

Assessment of Upland Rice Production Constraints and Farmers' Preferred Varieties in Liberia

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ABSTRACT

Rice (*Oryza* spp) is the primary staple food crop for over 5.3 million people in Liberia that significantly contribute to food security. Despite the numerous benefits of rice, its production in Liberia has remained heavily constrained by low yield, diseases and rainfall variability. To improve rice adoption and productivity in Liberia, it is very important to understand farmer's production constraints and identify their own preferred rice varieties. This study was conducted to assess key production constraints, and farmer preferred rice varieties across the three major upland rice growing Counties in Liberia. Participatory and group discussion were conducted among 328 upland rice farmers using comparative approach, probing and semi structured interviews. The results of the survey found that most of the farmers cultivated more than one variety. It also showed that there were significant differences in farmers' preferences for rice varieties among the three counties and the choice of varieties varied significantly across districts. Of the nine districts, Jorquelleh had the highest proportion of farmers who chose to grow Jaowo followed by Fassama, Mienpea Mahn district, and Congo, Zoe Gbao Districts. Across the nine districts, Jaowo is the most preferred variety grown by farmers followed by Fassama and Black rice respectively. Constraints such as drought, pest and diseases, availability of seed, high input cost and harvesting were the major challenges affecting upland rice production as observed in the study areas. The study found out that farmers grow these rice varieties due of its high yielding capacity, early maturity and Drought tolerant. The highly preferred varieties desired by farmers were high grain yield, tall plant height, early flowering and good cooking quality. Rice breeders in Liberia should grasp the preferences of farmers and consumers in their breeding programmes, and the farmers must also be aware of consumer preferences in order to be able to meet their demands.

Key words: Upland rice, Constraints, Varieties, and Farmers' preferences

INTRODUCTION

Rice (*Oryza sativa*) crop is a staple and source of income sourcing in most sub-Saharan Africa (SSA) countries, with a rising consumption rate of 7.2% per year (Africa Rice, 2015). The rising consumption rate in the SSA is mainly influenced by surging urban populations due to the product being more convenient to store and prepare than most staple foods (Africa Rice, 2011). Rice is the predominant dietary energy source in West Africa and is the second most important source of calories after maize in Africa. Demand for rice is growing at more than 6% per year, faster than for any other food staple in sub-Saharan Africa, because of population growth, urbanization and changes in consumer preferences (Africa Rice, 2011). Rice is the primary staple food of Liberia's 5.3 million people (MOA, 2018). It is produced by 71% of the estimated 404,000 farm families predominantly on the uplands where traditional technology of slash and burn shifting cultivation, resulting in low productivity (EPA, 2018). Annual per capita consumption of rice in Liberia is estimated to be 133kg per person, one of the highest in Africa. In 2010, rice was cultivated over a land area of 251,230 ha. With an average yield of 1.1 t/ ha, the total domestic rice production was estimated to be about 296,090 metric tons (USAID-BEST, 2014). The demand for rice in Liberia is extremely increasing due to the rapid population growth and low productivity. Domestic rice production, therefore, must increase

to address the demand-supply gaps and food security need for the growing population in Liberia. Despite the numerous benefits of rice, its production in Liberia has remained heavily constrained by diseases and rainfall variability. In response to these constraints, national and international research organizations have developed and released several high-yielding and stress tolerant varieties of rice with desirable agronomic and market traits (MOA, 2018). The development of improved rice varieties in Liberia started in early 1980s', at least six varieties were being released in the country. They include; Suakoko – 8, LAC- 23, Nerica -14, Nerica L- 19, Black rice and Bold Grains (Mulbah, 2015). To improve rice adoption and productivity, it is very important to understand farmers' constraints and identify their own preferences of the varieties. Despite the numerous potentials for rice production in the county, there is an urgent need to change the rice production landscape through stimulating producers to respond to the different value chain actors' preferences for specific attributes in rice or generally the market demand for rice (Atera *et al.*, 2018). This survey was conducted to identify key production constraints and farmers' preferences for rice varieties as a reflection of the market preference for consumers' taste in the central Northern region of Liberia.

MATERIALS AND METHODS

Study area

The survey was conducted in central Liberia (Bong County), northernmost (Lofa County), and Northern regions (Nimba County) of the country that forms the traditional rice farming zones of the country. According to the Ministry of Agriculture in 2008, these regions have been ranked the highest in the rice production with 55,880 (20.0 %) metric tons, Eastern, 46,760 (16.8 %) metric tons Central and 41,710 (14.9 %) metric tons north, respectively. The combined estimates of these regions accounted for more than half (51.7%) of the total rice production regions in the country (MOA, 2009). Figure 1 shows the location of the study areas.



