

論文の内容の要旨

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論文題目 Empirical essays on rice technology adoption behavior in developing countries: A case study of the central highland zone of Madagascar

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The high poverty ratio at present in rural areas of sub-Saharan Africa necessitates the improvement of agricultural productivity. In developing countries, a rural household rely on crop production which is food and major income source. An increase of crop productivity directly and indirectly benefit farmers and therefore agricultural productivity growth is considered to lead the inclusive, pro-poor growth of a developing economy. Due to the rapid population growth, land expansion will no longer be a promising measure for African farmers to increase crop production. There is an urgent need for action to promote intensification technology. However, we have not come to conclusion how to make it happen.

Madagascar is one of the poorest countries in the world. It has the world's 5th highest poverty head count ratio. The number of people in poverty is increasing. Since 80% of the population live in rural areas and depend on subsistence agriculture, crop productivity growth has been at the center of the national strategies of economic growth, poverty reduction, and food security. Rice production plays a crucial role in a rural economy as a source of a household's income and employment for unskilled laborers as well as being the staple food. Domestic rice production does not meet the domestic demands, and imported rice has been increasing in volume, necessitating policy efforts for rice productivity enhancement.

The main objective of this dissertation is to provide empirical evidence to help with a deeper understanding of technology adoption behavior and resource allocation in rice cultivation by Malagasy farmers. The mainstream of adoption literature has seen the low rates of adoptions of agricultural technologies such as chemical fertilizer and improved seeds in developing countries are largely due to market failure, physical inaccessibility, or lack of information. There is an implicit assumption that adoptions of these technologies lead to better outcomes for adopters. However, recent studies show that this assumption may not always hold for the real environment surrounding rural farmers in SSA. Since no universally applicable approach has been developed, context-specific study has potential to contribute to the literature.

This dissertation consists of 4 chapters excluding the introduction and the conclusion. Two datasets are used. Chapters 1 to 3 use a unique panel dataset with rich information collected from 600 households who were interviewed 8 times during a 4-year period from 2018 to 2021. The other dataset that consists of information from 70 farmers was specially prepared for the experimental study in Chapter 4.

Chapter 1 aims to describe the livelihood of rural households with a focus on their consumption levels, poverty status, and associations between rice productivity and these two. In this Chapter, the key findings include the followings

- From the poverty profile analysis based on the household's consumption, consumption levels and poverty status have geographical and temporal variation.
- Rice is strongly connected to a household's economy as 30% of crop land is devoted to rice, 40 % of consumption is for rice, and 75% of crop income comes from rice cultivation.
- Rice productivity has a strong association with household consumption level and poverty status especially some months after harvesting.

Rice production can be increased by either improving yields or expanding land for cultivation. Rice cultivation in Madagascar has a unique setting which enabled us to explore both approaches. In Chapter 2, after rice cultivation practices are briefly summarized, use of chemical fertilizer in rice cultivation is examined as an example of the technology related to the former approach. The main research objectives of this chapter are to answer the question of why adoption of chemical fertilizer is so low. While the literature mainly focuses on market-related factors such as price of fertilizer and transportation cost, this study focuses on marginal productivity as a factor that affects the profitability. Also, this study has novelty because it analyses plot-level application decisions. Using the panel dataset, the following findings were obtained.

- Although chemical fertilizer application is limited in general, there is a substantial difference in use of chemical fertilizer between lowland plot and upland plot. Rice plots in uplands are more likely to receive it.
- Production function estimation revealed that nitrogen fertilizer does not contribute to yield increase on average. As a result, nitrogen fertilizer application is not profitable, which may explain the low use.
- At the same time, marginal productivity of nitrogen fertilizer was higher in upland rice plots than in lowland rice plots, which underpin the farmers' behavior of using it more in uplands.

The key conclusion is that currently, only high price of fertilizer may not explain why many farmers do not use the chemical fertilizer. In addition to the conventional approach that help farmers access to the input markets, agronomic approach that improve crop yield response to chemical fertilizer should be taken for encouraging farmers to use chemical fertilizer.

Chapter 3 focuses on upland rice cultivation, which is an example of technologies for expansion of crop land in the context of study area. Madagascar is different from other SSA countries where upland rice has been promoted because it has a long tradition of rice cultivation in lowlands. Therefore, the research question includes

- What makes farmers who grow rice in lowlands grow rice in uplands.
- Whether or not the upland rice is alternative method of rice production or supplemental production system to traditional lowland rice cultivation.
- What impacts the upland rice cultivation has on welfare of adopters.

Based on the cross-section data, determinants of adoption of upland rice and its impact on household welfare were examined to answer this question. Regarding the determinants of its adoption, the experience of production shock was found to be associated in addition to the effects of communes, one of the administrative unit, of living. Using propensity-score-matching (PSM) method, this study found that upland rice contributes to households' welfare by increasing rice consumption per capita and consumption level. The conclusion of this chapter emphasizes that although the substantial role that upland rice plays as a supplemental rice production means, the adoption is related to unstable performance in lowland rice.

In chapter 4, the impact of information provision on chemical fertilizer adoption and allocation was examined. Heterogeneity of marginal productivity that was presented in Chapter 2 suggests the importance of site-specific information regarding effectiveness of fertilizer application. The experiment was designed based on the latest agronomic knowledge that crop yield response to nitrogen fertilizer depends on the amount of phosphorus in the soil. Most literature on the role of plot-specific advice uses information that encourages farmers to increase the

use of fertilizer to appropriate levels of fertilizer requirements. The experiment in this chapter provided a simple binary information of either High-Expected Effectiveness (High-EE) or Low-Expected Effectiveness (Low-EE). This information support farmers decision of using the fertilizer if the plot has High-EE and saving the fertilizer if the plot has Low-EE, thereby it helps farmers optimize the allocation of given amount of fertilizer in two ways. Key findings from this experiment include that

- Phosphorus amount in soil largely varies across study site and even within a village. This suggest that blanket-type of fertilizer recommendation without any additional field-specific information would not be useful for yield improvement.
- Farmers utilized the information to optimize the fertilizer allocation. The average intensity of nitrogen fertilizer application was higher in plots of those who received the information of High-EE and the adoption rate was lower in the plots of those who received the Low-EE information.
- Although the significant effects of intervention on household welfare and household level rice yield were not observed, the yield in the target plot was higher in plots of those who belong to treatment group and received the information of high-EE.

Together with the findings from Chapter 2, this chapter also confirmed that the policy efforts for enhancing crop yield response to chemical fertilizer has potential to encourage farmers to optimize the fertilizer use.

Throughout the dissertation, this dissertation described various efforts by farmers to increase rice production. However, due to lack of means of knowing some critical information, their efforts often do not lead to an expected result. Policy implications derived from these findings are clear-cut. Rice varieties and agricultural practices to enhance yield response of lowland rice to fertilizer will play a critical role in promotion of intensification. At the same time, we should think about provision of more context-specific information to reduce uncertainty in technology adoption. Since farmers in developing countries have been making important decisions with facing lots of uncertainty, information based on the deep analysis of the local context may greatly help farmers increase their productivity.