Chapter 4
On the Possibility of Rice Green Revolution in Rainfed Areas in Uganda: Impact Evaluation of a Management Training Program and Guidebook Distribution

Yoko Kijima

Abstract After providing an overview of rice sector development in Uganda, this chapter examines the effects of two technology dissemination programs on the enhancement of rice production in Eastern and Northern Uganda. One program was a JICA conventional training program that provided on-the-job training at demonstration plots three to four times a year, while the other was to distribute a rice cultivation guidebook to households that were randomly selected. The training program was shown to have improved rice productivity significantly. In contrast, there were no significant effects of the distribution of the guidebook on technology adoption or rice production. Although the distribution of the guidebook was less costly and easier to implement than the training program, distribution of the guidebook alone cannot be a substitute for conventional training programs.

Keywords Rice production • Uganda • Program evaluation • Cultivation practices • Technology adoption

4.1 Introduction

In Uganda, rice has long been a staple food, even though it is a relatively minor source of calorie intake (Benson et al. 2008). Rapid population growth and urbanization, however, has brought about dramatic increases in rice consumption, resulting in the importation of 60,000 tons of rice annually (Kikuchi et al. 2013b). Since an increase in domestic rice production might provide a way to save foreign currency reserves by decreasing dependence on imported rice and may help to improve food security and decrease rural poverty, the Government of Uganda (GoU) released

Y. Kijima (✉)
Faculty of Engineering, Information and Systems, University of Tsukuba,
1-1-1 Tennodai, Tsukuba 305-8571, Japan
e-mail: kijima@sk.tsukuba.ac.jp

K. Otsuka, D.F. Larson (eds.), *In Pursuit of an African Green Revolution*,
Natural Resource Management and Policy 48, DOI 10.1007/978-4-431-55693-0_4

the National Rice Development Policy (NRDP) in 2009. The policy made a commitment to doubling rice production in 10 years by joining the Coalition for African Rice Development (CARD) (MAAIF 2009).

According to the FAO Statistics, in the first 3 years since the target was set (2009–2012), rice production in Uganda has increased only by 3 % from 206,000 tons to 212,000 tons, while the area under rice cultivation increased by 7 %. Given that the areas suitable for rice cultivation will remain limited unless the greater investment in irrigation facilities is made, improving productivity is necessary to boost rice production in Uganda.

Based on the experience from the Asian Green Revolution, there is no doubt that the promotion of modern inputs such as high-yielding seeds and chemical fertilizer contributes to yield enhancement (Barrett et al. 2010). Without irrigation facilities, however, the use of expensive modern inputs may be too risky or may not be profitable, thereby resulting in the non-adoption of modern inputs (Kajisa and Payongayong 2011; Otsuka and Larson 2013b; Nakano and Kajisa 2013). In the case of rice cultivation in sub-Sahara Africa (SSA), agronomists and development practitioners have found that there is room to increase agricultural productivity by improving cultivation practices (Chap. 5). Since this type of technology does not require additional expenses, it may be easily accepted by small farmers. The question is how such information should be conveyed to a large population. The standard method of agricultural technology transfer is through agricultural extension workers (Feder et al. 1985). In many SSA countries, however, the extension system does not function effectively (Anderson and Feder 2007). While international development agencies may also play an important role in transferring agricultural technologies, providing training directly to rural farmers in large areas of the country tends to be excessively costly. It is, therefore, desirable to examine cheaper and more effective alternatives to disseminate relevant information to farm households. Given the high penetration of mobile phones, sending the information to farmers via short text messages has become a viable option (Aker 2011). It is not clear, however, whether farmers can understand and utilize such information on agricultural cultivation practices as effectively as they do when they have attended training programs and received advice from agricultural extension workers.

In 2010 and 2012, a household survey covering major rice growing areas in the rainfed lowlands in Eastern and Northern Uganda was conducted. This panel dataset makes it possible to gain an overview of the current status and the short-term variations in rice production in Uganda. In addition, in the study areas, two programs were implemented to disseminate improved rice cultivation practices: one was on-the-job training in the demonstration plots provided by the experts of the Japan International Cooperation Agency (JICA) and government extension officers in Uganda while the other was the distribution of a "rice cultivation guidebook," which was prepared by JICA experts and distributed by the survey team led by the author. By estimating the impact of these programs, this chapter attempts to derive policy implications to accelerate rice production in Uganda.

The organization of this chapter is as follows. Section 4.2 provides an overview of rice production in Uganda, which is followed by the explanation of data collection methods and technology dissemination projects in Sect. 4.3 and the examination of descriptive statistics in Sect. 4.4. While Sect. 4.5 explains the estimation methods of assessing the impacts of technology dissemination programs, Sect. 4.6 examines the estimation results. Finally, Sect. 4.7 discusses the conclusions and policy implications of this study.

4.2 Rice in Uganda

Table 4.1 shows the over-time trend of rice production in Uganda from 2008 to 2010 as well as differences by region. According to the Rice Census in 2008 (column 2), about half of the area under rice cultivation was located in the Eastern region (48 %), followed by the Northern region (34 %). The estimated total quantity of milled rice produced domestically (columns 3 and 5) increased from 122,000 tons in 2008 to 232,000 tons in 2011, implying that total rice production almost doubled.[1] In the Eastern region, the largest amount of rice was produced (57 % in 2011). In the Northern and Western regions, rice production has increased more rapidly than in the Eastern region. This is probably because upland rice cultivation has been expanding in the Northern and Western regions after the introduction of NERICA.[2] In 2011, the production in upland rice cultivating areas over the total rice cultivating areas accounted for 53 % and 97 % in the Northern and Western regions, respectively.

This impressive progress in the rice production, however, does not guarantee that this trend will continue in Uganda. In 2011, 70 % of the demand for rice was met domestically (Kikuchi et al. 2013b). According to the domestic resource cost ratio, domestic rice produced in the rainfed lowland and upland ecosystems is slightly less competitive than imported rice (from Pakistan and Tanzania) mainly due to the low yields and the high labor costs, while the rice cultivation in the irrigated ecosystem is competitive (Kikuchi et al. 2013b). Unless productivity is improved, domestic production is unlikely to replace rice imports.

In terms of consumption, rice has been a minor staple crop in Uganda. In 2005, the consumption of rice accounted for only 2.6 % of the total calorie intake in Uganda (Benson et al. 2008). In urban areas, more rice was consumed (6.2 %). Nationally, the main staple foods are tubers (22.6 %), matoke (18.9 %), maize (16.1 %) and pulses (13.1 %). In the rice producing areas, rice is often consumed at home, while rice is still considered a luxury item in non-rice growing areas, mainly

[1] While this massive increase (2008–2011) seemingly contradicts the FAO statistics cited above in the Introduction (2009–2011), there was a sharp increase in rice production between 2008 and 2009.

[2] NERICA is the abbreviation of New Rice for Africa, an upland rice variety suitable for African environments. See Kijima et al. (2008) for the potential of NERICA in Uganda and Kijima et al. (2011) for studies indicating NERICA's positive effect on household income.

