



24 JUNE 2017

LIBERIA POVERTY ASSESSMENT-
STATISTICAL ABSTRACT
AGRICULTURE RECALL SURVEY 2016

LISGIS- AGRICULTURE TEAM



Table of contents

Table of contents.....	i
List of tables	ii
List of figures	iii
Introduction	4
1. The data	6
2 Characteristics of farming Households.....	7
3 Farming Characteristics.....	10
4. Use of modern inputs	15
5. Labor utilization	18
6. Crop production and sales	22
6.1 Household crop portfolio	22
6.2 Productivity of crops	28
6.3 Gender gap in rice productivity.....	31
6.4 Effects of the Ebola crisis on rice farming	34
6.5 Crop commercialization.....	40
7. Livestock	45
7.1 Livestock participation and ownership.....	45
7.2 Disease rates and vaccination.....	48
Conclusion.....	50
References.....	49
Appendix.....	50

List of tables

Table 1. Linkages between the household and crop cut surveys	6
Table 2. Basic farming household characteristic.....	8
Table 3. Average land area (ha) cultivated by quintiles	9
Table 4. Land area cultivated by county.....	12
Table 5. Land tenure by County	14
Table 6. Modern inputs utilization and access to extension services.....	16
Table 7. Access to extension services by County.....	17
Table 8. Labor utilization.....	18
Table 9. Distribution of annual agricultural input expenditure and hired labor, by quintiles of land area cultivated.....	19
Table 10. Share of households owning agricultural assets, by quintiles of land area cultivated	19
Table 11. Agricultural labor	20
Table 12. Number of farming households engaged in fruits production by county (Top 4 fruits only)	24
Table 13. Number of farming households engaged in vegetable production by county (Top 6 vegetables only)	25
Table 14. Number of farming households engaged in cash crops production by county.....	27
Table 15. Total production of crop by land cultivated quintiles.....	29
Table 16. Estimated production of rice (based on farmer estimate)	30
Table 17. Estimated production of cassava (based on farmer estimate)	30
Table 18. Regression Results on Gender Differences in rice Productivity.....	31
Table 19. Incidence of sales of rice and cassava by county	41
Table 20. Share of sales of crop over total production	44
Table 21. Livestock participation by wealth quintiles.....	45
Table 22. Livestock participation by household head gender.....	45
Table 23. Livestock headcounts by wealth quintiles (averages for Livestock keepers only)	46
Table 24. Livestock headcounts by household head gender (averages for Livestock keepers only) ..	47
Table 25. Disease rates and vaccination by wealth quintiles.....	48
Table 26. Disease rates and vaccination by household head gender.....	48

List of figures

Figure 1. Histogram of area of land cultivated by percentage of households	10
Figure 2. Area of land cultivated by household head's gender	11
Figure 3. Land ownership patterns by households head gender.....	11
Figure 4. Gini coefficient of land area cultivated per capita	13
Figure 5. Land tenure by household head gender	14
Figure 6. Cause of soil erosion problems	15
Figure 7. Use of improved seeds and incidence of purchase seeds	17
Figure 8. Labor utilization by household head gender	22
Figure 9. Incidence of crop cultivation by household.....	23
Figure 10. Incidence of intercropping/monocropping	27
Figure 11. Reasons for intercropping	28
Figure 12. Gender gap in rice productivity	34
Figure 13. Effects of the Ebola crisis on rice farming activities	35
Figure 14. Reasons for not making rice farm during the Ebola crisis.....	35
Figure 15. Effects of the Ebola crisis on land clearing activities on rice farms	36
Figure 16. Effects of the Ebola crisis on the planting on rice farms	37
Figure 17. Effects of the Ebola crisis on chemical fertilizer application on rice farms	37
Figure 18. Effects of the Ebola crisis on rice harvesting.....	38
Figure 19. Effects of the Ebola crisis on the timing of rice harvesting.....	38
Figure 20. Reasons for not selling crops output during the Ebola crisis.....	39
Figure 21. Incidence of sales of crops	40
Figure 22. Incidence of sales of crops during the Ebola crisis	40
Figure 23. Household engagement with the market.....	42
Figure 24. Local linear non-parametric regression of crop commercialization on land cultivated area	43

Introduction

Agriculture sector is the main source of livelihoods for approximately 80 percent of Liberia's population¹. The sector plays an integral role in Liberia's economic and social development as it contributes significantly to employment, food security and household income. In 2016, the agricultural sector accounted for around 26 percent of the real Gross Domestic Product (GDP)², approximately one third of which originates in the livestock subsectors.

Despite the importance of agriculture in Liberian economy, the incidence of poverty is consistently higher among farming households than non-farming households. According to the 2014 Household Income and expenditure Surveys (HIES), 77.2 percent of farming households³ are in absolute poverty, nearly 60 percent are also in food poverty and more than one-third are in extreme poverty. Therefore, investment in agriculture will benefit to the majority of the poor population. In addition, cross-country evidence has convincingly shown that GDP growth in agriculture is more poverty reducing than GDP growth originating outside agriculture (Loayza and Raddatz, 2010; Christiaensen et al., 2011). This means for Liberia that fostering agriculture will potentially yield the fastest poverty reduction.

Building a structural transformation program in agriculture sector in Liberia necessitate up to date data on the sector. Thus, over the past three years, LISGIS has administered a number of linked household and agricultural surveys that can be used to study rural livelihoods, including the 2014 and 2016 HIES

This statistical abstract provides an insight into all-important components of the 2016 agricultural recall survey results. The report highlights major characteristics of farming households and agricultural activities including production of food crops and livestock.

The report points out that farming households have low level of formal education and limited access to infrastructure and basic services. The highest level of educational attainment of heads is at the primary school level: on average, the number of years of schooling

¹ The African Development Bank, The World Bank. Joint Interim Strategy Note 2007-2008.

² Central Bank of Liberia, 2016 Annual Report

³ According to the 2014 HIES, the absolute poverty rate is 54.1% at national level; food poverty rate is 45.0% and extreme poverty rate is 18.5%

of farming households head is under four years. Fewer than five percent of all Farming households report having access to an internal flush toilet, electricity and public/private garbage collection service

Farming is dominated by smallholders with limited land endowment and hire labor to make up for family labor shortages. Farming households cultivate on average 1.6 hectares and three percent of farming households cultivate more than five hectares of land. On average, 86 percent of farming households use hired labor or exchange labor (Kuu labor) to make up for family labor shortage.

Farming sector is characterized by an extremely limited use of modern inputs. Approximately 4 percent of the planted area is irrigated while respectively 5 and 2 percent is fertilised and pesticided. Meanwhile, 43 percent of farming households purchased seeds for agriculture, only 4 percent used certified improved varieties suggesting that most of the purchase seeds are traditional varieties.

The vast majority of farming households do not have access to extension services. Only 3 percent of farming households report having access to extension services.

Farming households have a diversify crop portfolio. While rice and cassava are the top two food crops grown, fruits and vegetables are grown by a high share of farming households. On average, 60 percent of households report growing vegetables, 27 percent grew fruits and 33 percent permanent cash crop. The top five cash crops grown are cocoa, sugar can, rubber, coffee and oil palm.

Rice and cassava productivity is extremely low. The national average yield is 1.26 metric ton per hectare for rice and 5.68 metric ton per hectare for cassava. The estimated total production of rice and fresh cassava for 2016 is estimated at 335,179 metric ton and 697,604 metric ton respectively.

There is a fair degree of market orientation. Nearly three out of four farming households sell a portion of their crop output. This suggests that most farmers engage with the market and have moved well beyond farming for subsistence only. However the share of the sales over total production is low (26 percent on average).

Most farming households have some livestock with high level of livestock diseases rates and low vaccination. Nearly 50 percent of farming households report holding animals. However, the average holding is small (10 heads of animals, all types combined). The level of reported livestock diseases rates is 31 percent while the vaccination rate is less than 3 percent.

1. The data

This chapter is based primarily on Agriculture recall survey covering all Farming households included in the 2016 HIES, which provides an opportunity to explore Farming household performance. Data was collected using household questionnaires in which information was obtained at the individual, household and plot level. Agricultural production data was collected at farm and crop level, with detail on the allocation of production and the use of inputs such as fertilizer, pesticides, hired labor, shared labor and household labor activity.

Data on livestock activities were also collected. Livestock data includes the ownership of a range of animals, the production and sales of products obtained from the animals. Other data used come from the crop cut surveys for 2014 and 2015. The linkages between the household and crop cut surveys are listing in the **Table 1** below. The 2014 Crop Cut Survey did not cover the entire country because of the Ebola crisis. In addition, the 2014 and 2016 HIES are Enumeration Area-level panel surveys (i.e. the same clusters were used but new households were selected).

Table 1. Linkages between the household and crop cut surveys

Agricultural Survey	Field Dates	Linked Survey	Household Survey
2014 Crop Cut Survey	July – Sept 2014 (southern counties only)	2014 HIES	
2015 Crop Cut Survey	July – Sept 2015 (southern counties) Oct 2015 – Jan 2016 (rest of country)	2014 HIES	
2016 Agricultural Recall Survey	January 2016 – January 2017	2016 HIES	

2. Characteristics of farming households

Farming households are households who reported being involved in agriculture activities through cultivating of land or ownership of livestock. They represent 35 percent of Liberian'

households in 2016. **Table 2** reports basic summary statistics for some key characteristics of Farming households. These households consist on average of 5 members.

However, there is some differences across regions in households' human capital endowment. Farming households in Liberia's South Eastern B, Montserrado, South Eastern, North Central and North Western regions have much higher levels of dependency ratio⁴ than households in the South Central region. The household size in per adult equivalent⁵ range from 3.29 in North western to 4.14 in South Eastern B

The great majority of farming households in Liberia are male-headed (Table 2). One fifth of household heads are female. Households in the South East B are larger and more likely to be headed by a woman. The average age of household heads is 44 years reflecting a relatively high level of experience in farming. Only a few share of Farming household head is single (7 percent).