Figure 1. Map of Liberia showing the study area

Climate and Agro-Ecological Zones

Nimba County is estimated to have an average annual rainfall of 1,800 mm with the average maximum and minimum temperature of 27.5°C in February, but drops as low as 23.09°C in June (ArcelorMittal, 2010). While Bong County has the maximum and minimum monthly temperatures between 30.09°C and 23.3°C with the average yearly rainfall of 2,013 mm. Lofa County (Northern region) has the maximum and minimum temperatures of 30.69°C and 18.69°C with average rainfall of 2,500 mm. Lofa county is located on the northernmost part of Liberia and it lies between latitude 8.1911°North and longitudes 9.7233°West and Bong County lies between latitudes 6.8295°North longitudes 9.3673° West while Nimba county lies between 6.8428° North and 8.6601°West. The soil types in both Bong and Nimba Counties are Oxisols while Lofa County has Ultisols.

Sampling Design

Districts were selected using a Purposive sampling approach in two stages. Selection of the districts was based on preliminary information on contrasting experiences in rice production and production levels. For example, farming communities that had been in rice production for less than five years were considered new while those that had been in rice production for more than five years were considered as experienced rice farmers. Three districts from each county were selected, in each of those districts, three villages were selected.

Sampling procedures

The sample population per district was divided by three towns to get the equal number of farmers in each town. Individual farmers were selected by randomly targeting those who grew rice in the selected villages. Individual farmers from the selected villages were interviewed. The individual farmers were selected from a list of rice farmers provided by the extension agent who was part of the survey team, a total number of 328 farmers were purposively select and interviewed.

Sample size Determination

The research used Slovin's formula (Galero, 2011) to determine the number of household respondents. Slovin's formula allows a researcher to sample the population with a desired degree of accuracy. Slovin's formula is written as

$$n = N / (1 + Ne^2)$$

Where:

n – Sample size,

N -Total population

e – Error of tolerance = 0.05

The total population in Bong (333,481), Lofa (276,863) and Nimba (462,026) Counties were sampled using Slovin's formula; the results were proportionally calculated across the various populations of each district.

Table 1: House hold sample per County

County	Total Population	Sample population per County
Bong County	333,481	400
Lofa County	276863	399
Nimba County	462026	400
Total	1072370	1,199

Source: Liberia national population and housing census, 2008

Table 2: Total number of households per District in three Counties

County	Distract	Population	Sample population per district
Bong County	Jorquelleh	79,129	96
	Panta	16,473	20
	Zota	20,240	24
Lofa County	Salayea	23,578	34
	zorzor	40,704	59
	Quardu Bondi	18,785	27
Nimba County	Sanniquele mahn	25,370	22
	Meinpea mahn	24,157	21
	Zoe Gboa	29,372	25
Grand total		278, 023	328

Source: Liberia national population and housing census, 2008

Data collection and analysis

Quantitative and qualitative approaches were used to gather data. In the quantitative approaches, information was gathered mainly through survey, while qualitative approaches were involved group discussions and making observations in the study areas. A group discussion was conducted with farmers and stake holders to identify key rice production zones, general constraints and sampling procedures. Individual interviews were conducted using pre-tested, semi-structured questionnaires to capture information on the farmers’ demographic characteristics, their preferred varieties and the susceptibility of these varieties to various biotic and abiotic stresses; problem listing, observations and cross-checking tools were used. Data from the formal survey (individual interviews) were coded and analyzed using SPSS software. Discussion with farmers and agricultural extension staff was conducted to generate information. Data obtained through multiple listing was subjected to chi-square testing to determine independence between different districts and the different variables using SPSS (version 15.0) computer package. Chi-square tests (X^2) for fixed ratio hypothesis for the variables and districts were used.

RESULTS AND DISCUSSION

Demographic Characteristics of Respondents

The respondents’ demographic information included the respondent’s gender, age range, education level, land acquisition and professional qualifications.

Table 3: Number of respondents by county

County	Frequency (n)	Percent (%)
Bong	139	42.1
Nimba	68	20.6
Lofa	121	36.7
Total	328	

Response Rate of respondents

A total sample size of 328 respondents and all questionnaires were filled completely and returned making a response rate of 42.1% from Bong, 20.6% from Nimba and 36.7% from Lofa Counties (Table 3). All Questionnaires (328) were considered during the data analysis representing 99.4% response rate. This implied that 99.4% response rate for this study was considered perfect and satisfactory. According to (Mugenda and Mugenda 2003), a response rate of 50 percent is adequate for data analysis and reporting; a rate of 60% is good and a response rate of 70% and over is excellent.