Table 4.1 Trends and differences by region in rice production in Uganda

	Total area under rice cultivation 2008/2009[a]		Rice production 2008[b]		Rice production 2011[c]		Upland rice, 2011[c]	
	(ha)	Share out of total area	(1,000 tons, milled rice)	Share out of total production	(1,000 tons, milled rice)	Share out of total production	(1,000 tons, milled rice)	Share of upland rice
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
North	25,913	0.34	13	0.11	45	0.20	24	0.53
East	36,343	0.48	84	0.69	133	0.57	13	0.10
Central	2,638	0.04	5	0.04	12	0.05	9.1	0.76
Southwest	1,397	0.02	4	0.03	5	0.02	5	1.00
West	9,106	0.12	16	0.13	37	0.16	36	0.97
Total	75,397	1.00	122	1.00	232	1.00	87.1	0.38

[a]Rice Census cited in Kikuchi et al. (2013b)
[b]Kikuchi et al. (2014)
[c]Kikuchi et al. (2013b)

because the relative price of rice is substantially higher than that of maize in Uganda (RATIN 2014).

As stated in Kikuchi et al. (2013a), about 40 different rice varieties were planted by farmers in Uganda. Among the domestic rice varieties, Supa is the most popular variety since it has some aroma and provides a stable yield. The price of Supa is usually higher than the other varieties (e.g., Kaiso and "Upland"), which are not differentiated in the markets. About half of the rice produced domestically is consumed in the capital city and the remainder is consumed in the regions where rice is produced (Kikuchi et al. 2013b).

4.3 Data and Descriptive Statistics

4.3.1 Sampling and Survey

Two types of household surveys were conducted: An extensive survey (ES) in 2010 and 2012 and an intensive survey for case study (CS) in 2010. The objective of ES was to monitor the progress of rice production in Uganda under the rainfed lowland ecosystems, while CS was conducted in areas where the JICA training project was implemented. The household questionnaire contained a wide range of questions so as to capture farm and non-farm activities undertaken in the last 12 months as well as household demography, consumption expenditure, and assets (land, livestock, farm equipment, and other household items). Since the data collected in 2010 and 2012 captured the information in 2009 and 2011, respectively, the years of the data sets will henceforth be referred to as 2009 and 2011.

4.3.1.1 Extensive Survey

The sample districts were purposively selected based on the availability of the wetlands usable for lowland rice production in Eastern and Northern Uganda. The other criteria used in selecting the sample districts were average rice cultivation experience as well as agro-ecological conditions so as to capture a wide variety of the rainfed lowlands and different levels of the rice cultivation skills. Five districts out of 28 Eastern and Northern districts were chosen (Fig. 4.1, Panel A).[3] Butaleja and Lira districts have large irrigation schemes and farmers in these districts have longer experience of rice production than the other districts. Households in Lira and Dokolo districts have larger landholdings on average than the other districts.

Two sub-counties that are locally well known as rice producing areas were selected from each district.[4] In these ten sub-counties, the names of all local council

[3] For the Northern districts, only those that are around Lake Kyoga are considered as population.

[4] The information was obtained from the district agricultural officer in each district.

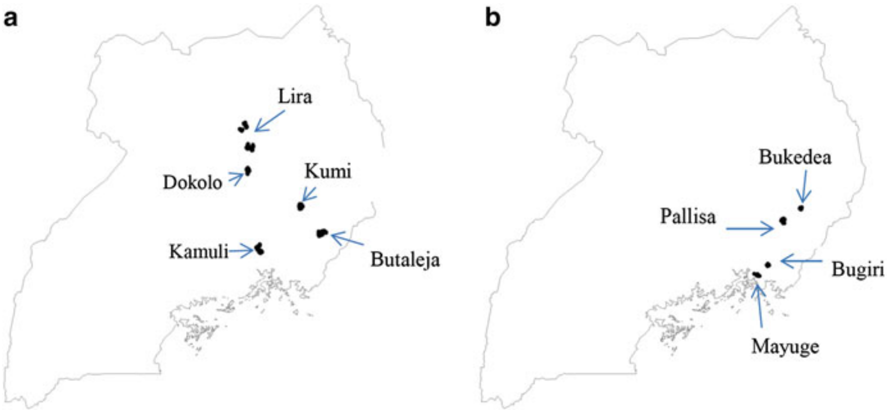

Fig. 4.1 Location of sampled households. (**a**) extensive study, (**b**) case study. Note: Plots were measured from GPS coordinates of the location of sampled households

1s (LC1s, the lowest administrative unit in Uganda) in each sub-county were listed up. From the list, 60 LC1s were randomly selected. In each LC1, ten households were randomly selected by using the lists of the households obtained from the LC1 chiefs. Thus, in total, 600 households were interviewed in 2010. For the second round, 30 sampled households were not available for interview (5 % attrition) and the number of the sampled households in the panel data declined to 570.

In each LC1, a community-level survey was also conducted. The respondents consist of the LC1 chairman, key informants, rice farmers, female farmers, youth, and elders. The questionnaire included general information such as the population, infrastructure, land ownership, land rental transactions, price information on agricultural inputs and outputs, ownership of cattle, access to credit organizations, local associations, and agricultural programs.

4.3.1.2 Case Study

As sample areas for the case study, four rice production areas were selected from (1) the project sites that JICA designated as demonstration plots and had provided training (namely, Bugiri and Mayuge) and (2) the sites that the JICA experts considered as candidates for future training projects (namely, Bukedea and Pallisa). All the sampled areas were located in wetlands that can be used for lowland rice cultivation (Fig. 4.1, Panel B). At each site, the demonstration plot (or plot where the training was planned to be offered) was identified by the JICA experts. Based on the distance from the demonstration plot, 75 households (rice plots) were randomly selected. In other words, sample households were chosen based on the location of their rice plots. Thus, all the sampled households were rice growers.

4.3.2 Projects on Improving Rice Cultivation Practices

4.3.2.1 Randomized Distribution of the Lowland Rice Cultivation Guidebook

In each district covered by ES, a half of the sampled LC1s were randomly selected as treatment LC1s, and the lowland rice cultivation guidebook was given to all sampled households within these selected LC1s when the 1st round of household surveys was conducted in 2010. Since weather patterns might play a critical role in deciding who farms rice and who does not, randomization of the beneficiaries (based on the location of the program) is an ideal method to solve any potential selection bias. As shown in Appendix Table 4.8, the observed characteristics of the sampled households and rice plots of treatment and control LC1s are not statistically different, suggesting that the randomization was successful.