On average, farming household heads have completed less than four years of schooling. The highest level of educational attainment of heads is at the primary school level: on average, the number of years of schooling of farming households head is under four years.

Table 2. Basic farming household characteristics

	Mont-serrado	North Central	North Western	South Central	South Eastern A	South Eastern B	National
	mean/sd	mean/sd	mean/sd	mean/sd	mean/sd	mean/sd	mean/sd
Household size	5.26	4.81	4.33	4.50	4.73	5.38	4.76
	2.40	2.09	2.01	2.04	2.09	2.37	2.12
Household size in per adult equivalent	4.12	3.66	3.29	3.41	3.62	4.14	3.63

⁴ The dependency ratio is the number of dependents (household members who are less than 14 or more than 65 years old) per household members of working age (14-65 years olds).

⁵ The adult equivalent measures used are based the standard FAO adult equivalent scales developed in Guinea in 2004, and are therefore considered more relevant to the West African context (see conversion factors in appendix 1)

Dependency ratio	1.94	1.60	1.49	1.56	1.60	1.87	1.63
	1.21	1.17	1.15	1.08	1.18	1.20	1.16
	1.34	1.00	1.03	0.92	0.97	0.96	1.01
<i>Household head characteristics</i>							
Household head age	49.29	43.37	45.83	42.23	45.13	46.84	44.26
	14.04	14.69	17.78	13.54	14.20	14.11	15.01
Female headed households	0.15	0.21	0.20	0.17	0.21	0.21	0.20
	0.36	0.41	0.40	0.38	0.41	0.41	0.40
Married	0.49	0.52	0.67	0.64	0.64	0.63	0.57
	0.51	0.50	0.47	0.48	0.48	0.48	0.49
Living together	0.36	0.26	0.16	0.17	0.16	0.18	0.23
	0.49	0.44	0.36	0.38	0.36	0.39	0.42
Separated/Divorced/Widow	0.01	0.15	0.11	0.13	0.15	0.13	0.13
	0.12	0.35	0.31	0.34	0.36	0.34	0.34
Never married	0.14	0.07	0.06	0.06	0.05	0.05	0.07
	0.35	0.26	0.24	0.24	0.22	0.22	0.26
HH head years of schooling	6.23	3.72	3.33	3.37	4.27	4.36	3.85
	4.95	4.53	4.52	4.30	4.45	4.76	4.57
<i>Dwelling characteristics</i>							
Flush Toilet	0.22	0.04	0.02	0.06	0.01	0.01	0.04
	0.42	0.19	0.15	0.23	0.12	0.12	0.21
Flush toilet owned	0.17	0.02	0.01	0.04	0.00	0.01	0.03
	0.38	0.14	0.10	0.19	0.05	0.11	0.16
Flush toilet shared	0.05	0.02	0.01	0.02	0.01	0.00	0.02
	0.23	0.14	0.10	0.13	0.11	0.04	0.13
Access to electricity	0.08	0.01	0.04	0.03	0.02	0.04	0.02
	0.28	0.12	0.19	0.16	0.12	0.19	0.15
Main Cooking Fuel Biomass (Wood/charcoal)	1.00	1.00	0.98	0.99	1.00	1.00	1.00
	0.00	0.03	0.14	0.09	0.03	0.06	0.07
Drinking Water from pipeline	0.14	0.36	0.22	0.20	0.26	0.28	0.30
	0.35	0.48	0.41	0.40	0.44	0.45	0.46
Drinking Water from Borehole	0.82	0.34	0.44	0.21	0.34	0.44	0.37
	0.39	0.47	0.50	0.41	0.48	0.50	0.48
Drinking Water from river/lake	0.02	0.12	0.28	0.52	0.37	0.26	0.22
	0.15	0.33	0.45	0.50	0.48	0.44	0.41
Public garbage collection	0.01	0.00	0.00	0.01	0.01	0.01	0.01
	0.11	0.07	0.05	0.09	0.07	0.09	0.07
<i>Average time to walk from the farm to (mn):</i>							
Home	10.29	40.37	33.17	24.17	36.83	46.72	35.82
	21.61	31.45	26.74	21.90	30.97	37.67	30.89
Main road	12.10	41.28	42.75	46.20	46.36	56.68	41.86
	17.32	43.43	57.43	54.53	70.66	67.99	51.24
Market	51.98	106.39	123.01	99.01	128.15	128.51	107.62

Access to infrastructure and basic services is also problematic for many Farming households. Fewer than five percent of all Farming households report having access to an internal flush toilet, electricity and public/private garbage collection service. Nearly the totality of Farming household uses wood, dung or charcoal as main source of cooking energy. On average, one fourth of all Farming households have access to drinking water through rivers and lakes. This suggests that access to clean drinking water is a challenge for a relatively high share of farming households. Nationally, farming households have poor access to road and market since they take on average 42 minutes to reach the nearest road and 108 minutes to reach the nearest input and output market.

The accessibility to infrastructure and basic services is much higher in Montserrado than in the other regions. Close to one fourth of farming households in Montserrado have access to flush toilet, 8 percent have access to electricity and around 96 percent have access to clean drinking water through pipeline and borehole. They take on average 12 minutes to reach the nearest road and 52 minutes to reach the nearest market. Farming households in Montserrado have better access to infrastructure and basic services than in the other regions probably because of their proximity to Monrovia, the country capital.

Table in appendix 1 shows that farming households are less favored in term of access to infrastructure and basic services compared to non-farming households. They appear to be poorer than non-farming households. The per adult equivalent total household expenditure is 58,742 Liberian Dollars for farming households against 108,859 for non-farming households.

3. Farm Characteristics

There is a prevalence of smallholder farmers in Liberia. Households in Liberia own an average of 2 farms. The average size of land cultivated per household is 1.6 hectares. The distribution of land cultivated illustrated in **Table 3** and Figure 1 shows the prevalence of smallholder farmers in the country. Less than three percent of Farming households cultivate more than five hectares of land; even in the top land quintile, average land cultivation is smaller than 4 hectares.

Table 3. Average land area (ha) cultivated by quintiles

Quintiles of land cultivated	Household land area cultivated		Household land area cultivated per capita		Number of observations ⁶
	Mean	SD	Mean	SD	
Quintile 1 (Smallest farm)	0.34	0.17	0.11	0.10	826
Quintile 2	0.83	0.13	0.23	0.15	1005
Quintile 3	1.25	0.12	0.34	0.24	809
Quintile 4	1.88	0.25	0.51	0.32	772
Quintile 5 (Largest farm)	3.60	1.07	0.84	0.58	636
Total	1.58	1.23	0.40	0.41	4048

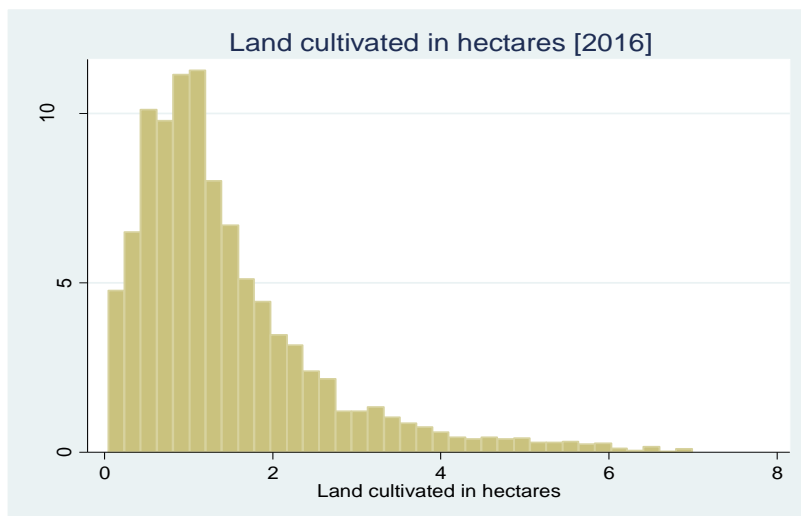


Figure 1. Histogram of area of land cultivated by percentage of households

Female farmers have less access to land compare to their male counterpart. Figure 2 present the kernel density estimates of land cultivated by household head gender and confirm the gap between male-headed households and female-headed households.

⁶ The figures in the table are weighted. However, the number of observations reflect the count of farming households in the sample

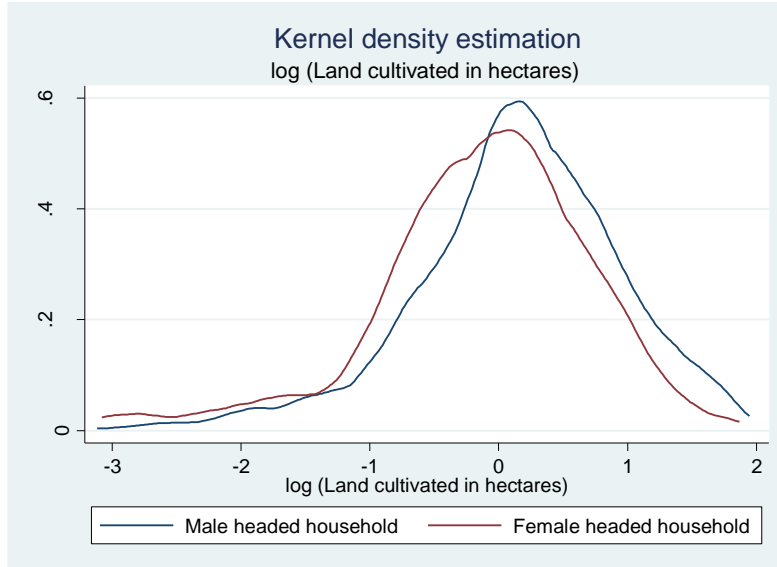


Figure 2. Area of land cultivated by household head's gender

Female-headed households cultivate on average 79 percent of the national average of land area cultivated per household. Since female-headed households account for 20 percent of the country's Farming households, this translate to women only controlling 16 percent of cultivated land in Liberia (Figure 3). The share of land cultivated controlled by female decrease further when considering the land area devote to permanent cash crops.