Table 4: Age of Household head interviewed

Age						
District	41 – 50	Above 60	25 – 30	31 – 40	51 – 60	below 25
Panta	6	4	3	2	3	2
Zota	7	4	5	7	2	0
Jorquelle	36	14	15	16	8	5
Mienpea Mahn	7	6	0	3	5	0
Zoe Gbao	7	5	4	6	1	2
Sanniquelle Mahn	8	6	0	4	4	0
Salayea	11	4	4	9	4	1
Zorzor	19	6	13	12	9	2
Quardu bundi	3	3	5	12	4	0
Frequency (N & %)	104 31.5%	52 15.8%	49 14.8%	71 21.5%	40 12.1%	12 3.6%

Age of Household head interviewed

On the age of the respondents the study found that majority of the respondents were between the ages of 41 and 50 years (Table 4) which constitutes 31.5%, follow by 21.5% then 15.8% were above 60 years. This demonstrated that the respondents represented all age groups though not equally distributed as those between the ages of 18 and 24 were slightly over sampled and those over 60 years were under sampled. Farmer’s knowledge and skills in agriculture, such as production operation and management increased with age. The accumulation of more knowledge and skills can help farmers maximize profits and efficient use of their inputs, such as pesticides and fertilizers, as well as labor (Guo *et al.*, 2015).

Educational level of the respondents

For the education level of respondents, the results indicated that 49 % (160) of the farmers interviewed had no formal education while 20.3% (67) had primary education. On junior high education, 19 % (62) of the farmers had junior high education and 10.0% (33) had senior high education. The study also showed that 2 % (5) of the farmers had technical education while 0.3% (1) had tertiary education (Figure 2).

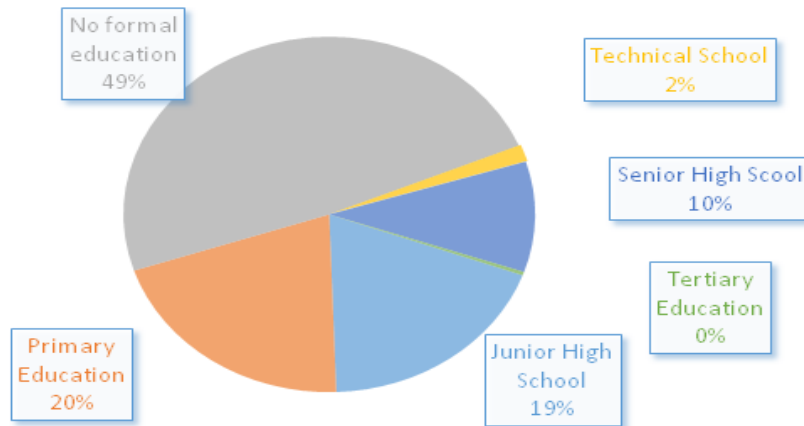


Figure: 2. Education level of the respondents

The lack of enough formal education among farmers, as few of the respondents had attained only primary, junior and senior high education could be some of the causes of low production in these Counties. Access to education makes one able to access critical services such as credit, technology and input supply which will enable farmers to make good maximization of their productivity (FAO, 2015). In terms of level of education, higher numbers of farmers in the study areas do not have formal education (Figure 2). The low level of educated farmers in Bong, Nimba and Lofa Counties indicated that majority of the farmers do not have access to extension services, this might have contributed to low agriculture productivity in these areas. (Mignouna *et al.*, 2011) reported that educated farmers were more inventive and exposed to new technologies than non-educated ones. Of the 328 farmers interviewed, only 7.6% had special training in agriculture while 91.2% had no specialization. Education is a tool for societal transformation and a powerful strategy to accelerate changes in the way it produces and consumes food. It refers to early learning and lifelong acquisition of skills for higher awareness and actions for solving food system challenges (FAO 2015). According to Ministry of agriculture, Liberia’s agriculture sector is dominated by traditional subsistence farming systems (MOA, 2009). These systems are mainly practiced on uplands that are characterized by shifting cultivation, labor intensity, low technologies and use of rudimentary inputs, all of which contribute to low productivity (FAO, 2016).

Table 5: Gender of the respondents

District	Gender		Total
	Female	Male	
Panta	8	12	20
Zota	9	16	25
Jorquelleh	34	60	94
Mienpea Mahn	11	10	21
Zoe Gbao	13	12	25
Sanniquelle Mahn	11	11	22
Salayea	15	18	33
Zorzor	25	36	61
Quardu bundi	13	14	27
Total	139	189	328
	42.1%	57.3%	

Gender of the respondents

Gender analysis shows that (57.62%) respondents interviewed were men while (42.39%) were women (Table 6) Therefore, study clearly revealed that majority of the respondents interviewed were dominated by male farmers. The socio-economic characteristics of the respondents indicated that majority of the rice farmers in the study areas were male thereby confirming the dominance of male farmers in upland rice

cultivation over women. The gender percentage in favour of men can be ascribed to the hard labour involved in the activities of upland rice production in the regions due to the use of rudimentary technologies. Similar reports had been made in other studies on the role of gender in rice production. This supports the findings of (Owolabi *et al.*, 2015) but disagrees with the findings of (Afolabi, 2008) who reported gradual dominance of women over arable crop cultivation. However, (Anyaocha, 2019) reported that there is dominance of men in upland rice production while the women dominated lowland and irrigated rice production systems.

