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Exploration of rainfed rice farming in Uganda based on a nationwide survey: Evolution, regionality, farmers and land

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Based on a nationwide survey of rice growing households, this paper explores how rainfed rice cultivation evolved in Uganda, how diverse it is in different regions of the country, what categories of farmers have adopted it, and how it has been integrated into their traditional cropping patterns. We find that the diffusion of rainfed rice cultivation accelerated at around the turn of this century when upland New Rice for Africa (NERICA) was introduced in the agro-ecological zones receiving annual rainfall of 1000 mm or more. The growth rate of area under rainfed rice cultivation from 2000 to 2009 was 14% year^{-1} in the lowest zone and as high as 31% year^{-1} in the highest zone. Rice was grown predominantly by smallholders. Farmers growing rainfed rice, upland and lowland alike, cultivated on average 2 ha of farm land, of which one-third (0.6 ha) was planted to rice, and the sizes of cultivated area and rice planted area of around 70% of farmers were below these averages. In terms of land tenure systems, rice was a crop of more importance in areas where the traditional customary tenure systems still remained, and the incidence of leasehold land tenure was higher for rice cultivation than for other crops.

Key words: Agro-ecological zone, farming system, land holding, land tenure, lowland, New Rice for Africa (NERICA), size distribution, upland.

INTRODUCTION

Rice is not a traditional staple crop in Uganda as well as in other East African countries, but its importance has recently been increasing rapidly both as a staple food in people's diet and as a source of income for farmers, in particular for smallholders who constitute the majority of countries' population. Recognizing its importance, the governments in the region, including the government of Uganda, joined the Coalition for African Rice Development (CARD), which was formed in 2008 aiming at doubling rice production in sub-Saharan Africa in 10 years and thereby increasing food-security and income of smallholders. In 2010, the Regional Rice Research and Training Centre was established at the National Crops Resources Research Institute (NaCRRI) in Uganda with the aim to train farmers, extension agents and researchers and conduct research on appropriate rice technologies.

In spite of such policy efforts towards increasing rice

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production, however, investigation into grass-root reality is not sufficient. In Uganda, on one hand, two rounds of agricultural household survey recently conducted by the government in 2005/2006 and 2008/2009 (UBOS, 2007, 2011) for the first time reported statistics on area under rice production and rice yields at the district level and above, but provided no details at the field level. On the other hand, earlier reports based on farm-level surveys have provided information on rice production at field level in sampled rice growing areas, but not on the nationwide scenario (Kijima et al., 2006, 2008, 2011; Lodin et al., 2009; Fujiie et al., 2010a). As a result, there has been a dearth of adequate information on the diffusion and pattern of rice production in the country. This information gap is addressed in this paper, based on a nationwide survey. We look into how rainfed rice farming has evolved in Uganda, how diverse it is in different regions of the country, and what type of farmers adopts it.

MATERIALS AND METHODS

The data used in this paper were collected by a nationwide survey on rice growing farmers conducted by NaCRRI in collaboration with the Africa Rice Centre under a project entitled "Strengthening the Availability and Access to Rice Statistics for sub-Saharan Africa: A Contribution to the Emergency Rice Initiative". Sample farmers from whom we obtained information were drawn by applying the following stratified random sampling: (1) we grouped rice growing areas into five regions, that is, North, East far, East near, Central and West, (2) randomly selected three rice growing districts in each sample region, (3) randomly selected two rice growing sub-counties in each sample district, (4) randomly selected two rice growing parishes in each sample sub-county, and (5) randomly selected 20 rice growing farm households in each sample parish.[1]

The survey was conducted between August and November, 2009 using two sets of questionnaire: The first set including questions on rice cultivation in the 2007 second season and the 2008 first season and the second set including questions on plots planted to non-rice crops. The total number of farmers interviewed is 1,267,[2] of which 10 farmers, or 0.8%, grow rice on farm land with irrigation[3]. Excluding these irrigated rice farmers and those with missing data, the data of 1,014 farmers who grew rice either in rainfed upland or in rainfed lowland were used in analysis[4]. The locations of our sample districts are shown in Figure 1 and the numbers of our sample rainfed rice farmers by region and district are presented in Table 1.

A major purpose of this paper is to look into the evolution of and regional differences in rainfed rice farming in Uganda, and therefore no sophisticated statistical methods, beyond simple statistical tests for sample means (Student's t-test and multiple comparison), are employed. Throughout the paper, the significance levels for these statistical tests adopted are 5%. For multiple mean comparisons, both Scheffe and Tukey tests are employed.

[1]Rice growing large scale, estate farms were not included in our population.

[2]The number of farmers interviewed is more than 1200, because some supplementary samples drawn as backup samples were interviewed in some sample regions / districts.

[3]The percentage share of irrigated rice farmers of our sample is lower than that 2% reported in Balasubramanian et al. (2007).

[4]Even for these sample farmers there are missing data for some information items, so depending on what respect of rice farming we look into, we use sub-samples of this entire sample.