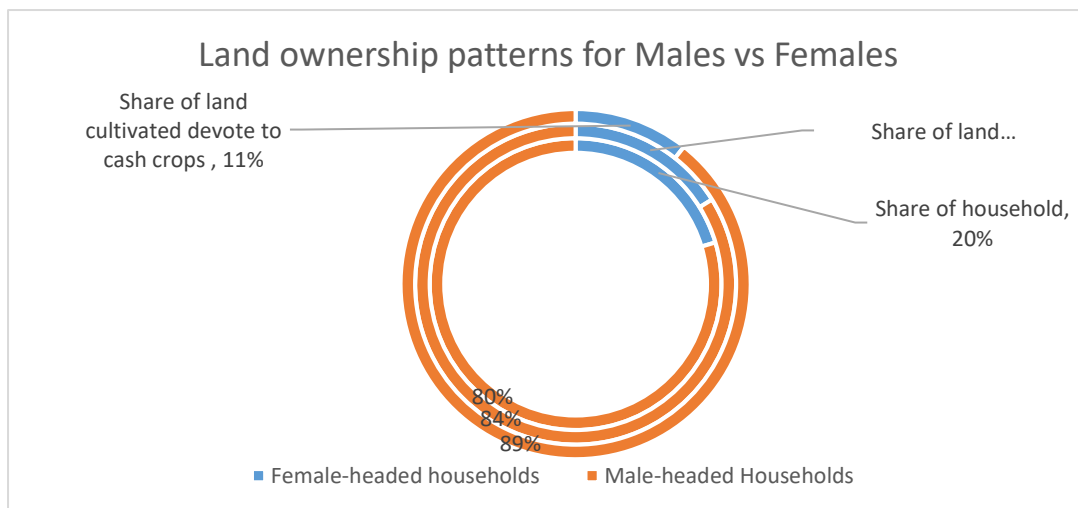


Figure 3. Land ownership patterns by households head gender

There is also significant difference across counties in term of land area cultivated as shown in Table 4. Households in Lofa County appear to have the highest land area cultivated per household.

Table 4. Land area cultivated by county

County	Male-headed households		Female-headed Households		All households		Land cultivated per capita	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Bomi	1.46	0.92	1.30	0.77	1.43	0.89	0.43	0.36
Bong	1.47	1.14	1.06	0.82	1.39	1.09	0.37	0.41
Grand Bassa	1.39	1.14	1.23	0.88	1.37	1.11	0.38	0.36
Grand Cape Mount	1.83	1.28	1.44	0.89	1.75	1.21	0.49	0.42
Grand Gedeh	1.22	0.93	1.07	0.61	1.18	0.86	0.33	0.36
Grand Kru	1.21	0.86	1.00	0.54	1.16	0.81	0.25	0.21
Lofa	2.42	1.50	1.59	1.13	2.20	1.45	0.53	0.45
Margibi	1.15	1.09	0.75	0.58	1.05	1.00	0.25	0.23
Maryland	1.20	1.04	0.89	0.76	1.14	0.99	0.24	0.23
Montserrado	0.74	0.66	0.71	0.82	0.73	0.67	0.16	0.16
Nimba	2.05	1.40	1.47	0.96	1.94	1.35	0.48	0.48
River Cess	1.39	1.03	0.80	0.64	1.29	1.00	0.33	0.30
Sinoe	1.14	0.75	0.93	0.76	1.09	0.75	0.26	0.23
River Gee	1.26	0.81	1.09	0.61	1.22	0.78	0.29	0.24
Gbarpolu	2.05	1.23	1.63	1.28	1.98	1.25	0.54	0.44
National	1.66	1.29	1.25	0.93	1.58	1.23	0.40	0.41

The Table 4 clearly shows that male-headed households cultivate more area of land than female-headed households across counties. Inequality in access to land measures by the Gini coefficient (see Figure 4) shows that Montserrado, Margibi and Grand Gedeh are the counties where farmland is the most unequally distributed among farming households.

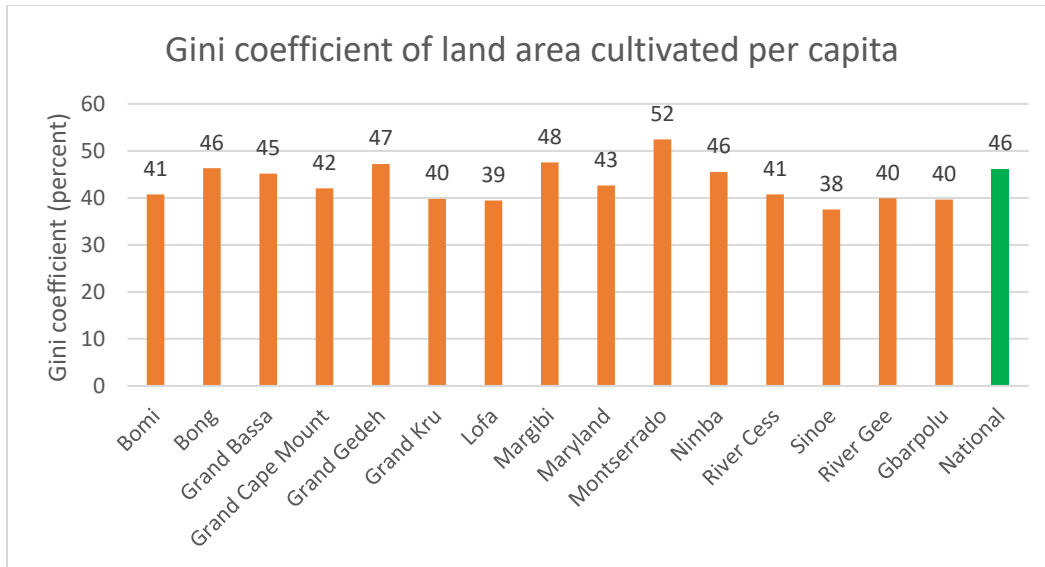


Figure 4. Gini coefficient of land area cultivated per capita

BOX 1. Inequality Measure

In term of access to farmland, equality can be defined as an equal distribution land area cultivated per capita across farming households. This means that each share of household cultivate the same share of land area per capita. The Lorenz Curve compares graphically the cumulative share of household with their cumulative share of land area cultivated per capita. A perfectly equal distribution of land area cultivated is indicated by a diagonal. The other extreme is complete inequality where one households cultivated all the farmland. These two (theoretical) extremes define the boundaries for observed inequality.

The Gini coefficient is the most commonly used measure for inequality. A Gini coefficient of 0 indicates perfect equality while 1 signifies complete inequality. In relation to the Lorenz Curve, the Gini coefficient measures the area between the Lorenz Curve and the diagonal.

The land tenure system is dominated by community, tribal and family land (Table 5).

Only five percent of cultivated farms are privately owned at national level and less than three percent of households have a deed to their farmland. The same patterns is observed across counties. Those figures flag out that land tenure security is potentially a challenge for Liberian farmers. Tenure security is central to agricultural growth and there is a large body of empirical literature in Africa showing the positive impact of tenure security on investment and productivity. Hence, improving land tenure security could be a good policy response to the underinvestment and low productivity in agriculture in Liberia.

Table 5. Land tenure by County

County	Land tenure (% of farms)					
	Community land	Tribal land	Distributed by family	Privately owned	Rented	Farming as a tenant
Bomi	43%	29%	22%	1%	0%	4%
Bong	29%	17%	40%	7%	4%	3%
Grand Bassa	45%	20%	32%	1%	1%	1%
Grand Cape Mount	48%	17%	33%	2%	0%	1%
Grand Gedeh	34%	21%	35%	6%	1%	2%
Grand Kru	56%	30%	11%	2%	0%	0%
Lofa	40%	34%	22%	2%	0%	1%
Margibi	33%	8%	35%	7%	1%	16%
Maryland	47%	21%	24%	6%	1%	2%
Montserrado	21%	6%	32%	17%	18%	6%
Nimba	26%	10%	55%	7%	1%	1%
River Cess	61%	30%	8%	1%	0%	0%
Sinoe	46%	29%	22%	2%	0%	1%
River Gee	32%	38%	21%	8%	0%	2%
Gbarpolu	40%	44%	14%	1%	0%	1%
National	35%	20%	35%	5%	2%	2%

Compared to male-headed households, female-headed households have less access to communal land (*Figure 5*) and the difference is statistically significant at 5 percent level. There is no statistical difference across gender for the other land tenure arrangements.

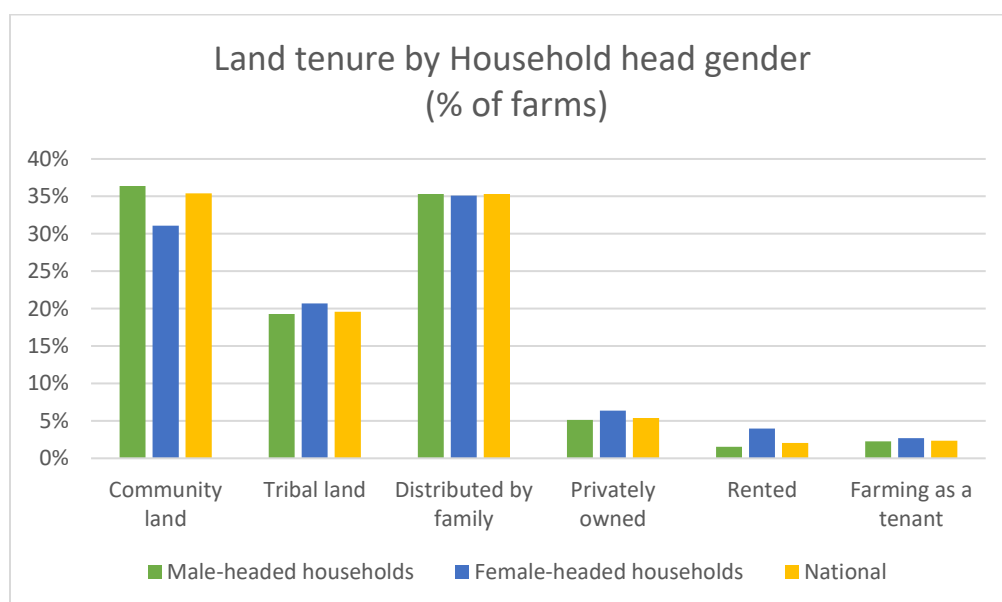


Figure 5. Land tenure by household head gender

The share of farms that experience soil erosion in 2016 is 30 percent at national level with minimal variation across counties. The main cause of soil erosion reported is flooding or rain. On average, 71 percent of Farming households that experience soil erosion problems reported that the erosion problem was due to flooding/rain while 31 percent of households reported animals as main cause of soil erosion.

