further investment. The findings also highlight the importance of cultural context, indicating that tailored strategies are necessary for smallholders versus large-scale producers. Persistent systemic barriers, including high costs, data complexity, and fragmented farmland, remain significant challenges despite ongoing technological advancements. These conclusions challenge the effectiveness of one-size-fits-all policy

approaches, advocating instead for region-specific solutions that are responsive to local agricultural ecosystems.

The implications of this study are multifaceted. For policymakers, there is a clear need to subsidize initial costs through grants or low-interest loans, particularly for smallholders, and to strengthen extension services by developing training programs that bridge technological literacy gaps. Investing in interoperable data platforms can also help reduce fragmentation and enhance usability. For technology providers, simplifying user interfaces and expanding technical support are essential steps toward lowering barriers to adoption. Addressing data privacy concerns through transparent ownership policies may alleviate farmers' apprehension.

The limitations of the study stem from its sample size and the potential for sampling bias, especially since snowball sampling may disproportionately include well-connected adopters. As a result, our findings lack perspectives from critical adopters who may have discontinued or abandoned the implementation of PAT. This could lead to an overly positive portrayal of adoption and overlook the challenges faced in real-world settings. While future studies could benefit from triangulating data and validating perceived outcomes, it is also important to recognize the barriers present in non-Western contexts.

Future research should focus on quantifying the long-term ROI of PAT adoption through longitudinal studies, exploring generational adoption patterns, and developing standardized metrics for evaluating environmental impacts. These efforts may help illuminate broader issues such as digital inequality and rural exclusion, offering deeper insight into persistent resistance to PAT despite technological progress. By integrating cultural, economic, and ecological considerations, stakeholders can foster more inclusive adoption pathways that enhance both productivity and resilience in agriculture.

Overall, the study underscores the transformative potential of PAT but cautions against unchecked techno-optimism that overlooks structural inequities. Addressing these challenges will be significant for realizing the full benefits of precision agriculture technologies in diverse agricultural contexts (FFTC, 2020; Venkatesh et al., 2003; Yatribi, 2020).

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