RESULTS AND DISCUSSION

Geographical distribution of rainfed rice farming and its evolution

Many authorities have divided Uganda into several agro-ecological zones, based on different approaches to the demarcation of edapho-climatic conditions and soil types. One way of zoning which divides Uganda into 9 zones[5] is presented in Table 2, together with corresponding farming systems and major traditional crops grown in each farming system prior to the "rice boom" begun in the early 2000s. Our sample districts belong to North Western Savannah Grasslands (NWSG), North Eastern Savannah Grasslands (NESG), Western Savannah Grasslands (NWSG), Kioga Plains (KP) and Lake Victoria Crescent (LVC).

Rainfed rice cultivation in Uganda is found almost all over Uganda, except for the northeastern corner of pastoral area and the southwestern corner of dry farming and pastoral area (Table 2 and Figure 1). The agro-ecological zones where rice cultivation is practiced are the zones where average annual rainfall is more than 1,000 mm. There are three agro-ecological zones associated with two farming systems where rainfall is too low to grow rice. The last agro-ecological zone in Table 2, Highland Ranges (Montane system), has sufficient rainfall, but the climate there is too cold to grow rice.

As shown in Table 2, rice appears in NESG or Lango system as one of major 'traditional' crops. Even there, "rice production … is gaining economic importance" in around 2000 (Musiitwa and Komutunga, 2001). In no other zones and systems was rice mentioned at all as a major crop. This observation stems from the fact that rice (*Oryza sativa*) is not a traditional crop in Uganda. In fact, our survey reveals that rainfed rice cultivation began in the 1960s,[6] spread gradually through the 1990s and gained its momentum at around the turn of the century (Figure 2). The spurt of the diffusion in the early 2000s and the rapid growth thereafter are impressive. The early 2000s was the time when NERICA varieties were introduced and disseminated eagerly. Figure 2 shows that the introduction of NERICA triggered the 'rice boom' in Uganda. However, not only NERICA but also other rice varieties have been supporting this 'rice boom', as shown in the right-hand chart of Figure 2.

The left-hand chart of Figure 2 shows that among the agro-ecological zones where upland rice cultivation is pervasive, KP has the oldest history in rainfed rice cultivation, followed by LVC, NWSG, WSG and NESG in that order. The first record of rice planting among our

[5]Actually 10 zones, but Para Savannah Zone is combined with North Western Savannah Grasslands in Table 2 (MAAIF, 2010).

[6]Rice was introduced to Uganda in the early 20th century (Biggs, 1940) and again during the World War II (McMaster, 1962), but in each time, its cultivation shrunk almost to nothing after some years. FAO (2013) shows that rice cultivation in Uganda picked up again in the late 1960s, which is consistent with our observation.

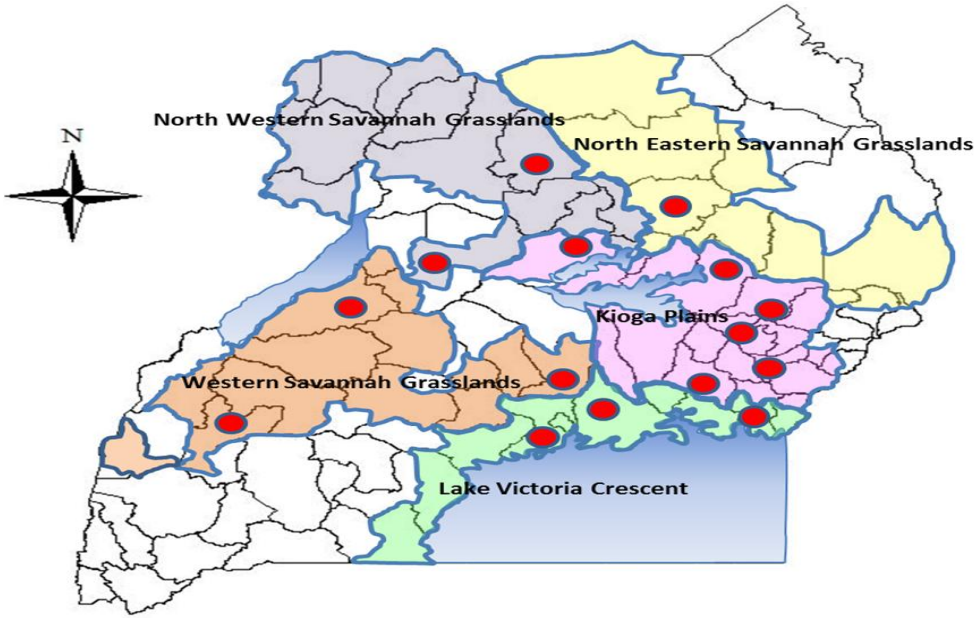

Figure 1. Agro-ecological zones in Uganga and sample districts

Table 1. Numbers of sample rainfed rice farmers and rice plots by region and district.