The lowland rice cultivation guidebook was prepared by the JICA experts for the project conducted in Uganda. It is 15-pages long with photos and written in English. The issues covered are carefully selected to be of critical importance for lowland rice cultivation and applicable to the Ugandan small farmers. The guidebook is practical, explaining the advantages of the transplanting method, including how to conduct the germination tests and carry out transplanting (spacing and depth of seedlings), and ways to prepare the land, seeds, and the seedbed for the transplantation. It also explains the appropriate type of fertilizer and the timing and amount of chemical fertilizer to apply, as well as the methods of weed management. There are photos of the insect pests and the diseases of the lowland rice as well as a graph indicating the effect of the seedling age in transplanting on the rice yield, which is meant to emphasize the importance of using the young seedlings for transplanting.

By the time of our survey, certified lowland rice seed had not been released in Uganda – the seeds of improved variety for lowland ecosystems were not yet being produced by seed companies and therefore they were not sold in local shops. When households start growing rice in the lowland ecosystem for the first time, rice seeds have to be obtained from relatives and neighboring households who also acquired the seeds from their neighbors when they started growing rice. Most of the farmers do not know whether their rice seeds are the improved varieties or not. In the guidebook, therefore, the information on the improved variety was not provided explicitly, but the name "K-85" is mentioned in the guidebook. K-85 is planted in large commercial farms in Uganda (Tilda Uganda Limited, Kibimba Rice Scheme) and is known as a high-yielding variety for lowland ecosystems.

4.3.2.2 Lowland Rice Training Project by JICA[5]

The JICA project was designed to build the capacity of the district agricultural officers (extension workers) who are supposed to train farmers after the training. The field training was provided by the JICA experts and the extension workers to

[5] See Kijima et al. (2012) for the further information on the JICA training project.

farmers at the demonstration plots. The field trainings are offered four times at each site per agricultural season: (1) the establishment of a demonstration plot including the construction of water channels in the surrounding area, and leveling the main field (1–3 days); (2) the preparation of nursery beds and seedlings at the nursery beds (0.5 day); (3) the methods of transplanting and weeding (0.5 day); and (4) the methods of harvesting and threshing (0.5 day). The contents taught in each session were summarized so that the trainees were able to remember the key points. In the training, the project did not involve the construction of the modern irrigation facilities. Chemical fertilizers and other kinds of chemicals were neither given to the training participants nor applied in the demonstration plots. Rice seeds used in the demonstration plots were selected by the JICA experts.

4.4 Descriptive Statistics

4.4.1 Community Information and Prices in 2009 and 2011 (ES Data)

Table 4.2 shows the input and output prices calculated from the community survey (ES data). All figures are the nominal prices. As shown in columns (2) and (4), in half of the sampled communities, rice was mainly sold as paddy rice (before milling) while in the other LC1s, rice was sold after milling it. The milled rice price was 350 shillings higher than the paddy rice price in 2009, while the difference increased by up to about 525 shillings in 2011. The rice price obtained by farmers during the harvesting season was lower than that sold during the off-harvest season by 400–550 shillings. Thus, the producer price of rice differs a lot by the form of rice sold and the timing of sales. Compared with maize, the other storable staple food, output price of rice per kilogram is two to four times higher.

The next sets of variables are the input prices. As shown in column 2, the number of observations is small (especially for chemical fertilizer) since the farmers rarely apply the agro-chemicals and they do not know the price. The relative prices of urea and diammonium phosphate (DAP) to the rice do not seem so expensive when compared with those in other SSA countries, because these prices are those charged by the agro-dealers in Kampala (RATIN 2014). Therefore, the actual costs of using the chemical fertilizer should be much higher.

Since agro-chemicals are rarely applied to rice production in Uganda, the labor and the land are the most important inputs. Table 4.2 indicates the piece rate wage per acre of rice plot, which is the cost of hiring labor to finish each task per acre This measure is used because in most labor activities, the labor cost is paid per land size, not per hour, and because the information on hours worked by hired labor tends to be inaccurate since those who hire labor do not care how long it takes for the hired labor to complete the assigned tasks. The labor cost per acre did not change much over time, except for harvesting. This was applicable to the land rent as well. Thus, the output-input price ratio for rice production did not change from 2009 to 2011.

Table 4.2 Median prices of paddy and purchased inputs, wage rates, and land rents in extensive survey sites in Uganda (LC1 level)

	2009		2011	
	Median	# obs	Median	# obs
	(1)	(2)	(3)	(4)
Producer price				
Paddy rice (harvesting season) (USh/kg)	750	29	1,100	29
Paddy rice (off-harvesting season) (USh/kg)	1,150	29	1,650	29
Milled rice (harvesting season) (USh/kg)	1,100	29	1,625	30
Milled rice (off-harvesting season) (USh/kg)	1,500	29	2,600	30
Maize (harvesting season) (USh/kg)	300	57	300	55
Maize (off-harvesting season) (USh/kg)	500	57	900	55
Input price				
UREA (USh/kg)	2,000	4	4,000	9
DAP (USh/kg)	3,000	3	3,000	7
Pesticide (1,000 Ush/l)	16.0	27	24.0	31
Fungicide (1,000 Ush/l)	20.0	12	20.0	14
Herbicide (1,000 Ush/l)	21.0	5	25.0	12
Wage rate				
Wage for rice production (1,000 Ush/acre) – all	55.5	56	60.0	45
Wage for rice production (1,000 Ush/acre) – harvesting	35.0	28	60.0	21
Wage for rice production (1,000 Ush/acre) – weeding	60.0	44	60.0	40
Wage for rice production (1,000 Ush/acre) – ploughing	50.0	45	60.0	40
Land				
% of HHs rented in land via fixed rent in upland areas	27.3	57	37.7	60
% of HHs rented in land via fixed rent in lowland areas	30.8	58	31.6	59
Land rent (1,000 USh, 1 season, 1 acre) – upland areas	50.0	50	55.0	51
Land rent (1,000 USh, 1 season, 1 acre) – lowland areas	100.0	43	100.0	41

4.4.2 Rice Cultivation Practices in 2009 and 2011 Based on ES Data

Table 4.3 indicates the changes in the rice cultivation practices in 2009 and 2011 based on ES data. The percentage of the households growing rice decreased from 67 to 54 %. This is likely to be due to the fact that some of the lowlands in the sample area suffered from the drought or the floods in 2011. However, among those who grew rice, the area under rice cultivation and the share of the rice area out of the total cultivated area did not change over time. The average size of rice plots per household is 0.6 ha, which accounts for 28 % of the total cultivated land (including both upland and lowland plots). The total rice production at household level slightly increased from 2009 to 2011 to just above 1 ton per year.