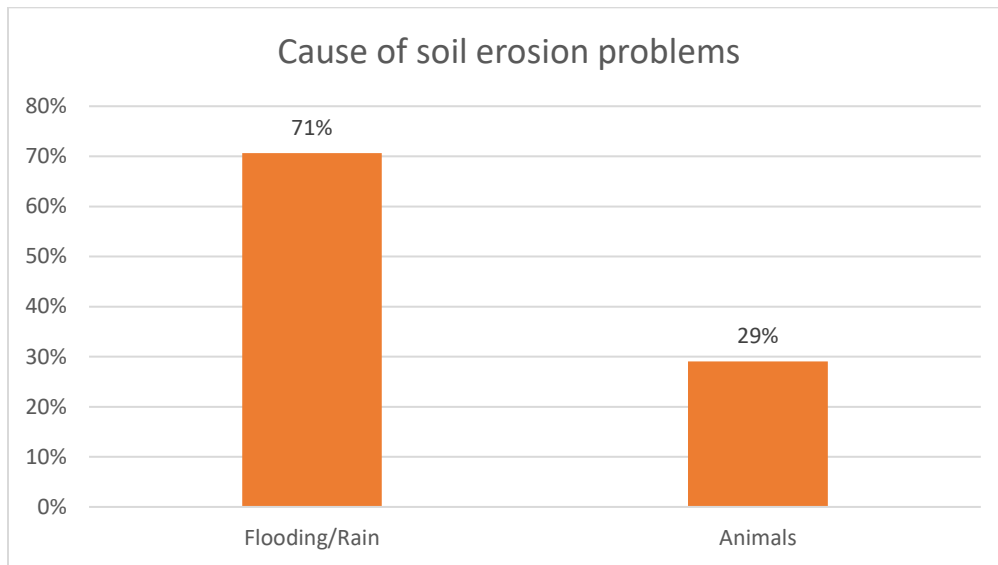


Figure 6. Cause of soil erosion problems

4. Use of modern inputs

The farming sector in Liberia is characterized by an extremely limited use of modern inputs. Approximately 4 percent of the planted area is irrigated while respectively 5 and 2 percent is fertilised and pesticided (*Table 6*). The average amount of chemical fertilizer used per hectare is less than 5 kilograms. Female-headed households has a lower level of fertilizer and pesticide usage compare to their male counterparts in per hectare term. Significant difference also emerge across gender in term of access to extension services with female-headed households having lesser access than male-headed households

Among other factors, the low input utilization could prevent farmers from achieving the greatest possible crop yields.

Table 6. Modern inputs utilization and access to extension services

	Male-headed households	Female-headed households	Total
	mean/sd	mean/sd	mean/sd
<i>Share of area planted that is:</i>			
Irrigated	0.033	0.052	0.037
	0.210	0.216	0.211
Fertilised	0.051	0.066	0.054
	0.267	0.242	0.262
Pesticided	0.024	0.010	0.021
	0.220	0.090	0.200
<i>Quantity (kg) of inputs use per ha</i>			
Chemical fertilizer	3.403	0.345	2.779
	29.977	3.821	26.830
Pesticide	0.701	0.058	0.570
	7.299	0.643	6.524
Household has access to extension services	0.036	0.028	0.034
	0.185	0.165	0.181

At national level, less than five percent of Farming households have access to extension services⁷ (

Table 7). The same patterns is observed across counties. The limited access to extension is not encouraging to improve the adoption of modern inputs. The provision of extension

⁷ Of note that the survey only capture accessibility to extensions services without providing information on the type of extension services available.

service is an important element contributing to enhance productivity and reduce food insecurity.

Table 7. Access to extension services by County

County	Share of households
Bomi	2.9%
Bong	2.4%
Grand Bassa	0.5%
Grand Cape Mount	1.4%
Grand Gedeh	5.0%
Grand Kru	6.1%
Lofa	6.8%
Margibi	3.4%
Maryland	1.5%
Montserrado	2.1%
Nimba	3.5%
River Cess	0.5%
Sinoe	2.3%
River Gee	7.2%
Gbarpolu	8.9%
National	3.4%

There is a low level of use of improve seeds (Figure 7). While the share of households purchasing seeds is high (43 percent), the use of improve seeds is very low. Only 4 percent of farming households reported having used improved seeds during the agricultural season 2016. This suggests that most of the seeds purchased are traditional. This is consistence with the low level of access to extension services reported earlier.

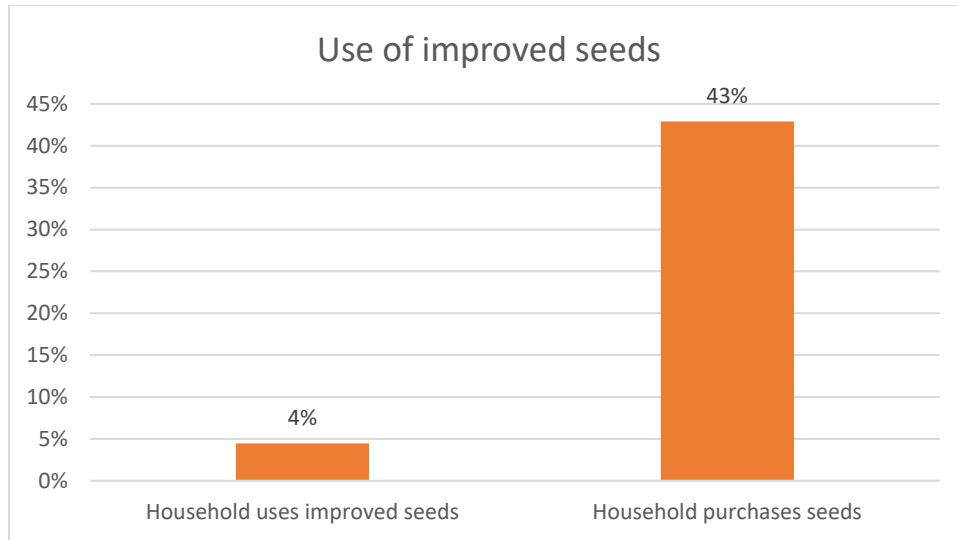


Figure 7. Use of improved seeds and incidence of purchase seeds

5. Labor utilization

Farming households use a combination of family labor and hired labor. A critical complement to land in the agricultural production process is labor. On average, more than 80 percent of Farming households report using hired/Kuu labor (

Table 8). Some differences emerge across counties.

The share of households using hired/Kuu labor range from 58 percent in Montserrado to 98 percent in Lofa. In general, hired/Kuu labor is mostly used for land clearing and planting activities. However, in Lofa County, a high level (in term of share of households) of use of hired/Kuu labor is observed for all farming activities.

The share of female⁸ labor in agriculture is nearly 50 percent at national level showing a high engagement of female in agriculture.

Table 8. Labor utilization

Counties	Share of households using hired/Kuu labor	Share of households using hired/Kuu labor for			Share of female labour in agriculture
		Clearing	Planting	Farm management Harvesting	

⁸ The share of female labor in agriculture is define as the ratio of total amount of female labor (in person-days) to the overall amount of labor use (in person-days)

Bomi	80%	77%	60%	17%	31%	40%
Bong	86%	83%	72%	38%	66%	50%
Grand Bassa	83%	81%	65%	21%	49%	42%
Grand Cape Mount	87%	83%	68%	45%	55%	39%
Grand Gedeh	86%	79%	69%	24%	61%	46%
Grand Kru	78%	72%	68%	31%	53%	50%
Lofa	98%	93%	89%	66%	91%	47%
Margibi	66%	63%	47%	24%	42%	55%
Maryland	84%	79%	67%	38%	45%	43%
Montserrado	58%	56%	34%	14%	34%	41%
Nimba	93%	90%	78%	43%	66%	43%
River Cess	85%	80%	66%	12%	52%	43%
Sinoe	79%	76%	65%	21%	49%	48%
River Gee	85%	80%	64%	31%	47%	48%
Gbarpolu	91%	85%	74%	18%	76%	49%
National	86%	82%	70%	37%	61%	45%

The share of households using hired/Kuu labor increases with the area of land cultivated from 69 percent in the first land quintile to 94 percent in the fifth quintile (*Table 9*). This shows that farming households rely heavily on hired/Kuu labor for crop production regardless the land area cultivated.