Location	Agro-ecological zone[1)]	No. of households	No. of rice plots
North		215	271
Lira	NESG	67	92
Gulu	NWSG	82	96
Apac	KP	66	83
East far		235	239
Soroti	KP	76	76
Kumi	KP	78	82
Pallisa	KP	81	81
East near		166	282
Butaleja[2)]	KP	20	43
Iganga	KP	82	120
Bugiri	LVC	64	119
Central		183	230
Mukono[3)]	LVC	71	87
Wakiso	LVC	63	73
Luwero[4)]	WSG	49	70
West		215	277
Hoima	WSG	73	124
Kamwenge	WSG	74	76
Masindi	NWSG	68	77
Total		1,014	1,299

1) Agro-ecological zones in Uganda are as follows: North Eastern Savannah Grasslands (NESG), North Western Savannah Grasslands (NWSG), Western Savannah Grasslands (WSG), Kioga Plains (KP) and Lake Victoria Crescent (LVC); 2) Include a part of Tororo district;.3) Include a part of Kayunga district; 4) Include a part of Nakaseke district.

Table 2. Agro-ecological zones and farming systems in Uganda and the sample zones and sample districts.

Agro-ecological zone[1)]	Farming system[2)]	Major districts[3)]	Major crops grown[4)]	Rainfall[5)] (mm year^{-1})
North western savannah grasslands (NWSG)[6)]	Northern and West Nile systems	Gulu, Masindi	Cotton, millet, sorghum, legumes, sesame	1,016 (Gulu) 1,345 (Masindi)
North eastern savannah grasslands (NESG)	Lango system	Lira, Apac	Cassava, maize, millet, sesame, rice	1,465 (Lira)
Kioga Plains (KP)	Teso system	Soroti, Kumi, Pallisa	Cotton, millet, ground nut	1,350 (Soroti)
	Banana-cotton-millet system	Iganga, Tororo, Butaleja	Banana, cotton, millet, sorghum, maize	1,556 (Tororo)
Western savannah grasslands (WSG)	Western banana-coffee-cattle system	Masindi, Hoima, Kamwenge, Luwero	Banana, coffee, maize, cattle	1,345 (Masindi) 1,475 (Kyenjojo)
Lake Victoria crescent (LVC)	Banana-coffee system	Wakiso, Mukono, Jinja, Bugiri	Banana, coffee, maize, sweet potato, beans, vegetables, flowers	1,308 (Kampala) 1,216 (Namulonge) 1,228 (Jinja) 1,128 (Mukono)
South western farmlands Pastoral rangelands	South western pastoral system	Mbarara, Bushenyi	Dairy cattle, millet, sorghum	896 (Ibanda)
North eastern dry lands	Karamoja pastoral system	Kotido, Moroto	Cattle, sorghum, maize, millet	657 (Kotido)
Highland ranges	Montane system	Kabale, Sironko	Sorghum, solanun potato, vegetables, coffee, maize, wheat	1,456 (Mbale)

1) From MAAIF (2010). Zones in bold letters are our sample zones. 2) Farming systems are adapted from Musiitwa and Komutunga (2001) and Mwebaze (2011). 3) Our sample districts are in bold letters. 4) Major traditional crops / livestock in respective farming systems until around the year 2000. 5) Long-term averages, though the years over which the averages are taken differ from an observatory to another. The names of observatory points are in parentheses. Most data are originally from the Meteorological Department of Uganda, but some are from Musiitwa and Komutunga (2001). 6) Include Para Savannah Zone.

sample farmers was 1968 by a farmer in KP (Kumi District), followed by another farmer in KP (Soroti) in 1974. The first planting in other zones was 1976 in LVC (Mukono) and NWSG (Gulu), 1979 in WSG (Hoima) and 1982 in NESG (Lira). If annual compound growth rate of the number of plots planted to rice is computed after 2000, it is 31% for WSG and NWSG, 23% for NESG, 16% for LVC, 14% for KP, and 18% for the entire sample[7]. The order of zones in terms of the speed of the diffusion is nearly inverted that of planting history, reflecting a fact that upland rice cultivation in the zones with an older history had been in progress even before 2000. Thus, NERICA had a particularly strong impact in creating the 'rice boom' in such zones as WS and NWSG where rice had been nearly nonexistent prior to the introduction of NERICA. However, growth rates of more than 10% year^{-1} of the 'older' rice growing zones are considerably high.

Rainfed rice farming

Upland and lowland

Rainfed rice farming can be divided broadly into rainfed upland cultivation and rainfed lowland cultivation. Here, lowland and upland are defined respectively as cultivated fields with or without standing water in the fields while growing crops. Lowland paddy fields are usually encircled by bunds or ridges. This distinction, however, is not as

[7]This growth rate is obtained from farmers who plant rice at the time of our survey and hence overestimates the actual rate of increase in area planted to rice. To estimates the actual rate of increase, it is necessary to take into account farmers who had once adopted but stopped rice cultivation. Kijima et al. (2011) found that substantial number of farmers who had once tried NERICA stopped planting it.