Table 4.3 Rice cultivation and income at household and plot levels in extensive survey sites in Uganda in 2009 and 2011

	2009	2011
Household level		
Number of households	564	564
% of households who grew rice	66.5	54.1
Rice cultivated area (ha) (among growers)	0.598	0.581
Share of rice area over cultivated land	0.283	0.275
Total rice production (household level) (tons)	0.82	1.19
Share of rice income over total household income	0.176	0.135**
Share of crop income over total household income	0.750	0.751
Rice cultivation experience (years)	8.32	9.83**
Per capita income (USD)	255	251
Rice plot level		
Number of observations (lowland rice plots × cultivation times in a year)	573	394
Number of rice plots	454	332
Number of plots where rice was grown more than once within a year	113	57
(% of plots under double cropping)	(20.8)	(18.3)
Number of households growing rice in 1 plot and once a year	227	232
Number of households with rice plot sample	368	302
% of plots with:		
Bunding	57.8	70.6**
Leveling	60.7	75.4**
Transplanting	59.3	56.3
Transplanting in rows	9.8	5.6
Improved seeds	9.4	9.1
% of plots where chemical fertilizer was applied	6.8	4.3
Yield (tons/ha)	2.53	2.28
% of rice plots with hired labor	73.4	72.5
On land preparation	49.5	49.6
On sowing	36.0	37.8
On weeding	35.5	37.0
On bird scaring	22.6	21.4
On harvesting	47.2	39.5
On post-harvest	34.3	38.3

**Indicates that means over time (2009 and 2011) are statistically different at 5 % level

The sample households tend to have about 9 years of experience of rice cultivation. The annual per capita income is about USD 250. The share of income earned from crop production reached 75 % and did not change over time, which means that economically, the sample households depend heavily on crop production. The income from rice production accounted for 17 % of the total household income in 2009.

The bottom half of Table 4.3 shows the management characteristics of the sample rice plots. The number of observations (rice plot level data) was quite different between 2009 and 2011 (573 and 394, respectively), even though the percentage of sampled plots where rice was grown more than once within a year did not change much over time (approximately 20 %). This change is greater than that of the number of households growing rice (from 368 to 302). This suggests that drought and floods in 2011 made some plots too dry or too flooded to cultivate rice. Even those who grew rice in 2011 cultivated rice in fewer plots than in 2009.

Regarding the rice cultivation practices, the proportion of rice plots in which bunding and leveling were being conducted increased over time. In contrast, the adoption of the other cultivation practices (transplanting and transplanting in rows) and the use of chemical fertilizer did not change over time. In terms of the productivity measured by the quantity harvested per hectare, there was no significant change over time (2.5 tons in 2009 and 2.3 tons in 2011). This seems puzzling since the improved cultivation practices (i.e., constructing bunds and leveling) were more frequently applied in 2011 without enhancing productivity.

4.4.3 Cultivation Practice and Rice Yield in 2009 (CS Data)

Table 4.4 shows the adoption rate of improved cultivation practices separately for each sample village in the CS data. In Bugiri, an area that was covered by the JICA project, all the recommended cultivation practices were adopted by most of the sample households. In Mayuge, which is another JICA project village, as well as Pallisa which is the non-project village, the proper timing of transplanting and transplanting in rows were not implemented on a large scale. In Bukedea, another non-project village, the adoption rate of all the practices was as low as 10–28 %. The table also shows the rice yield separately according to the number of improved cultivation practices adopted. It is clear that the average yield rises as more of the improved practices were adopted by the farmers. In Bugiri, the average yield was 4.5 tons per hectare when four of the practices were adopted, while the yield was 2.3 tons per hectare when only one practice was adopted. This significant difference in the rice yield suggests that there is some complementarity between the improved cultivation practices. In Mayuge, another JICA project village, a similar but less clear-cut relationship can be observed between the yield and cultivation practices. In contrast, there was no clear relationship between the number of practices applied and the yield in the other two non-project villages. Therefore, further detailed examination is needed in order to understand the relationship between the rice yield and cultivation practices.

Table 4.4 Adoption of cultivation practices and rice yield by case study villages in Uganda

	All	Bugiri	Mayuge	Bukedea	Pallisa
Cultivation practice	Adoption %				
Bunding	83.8	100.0	95.2	24.1	81.5
Leveling	69.7	83.3	84.1	27.6	48.1
Transplanting	75.1	100.0	71.4	10.3	92.6
Proper timing of transplanting	43.8	69.7	39.7	10.3	25.9
Transplanting in rows	33.0	81.8	4.8	10.3	3.7
Number of cultivation practices applied	Yield (ton/ha)				
4 practices[a]	4.13	4.47	2.89	1.22	0.37
	(3.14)	(3.20)	(1.83)	(0.74)	–[c]
3 practices[b]	3.20	4.15	1.89	–	1.54
	(2.78)	(3.17)	(1.31)	–	(1.14)
2 practices	2.25	3.07	2.00	3.95	2.26
	(1.75)	(3.44)	(1.44)	(1.40)	(1.09)
1 practice	1.81	2.30	1.91	1.89	1.38
	(1.43)	(0.80)	(1.13)	(1.87)	(1.23)
0 practice	1.33	–	0.79	1.42	0.66
	(1.99)	–	–[c]	(2.10)	(0.56)[d]

[a]4 practices include bunding, leveling, proper timing of transplanting, and transplanting in rows
[b]3 practices indicate that among the 4 practices, 3 of them were implemented
[c]Only 1 observation
[d]Only 3 observations

4.5 Methodology

4.5.1 Average Treatment Effect on the Treated (ATT)

Can the provision of cultivation guidebook be a substitute for the field training to increase rice production in Uganda? To investigate this question, the average treatment effect on the treated (ATT) is estimated for the two projects: the JICA training project and the distribution of the guidebook. Propensity score matching method was applied to construct a comparable control group. It is likely that the training participants were inherently different from the non-participants (Winters et al. 2011). Since CS data is non-experimental and cross-sectional data, the training participants and non-participants may not be directly comparable.[6] Thus, it is necessary to construct an appropriate counterfactual that has similar observable characteristics to those of the treated households (i.e., the JICA training participants). The propensity score is the predicted probability that a household has access to the treatment. The propensity scores are estimated by a Probit model of training participation, where the household-level control variables are the years of experience of rice cultivation, number of household members, age and years of education of household

[6]As shown in Appendix Table 4.9, characteristics of the training participants and non-participants are significantly different in CS sample.

heads, value of household assets, and membership in a local organizations; the plot-level variables are the size of the rice plot, the water source dummy, and the ownership of the rice plot; and the village level variables are the annual rainfall amount and the traveling time to the nearest district town (Kijima et al. 2012). Kernel matching is applied.

The effect of the distribution of the rice cultivation guidebook on the rice production was analyzed by using the ES data in 2011 (after the distribution). Unlike the JICA training, the beneficiaries of the guidebook distribution were randomly assigned, which means that treatment and control groups are comparable. Actually, in Appendix Table 4.8, where the household characteristics in 2009 are shown by the recipient status of the cultivation guidebook, the characteristics of households and rice plots before the distribution (2009) are not statistically different between the treatment and control households. In order to make the results comparable with those for the JICA training, the same methodology (ATT by using propensity score matching with the data collected after the treatment) was applied to the impact evaluation of the guidebook distribution. The descriptive statistics of the data after the treatment (2011) are provided separately for the treatment and control groups in Appendix Table 4.10.[7]

These programs (the JICA training and the guidebook distribution) may have a variety of effects on the rural households in Uganda. First, households who had not previously grown rice may commence growing rice following the program.[8] Second, households who grew rice before the program might learn more about the proper cultivation practices and apply them, resulting in higher productivity. While applying better cultivation practices and commencing rice cultivation are likely to increase the income from rice production, it is not clear whether the total household income and expenditure also increase significantly as more resources may be allocated to rice farming at the expense of other activities. Therefore, the effect of the program on household welfare measured by per capita expenditure and income was also examined.