Table 9. Distribution of annual agricultural input expenditure and hired labor, by quintiles of land area cultivated

	Land area cultivated quintiles					National
	Q1	Q2	Q3	Q4	Q5	
Share of Households using hired/Kuu labor	69.1%	87.6%	84.0%	92.2%	94.5%	85.9%
<i>Input expenditure</i>						
Seeds	11%	13%	10%	10%	8%	9%
Fertilizer	2.5%	0.5%	0.2%	0.3%	0.2%	0.4%
Pesticide	0.8%	0.0%	0.1%	0.1%	0.1%	0.1%
Labor	86.1%	86.9%	90.1%	89.7%	91.6%	90.2%

Looking at the composition of total input expenditures, we see that hired/Kuu labor is the most important cost items across all land area cultivated quintiles (*Table 9*). This highlights the importance of manpower for agricultural activities in Liberia. It is consistent with the extremely low level of usage of agricultural tools and mechanization (

Table 10). Most households appear to only own hoes and cutlass. There was less than 1 percent of households reporting owning tractor even in the top land quintile. The ownership of axe is relatively high ranging from 42 percent in the first quintile to 78 percent in the fifth quintile

Table 10. Share of households owning agricultural assets, by quintiles of land area cultivated

	Land area cultivated quintiles					National
	Q1	Q2	Q3	Q4	Q5	
Hand Hoe	83.0%	84.2%	85.7%	89.9%	91.8%	87.2%
Cutlass	94.7%	95.2%	95.2%	97.7%	99.0%	96.5%
Shovel	32.4%	30.4%	36.6%	35.1%	46.4%	36.8%
Digger	28.6%	26.8%	23.5%	26.8%	32.4%	27.9%
Axe	41.6%	60.3%	58.3%	61.0%	77.7%	60.7%
Rake	17.9%	16.3%	18.4%	15.5%	23.3%	18.6%
Filing / File	50.1%	58.8%	53.7%	57.7%	65.8%	57.6%
Whipper/Wipper	15.0%	5.8%	9.4%	10.4%	11.1%	10.5%
Wheel Barrow	10.5%	6.7%	5.9%	4.6%	8.6%	7.4%

Tractor	0.0%	0.1%	0.3%	0.0%	0.0%	0.1%
Saw/Powersaw	0.5%	0.2%	0.6%	1.2%	2.1%	1.0%
Hand-powered Sprayer	1.7%	0.5%	1.4%	0.6%	1.7%	1.2%
Thresher/Sheller	0.0%	0.1%	0.5%	0.0%	0.0%	0.1%
Mill/Grinder	0.8%	0.2%	1.0%	0.1%	0.5%	0.5%
Grater	4.2%	6.9%	2.8%	3.9%	5.4%	4.6%
Watering can/ bucket	19.5%	12.3%	14.1%	12.8%	16.3%	15.2%
Pingalay	10.1%	18.6%	13.5%	12.0%	25.4%	16.3%
Knives	61.9%	76.6%	73.2%	75.0%	80.9%	73.8%
Other	1.0%	1.4%	1.3%	1.0%	2.0%	1.3%

As farm labor demand is time sensitive to the crop cycle,

Table 11 shows agricultural labor used on the household's cultivated farm for different phases of the crop cycle: clearing, planting, farm management (weeding, fertilizing, fencing and caretaking) and harvesting. The table also shows the average number of days that men, women and under 14 laborers spend on family labor and hired/Kuu labor during the 2016 agricultural season. Panel A shows hired labor; most of the hired labor occurs during the clearing phase and at harvest time.

Panel B in

Table 11 shows the number of day household members worked in household agricultural production. The patterns are similar to hired/ Kuu labor for land clearing and planting. Overall, males are more engaged in land clearing activities, while female labor is mostly used for planting, managing and harvesting (

Table 11).

Table 11. Agricultural labor

	Land area cultivated quintiles					National mean/sd
	Q1 mean/sd	Q2 mean/sd	Q3 mean/sd	Q4 mean/sd	Q5 mean/sd	
<i>Panel A: Hired/Kuu labor</i>						
<i>Clearing</i>						
Number of days--Men	18.28	25.63	34.12	40.57	56.52	36.39
	47.26	33.29	51.74	58.43	87.24	62.32
Number of days--Women	0.78	1.04	1.41	2.27	1.94	1.53
	5.27	5.30	5.72	11.14	7.63	7.48
<i>Planting</i>						
Number of days--Men	3.47	3.84	9.89	8.37	16.41	8.91
	17.51	11.03	34.31	23.01	52.61	33.39

	Land area cultivated quintiles					National
	Q1	Q2	Q3	Q4	Q5	
	mean/sd	mean/sd	mean/sd	mean/sd	mean/sd	
Number of days--Women	8.19	15.12	19.54	25.67	31.71	20.78
	16.31	26.17	31.71	39.04	61.03	40.65
<i>Farm management</i>						
Number of days--Men	1.68	2.65	5.50	4.99	9.54	5.16
	7.95	9.78	16.82	16.26	26.81	17.89
Number of days--Women	3.72	6.20	7.51	9.10	15.46	8.82
	15.71	32.66	26.47	30.76	83.16	47.69
<i>Harvesting or store preparation</i>						
Number of days--Men	3.72	6.68	10.22	14.20	21.71	11.98
	23.34	33.78	31.53	43.59	70.47	46.21
Number of days--Women	8.03	19.75	23.48	34.03	39.50	25.86
	21.35	49.32	50.21	82.69	94.14	68.25
Panel B: Household labor						
<i>Clearing</i>						
Number of days--Men	10.31	18.49	23.59	30.62	34.37	24.16
	17.58	24.76	32.70	42.43	44.84	36.02
Number of days--Women	5.65	9.45	7.56	8.19	11.47	8.58
	11.74	19.76	15.32	17.93	25.27	19.03
Number of days--Under 14 laborers	1.59	2.72	4.81	2.54	4.02	3.17
	7.30	11.42	14.15	11.86	15.59	12.60
<i>Planting</i>						
Number of days--Men	6.92	10.86	12.68	14.65	21.16	13.71
	10.00	15.23	20.49	21.18	28.98	21.41
Number of days--Women	11.27	17.25	18.02	21.34	26.46	19.29
	12.38	19.47	21.08	25.05	32.42	24.26
Number of days--Under 14 laborers	2.30	3.76	6.17	4.07	8.87	5.24
	6.68	10.38	16.33	11.51	19.26	14.14
<i>Farm management</i>						
Number of days--Men	9.81	16.74	18.16	23.15	30.51	20.30
	20.86	28.54	35.28	43.41	62.94	43.14
Number of days--Women	14.15	19.55	20.64	23.84	28.39	21.71
	26.18	29.37	31.16	38.21	49.50	37.18
Number of days--Under 14 laborers	4.17	5.94	8.63	5.86	9.59	6.97
	21.04	22.20	32.87	27.96	25.57	26.33
<i>Harvesting or store preparation</i>						
Number of days--Men	11.49	17.69	19.93	27.15	35.70	23.21
	18.20	22.95	27.88	40.62	50.07	36.39
Number of days--Women	14.70	21.47	23.02	29.64	34.60	25.28
	19.41	23.89	25.12	33.36	43.81	32.17
Number of days--Under 14 laborers	3.93	5.94	8.47	7.75	11.19	7.67
	14.02	16.43	24.10	21.23	27.33	21.75

Labor inputs by household members who are men are higher on plots controlled by men; female labor and under 14 household labor are more intensively used on plots controlled by women (*Figure 8*)

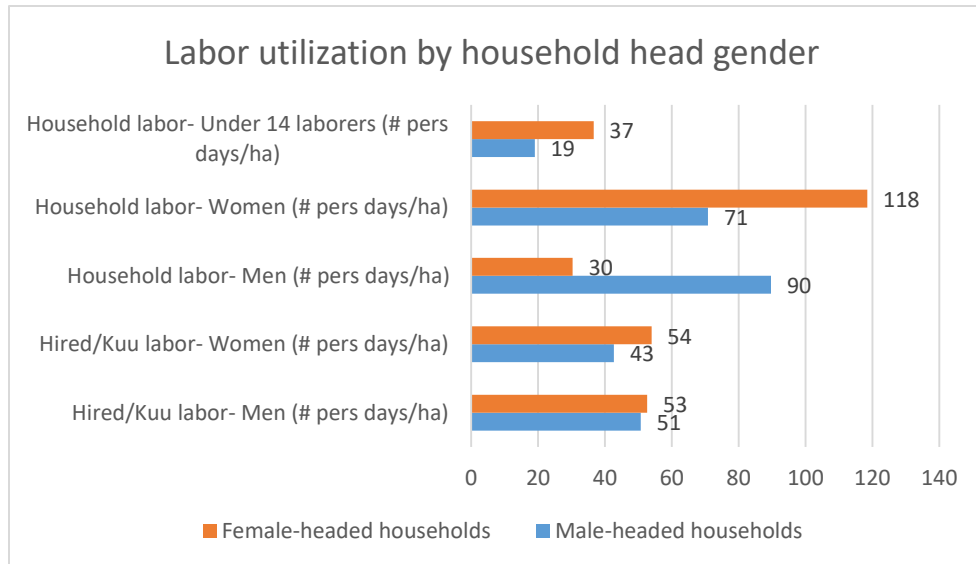


Figure 8. Labor utilization by household head gender

6. Crop production and sales

6.1 Household crop portfolio

Farming households in Liberia diversify their crop production. During the 2016 agriculture season, Farming households grew on average of 3 different types of crops. In *Figure 9*, we present the percentage of household reporting growing each type of crop to show the diversification of household crop portfolio.

Cassava and rice are the main crops grown by Farming households (they account for 74 percent of households' crop portfolio each). Vegetables growing are also important (60% of the crop portfolio). The share of households growing corn is 34 percent. Permanent cash crops are grown by 33 percent of households while only 27 percent of households grow fruits (Banana, Papaw/Papaya, Pineapple, Plantain etc) and 20 percent grow other tuber or roots (Eddoes, Ginger, Irish potatoes, Onions, Sweet Potatoes and Yams). These figures vary

minimally across counties. Some statistical significant gap between male-headed households and female-headed households emerge in term of incidence of crop cultivation (Appendix 2).