Table 6: Number of Farmers specialized in Agriculture

Respondents			
District	Yes	No	
Panta	1	19	
Zota	2	23	
Jorquelleh	6	88	
Mienpea Mahn	4	15	
Zoe Gbao	1	24	
Sanniquelle Mahn	2	20	
Salayea	2	31	
Zorzor	7	54	
Quardu bundi	0	27	
Frequency (n & %)	25 7.6%	303 91.2%	

Number of Farmers specialized in Agriculture

The majority of the farmers specialized in agriculture, (303) 91.2% said they did not have any specialized training, while (25) 7.6% of the respondents said they have had some specialized training in the field of agriculture (Table 7). Farmer specialization in agriculture helps to reduce unit costs through an increase in the scale of production, subsequently, improvement of the value added from agricultural activities (Czy?ewski *et al.*, 2015). Farmers will economize their efforts leading to an increase in productivity and production levels, by performing tedious tasks, improving the practical and theoretical knowledge about their specialization, resulting in a reduction of production costs (Czy?ewski *et al.*, 2015).

Table 7: Land ownership in the nine districts of Liberia

District	Inherited land	Leased land	Purchased land
Panta	12	8	0
Zota	24	1	0
Jorquelleh	91	3	0
Mienpea Mahn	21	0	0
Zoe Gbao	25	0	0
Sanniquelle Mahn	21	1	0
Salayea	33	0	0
Zorzor	59	0	2
Quardu bundi	23	4	0
Frequency (n & %)	309 94.2%	17 5.2%	2 0.6%

Land ownership in the nine districts of Liberia

Access to land in Liberia portrays significant input to the development of smallholder agricultural farmers which helps to increase production and raise incomes for rural farmers. Land is considered one of the most

important aspects of crop production, especially agricultural production (Tefft, 2005). The study sought to understand how farmers acquire land for agriculture activities in Liberia. Table 8 result reveals that majority of the lands farmer use for agriculture purposes in Liberia are acquired from their ancestors. Across the nine districts in Liberia, 309 respondents indicated that the lands used for farming activities are inherited and 17 respondents indicated that they used leased land for agricultural activities while 2 respondents agreed that they used purchased land for farming purposes. Accessing farm land signifies an important input to the development of smallholder agricultural systems in Liberia, which are needed to increase production and raise incomes in rural areas. Acquiring farming land in Liberia has become a challenge for many people especially local farmers. However, women’s rights to acquire agricultural land are sometimes restricted despite the statutory establishment of equal inheritance in the customary relationships. Insecure land tenure sometimes discourages women from investing in land for fear of losing their land use rights upon divorce or death of a husband (MOA, 2012). Increasing the efficiency of agricultural land use is an important factor for improving agricultural production (Viana *et al.*, 2021).

Description of farming systems in Bong, Nimba and Lofa Counties

Rain fed agricultural systems have caused low crop yields in many parts of Africa, due to rainfall dependency, farmers cultivate their crops only in one growing season per year, with high vulnerability to periodic droughts and flooding (Jaramillo, *et al.* 2020). The study was conducted in nine districts in Liberia to ascertain the systems of farming among local farmers in Liberia; all 328 respondents indicated that they practiced rain-fed agriculture. Rain-fed agriculture is highly practiced by all local farmers across Liberia which reduces agricultural productivity of farmers and annual yields due to climate variation resulting in fluctuation in the rainy season (EPA, 2019). According to (Mueller *et al.*, 2012), the relatively low productivity in rainfed agriculture is often due to limited water and nutrient availability, degraded soils, and poor water and nutrient management.

Farmer’s awareness of agronomic practices of upland rice production in Liberia

Shifting cultivation or slash and burn agricultural system has been used in Liberia for at least 300 years and currently provides livelihoods for 40% of the population. Shifting cultivation is a traditional agricultural practice that involves clearing and burning vegetation to prepare land, cultivating for one or more years, and then abandoning the land to fallow for several years before returning (Fouladbash *et al.*, 2013).