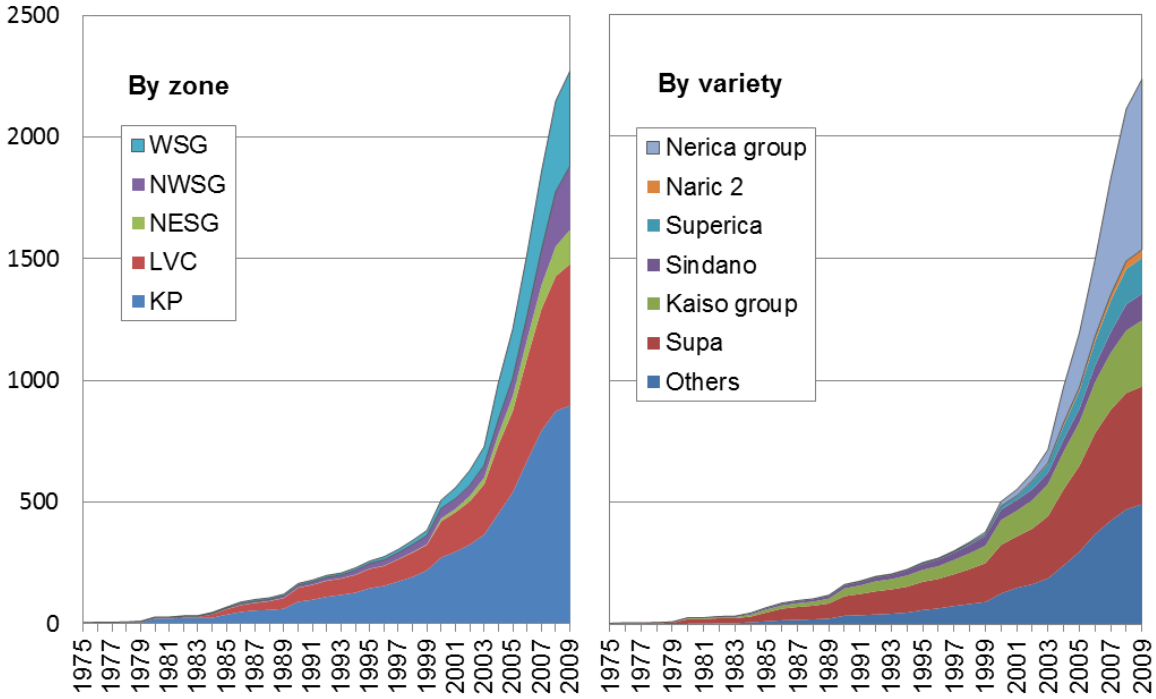

Figure 2. Number of plots planted to rice first time.

Table 3. Distribution of rice plots by agro-ecological zone and by land type, 2007-2008[1)].

Zone	Upland (%)	Lowland (%)	Total
WSG	81	19	100
NWSG	81	19	100
NESG	34	66	100
LVC	24	76	100
KP	21	79	100
Total	43	57	100

1) For 1,299 plots, consisting of 559 upland and 740 lowland plots.

clear-cut in Uganda as in the countries in Asia.

Except for the mountainous and cattle corridor zones in eastern and South Western Uganda, the typical landscape all over the country is gently undulating topography, in which hills and slopes with wetland at the shallow inland valley bottom repeatedly appear as sea waves. Farmers grow various crops on these hill tops, slopes and valley bottoms, the selection of which depends heavily on soil moisture content at various parts of this topography (Fujiie et al., 2010b). In the zones with sufficient rainfall and temperature, rainfed rice cultivation can be practiced at the lower part of the slopes and/or the valley bottoms, where the soil is relatively moister than in the upper parts. In case rice is planted on the slopes, it is on upland with few exceptions of terraced lowland. In case it is planted on the valley bottoms under hydromorphic conditions, it is usually on lowland. There lies a wide spectrum land types between the typical lowland and upland. For example, lowland paddy fields with no bunds/ridges are fairly common in Uganda. For the categorization of farm fields, we recorded the farmers' report in accord with their perceptions of the upland and lowland categories.

Given this background caveat, Table 3 presents the distribution of rice plots between upland and lowland by agro-ecological zone. For the entire sample, the upland and lowland ratio was about 40:60. There is, however, a clear regionality in the ratio: it was 80:20 in WSG and NWSG, 20:80 in KP and LVC, and NESG in between.

The comparison of Table 3 and Figure 1 make this

Table 4. Farmers' household characteristics by land type and by agro-ecological zone [1].