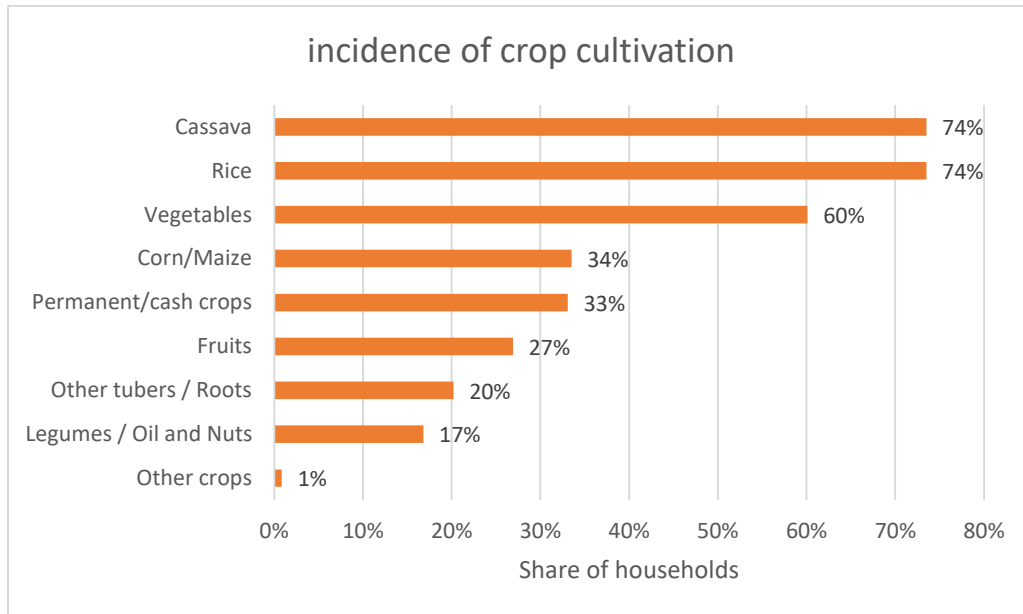


Figure 9. Incidence of crop cultivation by household

The estimated number of farming households growing each type of crop across counties is presented in the tables below.

Table 12 shows that banana and plantain growers are concentrated in Nimba, Lofa, Montserrado and Bong Counties while Montserrado and Bong Counties are home of Papaya growers.

There is a high number of farming households growing vegetables across counties. Only few households reported growing permanent cash crops (Table 14). Coffee is mostly produced in Lofa and Nimba Counties

Table 12. Number of farming households engaged in fruits production by county (Top 4 fruits only)

County	Total number of farming households	Banana	Papaw/Papaya	Pineapple	Plantain
Bomi	12 498	640	294	626	891
Bong	53 885	3 583	1 735	3 147	6 790
Grand Bassa	22 294	2 225	28	1 826	4 013
Grand Cape Mount	23 444	1 043	113	1 704	1 686
Grand Gedeh	8 956	1 406	358	914	2 400
Grand Kru	7 725	834	19	470	1 985
Lofa	38 883	6 960	696	2 364	8 632
Margibi	15 668	931	307	436	2 068
Maryland	5 677	800	102	255	1 476
Montserrado	17 061	4 555	5 135	3 020	7 336
Nimba	74 658	9 183	580	4 763	18 888
River Cess	8 491	951	110	701	3 014
Sinoe	9 874	2 044	82	879	3 347
River Gee	5 741	752	21	268	1 326
Gbarpolu	7 459	783	80	1 014	1 872
Total	312 314	36 691	9 659	22 387	65 726

Table 13. Number of farming households engaged in vegetable production by county (Top 6 vegetables only)

County	Total number of farming households	Bitterballs	Cucumber	Egg Plant	Okra	Pepper	Pumpkins
Bomi	12 498	4 837	1 837	2 050	3 324	4 787	1 675
Bong	53 885	14 926	7 436	1 579	11 962	21 716	5 927
Grand Bassa	22 294	8 561	2 408	1 175	4 637	8 762	1 208
Cape Mount	23 444	12 027	3 728	8 041	7 197	11 792	2 173
Grand Gedeh	8 956	3 851	419	1 729	2 902	4 684	1 102
Grand Kru	7 725	3 693	1 344	2 480	3 554	4 341	2 202
Lofa	38 883	20 841	9 876	2 737	12 754	25 118	4 394
Margibi	15 668	5 123	616	1 261	4 371	5 546	1 896
Maryland	5 677	2 316	367	1 760	1 720	2 384	835
Montserrado	17 061	7 268	961	942	2 952	4 999	1 535
Nimba	74 658	26 653	8 436	3 882	23 592	31 282	7 615
River Cess	8 491	4 500	1 138	717	3 167	4 619	951
Sinoe	9 874	3 594	1 679	2 202	3 476	4 542	2 083
River Gee	5 741	3 370	660	2 124	2 113	3 255	1 424
Gbarpolu	7 459	4 050	1 417	955	1 604	4 572	977
Total	312 314	125 611	42 321	33 634	89 324	142 400	35 997

Table 14. Number of farming households engaged in cash crops production by county

County	Total number of farming households	Cocoa	Coffee	Oil Palm	Rubber	Sugar Cane
Bomi	12 498	137	-	307	1 187	204
Bong	53 885	1 304	-	164	8 083	5 265
Grand Bassa	22 294	829	-	-	2 631	3 567
Grand Cape Mount	23 444	237	86	1 620	1 744	326
Grand Gedeh	8 956	1 281	39	76	134	18
Grand Kru	7 725	96	-	18	462	125
Lofa	38 883	10 421	10 965	1 485	278	1 170
Margibi	15 668	-	-	-	1 141	1 598
Maryland	5 677	-	-	36	642	999
Montserratado	17 061	363	-	998	-	2 423
Nimba	74 658	17 097	3 151	7 690	21 875	8 660
River Cess	8 491	276	-	132	709	194
Sinoe	9 874	-	-	115	101	227
River Gee	5 741	855	-	41	185	175
Gbarpolu	7 459	454	-	38	449	174
Total	312 314	33 350	14 240	12 719	39 620	25 125

The prevailing cropping system is intercropping. An average of 69 percent of the cultivation is intercropped while only 31 percent is monocropped (*Figure 10*).

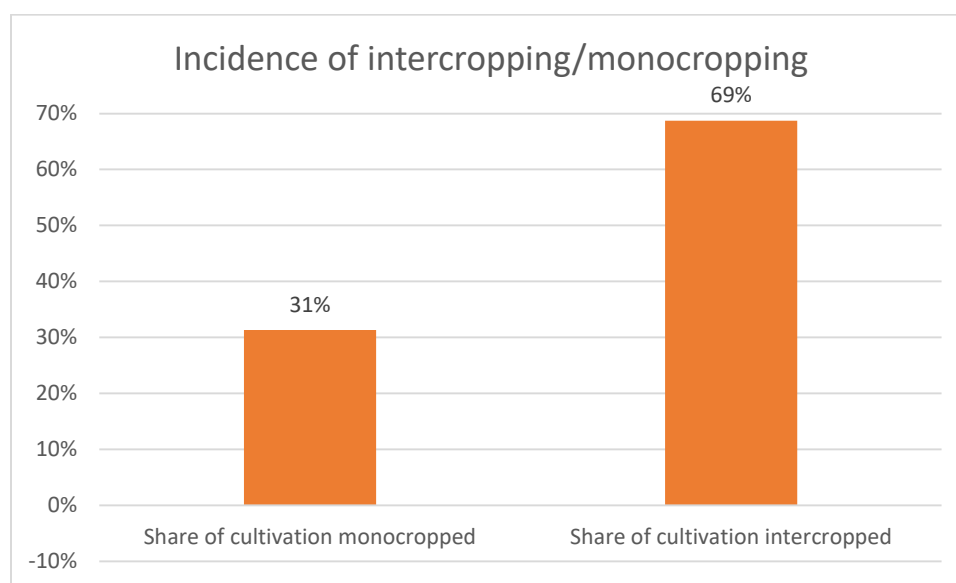


Figure 10. Incidence of intercropping/monocropping

The main reason for intercropping is related to cultural practice (Figure 11). Cultural practice is reported by nearly 80 percent of farming households as the main reason of intercropping. Substitute if either crop fails is the main reason for intercropping for only 13 percent of farming households. This implies that intercropping is less used as risk management strategy at farm level.

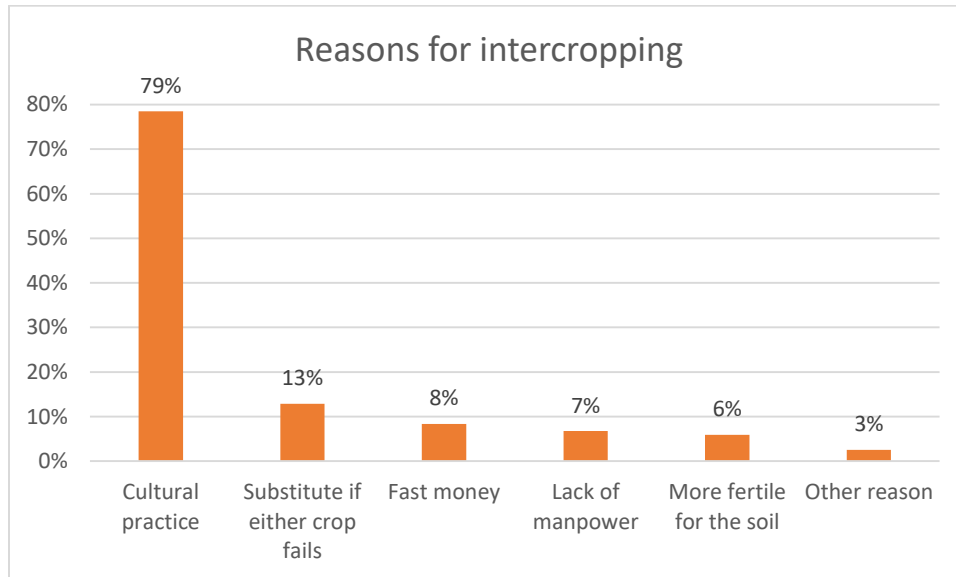


Figure 11. Reasons for intercropping

6.2 Productivity of crops

In rming in Liberia

Table 15, we show the total production of crop by land cultivated quintiles. The table shows large heterogeneity among farming households. While the average harvest is close to 2 tons par household at national level, the total production of farmers at the top land cultivated quintile (16 percent in total) is 2.4 times the total production of those at the bottom quintile. The total production per capita raise with the land quintile. The average production per capita is less than 0.5 ton at national level.