Table 8: The way farmers clear their lands before planting

District	Burning straws	Throwing straws	Spraying straws	Leaving straws to decompose	Total
Panta	10	7	3	0	20
Zota	24	1	0	0	25
Jorquelleh	91	0	0	3	94
Mienpea Mahn	21	0	0	0	21
Zoe Gbao	25	0	0	0	25
Sanniquele Mahn	22	0	0	0	22
Salayea	33	0	0	0	33
Zorzor	61	0	0	0	61
Quardu bundi	27	0	0	0	27
Frequency (n & %)	314 95.7%	8 2.4%	3 0.9%	3 0.9%	328

Slash and burn agriculture are the traditional and predominant land use practices in many parts of Liberia. During the interviews, every household head was asked the process of clearing farm land before planting. According to the results on (Table 9), 314 respondents said they burn farm straws before planting rice, eight farmers indicated that they throw farm straws away, 3 farmers reported that they spray while 3 said they keep the farm straws to decompose before planting their rice.

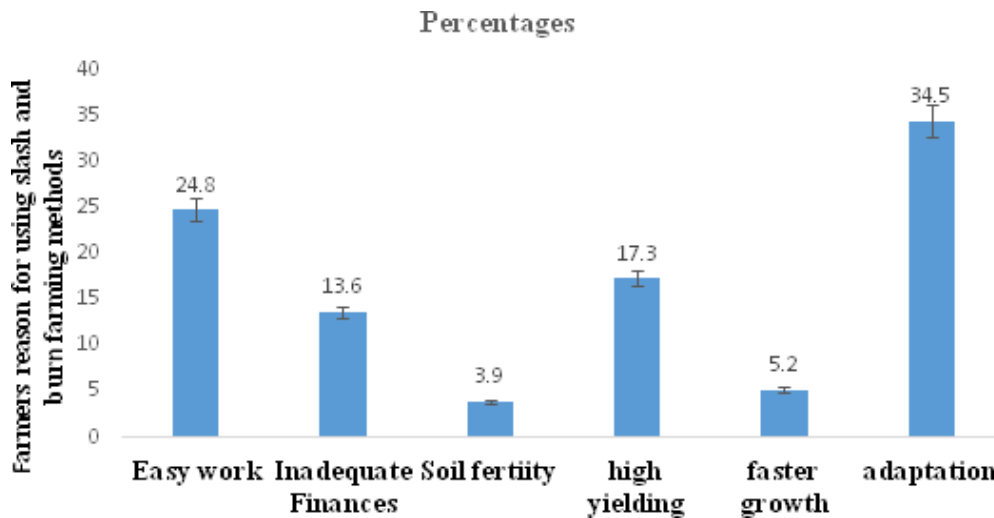


Figure 3. Farmers’ reasons for using slash and burn farming methods

The study sought to understand how farmers clear their farms before cultivation, and all the respondents indicated that they burn the straws before planting their rice. Respondents were also asked to state the reason for using this farming method. The result in figure 3 shows that (34.5%) of the respondents burn straws due to its fast adaptability to the environment; (24.8%) indicated that it makes the farming work easy; (17.3%) stated that burning straws on the farm gives them high crop yield; (13.6%) reported that it is due to inadequate finance and (5.2%) agreed that it makes the rice grow faster while (3.9%) agreed that burning straws helps to make the soil more fertile.

Methods of planting upland rice in Liberia

There are three (3) methods of planting upland rice in Liberia, namely; drilling, dibbling and broadcasting. drilling and dibbling allow straight row planting that ensures optimum plant population and use a hoe for weeding. Straight row planting can be achieved by using a planting rope or line markers.

Table 9: Method of planting upland rice in Liberia

District	Broadcasting with scratching	Transplanting	Total
Panta	19	1	20
Zota	24	1	25
Jorquelleh	94	0	94
Mienpea Mahn	21	0	21
Zoe Gbao	25	0	25
Sanniquelle Mahn	22	0	22
Salayea	33	0	33
Zorzor	57	4	61
Quardu bundi	27	0	27
Frequency (n &%)	322 98.2%	6 1.8%	328

Three hundred twenty-eight (328) farmers were interviewed across nine (9) districts on the methods used in planting upland rice in Liberia. Table 10 shows that 322 farmers practiced broadcasting method while 6 farmers used the transplanting method. Rice broad casting technique offers a useful option to reduce the limitations of transplanted rice where no nursery development requires for transplanting unlike transplanting where additional man power required for nursery, and transplanting operations. Broad casting has been practiced in many developed countries where labour is scarce and expensive and occupies 26% of the total rice area in South Asia (Gupta *et al.*, 2006). Broad casting of rice can also facilitate crop intensification, as studies in other countries have shown that broad casting of rice has a comparative advantage over transplanted rice mainly due to reduction in labour cost and is more economical than transplanted rice (Naresh *et al.*, 2013).

Weeding

Weeding is usually the most labor-intensive activity in upland rice production as it is very difficult to remove weeds, especially when attached to the rice plant. Moreover, laborers have to be very careful to uproot the weeds only leaving the rice planted intact. Weeds are one of the major constraints in rain-fed upland rice farmers in Liberia.

