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Factors Affecting Precision Agriculture Technologies Adoption in Hong Kong

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Eric Kin Wai Lau*

Lee Shau Kee School of Business & Administration, Hong Kong Metropolitan University, Hong Kong, China

***Corresponding Author:** Eric Kin Wai Lau, Lee Shau Kee School of Business & Administration, Hong Kong Metropolitan University, Hong Kong, China.

Abstract

The study aims to investigate the current precision agriculture technologies adoption in Hong Kong and construct a model of adoption. It is the first comprehensive study of precision agriculture technologies adoption utilizing both grounded theory approach and quantitate studies. The study began with open-ended interviews with farmers in Hong Kong on their perceptions about the use of precision agriculture technologies in their farms. Using grounded theory approach, the research team identified predictors of their adoptions. In the second phase, the research team will develop and administer a survey and test the adoption model.

Keywords: precision agriculture technology; harvest automation; information technology adoption; modern farming management

Background

According to the latest statistics provided by the Agriculture, Fisheries and Conservation Department of the Hong Kong Government, the local agriculture industry produced HK$1,666 million worth of agriculture products in 2020 (AFCD website, 2021). It contributed 1.6% of the fresh vegetables consumed in 2020. Hong Kong farmers produce mostly leafy vegetables and high-value cut flowers. By the end of 2020, 2500 farms were located in Hong Kong with about 4300 farmers and direct workers.

The Study

The study investigated the adoption and usage of precision agriculture technologies in Hong Kong. Precision agriculture technologies are important in modern farming. It is expected that adopting precision agriculture technologies can help for the improvement of productivity and effectiveness of crop production. Applications of precision agriculture technologies include robots, moisture and temperature sensors, aerial imaging and global positioning systems used in farms. Many of these technologies are well developed and mature. In general, the Hong Kong agriculture industry is relatively traditional and conventional. By the application of precision agriculture technologies, it may allow farmers to operate and manage their farms better. The qualitative and quantitative studies data allow researchers and policy-makers a better understanding of the current farming situation in Hong Kong. With the capabilities of PI in several related government consultancy committees, more customized incentives, education and supports (Kitchen, Snyder, Franzen and Wiebold, 2002) can be proposed on the agriculture sector in Hong Kong as a long-term goal.

Factors affecting the adoption of precision agriculture technologies

Precision agriculture technologies refer to the use of technologies in crop farming that help farm operations for better control and productivity. Technologies including robots, moisture and temperature sensors, global positioning systems, aerial imaging, and IoT applications in greenhouses are commonly used in today's crop farming (Mcbratney, Whelan, Ancev and Bouma, 2005; Coble, Mishra, Ferrell and Griffin, 2018; Giua, Valentina and Camanzi, 2021). Precise farm operation decisions can be made and executed for efficiency and productivity (Lowenberg-DeBoer, 2019; Young, Kwon, Smith and Young, 2003). Some of these technologies have been available since the 1980s (Plant, 2001).

As defined by the United States Department of Agriculture (2007), precision agriculture technologies are "a management system that is information and technology based, is site-specific and uses one or more of the following sources of data: soils, crops, nutrients, pests, moisture, or yield, for optimum profitability, sustainability, and protection of the environment (p. 1)". It helps the management of crop production through cost reductions, better productivity, improved efficiency and sustainability. Importantly, a recent study tested the adoption of various precision agriculture technologies against their profitability with a dataset from the Kansas Farm Management Association in the US, and found that the financial returns from the adoption of precision agriculture technologies varied and depended on different factors (Dhoubhadel, 2021). However, it is questionable that the farm size will affect the adoption decision due to the efficiency of the adopted applications (Loures, Chamizo, Ferreira, Loures, Castanho and Panagopoulos, 2020).

Another study found that farmers tended to be passive and late adopters for the technologies (Miller, Griffin, Bergtold, Ciampitti and Sharda, 2017). They investigated three information technologies used in Kansas farms for the following farm management: yield monitoring (YM), variable rate application of inputs (VR) and precision soil sampling (PSS). They found that American farmers adopted a limited level of technologies in their operations. Therefore, it is necessary to review those adoption factors (see Table 1) for education and promotion purposes.