4.5.2 Adoption of Cultivation Practices in Case Study

The determinants of adopting designated cultivation practices are analyzed by IV Probit model. The main question is whether the JICA training had increased the probability of adoption of the improved cultivation practices or not. Participation in the JICA training was expected to enhance the knowledge that was gained regarding improved production practices and to increase adoption rates. Even without the training, some farmers may have learned effective ways of growing rice based on their own experience, which may lead to an increased adoption rate among more

[7] Given that the randomization is preferred to the matching method, the results of ATT without matching are estimated and compared with the results with matching.

[8] Regarding the decision to grow rice, the effect of JICA training cannot be estimated since all the households selected grew rice at the time of the sampling.

experienced farmers. Since these practices require greater labor inputs, households may need to hire additional labor. Thus, asset holdings may affect their adoption. These practices also can have particularly significant impacts on rice production when water is available, and thus their adoption is also likely to be affected by the availability of irrigation water. If the plot is rented, the tenant farmers may attempt to increase the net returns so as to at least recover the land rental fee, which requires intensification such as the adoption of better cultivation practices.

In the regression analyses, a dependent variable takes unity if a new cultivation practice (bunding, leveling, transplanting, or transplanting in rows) was adopted. Explanatory variables at the household and plot level take the values before the households made decisions on cultivation practices at each respective cropping season. As explained before, the training variable is considered to be an endogenous variable. Thus, the IV Probit model is applied. The instrumental variable for the JICA training participation (precisely, the training participation is measured by the number of training days participated) is the membership of farmers organizations unrelated with rice farming. The reason why this variable suits the condition of IV for training participation status in input demand functions for rice cultivation is that since the participation in JICA training requires the formation of producer group, those farmers who are members of farmers organization may have advantage in the participation, even though the membership per se does not affect rice farming efficiency.

4.5.3 Yield Function in Case Study

The yield is assumed to be determined by the household characteristics such as participation in the JICA training, application of the recommended practices, rice cultivation experience, asset holdings, and household composition as well as the plot characteristics such as water availability and the security of tenure of the plot in the respective cropping seasons. Given that training participation and application of the improved cultivation practices are highly correlated, these variables are used in different estimation models separately. As explained in the previous sub-section, the cultivation practices are endogenous. Therefore, the predicted adoption status of the cultivation practice, instead of the actual adoption status, is used as the explanatory variable.

4.6 Results

4.6.1 Adoption of Management Practices

The estimation results examining the adoption of improved management practices are provided in Table 4.5, which shows the results for the adoption function of constructing bunds, leveling, transplanting, and planting in rows in columns 2–5,

Table 4.5 Estimation results on adoption function of improved cultivation practices in case study villages in Uganda

	Num. of days of training	Bunds	Leveling	Trans planting	Trans planting in rows
	OLS	IV Probit	IV Probit	IV Probit	IV Probit
	(1)	(2)	(3)	(4)	(5)
Number of days of JICA training[a]		0.691**	−0.014	0.287*	0.257**
		(2.53)	(0.17)	(1.80)	(2.37)
Household head's age	−0.035**	−0.028	−0.023**	−0.016	0.013
	(2.02)	(1.03)	(2.26)	(1.24)	(0.80)
Household head's years of schooling	0.060	0.076	−0.011	0.026	0.024
	(1.10)	(1.17)	(0.37)	(0.50)	(0.47)
Female-headed household	0.536	0.139	0.000	−0.410	0.000
	(0.48)	(0.10)	(0.00)	(0.63)	(0.000)
Rice cultivation experience (years)	−0.237	0.552	0.148	0.476	0.997**
	(0.61)	(1.05)	(0.72)	(1.40)	(2.28)
Moved to this area after 2,000 dummy	0.013	0.060	0.013	0.026	0.009
	(0.46)	(1.44)	(0.84)	(0.93)	(0.36)
Land owned (ha)/number of adult family members (aged 15–64)	−0.817	−1.291	0.024	0.368	−0.558
	(1.65)	(1.90)	(0.09)	(0.88)	(1.25)
Initial assets (household, agricultural, livestock) (thousand USD)	0.218	0.409	0.140	0.178	−0.585
	(0.80)	(1.10)	(1.00)	(0.73)	(1.49)
Water source: depending solely on rainfall	−0.149	−1.710**	−0.582**	−0.635	−0.594
	(0.28)	(2.50)	(2.10)	(1.58)	(1.11)
Plot is rented	0.510	1.549**	0.286	−0.233	0.098
	(1.25)	(2.27)	(1.23)	(0.64)	(0.26)
Size of the plot (ha)	−0.043	1.252	0.023	0.368	−1.676
	(0.04)	(0.84)	(0.04)	(0.45)	(1.62)
Plot is under a customary tenure system	−0.089	0.410	0.735	−0.420	1.060
	(0.09)	(0.60)	(1.33)	(0.62)	(0.83)
Distance to demonstration plot (km)	−0.407	−1.919***	−0.159	0.429	−1.873***
	(1.15)	(3.02)	(0.75)	(1.52)	(3.69)
Farmers association member (non-rice)	3.415***				
	(7.01)				
District dummies	Yes	Yes	Yes	Yes	Yes
Planting month dummies	Yes	Yes	Yes	Yes	Yes
Observations	252	252	252	252	252
R-squared	0.51				
Log likelihood		−632.4	−711.6	−291.9	−629.2
Prob > Chi-squared		0.044	0.001	0.001	0.001

The numbers in parentheses are *t*-statistics in column (1) and *z*-statistics in columns (2) to (5)
***, **, and * indicate significance at 1, 5, and 10 %, respectively
Column (2) to (5) show the marginal effects (dF/dX)
[a]Endogenous variable whose IV is a dummy variable of being a member of a local organization (other than rice association)

respectively. Since training participation is an endogenous variable, the instrumental variable estimation model is applied where an instrumental variable for training participation is a dummy variable of being a member of a local organization (other than the rice association). The estimation result for the first stage analysis is shown in column 1, in which the coefficient of the farmer group membership dummy is found to be positive and significant.

The training participation (the number of JICA training days participated in) had significant and positive effects on the adoption of the improved cultivation practices except the leveling (column 3). The more experienced farmers with rice cultivation tended to adopt transplanting in rows more frequently. The younger household heads tended to adopt leveling. Poor access to water had a negative effect on the adoption of constructing bunds and leveling.[9] A shorter distance to the demonstration plot increased the probability of constructing bunds and transplanting in rows, which are reasonable.