Variable	No. of HHs	Head age (year)	Head education (category)[2]	Female headed HH (%)	Years in village[3]	HH with crop production as main activity (%)	No. of total family members	No. of children between 6 and 15 years
Land type[4]								
Upland	368	45.1[a]	2.8[a]	11.7[a]	34.5[a]	85.9[a]	7.4[a]	2.7[a]
Lowland	523	39.6[b]	2.6[b]	8.8[a]	32.8[a]	95.0[b]	7.4[a]	2.8[a]
Zone								
WSG	185	44.2[a]	2.5[a]	10.8[a]	31.4[a]	90.8[ab]	7.2[ab]	2.5[a]
NWSG	122	41.7[ab]	2.5a	9.0[a]	29.9[a]	91.0[ab]	7.2[ab]	2.7[a]
NESG	53	43.2[ab]	2.5[ab]	9.4[a]	41.3[b]	96.2[ab]	7.7[ab]	3.3[a]
LVC	168	42.6[ab]	3.1[b]	11.9[a]	30.8[a]	85.1[a]	6.8[a]	2.5[a]
KP	363	40.3[b]	2.6[a]	9.1[a]	36.6[b]	93.7[b]	7.7[b]	2.9[a]
All	891	41.9	2.7	10.0	33.8	91.2	7.4	2.8

1) For 891 farmers for whom data are available. For each characteristic, the means followed by the same alphabet are not statistically different; 2) Average over the numbers allocated to the following categories: no formal education=0, pre-primary=1, primary=2, junior=3, Ordinary level = 4, Advanced level = 5, tertiary institution after O-level = 6, tertiary institution after A-level = 7, university = 8; 3) The years living in the village of present domicile; 4) Farmers growing rice in upland or in lowland. Farmers who grow rice both in upland and lowland are categorized into one of the two types according to which type of land is larger.

regional pattern clear: If we draw a demarcating line diagonally from south-west to north-east dividing the county into nearly equal halves, rainfed upland cultivation dominates in the western side of the line whereas rainfed lowland cultivation dominates in its eastern side.

Rice farmers, land and the cropping pattern

This sub-section observes what sort of farmers rainfed rice farmers are, in terms of their household characteristics, land holdings, land tenure and cropping pattern.

Household characteristics

On average for the entire sample, rice farmers were around 40 years old, having the educational level of junior high school background, living in their villages more than 30 years, and with 7 family members of whom about 3 members were children between 6 and 15 years old (Table 4). Ten percent (10%) of them were female-headed household and crop cultivation was their main economic activity for more than 90% of them. These household characteristics are quite comparable to those of rainfed rice farmers in the earlier studies conducted in various parts of Uganda (Kijima et al., 2006, 2008, 2011; Fujiie et al., 2010a).

For many of the characteristics, there was no significant difference between upland and lowland farmers and among agro-ecological zones (Table 4). For instance, female- headed household ratio and number of children between age 6 and 15 years were uniform, as far as their means were concerned, among zones as well as between upland and lowland. No difference was found for the years living in the same village and the number of family members between upland and lowland. It is interesting to observe that upland rice farmers tended to be older, with higher education and with higher probability to have economic activities other than crop production, than lowland rice farmers. In other words, lowland rice farmers could be more dependent on crop cultivation than upland farmers who have to seek some income opportunities for their livelihood other than crop cultivation compared to their lowland counter parts.

Looking at the mean differences among the zones, farmers in LVC tended to have distinct characteristics compared to farmers in other zones: On average they were more educated, shorter history in residing in their villages, less specialized to crop production and with smaller family size than farmers in other zones. This observation can largely be explained by the fact that LVC is the zone which is comprised of the most urbanized and developed areas in the country, including the Kampala Metropolitan areas.

Land holdings

For the entire sample, rainfed farmers cultivated on average 3.8 farm land plots for various crops including rice, the total area of which was 5.1 ac (2.1 ha) (Table 5). The average cultivated area per farmer in our sample is nearly comparable to that of rainfed upland rice farmers in districts situated in the western side of the demarcating line explained earlier (Kijima et al., 2006, 2008, 2011; Fujiie et al., 2010a), but larger than the average

Table 5. Number of plots and total cultivated area per farm by land type and by agro-ecological zone, 2007-2008 [1)].

Variable	Number of plots	Total cultivated area	
	No. farm^{-1}	ac farm^{-1}	ha farm^{-1}
Land type			
Upland	4.0[a]	5.5[a]	2.2
Lowland	3.7[a]	4.8[a]	2.0
Zone			
WSG	3.1[a]	3.6[a]	1.5
NWSG	5.0[b]	7.2[b]	2.9
NESG	4.0[a]	6.4[ab]	2.6
LVC	3.7[a]	3.8[a]	1.5
KP	3.4[a]	4.7[a]	1.9
All	3.8	5.1	2.1

1) For 521 farmers, 215 upland and 306 lowland, for whom data are available. Means followed by the same alphabet are not statistically different.

Table 6. Size distribution of farmers' cultivated area by land type, 2007-2008[1)].