Hari, Brown and Best (2019) conducted a meta-analysis of the previous studies on the adoption of precision agriculture technologies. The majority of the previous studies were conducted in the US, Germany and Australia. They were all conducted in developed countries. Five main groups of information technologies were investigated, including yield monitoring, soil monitoring, remote sensing, geographical information systems and bundle technologies. Table 1 shows the key determinants and the components identified in the adoption process.

Another empirical study also found that the educational level of the farmers and their age were related to adoption (Paxton et al., 2011). With a sample of 892 cotton producers in the US, they found that the number of precision agriculture technologies adopted by the cotton producers was positively related to their education levels and negatively correlated with their age. Similarly, Paustian and Theuvsen (2017) tried to investigate farmers' demographics and farm characteristics with the adoption of precision farming. With a sample of 227 crop farmers in Germany, they found that farmers with 11–15 years of farming experience were more willing to adopt precision farming than other groups. Full-time farmers were also more willing to adopt precision farming than part-time farmers were. Interestingly, farms with no family employees were precision farming adopters. Farms that offer contractor services were precision farming adopters. In a study conducted in Brazil with a sample of 504 farmers, the respondents suggested that the benefits and costs of precision agriculture technologies are their main considerations for adoption (Bolfe, de Castro Jorge, Sanches, Cabral da Costa et al., 2020). Complexity and connectivity are also important factors affecting their adoption.

Component	***Key determinants***
Innovation component	Relative advantage
	Compatibility
	Low complexity
	Trialability
	Observability
	Technical support
Communication and influence	Social networks
	Change agents
	Marketing
	Peer opinion
	Expert opinion
External context	Socio-political climate
	Incentives
	Mandates
	Interorganisational norm-setting
	Network
	Environmental stability
Adopter	Skills
	Motivation
	Values and goals
System antecedents for innovation	
System readiness for innovation	

Table 1: Key determinants and the components identified in the adoption process (Hari, Brown and Best, 2019).

In an earlier study, Daberkow and McBride (2003) conceptualised that the awareness of precision agriculture of the farmer affects his/her adoption. They tried to test the effect of farmers' socioeconomic characteristics on the level of adoption. Human capital, risk preferences, farmland ownership, labour supply, financial capability, and physical location factors were tested. With survey data from USDA's study in 1998, they found that farmers' education and computer literacy, full-time farming, farm size, physical location factors and crop type positively affected the awareness of precision agriculture.

Apart from those demographic factors identified in previous studies, Tey and Brindal (2012) proposed a comprehensive adoption model with seven main factors affecting the decisions to adopt precision agriculture technologies in farms identified from previous empirical studies. These are socio-economic factors, agro-ecological factors, institutional factors, informational factors, farmer perception, behavioural factors and technological factors.

As mentioned, information technology is heavily rooted in those precision agriculture applications investigated in previous studies. It is important to apply Davis's (1989) technology acceptance model (TAM), which relatively few previous empirical studies have used for the adoption of precision agriculture technologies in farms. Davis (1989) defined the attitude of people toward technology adoption as follows: "people's feeling, whether positive or negative, as regards the behavioural intention towards accepting the use of a system, is predicted by their perceived usefulness and perceived ease of use". These are two important factors we need to include in the proposed framework.

Researchers	***Publication year***	***Samples***	***Dependent variable (DV)***	***Independent variables and their relationship with DV***
Daberkow, S. G., & McBride, W. D.	2003	Data from USDA's study in 1998	Awareness of precision agriculture	Farmers' education and computer literacy, full-time farming, farm size, physical location factors and crop type
Paxton, K. W., Mishra, A. K., Chintawar, S., Roberts, R. K., Larson, J. A., English, B. C., & Martin, S. W.	2011	892 cotton producers in the US	Number of precision agriculture technologies adopted	Education levels (+), Age (-)
Paustian, M., & Theuvsen, L.	2017	227 German crop farmers	Adoption of precision farming (adopter or non-adopter)	Farming experience (-) Full-time farmers (+) Farm size (+) Number of family employees (+) Farm with contractor service (+)
Bolfe, É. L., de Costa Jorge, L. A., Sanches, I., Luchiari Jr, A., Cabral da Costa, C., de Castro Victoria, D., Inamasu, R. Y., Grego, C. R., Ferreira, V. R., & Ramirez, A. R.	2020	504 Brazilian farmers	Digital technologies used in farm	Benefits (+) Costs (-) Complexity (-) Internet access (-)

Table 2: Selected empirical findings about adoption factors of precision agriculture technologies.