4.6.2 Effects of Training and Management Practices on Rice Yield

Table 4.6 shows the estimation results of the rice yield function. As shown in columns 1–4, all cultivation practices had positive impacts on rice yields. The marginal effect of applying the cultivation practice on rice yield was approximately 0.26 tons per hectare, except for transplanting replacing direct seeding, whose marginal effect is 0.70 tons per hectare. Since the average rice yield was 2.5 tons per hectare, the marginal effect means that applying the cultivation practice can increase the yield by 10 % on average. Our analysis, however, cannot assess the effect of package adoption of new management practices due to high correlation among them. Unexpected result is that the direct effect of the training participation on the rice yield is not significant (column 5). This seems to indicate that the JICA training participation has only indirect effects by increasing the application rate of the cultivation practices, which turns out to be the factor significantly enhancing rice yield.

Somewhat unexpectedly, previous rice cultivation experience did not increase the yield. Recent migrant households tend to have a higher yield. The other household characteristics also did not have a significant impact on rice yields. Among the plot characteristics, the size of the plot is the only variable that is significant: Smaller plots are associated with higher yields, probably due to better field leveling, water control and good crop management.

[9] Access to water is measured by a dummy indicating that the rice plot depends only on rainfall (compared with the plots with additional water sources such as canals or wells).

Table 4.6 Yield function (ton/ha) using case study survey data in Uganda by 2SLS estimation

	(1)	(2)	(3)	(4)	(5)
Bunds = 1[a]	0.265***				
	(4.04)				
Leveling = 1[a]		0.261***			
		(2.69)			
Transplanting = 1[a]			0.700***		
			(4.32)		
Transplanting in rows = 1[a]				0.261***	
				(2.69)	
Number of days of JICA training[b]					−0.097
					(0.95)
Household head's age	−0.012	−0.014	0.006	−0.014	−0.014
	(0.93)	(1.06)	(0.45)	(1.06)	(0.97)
Household head's years of schooling	−0.004	−0.030	−0.045	−0.030	−0.007
	(0.09)	(0.70)	(1.06)	(0.70)	(0.17)
Female-headed household	−0.609	−0.403	−0.305	−0.403	−0.645
	(0.71)	(0.46)	(0.36)	(0.46)	(0.74)
Rice cultivation experience (years)	0.361	0.040	−0.099	0.040	0.177
	(1.21)	(0.13)	(0.32)	(0.13)	(0.59)
Moved to this area after 2,000 dummy	0.054**	0.031	0.017	0.031	0.047**
	(2.47)	(1.42)	(0.76)	(1.42)	(2.07)
Land owned (ha)/number of adult family members (aged 15–64)	0.105	0.437	0.170	0.437	0.375
	(0.27)	(1.12)	(0.45)	(1.12)	(0.96)
Initial assets (household, agricultural, livestock) (thousand USD)	0.185	0.367	−0.008	0.367	0.190
	(0.88)	(1.62)	(0.04)	(1.62)	(0.91)
Water source: dependent solely on rainfall	−0.455	0.043	0.441	0.043	0.070
	(1.10)	(0.10)	(1.04)	(0.10)	(0.17)
Plot is rented	−0.117	−0.487	−0.380	−0.487	−0.326
	(0.36)	(1.51)	(1.21)	(1.51)	(0.98)
Size of the plot (ha)	−3.788***	−3.766***	−4.365***	−3.766***	−4.309***
	(4.52)	(4.35)	(5.28)	(4.35)	(5.08)
Plot is under a customary tenure System	−0.534	−0.551	−0.266	−0.551	−0.210
	(0.69)	(0.70)	(0.34)	(0.70)	(0.30)
District dummies	Yes	Yes	Yes	Yes	Yes
Planting month dummies	Yes	Yes	Yes	Yes	Yes
Observations	268	268	268	268	268
R-squared	0.38	0.36	0.39	0.36	0.28

The numbers in parentheses are *t*-statistics
***, **, and * indicate significance at 1, 5, and 10 %, respectively
[a]Predicted value of adoption of each cultivation practice by IV probit model shown in Table 4.5
[b]Endogenous variable whose IV is a dummy variable of being a member of a local organization (other than rice association)

4.6.3 ATT

Table 4.7 shows the means of outcome variables separately for the treatment and control groups as well as ATT.[10] Columns 1–4 present the results of the JICA training, while columns 5–8 are for the distribution of the rice cultivation guidebooks. Regarding the effects on the decision to grow rice, neither the training nor the guidebook distribution increased the area size under rice cultivation or the share of the area under rice over the total cultivated land. Distribution of the guidebook failed to provide sufficient incentives to enhance the probability of growing rice. This is likely because those who have never grown rice need to obtain rice seeds as well as rice plots located in the lowlands suitable for rice cultivation. Unlike upland rice cultivation, there appears to be entry barriers for the expansion of lowland rice cultivation because unutilized wetlands tend to be customary land or communally owned. When such lands are used as communal grazing lands, permission from the local chief as well as the community members is needed for converting the wetlands into rice fields, which are managed individually. Therefore, it is plausible that both receiving the guidebook and participating in the JICA training will not result in significant effects on the area expansion for rice cultivation. This is also consistent with the fact that the training program and the guidebook focus on the intensification rather than on the expansion of rice cultivation areas.

The next set of outcome variables are related to the adoption of the improved management practices. The distribution of the guidebook increased the probability of applying the transplanting in rows by 6 percentage points, while there was no effect on the adoption of the other cultivation practices. The JICA training also increased the probability of applying the transplanting in rows and the effect was much greater than that of the distribution of the guidebook (22 percentage points vs. 6 percentage points). Participation in the training had a positive and significant impact on the probability of applying the chemical fertilizer (4 percentage points). A question therefore is why the guidebook distribution program had a significant effect only on the adoption of the transplanting in rows. This may be because the transplanting in rows can be easily observed and, hence, imitated and because in the guidebook, more than half of the pages are used for explaining the methods and benefits of transplanting in rows.

Looking at the productivity and the income of rice production, this study found that the JICA training increased the yield, while the distribution of the guidebook did not have any effect on rice productivity. The impact of the training on the rice yield was far from negligible (0.45 ton per hectare). In contrast, participation in the training did not have significant impacts on rice income. A possible explanation for the contrasting results of the training participation on rice yield and income is that transplanting in rows takes more time than direct seeding and "random" transplanting, resulting in higher costs of hiring labor.

[10] The results without matching for ES are provided in Appendix Table 4.11.