Size class	Upland		Lowland	
	No. (%)	Area (%)	No. (%)	Area (%)
- 2ac (0.8 ha)	14	2	20	4
2-4 (0.8-1.6)	24	11	34	17
4-6 (1.6-2.4)	28	22	21	19
6-8 (2.4-3.2)	15	17	8	11
8-10 (3.2-4.0)	5	8	7	11
10-12 (4.0-4.9)	5	10	1	3
12-14 (4.9-5.7)	3	6	2	5
14-16 (5.7-6.5)	2	4	3	8
16-18 (6.5-7.3)	2	5	1	4
18-20 (7.3-8.0)	0	1	1	2
20 ac (8 ha) -	2	15	2	15
Total	100	100	100	100

1) For 521 farmers, 215 upland and 306 lowland, for whom data are available.

cultivating size of the entire agricultural households in the country estimated from the recent two rounds of national household survey (UBOS, 2007, 2011).

The number of plots and the cultivated area per farmer were larger for upland farmers than for lowland farmers, but the differences were both not statistically significant. Among zones, the average cultivated area as well as the number of plots was significantly larger for rice farmers in NWSG. The same pattern was observed for rice farmers in NESG, but their average number of plots and the average size were not significantly different from those of WSG, LVC and KP.

The size distribution of land area cultivated by the sample farmers is shown in Table 6. Three distinct features can be discerned. First, both for upland and lowland rice farmers, the majority of them were smallholders: For both types, around 70% of farmers belonged to the three smallest size classes. Second, the small-size of rainfed rice farmers was relatively more distinct for lowland: the mode of the distribution was the 0.8 to 1.6 ha size class for lowland, while it was the 1.6 to 2.4 ha size class for upland. Third, upland and lowland alike, the size distribution in terms of area had the second peak for the largest size class: for both land types, 2% of farmers controlled as much as 15% of cultivated land. Such size distributions are not specific to our sample. Haneishi et al. (2013) and UBOS (2007) found similar distributional patterns for upland rice farmers in Namulonge and for the entire agricultural households in the country, respectively.

Table 7. Distribution of sample plots by land tenure status and by agro-ecological zone, 2007-2008[1].

Parameter	Owner[2] (%)	Mailo/customary tenure (%)	Lease-hold[3] (%)	Others[4] (%)	Total (%)
WSG	59	31	7	3	100
Rice	50	34	13	2	100
Other crops	66	28	2	3	100
NWSG	27	70	1	2	100
Rice	22	71	2	5	100
Other crops	30	69	1	1	100
NESG	5	85	0	10	100
Rice	4	86	0	10	100
Other crops	6	84	0	10	100
LVC	67	22	8	3	100
Rice	52	29	15	4	100
Other crops	77	18	3	2	100
KP	66	18	5	11	100
Rice	63	17	4	16	100
Other crops	66	19	6	9	100
Total	50	39	5	5	100
Rice	41	44	8	7	100
Other crops	57	36	3	5	100

1) For 1,765 plots for which data are available; 2) Freehold and private mailo; 3) Include both long-term lease and short-term, spontaneous leasehold arrangements; 4) Include 'unknown.'

Land tenure

Sample farmers' land tenure is summarized in Table 7 by zone. Land tenure in Uganda is a complicated and unsettled issue with a long historical background (Place and Otsuka, 2002; Batungi, 2008; Kyomugisha, 2008). The present 1995 constitution specifies freehold system as a desirable land tenure system, while recognizing four tenure systems that have been enduring since the colonial period: Mailo, customary, freehold and leasehold (Batungi, 2008:233). Mailo is a land tenure system created by the British colonial administration in the territory of Buganda Kingdom when the Buganda Agreement was signed in 1900, in which the kabaka (king) and his chiefs were given the ownership of land under their controls. In subsequent years in the 1900s, all traditional lands in Uganda outside Buganda kingdom were converted to crown lands, and traditional land tenure systems, mostly owned and controlled by communities (clans and families), were recognized as customary tenure. Leasehold system, though not large in extent, was also introduced by the colonial administration to lease out public lands under long-term contracts (usually 99 years) to individuals/institutions such as missionaries. The history of land tenure in Uganda since then until the present time has been to convert mailo and customary tenure to freehold system.

In this study, we categorize land tenure systems into three: Owner, mailo/customary and leasehold. "Owner" includes freehold (with land title) and private mailo (*de fact* freehold, without land title), and "mailo/customary" are the traditional systems not subject to the formalization process yet. "Leasehold" includes not only the traditional long- term leasehold system but short-term spontaneous contracts between farmers. For the entire sample, 50% of the plots fell in the category of owner, 40% of mailo/customary and 5% of leasehold (Table 7). It is interesting to see that for the plots planted to rice the share of mailo/customary tenure was larger than that of owner. It should also be noted that leasehold system was more frequently found for plots panted to rice than for plots planted to non-rice crops. Clear regional differences are found in farmers' land tenure. The percentage share of owner, or the formalized systems, was higher in LVC, KP and WSG, whereas that of mailo/customary tenure, or the traditional systems, was higher in NESG and NWSG.