Conceptual framework and hypothesis

The study built on the original technology acceptance model TAM (Davis, 1989) and extends it with those factors identified in previous empirical studies on the adoption of precision agriculture technologies (Kolady, Van der, Mahi and Deutz, 2021). Figure 1 shows the conceptual framework of the proposed study. The research model is initially based on three major constructs from TAM: perceived ease of use [Construct 1], perceived usefulness [Construct 2] and farmer's adoption intention [Construct 6]. An additional three situational and institutional factors to the intentions identified in previous empirical studies were added (Roberts, English and Larson, 2002): farmer's demographics [Construct 3], farm's characteristics [Construct 4] and institutional factors [Construct 5]. Lastly, the study tested the relationship between farmers' intentions [Construct 6] and their actual adoption decisions [Construct 7].

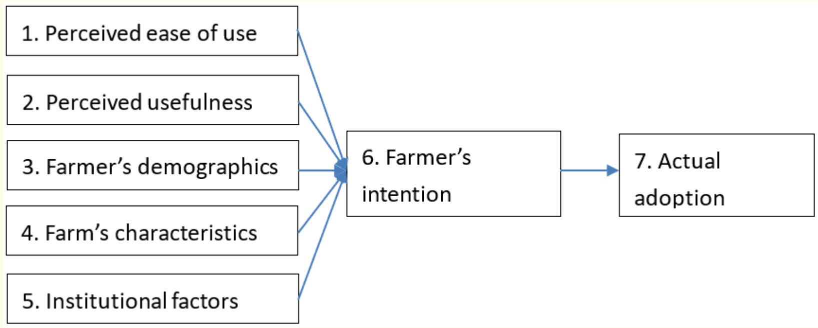

Figure 1: The conceptual framework.

The following are the hypotheses developed in the study

Perceived ease of use

H1: Perceived ease of use will have a significant positive influence on farmers' intentions to accept and use precision agriculture technologies.

Perceived usefulness

H2: Perceived usefulness will have a significant positive influence on farmers' intentions to accept and use precision agriculture technologies.

Farmer's demographics

H3: Age of farmers will have a significant negative influence on farmers' intentions to accept and use precision agriculture technologies.

H4: Farming experience will have a significant positive influence on farmers' intentions to accept and use precision agriculture technologies.

H5: Education level of farmers will have a significant negative influence on farmers' intentions to accept and use precision agriculture technologies.

H6: Computer literacy of farmers will have a significant negative influence on farmers' intentions to accept and use precision agriculture technologies.

H7: Gender will influence farmers' intentions to accept and use precision agriculture technologies.

Farm characteristics

H8: Farm size will have a significant negative influence on farmers' intentions to accept and use precision agriculture technologies.

H9: Category of crop produced will influence farmers' intentions to accept and use precision agriculture technologies.

H10: Ownership of the farmland will influence farmers' intentions to accept and use precision agriculture technologies.

H11: Family member employment on the farm will influence farmers' intentions to accept and use precision agriculture technologies.

Institutional factors

H12: Facilitating conditions will have a significant positive influence on farmers' intentions to accept and use precision agriculture technologies.

H13: Financial support will have a significant positive influence on farmers' intentions to accept and use precision agriculture technologies.

H14: Perceived risks will have a significant negative influence on farmers' intentions to accept and use precision agriculture technologies.

H15: Social norms will influence farmers' intentions to accept and use precision agriculture technologies.

H16: Farmers' intentions to accept and use precision agriculture technologies will have a significant negative influence on the actual usage of precision agriculture technologies.

Research Methodology

The proposed study utilized both qualitative and quantitative approaches to investigate the research hypotheses posed (see Figure 2). First, in-depth interviews conducted to collect detailed descriptions of how precision agriculture technologies are adopted in Hong Kong and the barriers. Quantitative studies focused on the factors influencing farmers' intentions to accept and use precision agriculture technologies.

