Why Farmers in the Rainfed Rice Regions of Southern Cambodia Adopt the System of Rice Intensification

論文の内容の要旨

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論文題目： **Why Farmers in the Rainfed Rice Regions of Southern Cambodia Adopt the System of Rice Intensification (SRI)**

（カンボジア南部天水稲作地域の農家が集約稲作農法(SRI)を採用するのはなぜか）

Chapter 1. Introduction

Cambodia is a small country located in the Mekong region between Thailand and Vietnam, and has a total population of over 15 million, of which the majority (79.7%) lives in rural areas. Across the past 35 years, there has been more-than twofold increase in wet-season rice yield from just over 1.19 t/ha in 1980 to 2.82 t/ha in 2015, growing by 2.9%. Although rice yield has thus increased, Cambodia's rice harvest still comes mostly from rainfed lowland fields, and has year after year been threatened by natural disasters, such as floods and drought.

The System of Rice Intensification (SRI) was established in the early 1980s by Fr. Henri de Laulanie, S. J in Madagascar. Over the past 30 years, many researchers have demonstrated that SRI in comparison with conventional practices increased rice yield by 20-40% with 20-50% less water use and 50-70% reduced seed cost in irrigated as well as rainfed fields.

In recent years, adoption of the SRI is spreading in most Asian countries, and more recently in some two dozen countries in Africa and Latin America. Cambodia is one of the Asian countries

with high adoptions of SRI. Even though SRI would increase rice yield in irrigated paddies where shallow water level can be maintained, the water constraint in rainfed fields could negate the yield increase by SRI. In rainfed fields, the water level can be hardly controlled.

In my thesis, I found the possibility of SRI in improving rice farming under the water constraint of rainfed lowland fields of Cambodia. Therefore, I took field science approach including interview surveys and on-farm experiment to better understand the farmers' adoption of SRI and thereby to contribute to a securer livelihood among the small holder farmers in rainfed region of Cambodia.

Chapter 2. Rice yield increase by SRI with dependency on supplementary water availability in rainfed lowland fields of southern Cambodia

I conducted an interview survey with the farmers in Popel commune of Tram Kak District of Takeo Province. Tram Kak district was selected for its higher rate of SRI adoption among the farmers than other districts. In the study area, rice farming is done mostly in wet season.

I interviewed with 106 smallholders in 2015 and asked about the characteristics of their rice fields, such as soil properties and topography, and their agronomic practices including SRI practices in the wet season of 2014, when the fields were hit by a severe drought early in the season. The results indicated a clear difference in rice yield between SRI and Non-SRI fields with mean rice yield in SRI fields being 4.0 t ha^{-1} as compared with 2.8 t ha^{-1} in Non-SRI fields. The results further showed that the yield increase by SRI was associated with the planting of young seedlings at lower density. More importantly, the SRI-induced rice yield increase was dependent on supplementary water availability to the fields: there was no rice yield increase by SRI in the fields without the availability of supplementary water. The rice harvest in SRI fields without water supply was delayed due presumably to severer drought which caused delayed heading than those in Non-SRI fields.

Chapter 3. Assessing the acceptance of SRI among rice farmers in a rainfed lowland area of southern Cambodia

With the same fields and interview survey design as in chapter 2, I addressed, in this chapter,

the acceptance of SRI by the farmers in various environmental conditions including supplementary water availability. I also analyzed the farmers' recognition of positive and negative aspects of SRI with the intention to understand the determinants of the farmers' adoption (or rejection) of SRI. Better understandings of farmers' adoption of SRI will clarify the prospect of SRI in promoting rice production under the natural and socioeconomic environments of rural Cambodia.

The temporal change in SRI adoption exhibited two timings of the rapid increase. However, I also found the period of increased SRI discontinuation which coincided with the declining trend of wet-season rainfall since 2011. It is evident that availability of supplenmentary water is among the major determinants of the farmers' decision on SRI adoption. Another constraint against SRI adoption was the difficulties at transplanting, i.e. the hardships of using transplanting rope and meeting the heavier labor requirement for SRI. The latter constraint could be ameliorated by experiences to some extent, whereas the former constraint, i.e. lack of supplementary water to the fields, cannot be ameliorated by experience but needs increased source of water supply.

Chapter 4. On-farm evaluation of the effects of SRI on rice growth and yield in rainfed fields of southern Cambodia

I conducted on-farm experiment to investigate the effects of SRI on rice growth and yield in the farmers' fields in southern Cambodia. The study was undertaken in rainfed lowland fields of Popel commune of Tram Kak District in Takeo Province during the wet seasons of 2012, 2013, and 2015. A total of 32 on-farm experiments were conducted during the wet seasons for three years of 2012 (11 fields), 2013 (8 fields), and 2015 (13 fields).

Across the three years of study, SRI produced significantly greater plant biomass and grain yield than Non-SRI. The yield increase was mostly ascribed for the increased number of grains per land area, which was due to the increased number of spikelets per panicle rather than the number of panicles per land area. With no significant difference between SRI and Non-SRI with respect to seedling age, the greater number of grains per panicle was accounted for by the reduced planting density and increased amount of manure application in SRI than Non-SRI

fields. It was found that the greater manure application has increased soil nitrogen content in SRI and Non-SRI fields. While SRI did not increase the number of panicles per land area, it did increase the number of panicles per hill.

Chapter 5. General discussion

Synthesizing the findings in the preceding chapters, I conclude that SRI increases rice yield in rainfed lowland fields of Cambodia by planting young seedlings in the fields where supplementary water is available, and by planting the seedlings at lower density in combination with increased application of farmyard manure.

The yield increase by SRI have made a good reason for the farmers to adopt SRI, however, many farmers could not do so due to the lack of supplementary water in their fields. Some farmers have once adopted SRI, but discontinued it later due likely to the lack of supplementary water. Some other farmers, who have fields at more than one location managed to perform SRI in some of their fields with supplementary water availability. Another reason for the farmers for not adopting SRI was the difficulties at transplanting according to the SRI principles. The ongoing urbanization and increasing opportunities of off-farm jobs raise the labor cost for transplanting and make the labor-intensive SRI practices less feasible for the farmers.

I would rather argue that SRI must be adapted for lower labor requirement along with a higher yield. Such improvement could take advantages of the labor-saving components of SRI: lower number of seedlings planted per land area and utilization of the tillering capacity of the young seedlings to compensate for the lower planting density. With the reduced labor requirement as an additional target, the adapted SRI may not be simply called a system of rice *intensification* any more, however.