The total production per hectare decreases with the land cultivated quintile. This is consistent with the inverse relationship between yield and farm size in developing countries found in the literature. The low level of output reported by farming households in 2016 denote the prevalence of subsistence farming in Liberia

Table 15. Total production of crop by land cultivated quintiles

	Land area cultivated quintiles					National
	Q1	Q2	Q3	Q4	Q5	
	mean/sd	mean/sd	mean/sd	mean/sd	mean/sd	mean/sd
Total production (kg)-all crops	758	1368	1721	2066	3247	1829
	857	1491	2851	2333	4123	2711
Total production per ha	1225	776	2903	512	451	1172
	1784	1198	2753	727	749	1236
Total production in kg per capita	239	357	448	523	698	452
	345	468	763	615	987	690

As shown in the section above, rice and cassava are the most cultivated crops throughout the country. The estimates of production of rice and cassava are shown in

Table 16 and Table 17 below. Of note that the figures in those tables are based on farmer estimate. The average yield of rice is 1.26 Metric Ton (MT) per hectare at national level and cassava yield is estimated at 5.28 Metric ton per hectare.

Table 16. Estimated production of rice (based on farmer estimate)

County	Number of farming households	Average area per household (Ha)	Average yield / ha (MT)	Average yield/ household (MT)	Total Production (MT)
Bomi	12 498	0.85	1.26	1.07	13 413
Bong	53 885	0.85	1.26	1.07	57 830
Grand Bassa	22 294	0.85	1.26	1.07	23 926
Grand Cape Mount	23 444	0.85	1.26	1.07	25 160
Grand Gedeh	8 956	0.85	1.26	1.07	9 612
Grand Kru	7 725	0.85	1.26	1.07	8 291
Lofa	38 883	0.85	1.26	1.07	41 730
Margibi	15 668	0.85	1.26	1.07	16 815
Maryland	5 677	0.85	1.26	1.07	6 093
Montserrado	17 061	0.85	1.26	1.07	18 310
Nimba	74 658	0.85	1.26	1.07	80 124
River Cess	8 491	0.85	1.26	1.07	9 113
Sinoe	9 874	0.85	1.26	1.07	10 597
River Gee	5 741	0.85	1.26	1.07	6 161
Gbarpolu	7 459	0.85	1.26	1.07	8 005
Total	312 314				335 179

Source: HIES, 2016

Table 17. Estimated production of cassava (based on farmer estimate)

County	Number of farming households	Average area per household (Ha)	Average yield / ha (MT)	Average yield/ household (MT)	Production (MT)
Bomi	12 498	0.39	5.68	2.23	27 916
Bong	53 885	0.39	5.68	2.23	120 361
Grand Bassa	22 294	0.39	5.68	2.23	49 797
Grand Cape Mount	23 444	0.39	5.68	2.23	52 366
Grand Gedeh	8 956	0.39	5.68	2.23	20 005
Grand Kru	7 725	0.39	5.68	2.23	17 255
Lofa	38 883	0.39	5.68	2.23	86 852
Margibi	15 668	0.39	5.68	2.23	34 997
Maryland	5 677	0.39	5.68	2.23	12 681
Montserrado	17 061	0.39	5.68	2.23	38 109

Nimba	74 658	0.39	5.68	2.23	166 761
River Cess	8 491	0.39	5.68	2.23	18 966
Sinoe	9 874	0.39	5.68	2.23	22 055
River Gee	5 741	0.39	5.68	2.23	12 823
Gbarpolu	7 459	0.39	5.68	2.23	16 661
Total	312 314				697 604

Source: HIES, 2016

While the yields per hectare varies among counties, the national average has been used to estimate the total production to be consistent with FOA methodology. The estimated total production of rice and fresh cassava for 2016 is estimated at 335,179 MT and 697,604 MT respectively.

6.3 Gender gap in rice productivity

In order to explore the gender gap in rice productivity, we estimate a production function at household level using the equation below:

$$\ln Y_i = \alpha_0 + \alpha_1 \text{Gender}_i + \alpha_2 H_i + \beta P_i + \gamma L_i + \delta w_i + \varepsilon$$

Where Y_i is the i^{th} household rice yield in kilogram per hectare, Gender_i is a dummy variable for the sex or for the sex or gender of the household head, H_i is the household head characteristics (age, year of schooling, year of schooling, access to extension services dummy), P_i is a vector of land, capital, and other conventional other conventional inputs, L_i is labour input (hired/Kuu or family), w_i is a vector of household household characteristics and ε is the error term. The analysis presented here has been done at household level. at household level. The results of the regression are presented in

Table 18. The independent variables include in the regression are selected based on the empirical literature. The rationale behind the inclusion of each of the independent variable can be found in Aguilar et al. (2015), Karamba and Winter (2015) and Slavchevska (2015). The

Table 18 shows that households head age and access to agricultural implement display a positive effect on rice productivity. As usually found in the literature, land area cultivated has a negative effect on rice productivity.

Table 18. Regression Results on Gender Differences in rice Productivity

	(1) Log [Rice yield kg/ha]	(2) Log [Rice yield kg/ha]
Female headed households	-0.133* (0.0742)	-0.213*** (0.0795)
Household head Characteristics		
Household head age		0.00351* (0.00188)
HH head years of schooling		-0.00310 (0.00657)
HH has access to extension services		0.160 (0.147)
Land Tenancy		

	(1) Log [Rice yield kg/ha]	(2) Log [Rice yield kg/ha]
Log [HA]- total size		-0.476*** (0.0583)
Number of farms per HH		0.252*** (0.0372)
Privately owned		0.130 (0.146)
Rented		0.335 (0.265)
Farming as a tenant		-0.0497 (0.230)
Farm Characteristics		
Share of cultivation intercropped		-0.0336 (0.0876)
Time to walk from the farm to HOME		0.000120 (0.000914)
Time to walk from the farm to MAIN ROAD		-0.000310 (0.000478)
Time to walk from the farm to MARKET		0.000367 (0.000301)
Household's Agricultural Non-Labor Input Use		
Farms use (% of Total)		
Irrigation		-0.134 (0.185)
Organic fertilizer		0.683*** (0.211)
Chemical fertilizer		-0.0723 (0.568)
Pesticide		0.104 (0.350)
Household Uses improved seeds		-0.0735 (0.163)
Quantity of chemical fertilizer per ha (kgs/Ha)		0.0163 (0.0131)
Agricultural Implement Access Index		0.106*** (0.0383)
Household's Agricultural Labor Input Use		
Household labor- Men (# pers days/ha)		-0.000746* (0.000400)
Household labor- Women (# pers days/ha)		0.000276 (0.000396)
Household labor- Under 14 laborers (# pers days/ha)		0.0000963 (0.000627)
Hired/Kuu labor per ha (# pers days)		0.000555***

	(1)	(2)
	Log [Rice yield kg/ha]	Log [Rice yield kg/ha]
		(0.000153)
Household Characteristics		
Log [Consumption (LD)]		0.105 (0.0675)
Household size		-0.0284 (0.0178)
Dependency ratio		-0.0427 (0.0351)
HH sold more than half of production		-0.431*** (0.0987)
Shocks		
HH reported pre-harvest loss		0.152* (0.0857)
Constant	6.178*** (0.0772)	4.776*** (0.760)
County fixed effect	Yes	Yes
Observations	3029	2831

*Note: Standard errors are in parentheses. The superscripts ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.*

The gender productivity gap measures are derived from the regression above (Figure 12). The unconditional gap is derived from model (1) whereas the conditional gap is derived from model (2). The unconditional gap constitute the difference in the rice productivity measured in kg per hectare between male-headed households and female-headed households. However, this unconditional gender gap does not take into account the fact that, on average, female-headed households work on smaller plots than male-headed households. Also other factors affect productivity that we control for in the conditional gap estimate. As shown in Figure 12, the unconditional gap is 12 percent. As expected, the conditional gap is higher, 19 percent on average. The differences are statistically significant. This suggests that on average, rice farm households headed by females are 19 percent less productive than their males counterparts.

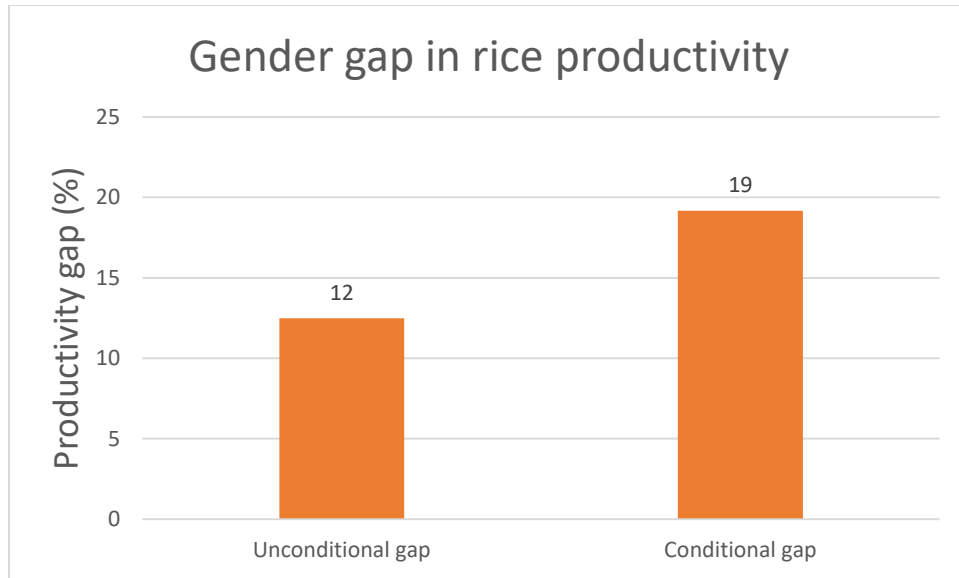


Figure 12. Gender gap in rice productivity

6.4 Effects of the Ebola crisis on rice farming

In this section, we analyse the effect of the Ebola crisis in rice farming. Figure 13 shows the effect of the Ebola crisis on each farming activity. The main effect is that 52 percent of farming households did not make rice farm during the Ebola crisis. Of the 48 percent of farming households that made rice farm, 24 percent reported that the Ebola crisis affected land clearing and planting. Only 2 percent of those who made rice farming did apply fertilizer during the Ebola crisis. This figure is close to normal situation (see section 3) and so, there is no evidence that the Ebola crisis affected fertilizer application. Around 3 percent of farming household that made rice farm during the Ebola crisis did not harvest any portion of their rice. On average, 17 percent of farming households harvested their rice later than usual due to the Ebola crisis.