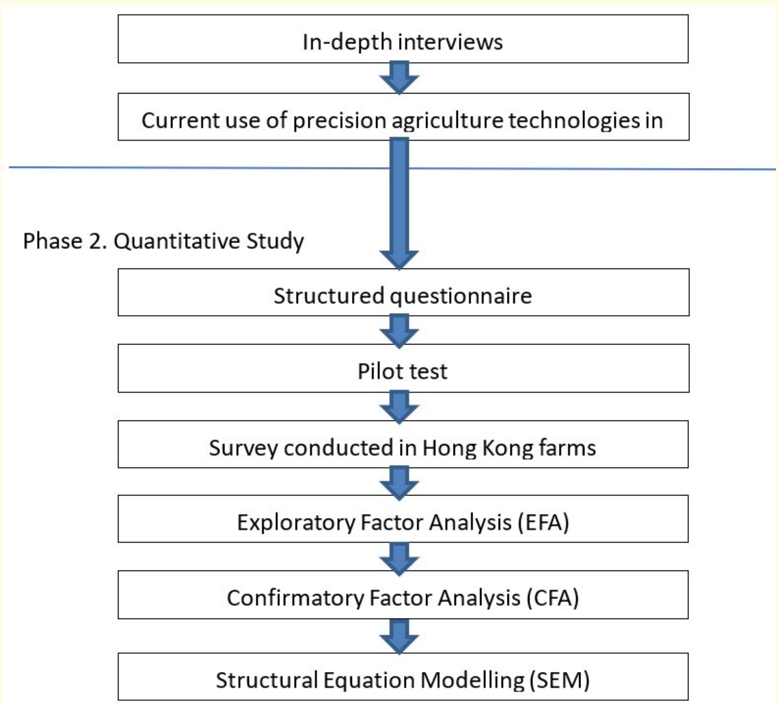

Figure 2: The Research Methodology.

Phase 1. Qualitative Study - Ground Theory Approach

The grounded theory approach was adopted because it identifies the objective of building the conceptual framework from the qualitative data and detailed interpretation. As suggested by Strauss and Corbin (1994), grounded theory is "a general methodology for developing theory that is grounded in data systematically gathered and analyzed (p. 273)". The process includes direct observation, written documentation and literature (Byrne, 2001). Since it is relatively few research efforts on the precision agriculture technologies application and adoption in Hong Kong, it is necessary to adopt the grounded theory approach as the first phase in the proposed study. Based on the research team's networks with the Agriculture, Fisheries and Conservation Department and local farm associations in Hong Kong, an invitation for volunteers to participate in the study sent to all convention and organic farmers. Open-ended interviews conducted as to collect farmers' perceptions on the precision agriculture technologies application and their adoption in Hong Kong. First, the respondents were asked to share their experience in the crop farming. Then they were asked about whether they understand precision agriculture technologies applications and their usage. Finally, the research team asked them about their opinions about factors affecting their adoptions of precision agriculture technologies in their farms. The research team coded and content analyzed the responses according to whether they supported or opposed the applications.

Quantitative Study

By adopting the grounded theory approach of Glaser and Strauss (1967), factors affecting farmers' adoptions of precision agriculture technologies were identified from the qualitative data. Building on prior research, the theoretical model was developed within the context of farmer's demographics, farm's characteristics, institutional and social constructs. A structured questionnaire was developed and the pre-test conducted in order to precisely define measurements for a construct (Dolnicar, 2013). Then, the research team conducted a survey to all convention and organic farmers in Hong Kong.

In terms of the analysis, an exploratory factor analysis (EFA) was utilized to explore the measurement of the constructs that affect farmers' adoptions of precision agriculture technologies in their farms. Next, confirmatory factor analysis (CFA) with maximum-likelihood estimation was used to test the unidimensionality and convergent validity of the constructs. Then the structural equation modeling (SEM) confirmed the proposed theoretical model.

Concluding Remarks

It is relatively little research attention on the technology acceptance and adoption in the agricultural sector. Prior investigation on the precision agriculture technologies adoption about the basic farm characteristics and situational factors. It is necessary to consolidate a list of explanatory factors in the adoption of precision agriculture technologies in farms. The model constructed on the existing empirical study results and technology acceptance framework (Davis, 1989). The project includes grounded theory study and structured equation modeling of precision agriculture technologies adoption. Theoretically, it provides meaningful insights and a completed empirical picture for the precision agriculture technologies adoption decisions in Hong Kong farmlands. The study attempts to propose and test a conceptual model of predictors on the precision agriculture technologies adoption decisions with a view to filling some gaps in this area.

The majority of previous studies regarding the precision agriculture technologies adoption were conducted in Western countries. Therefore, this study extends the existing technology literature with Asian perspectives. For the short and medium-term, it provides a better understanding of complex adoption decisions with different demographic and cultural settings.