Table 4.7 Average treatment effects of the distribution of rice cultivation guidebook and the JICA training participation in extensive survey in Uganda (Kernel matching method 2011)

	ES 2011				CS 2009			
	Treatment (recipient)	Control (non-recipient)	ATT	s.e.[a]	Treatment (participants)	Control (non-participant)	ATT	s.e.[a]
Plot level	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Adoption of cultivation practice								
Bunding	0.741	0.674	0.067	0.058	0.974	0.992	–0.018	0.016
Leveling	0.793	0.725	0.068	0.054	0.838	0.778	0.059	0.088
Transplanting	0.565	0.542	0.023	0.050	0.923	0.971	–0.048	0.055
Transplanting in rows	0.088	0.021	0.067	0.023***	0.718	0.496	0.222	0.119*
Improved variety (k-series)	0.104	0.064	0.040	0.036	0.829	0.907	–0.078	0.083
Chemical fertilizer use	0.052	0.052	–0.000	0.029	0.043	0.000	0.043	0.024*
Yield (ton/ha)	2.23	2.30	–0.067	0.187	3.673	3.221	0.452	0.221*
Rice income (USD/ha)	6.306	6.348	–0.042	0.135	6.865	6.641	0.224	0.581
Household level								
Growing rice (dummy)	0.548	0.541	0.007	0.036	–	–	–	–
Area under rice (ha)	0.512	0.295	0.217	0.177	0.385	0.446	–0.060	0.096
Share of area under rice over cultivated land	0.153	0.147	0.006	0.014	0.272	0.282	–0.009	0.060
ln (per capita income)	4.730	4.846	–0.115	0.102	4.804	4.596	0.207	0.310
ln (per capita expenditure)	5.366	5.390	–0.024	0.043	5.476	5.433	0.043	0.137

[a]bootstrapped standard errors
***, **, and * indicate significance at 1, 5, and 10 %, respectively

Even though the distribution of the guidebook increased the probability of transplanting in rows, the program did not have a significant impact on the rice yield and income. The question here is then why the JICA trainings had significant effects on the yield, while the distribution of the guidebook did not. One possibility was the difference in transplanting experience among the CS and ES sample households. Most of the sample households in the CS applied transplanting, while transplanting was conducted in only in about half of the rice plots of the ES In order for the transplanting method to enhance the rice yield, the timing (the age of seedlings) is critical. As pointed out in the guidebook, however, farmers tend to transplant when the seedlings have already grown too much, which affects the yield negatively. It is likely that those who received guidebook might be less able to comprehend the essence of the transplanting method. Similar arguments may be applied with regard to the adoption of other cultivation practices.

The bottom part of Table 4.7 shows the results in terms of household welfare. Neither the JICA training program nor the distribution of the guidebook increased per capita household income or consumption expenditure significantly.[11] This is consistent with the results that they did not increase the rice income or the area under rice cultivation.

4.7 Conclusion

This chapter examined the extent to which the JICA onsite training and the distribution of the cultivation guidebook had any impacts on the enhancement of rice production in this country. Unlike the estimates from the other sources, rice production did not increase much from 2009 to 2011 among the sample households in Eastern and Northern Uganda. This is likely because there were wetlands that were severely affected by drought and floods in 2011. The rainfed lowlands in the sample areas are vulnerable to floods and drought since it is difficult for farmers to control the amount of water. It is important to note, however, that 72 % of the sample households in the ES grew rice in 2010, which is 5 percentage points higher than in 2009. Without the unfavorable weather shocks in 2011, the proportion of households who grew rice would likely have been increased. Therefore, it may not be necessary to draw adverse conclusions about the negative trend in rice production witnessed from 2009 to 2011. Having noted this, the goal of doubling rice production in 10 years may prove difficult.

In Uganda, the area under rice cultivation rapidly increased prior to 2009, a fact that was mainly explained by push factors such as the shortage of agricultural land for upland crops (Kijima 2012). According to the ES in 2011, the main reasons why rice was not grown in 2011 were the labor shortage (reported by 48 % of households who did not grow rice in 2011), the drought (13 %), floods (14 %), and the shortage of land suitable for rice cultivation (6 %). Thus, it may not be realistic to expect that

[11] Income and expenditure are in natural logarithm form.

rice production in Uganda will continue to grow as rapidly as in the period prior to 2009.

As examined in Kikuchi et al. (2014), unless productivity is improved, rainfed lowland rice production in Uganda cannot compete with imported rice. To enhance productivity through improved cultivation practices, two programs (the JICA training and the distribution of the rice cultivation guidebook) were implemented in the Eastern and Northern Uganda. A comparable control group was constructed by the propensity score matching method so as to overcome endogenous program placement and the selection bias of program participation. The training program provided by the JICA showed promising results, since it had a positive impact on the rice yield by 0.45 tons per hectare. Even though the distribution of the guidebook enhanced the probability of applying the transplanting in rows, there was no appreciable impact on the rice yield. These results, therefore, suggest that distributing the guidebook alone cannot be a substitute for conventional training programs. The guidebook distribution project should be either abandoned or improved, e.g., by supplementing it by the use of mobile phones to facilitate discussions between farmers and extension workers.

Appendix

Table 4.8 Household characteristics before the distribution of the cultivation guide book in extensive survey sites in Uganda in 2009

	Received guidebook (treatment)		Not received (control)		Diff in means[b]
	Means	(s.d.)	Means	(s.d.)	
Household characteristics					
Number of household members	8.00	(3.50)	7.95	(3.82)	
Share of male members aged 15–64	0.245	(0.137)	0.238	(0.141)	
Share of female members aged 15–64	0.348	(0.120)	0.235	(0.124)	
Female headed household dummy	0.093	(0.295)	0.078	(0.269)	
Head's age	44.8	(13.47)	45.1	(13.96)	
Head's years of schooling completed	6.21	(3.52)	5.72	(3.30)	
Land owned (ha)	1.96	(2.33)	1.71	(1.83)	
Ownership of bull (dummy variable)	0.291	(0.455)	0.344	(0.476)	
Rice cultivation experience (years)	8.840	(10.24)	7.801	(8.854)	
% of households who grew rice	65.2	(47.7)	67.7	(46.8)	
Rice cultivated area (ha)	0.604	(0.700)	0.592	(0.700)	
Share of rice area (out of cultivated land)	0.184	(0.198)	0.194	(0.202)	
Per capita income (USD)	187.5	(216.6)	201.0	(232.3)	
Per capita expenditure (USD)	285.3	(223.1)	257.9	(154.8)	

(continued)

Table 4.8 (continued)

	Received guidebook (treatment)		Not received (control)		Diff in means[b]
	Means	(s.d.)	Means	(s.d.)	
Share of crop income	0.738	(0.258)	0.775	(0.261)	
Share of livestock income	0.106	(0.167)	0.082	(0.150)	
Share of non-farm income	0.098	(0.194)	0.095	(0.216)	
Share of non-labor income	0.058	(0.110)	0.048	(0.113)	
Share of rice income	0.182	(0.254)	0.170	(0.226)	
Plot characteristics					
Share of rice plots with					
Bunding	0.564	(0.497)	0.592	(0.492)	
Leveling	0.632	(0.483)	0.581	(0.494)	
Transplanting	0.588	(0.493)	0.599	(0.491)	
Line planting	0.139	(0.346)	0.054	(0.227)	
Improved variety (k-series)	0.091	(0.288)	0.097	(0.297)	
Fertilizer use	0.084	(0.279)	0.051	(0.219)	
Rice yield (ton/ha)	2.569	(1.623)	2.420	(1.742)	
Income from rice (USD/ha)	634.9	(507.4)	713.1	(848.5)	
Walking time from homestead to rice plot (mins)	35.64	(35.47)	32.29	(32.91)	
Plot size (ha)	0.705	(0.666)	0.730	(0.818)	
Plot tenure: owner[a]	0.520	(0.500)	0.455	(0.499)	
Plot tenure: tenant[a]	0.291	(0.455)	0.310	(0.464)	