Table 10: Weeding

Response	Frequency(n)	Percentage (%)
Yes	327	99.1
No	1	0.3
At what time do farmers start weeding	Frequency(n)	Percentage (%)
Two weeks after planting	3	0.9
Three weeks after planting	7	2.1
Four weeks after plating	318	96.4
Number of times farmers weed	Frequency (n)	Percentage (%)
Once	288	87.3
Twice	37	11.2
Three times	2	0.6

Weed management after sowing is mainly performed using hoes in the northern and eastern regions of Liberia, with manual weeds removal in the rice fields by the majority of farmers in the northern central regions of Liberia. During the survey, most of the farmers (99.1%), indicated that they do manual weeding before harvesting rice. 96.4% of the respondents weed four weeks after plating and 0.9% of the farmers weed two weeks after planting while 2% of the farmers do their weeding three weeks after planting (Table 11). The result in table 11 showed that 87.3% respondents weed their farms once and 11.2% weed their farms twice while 6% weed their farms before harvesting. Weed invasion has been revealed as a main cause of yield losses under rain fed agriculture in the tropics (Affholder *et al.*, 2013). Weeds contribute to about 25% yield losses in cereal crops including rice. Inappropriate weed management practices have been highlighted as constraints in rice producing regions of Liberia including Bong, Lofa and Nimba Counties where hoe weeding was found to be the most preferred management option for small holder farmers due to cost and the lack of basic knowledge on the use of modern agricultural technologies (Mkanthama *et al.*, 2012). Weed control is imperative to avoid losses in yield and production costs and to preserve good grain quality (Zhang, 2011). It is important to design effective weed management strategies that will control the damage of weeds in rice fields. Effective control and management of weeds in upland rice farming will enable farmers to maximize profits and enhance sustainable rice production.

Farmers preferred upland rice varieties in nine districts of Liberia

The results of the survey found that most of the farmers cultivated more than one variety. It also showed that there were significant differences in farmers’ preferences for rice varieties among the three counties, since the computed chi-square value was larger than the corresponding tabular value with 144 degrees of freedom at a 5% and 1% level of significance (Table 12). A total of nineteen rice varieties were grown by the farmers interviewed in the studied area. The analysis revealed that varieties grown by the farmers differed significantly among the districts. Table 12 Chi-tests for fixed ratio hypothesis for different varieties were then applied separately for each variety, the choice of varieties varied significantly across districts. Of the nine districts, Jorquelleh had the highest proportion of farmers who chose to grow Jaowo (62%) followed by Fassama (21%), Mienpea Mahn and Congo (20%), Zoe Gbao District. Across the nine districts, Jaowo is the most preferred variety grown by farmers follow by Fassama and Black rice respectively.

Table 11: Farmers preferred upland rice varieties in nine districts of Liberia

Variety name	Bong County			Nimba county			Lofa County			Total
	District	District	District	District	District	District	District	District		
	Panta	Zota	Jorquelleh	Mienpea Mahn	Zoe Gbao	Sanniquele Mahn	Salayea	Zorzor	Quardu bundi	
Kpatawee	18	6	1	–	–	–	–	–	–	25
Suacoco-8	2	–	–	–	–	–	–	–	–	2
Youmo	–	15	2	–	–	–	2	–	–	19
Lac-23	–	3	2	–	–	–	8	9	–	22
Jaowo	–	1	62	–	–	–	–	–	–	63
Dirty Rice	–	–	8	–	–	–	–	–	–	8
Fassama	–	–	19	21	–	–	–	–	–	40
Congo	–	–	–	–	20	–	–	–	–	20
Duaka	–	–	–	–	5	–	–	–	–	5
Zain	–	–	–	–	–	9	–	–	–	9
Yorla	–	–	–	–	–	1	–	–	–	1
Mafela	–	–	–	–	–	12	–	–	–	12
White Rice	–	–	–	–	–	–	2	10	–	12
Black Rice	–	–	–	–	–	–	18	11	–	29
Red Rice	–	–	–	–	–	–	3	8	–	11
Yellow	–	–	–	–	–	–	–	8	–	8
Pusawa	–	–	–	–	–	–	–	1	2	3
Uniform	–	–	–	–	–	–	–	14	6	20
Samaka	–	–	–	–	–	–	–	–	19	19
Total	20	25	94	21	25	22	33	61	27	328