Table 8. Percentage shares in total cultivated area of crops grown by rainfed rice farmers by land type and by agro-ecological zone, 2007-2008[1)].

Parameter	All	Land type		Agro-ecological zone				
		Upland	Lowland	WSG	NWSG	NESG	LVC	KP
Distribution (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Rice	30	25	33	30	19	34	31	30
Maize	14	14	13	19	9	10	11	20
Cassava	12	13	11	10	15	13	11	12
Sweet potato	7	8	7	6	7	5	7	10
Sorghum	4	4	4	1	8	4	2	4
Millet	3	3	3	0	5	6	1	3
Beans	5	6	4	4	8	11	3	1
G-nut	4	5	4	5	8	0	2	5
Banana	3	3	3	5	0	0	7	4
Coffee	5	4	7	13	0	0	14	4
Sesame	3	4	3	1	11	3	0	0
Tomato	1	1	1	1	1	0	2	2
Others	8	10	7	5	10	15	10	4

1) For 521 farmers for whom data are available.

Another interesting finding in this table is that in WSG and LVC, the share of leasehold system was substantially larger for rice plots than for plots planted to other crops. This difference would be attributed to the fact that in these zones many farmers tried to plant rice by renting plots from other farmers under short-term leasehold arrangements, as found for rainfed upland farmers in LVC (Haneishi et al., 2013). This observation, coupled with the observation that the share of leasehold was larger in the zones where the formalization of land tenure systems were advanced, suggests that the modernization of land tenure systems from the traditional systems to the freehold system helps rapid diffusion of rice cultivation.

Cropping pattern

As already explained, rainfed farmers plant rice as one of many crops they grow. For the entire sample, the share of plots devoted to rice in the total cropped plots was 30%, followed by maize, cassava, sweet potato and other crops (Table 8). This confirms in a country-wide scale the findings of Lodin et al. (2009) in WSG and Haneishi et al. (2013) in LVC that rainfed rice farmers on average dedicated around one third of their cultivated land to rice. The cropping patterns by agro-ecological zone shown in this table reflect well the farming systems shown in Table 2. For example, the shares of banana and coffee were high in LVC and WSG where the banana-coffee system or the banana-coffee-cattle system prevailed, and the shares of millet, sorghum and sesame were relatively high in the northern zones. The fact that the weight that rice took in the cropping patterns of rainfed rice farmers was about one-third of total cultivated area indicates that rice is deep rooted in the cropping pattern of rainfed farming in Uganda. This weight was higher for lowland than for upland, suggesting that the importance of rice was higher for lowland rice farmers than for their upland counterparts.

Area planted to rice

The 1,014 rice farmers in our sample altogether cultivated 1,299 rice plots, the total area of which was 654 ha. These figures stand for plots and areas planted to rice, either in the 2007 2nd or 2008 1st seasons, or in both. The proportions of farmers who planted rice, and plots and areas planted to rice in each season are presented in Table 9, together with their rates of change between the two seasons.

Overall, 77% of the sample farmers planted rice in the 2007 2nd season, whereas 93% did so in the 2008 1st season. Similarly, the ratios of the number and area of rice plots to the total number and area of farm plots, respectively, were substantially higher in the 2008 1st season than in the 2007 2nd season. Farmers' decision whether to plant rice in a certain season depends on various factors, of which rainfall would be the most decisive (Fujiie et al., 2010b). The average rainfall was more in the 2007 2nd season (July – December 2007) than in the 2008 1st season (January - June 2008) for all the five sample zones. As far as rainfall is concerned, therefore, there was no reason for farmers to plant rice less in the 2007 2nd season than in the 2008 1st season.

Table 9 shows the rate of increase in rice planting by

Table 9. Percentage shares of farmers who planted rice, and plots and area which were planted to rice, in 2007 1st and 2008 2nd seasons by land type and by agro-ecological zones[1)].

Variable	2007 2nd season			2008 1st season			Rate of change (2008/2007)		
	No. of farmers (%)	No. of plot (%)	Area (%)	No. of farmers (%)	No. of plots (%)	Area (%)	No. of farmer (%)	No. of plots (%)	Area (%)
Land type									
Upland	70	67	66	90	87	98	129	130	148
Lowland	83	79	79	95	93	92	114	117	117
Zone									
WSG	82	78	72	91	90	93	111	115	128
NWSG	48	47	45	91	90	93	189	191	209
NESG	73	68	77	93	90	99	127	132	128
LVC	73	70	65	89	86	90	123	124	139
KP	89	85	87	96	93	94	108	109	107
All	77	74	74	93	90	94	120	122	178

1) For the entire sample of 1,014 farmers with 1,299 rice plots, or 654 ha, which were planted to rice either in the 2007 2nd season or in the 2008 1st season, or in both.

Table 10. Number of plots and area planted to rice per farm by land type and by agro-ecological zone, 2007-2008[1)].