For all variables, the means of two groups are not statistically different at 5 % level
[a]Reference group is occupant
[b]*Indicates that mean between treatment and control groups is significantly different at 5 % level

Table 4.9 Household characteristics by training participation in case study sites in 2009 (before matching)

	Training participants (treatment)		Non-participant (control)		Diff in means[b]
	Means	(s.d.)	Means	(s.d.)	
Number of observations	82		218		
Household characteristics					
Number of household members	6.743	(2.956)	7.830	(3.735)	*
Share of male members aged 15–64	0.283	(0.231)	0.242	(0.149)	*
Share of female members aged 15–64	0.264	(0.151)	0.246	(0.135)	
Female headed household dummy	0.024	(0.155)	0.064	(0.246)	
Head's age	39.90	(11.54)	40.77	(13.33)	

(continued)

Table 4.9 (continued)

	Training participants (treatment)		Non-participant (control)		Diff in means[b]
	Means	(s.d.)	Means	(s.d.)	
Head's years of schooling completed	5.829	(3.150)	5.791	(3.927)	
Land owned (ha)	0.836	(1.501)	1.670	(1.615)	*
Ownership of bull (dummy variable)	0.073	(0.262)	0.358	(0.480)	*
Rice cultivation experience (years)	8.122	(6.743)	9.151	(8.795)	
Rice cultivated area (ha)	0.385	(0.413)	0.395	(0.304)	
Share of rice area (out of cultivated land)	0.272	(0.219)	0.201	(0.184)	*
Per capita income (USD)	169.4	(150.2)	137.4	(137.6)	
Per capita expenditure (USD)	264.7	(127.5)	280.2	(155.8)	
Share of agricultural income	0.689	(0.322)	0.549	(0.296)	*
Share of livestock income	0.061	(0.131)	0.176	(0.223)	*
Share of non-farm income	0.209	(0.314)	0.242	(0.283)	
Share of non-labor income	0.049	(0.129)	0.052	(0.111)	
Plot characteristics					
Share of rice plots with					
Bunding	0.974	(0.159)	0.719	(0.451)	*
Leveling	0.838	(0.370)	0.595	(0.493)	*
Transplanting	0.923	(0.268)	0.634	(0.483)	*
Line planting	0.718	(0.452)	0.124	(0.331)	*
Improved variety (k-series)	0.829	(0.378)	0.490	(0.502)	*
Fertilizer use	0.043	(0.203)	0.007	(0.081)	*
Rice yield (ton/ha)	3.05	(2.03)	2.11	(1.89)	*
Income from rice (USD/ha)	1327.3	(1327.5)	905.09	(1496.6)	*
Distance from homestead to rice plot (km)	0.718	(0.452)	0.124	(0.331)	*
Plot size (ha)	0.215	(0.168)	0.297	(0.206)	*
Plot tenure: owner[a]	0.308	(0.464)	0.556	(0.499)	*
Plot tenure: tenant[a]	0.641	(0.482)	0.386	(0.488)	*

*Indicates the means of two groups are statistically different at 5 % level
[a]Reference group is occupant
[b]*Indicates that mean between treatment and control groups is significantly different at 5 % level

Table 4.10 Rice cultivation by recipient status of guide book in extensive survey in Uganda in 2011

	Received guidebook (treatment)		Not received (control)		Diff in means[b]
	Mean	s.d.	Mean	s.d.	
Household level					
Number of households	288		282		
% of households who grew rice	0.550	0.498	0.532	0.500	
Rice cultivated area (ha)	0.332	0.601	0.295	0.477	
Rice cultivated area (ha) (among growers)	0.607	0.702	0.554	0.533	
Share of rice area (out of cultivated land)	0.154	0.196	0.146	0.187	
Share of rice area (among rice growers)	0.280	0.185	0.275	0.173	
Income from rice (USD/ha)[a]	731.8	(825.0)	713.1	(872.8)	
Per capita income (USD)[a]	209.7	(234.9)	201.0	(180.5)	
Per capita expenditure (USD)[a]	263.8	(206.2)	257.9	(259.4)	
Share of crop income	0.760	(0.242)	0.775	(0.267)	
Share of livestock income	0.133	(0.184)	0.082	(0.216)	
Share of non-farm income	0.059	(0.153)	0.095	(0.141)	
Share of non-labor income	0.048	(0.109)	0.048	(0.107)	
Share of rice income	0.135	(0.214)	0.136	(0.208)	
Number of lowland rice plots	206		188		
% of plots with:					
Bunding	73.8	(44.1)	67.0	(47.1)	
Leveling	76.7	(42.4)	74.6	(43.7)	
Transplanting	57.8	(49.5)	54.6	(49.9)	
Transplanting in rows	9.22	(29.0)	1.62	(12.7)	*
Improved seeds	12.1	(32.7)	5.41	(22.7)	*
Fertilizer use	6.80	(25.2)	1.62	(12.7)	*
Yield (ton/ha)	2.23	(1.57)	2.35	(1.75)	
ln(rice income USD/ha)[a]	6.26	(1.26)	6.36	(1.14)	

[a]Deflated into 2009 price level
[b]*Indicates that mean between treatment and control groups is significantly different at 5 % level

Table 4.11 ATT without matching in extensive survey data in ES 2011

	Treatment (recipient)	Control (non-recipient)	ATT	s.e.[a]
Plot level	(1)	(2)	(3)	(4)
Adoption of cultivation practice				
Bunding	0.738	0.670	0.068	0.046
Leveling	0.767	0.746	0.021	0.044
Transplanting	0.578	0.546	0.032	0.050
Transplanting in rows	0.092	0.016	0.076	0.023***

(continued)

Table 4.11 (continued)

	Treatment (recipient)	Control (non-recipient)	ATT	s.e.[a]
Plot level	(1)	(2)	(3)	(4)
Improved variety (k-series)	0.121	0.054	0.067	0.029**
Chemical fertilizer use	0.068	0.016	0.052	0.021**
Yield (ton/ha)	2.23	2.35	0.12	0.17
Ln(rice income (USD/ha))	6.256	6.357	0.101	0.130
Household level				
Growing rice (dummy)	0.512	0.295	0.217	0.185
Area under rice (ha)	0.550	0.532	0.018	0.042
Share of area under rice over cultivated land	0.154	0.146	0.008	0.016
ln(per capita income)	4.728	4.857	0.129	0.092
ln(per capita expenditure)	5.365	5.370	0.004	0.049

***, **, and * indicate significance at 1, 5, and 10 %, respectively