Chi-square value =1837.410 (computed) against a tabulated value of 31.803 and 28.217 with df=144 and at p<0.00 respectively (Source: Survey data, January 2022) Farmers are growing many local varieties of rice (*Oryza sativa* L.) in Liberia, but little research has been conducted and researchers are still improving on the varietal traits to increase production and productivity of upland rice in the Country. However, farmers’ perceptions of the best rice varieties are particularly important in determining which variety to grow (Sall *et al.*, 2000). Participatory approaches to breeding will be the way forward to increase farmer adoption of different varieties with high yielding quality (Ceccarelli and Grando, 2003). A successful participatory varietal selection programme has four phases: a means of identifying farmers’ needs in a cultivar; a search for a suitable material to test with farmers; determining acceptability of farmers and wider distribution of farmer-preferred cultivars. One major method of identifying farmers’ preferences for a cultivar is through participatory rural appraisal

(PRA). This approach emphasizes local knowledge and assistance to local people in a community for them to make their own decision, analyze and plans. It is a rapid and cost- effective method of identifying farmer-preferred cultivars and it can reveal a number of important characters that would not have been considered in breeders’ experiments (Danial *et al.*, 2007). High-yielding varieties with preferred grain characteristics would have a great impact on the Liberian rice industry because there is likely to be a good market for farmers’ product. This could encourage them to significantly increase domestic rice production. Rice breeders in Liberia must grasp the preferences of farmers and consumers in their breeding programmes, and the farmers must also be aware of consumer preferences in order to be able to meet them.

Table 12: The reason for planting these rice varieties

Reasons	Frequency (n)	Percent (%)
Drought resistant	39	11.8
Early Maturing	79	23.9
High yielding	145	43.9
High quality	11	3.3
Disease resistant	2	0.6

Farmers reason for planting these rice varieties

Little research has been done on how variety traits influence farmers’ preference for improved rice varieties in Liberia. During interview, farmers were asked to give reasons for growing some of these upland rice varieties, their reasons were grouped into five. The results presented in Table 13 revealed that (43.9%) of the respondents indicated that they grow these rice varieties due to its high yielding capacity, (23.9%) for early maturity, (11.8%) for drought resistance, (3.3%) indicated that it has high quality, while (0.6%) agreed that these varieties are resistant to disease. According to the result on Table 13 farmers listed high yield as the main reason for their variety choice, thus, one can suggest that yield is a major consideration that farmerstake into account when deciding on the variety to cultivate. Majority of the upland rice farmers in Liberia prefer tall plants to lessen the burden of slouching to cut the panicles with a knife during harvesting. However, extremely tall rice cultivars have a propensity to lodge, particularly, under stormy conditions; hence high yielding, relatively medium height and improved rice cultivars or their interspecific hybrids are recommended (Soares *et al.*, 2014). Most of the farmers from the three surveyed Counties indicated that they grow these varieties due to their better performance, high yield and stress tolerance as compared to other rice varieties that have already been cultivated by farmers. Doing the survey, farmers were asked about the preferred traits and perception of new varieties for early adoption and dissemination. The highly preferred traits desired by farmers were high grain yield, tall plant height, early flowering and good cooking quality. Early flowering is one of the deciding factors for variety adoption because late flowering variety often faces environmental and disease stress doing upland rice growth stage.

Table 13. Agronomic Constraints of upland rice farmers in Liberia

	Response			
	Yes	Percentage	No	percentage
Disease	322	97.6%	6	1.8%
Drought	321	97.3	7	2.1%
Available seed	234	70.9%	94	28.5%
High inputcost	249	75.5	79	23.9%
Harvestingchallenges	275	83.3%	53	16.1%
Birds	328	99.4%	0	

Table 14. Market constraints for upland rice farmers in Liberia

	Response			
	Yes	Percentage	No	percentage
Market availability	158	47.9%	169	51.2%
Market Accessibility	154	46.7%	173	52.4%
Market price	233	70.6%	95	28.3%
Low income	388	87.3%	40	12.1%
Lack of access to credit	215	65.2%	112	33.9%

Market constraints for upland rice farmers in Liberia

On the market constraints of upland rice farmers in Liberia, most of the respondents (47.7%) agreed to market availability and (51.2%) reported no. Market accessibility (46.7%) indicated yes while (52.4%) did not agree (Table 14). For market price, (70.6%) showed yes and (28.8%) respondents indicated no, in the case of low income for farmers, (87.3%) indicated yes and (12.1%) said no. Of the 328 respondents, (65.2%) consented to lack of access to credit while (33.9%) said not at all. This is an indication that lack of access to credit facilities, market accessibility, market availability and low price were major concern for farmers in those counties. Many constraints to rice cultivation were identified by farmers and were similar across the three major rice growing regions of Liberia studied. Most of them made special reference to lack of capital to expand their production, inadequate market for local rice and high cost of inputs such as agro-chemicals and fertilizers. It was observed that most of the constraints were due to poor quality of the road network which was a crucial challenge for mobility in the Country, preventing them from market accessibility. Roads in the rural parts of the country are in deplorable condition making it difficult for farmers to transport their produce to the market area. According to Ministry of Agriculture (2012), lack of feeder roads inhibits the flows of rice and other commercial goods thereby preventing input suppliers from delivering seeds and other agricultural inputs at the right volumes and price, and farmers from getting the knowledge needed to make informed investment decisions.

