論文の内容の要旨

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論文題目 Research on Adoption of Sustainable Agriculture Practices of Smallholder Farmers in the Northwest and Southern China

（中国西北と西南地域における小農の持続可能な農作方式の採用意識に関する研究）

Sustainable agricultural development was defined as the management and conservation of the natural resource base, and the orientation of technological change in such a manner as to ensure the attainment of continued satisfaction of human needs for present and future generations (FAO 2014). Within the scheme of Sustainable Development Goals (SDGs) of the UN's Post-2015 Development Agenda, identifying and implementing policies, strategies, and technologies that contribute to sustainable agriculture play an essential role in conserving land, water, and plant and ensuring natural resources basis (United Nations 2012). Despite the attractive alternatives that SAPs represent for many farmers and given the well-established economic and environmental benefits, widespread adoption of SAPs has not yet occurred. For example, China began to promote conservation agricultural practices in the dryland regions in 2002 and not until 2014, the application area only reached 86 million hectares, a share of 6.4% of the total cultivated area in China. Nevertheless, there is extensive literature on the adoption and diffusion of agricultural technologies and innovations, of which the adoption of SAPs is one hot topic that has attracted much attention by scholars and public sectors.

- **Research Objectives**

This study aims to address the process of decision-making on SAPs adoption and provide insights for site-specific policy design in the face of structural changes in agricultural production using survey data from northwest and southern China. How the decision is made on SAPs adoption was divided into three stages: behavioral intention, behavior, and the confirmation of the behavior. Based on the current literature and survey data, the principal objectives are provided as following:

The first objective is to clarify the intention of SAPs adoption based on a survey in northwest China. To begin with the intention of adoption, we first focus on adoption preferences of SAPs among two main kinds of smallholder farmers, i.e., the grain crop farmers and cash crop farmers. Then taking into consideration the preferences, a specific design adoption package including details of the adopting process and supplementing technical assistance was provided for farmers, and the aim is to estimate farmers' decisions on these packages within different cropping systems, and thirdly the heterogeneity of the decision-making will be measured. The second objective is to examine the consistency between the perception, intention, and behavior of cover crop adoption. The effect of perception on both intention and behavior among smallholder farmers will be first examined using the bivariate-probit model. Then the consistency between behavioral intention and behavior is investigated. And the third objective is to evaluate the economic and ecological effects of the cover crop adoption in orchards, to confirm the influence of the practice adoption, and provide a comprehensive understanding of the effects.

- **Contributions of the Study**

The major analytical contribution of the study is that it not only integrates three stages of decision-making in the context of the agricultural structural adjustment, but also recognizes the diversified farming portfolios in each stage. Although studies of conservation agriculture and technology adoption are not new, the scheme taken here is novel. Also, the localized features and farming options further depict how farmers decide to adapt SAPs to their farming systems and help to explain the trade-offs in their production.

This study extends the hierarchy of the influencing factors in each stage. The existing researches mostly apply binary or ordinary logit and probit model for factor analysis, and this study conducts multiple approaches including Best-worst scaling, Discrete Choice experiment, bivariate-probit, and effect analysis to explore the influencing factors at all levels of the decision-making process, aiming at a thorough and clear elaboration on key factors affecting decisions.

This study also contributes to our empirical understanding of localized climatic features and cropping systems in affecting farmers' decisions. The statistical assessment in arid and semiarid northwest offers precise proves showing that the precipitation and the traditional cropping systems can lead to diverse decisions on SAPs adoption. More importantly, the findings in this study further indicate that the decisions on the SAPs adoption are closely related to how farmers perceive the adaptability of the technology and how easy these practices can be adjusted with the current cropping system. The findings have important policy implications for agricultural sustainability and food security in many developing countries, where farming is dominated by millions of smallholder farmers.

- **The Structure of the Dissertation**

This thesis is organized into eight chapters. Chapter 1 first describes the basic dimensions of environmental degradation and agricultural development in China and the motivation of this research. Based on the statement of problems regarding the low adoption rate of SAPs and the lack of study on how the smallholder farmers decide to adopt SAPs along with the adjustment of their agricultural production and cropping structure, the research objectives were presented and the main contribution of this study was discussed.