Variable	Number of plots	Area plot^{-1}	Rice planted area	
	No farm^{-1}	ac plot^{-1}	ac farm^{-1}	ha farm^{-1}
Land type				
Upland	1.3^{a}	1.3^{a}	1.5^{a}	0.6
Lowland	1.2^{a}	1.2^{a}	1.4^{a}	0.6
Zone				
WSG	1.4^{a}	1.2^{a}	1.6^{a}	0.7
NWSG	1.2^{b}	1.2^{a}	1.3^{a}	0.5
NESG	1.4^{ab}	1.1^{a}	1.5^{a}	0.6
LVC	1.4^{a}	1.0^{a}	1.5^{a}	0.6
KP	1.2^{b}	1.2^{a}	1.5^{a}	0.6
All	1.3	1.2	1.5	0.6

1) For 1,013 farmers, excluding an extremely large farmer (52 ha) in NESG. The means followed by the same alphabet are not statistically different.

about 20% for the number of farmers and plots and by nearly 80% for area. Even excluding NWSG,[8] which shows very high rates of change, the rates of increase were 17%, 20% and 26% for farmers, plots and areas, respectively. The rate of 17% season^{-1} for the number of farmers who planted rice is higher than our earlier estimate of 18% year^{-1} for the period of 2000-2009.

Table 10 shows the average number of plots and area planted to rice per farm for 2007 to 2008.[9] An average rice farmer planted rice to 1.3 plots, the area of which was 1.5 ac (0.6 ha), which is nearly one-third of the mean farm size (Table 5). No significant difference is found for the number of plots and area planted to rice between upland and lowland. Among agro-ecological zones, area planted to rice per farm and area per rice plot had also no significant difference, but the number of rice plots per farm was greater in WSG and LVC than in NWSG and KP.

[8]Although the rainfall in the 2007 2nd season was higher than in the 2008 1st season on average for NWSG, it was exceptionally lower in the 2007 2nd season for Masindi, one of the sample districts in NWSG, which might have caused the low rate of rice planting in the 2007 2nd season in this zone. For all other sample districts, the rainfall in the 2007 2nd season was higher than, or comparable to, that in the 2008 1st season.

[9]For farmers planted rice both in the 2007 2nd and the 2008 1st seasons, the average of the two seasons was taken. For those planted rice in one of the two seasons, the number of plots and area were counted as they were.

Table 11. Size distribution of land area planted to rice per farm by land type, 2007-2008 (%)[1)].

Size class	Upland		Lowland	
	No.	Area	No.	Area
- 0.5 ac (0.2ha)	3	1	3	1
0.5-1 (0.2-0.4)	18	7	17	7
1-1.5 (0.4-0.6)	43	29	45	28
1.5-2 (0.6-0.8)	11	11	11	11
2-2.5(0.8-1.0)	12	16	11	14
2.5-3 (0.8-1.2)	4	7	2	3
3-4(1.2-1.6)	4	8	5	9
4-5 (1.6-2.0)	2	6	2	5
5-10(2.0-4.0)	1	5	2	8
10-20 (4.0-8.0)	0.2	2	0.3	2
20ac (8ha) -	0.5	8	0.2	12
Total	100	100	100	100

1) For 1,014 farmers.

The size distribution of land area planted to rice has a pattern similar to that of cultivated land area, albeit with much smaller size classes (Table 11 compared to Table 6). For both upland and lowland farms, nearly 70% of farmers planted rice in the area smaller than the average planted area of 1.5 ac (0.6 ha), indicating that rice is a crop preferred by smallholders.

Conclusions

It is found in this research that rainfed rice cultivation in Uganda began in the 1960s in KP, followed by LVC, but its diffusion accelerated at around the turn of century when NERICA was introduced to the agro-ecological zones with annual rainfall of 1,000 mm or more. The growth rate of rainfed rice cultivation from 2000 to 2009 was 14% year^{-1} in the lowest zone and as high as 31% year^{-1} in the highest zone. Rainfed upland cultivation dominates in western to northwestern parts and rainfed lowland cultivation dominates in the other eastern side of the country.

Rice was grown predominantly by smallholders. Upland and lowland alike, the mean farm size was 2 ha, and the farm size of about 70% of farmers was below the mean. For both upland and lowland rice farmers, rice cultivation was deep rooted, around one-third of their cultivated area being devoted to it. The cropping patterns of upland and lowland rice farmers were similar, though the dependence on rice was slightly higher for lowland than for upland farmers. Rice was a crop of more importance in areas where the traditional customary tenure systems still maintained, and the incidence of leasehold land tenure was higher for rice cultivation than for other crops.

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ABBREVIATIONS

KP, Kioga Plains; **LVC,** Lake Victoria Crescent; **NaCRRI,** National Crops Resources Research Institute; **NERICA,** New Rice for Africa; **NESG,** North Eastern Savannah Grasslands; **NWSG,** North Western Savannah Grasslands; **WSG,** Western Savannah Grasslands.

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