Agronomic Constraints of upland rice farmers in Liberia

Agronomic constraints to rice cultivation were identified and highlighted by many farmers in the three major rice growing counties of Liberia. Many constraints to rice production were listed by the farmers during the group interactions. The result in Table 14 shows that (97.6%) indicated that their farms have been affected by diseases while (1.8%) indicated no to disease infestation. (97.3%) said yes to drought and 2.1% said no, their farms have not been affected by drought. For seed availability, 70.9% indicated yes and 28.5% said no. Farmers were asked about the high input cost, (75.5%) indicated yes and (23.9%) said no. (83.3%) of the farmers admitted having challenges during harvesting while (16.1%) said no challenges. On the issue of bird, all the Farmers (99.4%) agreed that it is one the major constraints faced in the country. Constraints such as drought, pest and diseases, availability of seed, high input cost and harvesting were the major challenges affecting upland rice production as observed in this study area. (Longtau, 2003) and (Adebayo *et al.*, 2012) reported that pests and diseases, weeds and drought stress were the major agronomic constraints to rice production in many parts of the world. In a different study, (Anyaocha *et al.*, 2019) observed variability in rainfall pattern is an important environmental dangerous factor affecting upland rice

production in Liberia. This suggests that if these constraints are not properly addressed, it may lead to reduced yield, loss of income and decline in the standards of living for the entire farming community of Liberia. However, some of the popular and cultivated rice varieties in these counties were low yielding as they were unimproved upland rice. This agrees with Dalton (2004) that yield is not the only determinant that will make farmers to adopt and cultivate a new variety but should be accompanied by other agronomic traits of interest such as aroma, resistance to diseases, grain shape and quality as preferred by farmers and end-users. In rice production, harvesting is an important and sensitive part of production from seedling stage to storing. Harvesting is the process of collecting matured rice from the field. Timely harvesting operation is a very crucial and influential process on yield, quality and production cost of rice (Wang *et al.*, 2021). All rice harvested in Liberia is done by knife and hand sickle. During the group discussion with some farmers, most of them lamented that manual harvesting of rice is sometimes a worrying, time-consuming, labor intensive and costly operation.

Market constraints for upland rice farmers in Liberia

On the market constraints of upland rice farmers in Liberia, most of the respondents (47.7%) indicated yes to market availability and (51.2%) of the respondents said no. (46.7%) consented to market accessibility while (52.4%) said no. For market price, (70.6%) indicated yes and (28.8%) respondents said no, (87.3%) agreed to low income and (12.1%) said no. Of the 328 respondents, 65.2% (215) indicated yes to lack of access to credit while (33.9%) said no to lack of access to credit (table 14). This is an indication that lack of access to credit facilities, market accessibility, market availability and low income were major concerns for farmers in those counties. Many constraints to rice cultivation were identified by farmers and were similar across the three major rice growing regions of Liberia. Most of them made special emphasis on lack of capital to expand their production, inadequate market for local rice and high cost of inputs such as agro-chemicals and fertilizers. It was observed that majority of the constraints were due to poor quality of road network which was a crucial challenge for mobility in the Country, preventing them from market accessibility. Roads in the rural parts of the country are in deplorable conditions making it difficult for farmers to transport their produce to the market area. According to Ministry of Agriculture (2012), lack of feeder roads inhibits flows of rice and other commercial goods thereby preventing input suppliers from being able to deliver seeds and other agricultural inputs at the right volumes and price, and farmers from getting the knowledge needed to make informed investment decisions.

CONCLUSIONS AND RECOMMENDATIONS

The study was conducted in three Counties of Liberia to assess farmers' constraints and preferred upland rice varieties, their knowledge and understanding on the management practices of growing upland rice in the Country. Farmers were both male and female with little or no education and all the respondents practiced traditional farming methods and the agricultural activities were manually done. Farmers' preferred rice varieties were Jaowo followed by Fassama, and Congo and the selection of these varieties was based on certain plant characteristics such as plant height, disease tolerance, early maturity, high yield followed by cooking quality and taste. These characteristics were the highest farmer's priority and dominant in selecting new varieties. Drought stress, diseases, lack of access to credit, unstable market price, and lack of market accessibility due to bad roads, high input cost and harvesting challenges were among the major constraints of rice production which were flagged by majority of the farmers in the survey area. Farmers' preferred varieties should be used in breeding programs to help enhance the adoption of improved varieties for sustainable rice production that contribute to food security of smallholder farmers of Liberia.

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