Chapter 2 reviews the theoretical and empirical studies that provide the theoretical base and empirical evidence of the adoption analysis. As multiple practices regarding SAPs were discussed in the previous studies, this chapter focuses on the use of cover crops, crop rotation, conservation tillage of crop residue mulching, and fallow. The body of this chapter consists of a narrative review of influencing factors, motivations for and barriers to the adoption, as well as a summary of recommendations and suggestions relevant to the reviewed studies. This review intends to provide the conceptual model and analytical framework for this study.

Chapters 3-5 present a series of models that make up the analytical core of field study in northwest China. Analyses in these chapters make use of different approaches and parameter values to explore the decision on SAPs. Chapter 3 uses a best-worst scaling approach to examine the adoption preferences for nine SAPs among grain and cash crop farmers and investigates the influence of farm and climatic characteristics on adoption preferences. This chapter helps to understand how farmers in diverse agroclimatic zones perceive and respond to different conservation practices regarding SAPs.

Chapter 4 introduces a discrete choice model to investigate the decision-making regarding diversifying farming with cover crops for sustainable farm management (SFM) and examine whether the adoption decisions differ in different cropping systems. In this study, based on the face-to-face surveys in two regions of the Hexi corridor (D1) and the west Loess Plateau (D2) in northwest China, the smallholder farmers' adoption preferences for preferable cropping patterns of cover crops, duration of adoption, and supplementing technical support for reducing agrochemicals regarding SFM were investigated. Also, the empirical analysis was used to identify factors affecting farmers' decisions, and the differences between the two regions were compared.

Chapter 5 provides the latent class analysis for investigating the heterogeneity in farm and farmers' characteristics in shaping decision-making. Based on the Best-worst scaling (BWS) and Discrete Choice Experiment (DCE) choice survey conducted in chapter 3 and chapter 4, this chapter intends to divide the surveyed farmers into different classes for a better understanding of the decision-making of the proposed practices and packages. The primary goal of this chapter is to provide policy implications derived from the results of the divided classes.

Chapter 6 and Chapter 7 shift focus from northwest China to southern China and examine the specific practice of cover cropping. Chapter 6 contains a case study of Guangxi by investigating the adoption decision on cultivating cover crops. Using the bivariate-probit model approach, this study estimates the effect of perception on the intention and behavior of cover crop adoption among smallholder farmers in southern China. Also, the consistency between intention and behavior of cover crop adoption was examined.

Chapter 7 contributes to the understanding of the comprehensive effect of SAPs from the aspects of the cost and benefit of production and ecological value. A concise statistical assessment of orchard production in Yunnan, southern China with and without integrating livestock and cover crops is presented. The economic and ecological values of integrating livestock and cover crops as a technology for alleviating soil degradation and providing forage in orchard agriculture are also assessed to explain the comprehensive effect of SAPs adoption based on a precise case study.

Chapter 8 summarizes the analytical and empirical findings of this study. It also discusses the policy implications and indicates future areas for research, in particular for the regions possessing similar geographic and climatic features as northwest and southern China. The focus of this chapter is on the interactions between northwest and southern China.

Conference presentation

Factors affecting farmers' willingness to adopt green manure/cover crops? A case study of Guangxi, China, Oral presentation delivered at the Annual Meeting of the Agricultural Economic Society of Japan at the University of Tokyo, Tokyo, 31st March 2019.

Publication and progress

1. Nong, Yixin, Changbin Yin, Xiaoyan Yi, Jing Ren, and Hsiaoping Chien. "Farmers' Adoption Preferences for Sustainable Agriculture Practices in Northwest China."Sustainability 12(15), 2020, 6269.
2. Effect analysis of the grass-orchard-livestock integrated circular agriculture model——based on a comparative study of orchards in Luxi, Yunnan (Accepted, in press.)
3. Smallholder farmer preferences for diversifying farming with cover crops of sustainable farm management: A discrete choice experiment in northwest China (Submitted to *Ecological Economics,* under review)
4. Heterogeneity in the adoption preferences of sustainable soil management practices (In process)
5. Farmers' perception, intention and behavior of cover crop adoption in Guangxi, Southern China (In process)

6 Farmer behavior and adoption intention for sustainable agricultural practices: a review and research agenda (In progress)