References

1. AFCD. Agriculture, Fisheries and Conservation Department, Hong Kong SAR Government.
2. AFCD website. (2021). https://www.afcd.gov.hk/english/agriculture/agr_hk/agr_hk.html
3. Bolfe ÉL., et al. "Precision and digital agriculture: Adoption of technologies and perception of Brazilian farmers". Agriculture

10.12 (2020): 653.
4. Byrne M. "Grounded theory as a qualitative research methodology". AORN Journal 73.6 (2001): 1155-1156.
5. Coble KH., et al. "Big data in agriculture: A challenge for the future". Applied Economic Perspectives and Policy 40.1 (2018): 79-96.
6. Daberkow SG and McBride WD. "Farm and operator characteristics affecting the awareness and adoption of precision agriculture technologies in the US". Precision Agriculture 4.2 (2003): 163-177.
7. Davis FD. "Perceived usefulness, perceived ease of use, and user acceptance of information technology". MIS Quarterly 13.3 (1989): 319-340.
8. Dhoubhadel SP. "Precision agriculture technologies and farm profitability". Journal of Agricultural and Resource Economics 46.2 (2021): 256-268.
9. Dolnicar S. "Asking good survey questions". Journal of Travel Research 52.5 (2013): 551-574.
10. Glaser B and Strauss A. "The Discovery of Grounded Theory: Strategies for Qualitative Research". Chicago: Aldine (1967).
11. Giua C, Valentina CM and Camanzi L. "Management information system adoption at the farm level: Evidence from the literature". British Food Journal 123.3 (2021): 884-909.
12. Hari SP, Brown P and Best T. "A systematic literature review of the factors affecting the precision agriculture adoption process". Precision Agriculture 20.6 (2019): 1292-1316.
13. Kolady DE., et al. "Determinants of adoption and adoption intensity of precision agriculture technologies: Evidence from south Dakota". Precision Agriculture 22.3 (2021): 689-710.
14. Kitchen NR., et al. "Education needs of precision agriculture". Precision Agriculture 3.4 (2002): 341-351.
15. Loures L., et al. "Assessing the effectiveness of precision agriculture management systems in mediterranean small farms". Sustainability 12.9 (2020): 3765.
16. Lowenberg-DeBoer J. "The economics of precision agriculture". In Precision Agriculture for Sustainability, 1st ed.; Sttaford, J., Ed.; Burleigh Dodds Science Publishing Limited: Cambridge, UK (2019): 461-482.
17. Mcbratney A., et al. "Future directions of precision agriculture". Precision Agriculture 6.1 (2005): 7-23.
18. Miller NJ., et al. "Farmers' adoption path of precision agriculture technology". Advances in Animal Biosciences 8.2 (2017): 708-712.
19. Paustian M and Theuvsen L. "Adoption of precision agriculture technologies by German crop farmers". Precision Agriculture 18.5 (2017): 701-716.
20. Paxton KW., et al. "Intensity of precision agriculture technology adoption by cotton producers". Agricultural and Resource Economics Review 40.1 (2011): 133-144.
21. Plant RE. "Site-specific management: The application of information technology to crop production". Comput. and Electron. in Agric 30 (2001): 9-29.
22. Strauss A and Corbin J. "Grounded Theory Methodology". In NK Denzin & YS Lincoln (Eds.) Handbook of Qualitative Research. Thousand Oaks: Sage Publications (1994): 217-285.
23. Strauss A and Corbin J. "Basics of Qualitative Research". Newbury Park, CA: Sage Publications (1990).
24. Tey YS and Brindal M. "Factors influencing the adoption of precision agricultural technologies: A review for policy implications". Precision Agriculture 13.6 (2012): 713-730.
25. Thompson NM., et al. "Farmer perceptions of precision agriculture technology benefits". Journal of Agricultural and Applied Economics 51.1 (2019): 142-163.
26. Roberts RK, English BC and Larson JA. "Factors affecting the location of precision farming technology adoption in Tennessee". Journal of Extension 40.1 (2002): 1-10.
27. United States Department of Agriculture. "Precision Agriculture: NRCS Support for Emerging Technologies." United States Department of Agriculture, National Resources Conservation Services. Washington, D.C (2007).
28. Young DL., et al. "Site-specific herbicide decision model to maximize profit in winter wheat". Precision Agriculture 4.2 (2003): 227-238.