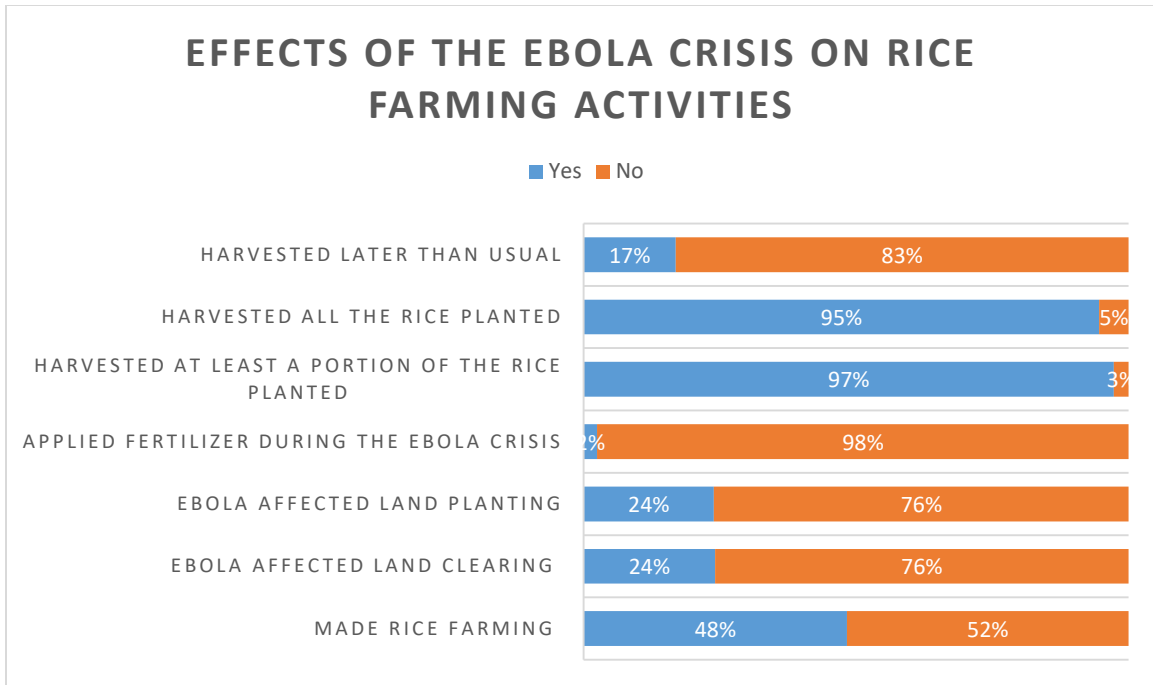


Figure 13. Effects of the Ebola crisis on rice farming activities

Of the 52 percent of farming households that did not make rice farm during the Ebola crisis, 47 percent reported that they were doing other activities (Figure 14).

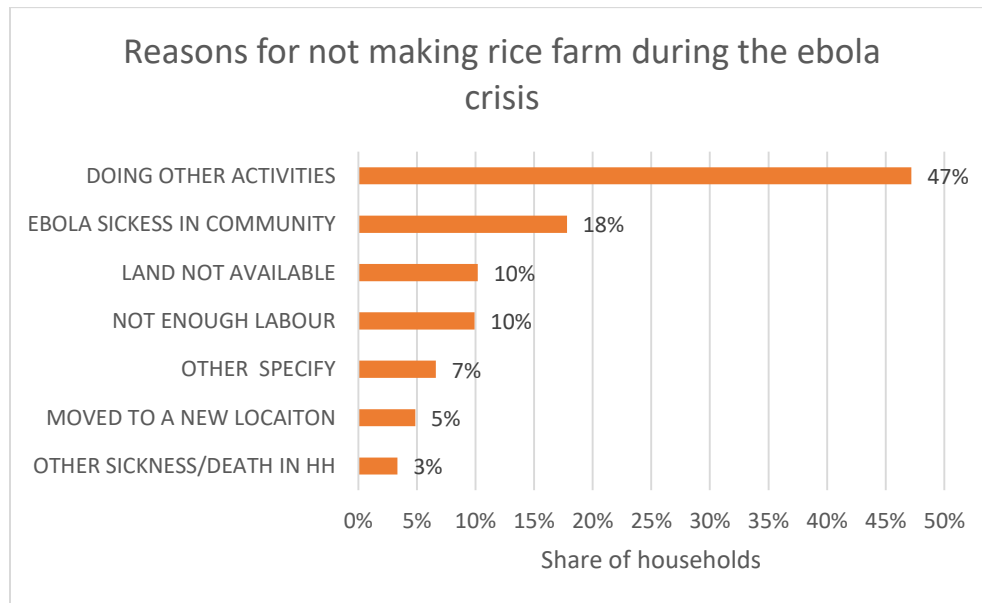


Figure 14. Reasons for not making rice farm during the Ebola crisis

For 18 percent of farming households, Ebola sickness in community was the reason that prevented them from making rice farm. The availability of land and labor were the reasons for not making rice farm for 10 percent of farming households

As show in Figure 15, farming households reported that the Ebola crisis affected land clearing mainly because they could not clear as much land due to the Ebola (78 percent). For 14 percent of farming households, the land clearing took much longer due to the Ebola crisis potentially because of the unavailability of kuu labor.

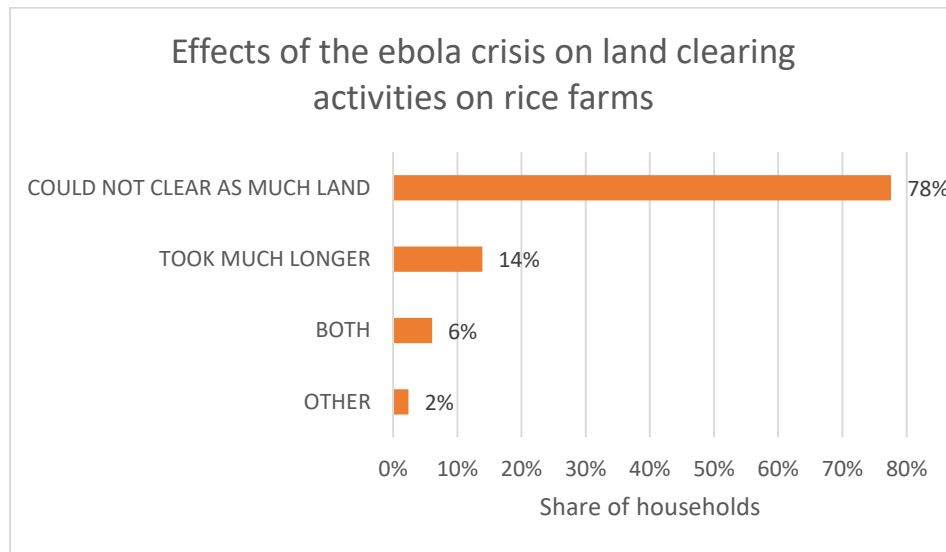


Figure 15. Effects of the Ebola crisis on land clearing activities on rice farms

Nearly two third of farming households that made rice farm planted less area than usual due to the Ebola crisis (Figure 16). On average 35 percent of them planted later than usual. Close to 30 percent of farming households reported that, the Ebola has affected their crop diversification (planted fewer crops).

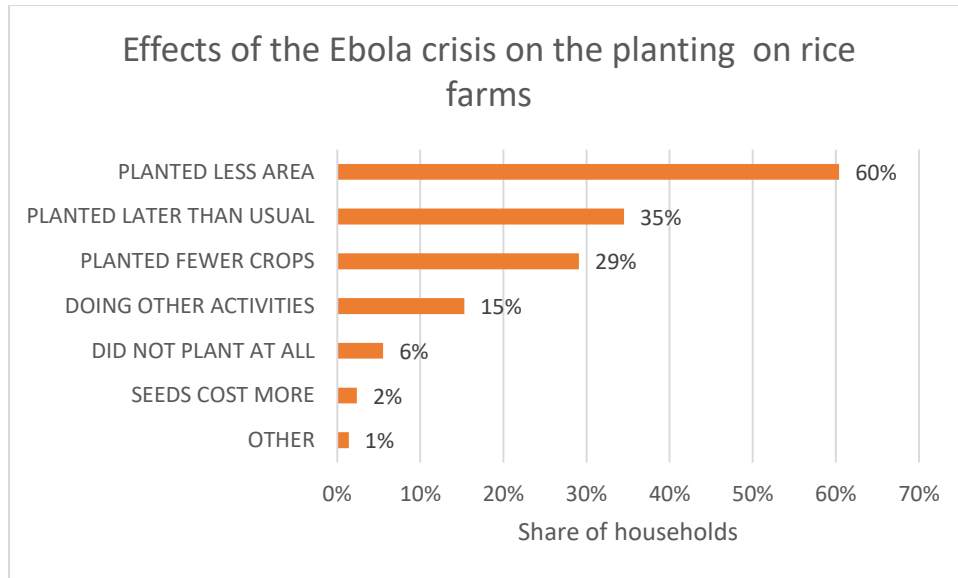


Figure 16. Effects of the Ebola crisis on the planting on rice farms

The main reason why most farming household did not apply chemical fertilizer during the Ebola crisis is that it is not necessary (Figure 17). This reinforce our claim that the Ebola crisis did not have much impact on fertilizer application. Only 22 percent of farming households did not apply chemical fertilizer on rice farms because it was not available. For 7 percent of farming households, they did not apply chemical fertilizer on their rice farms because it was too expensive.

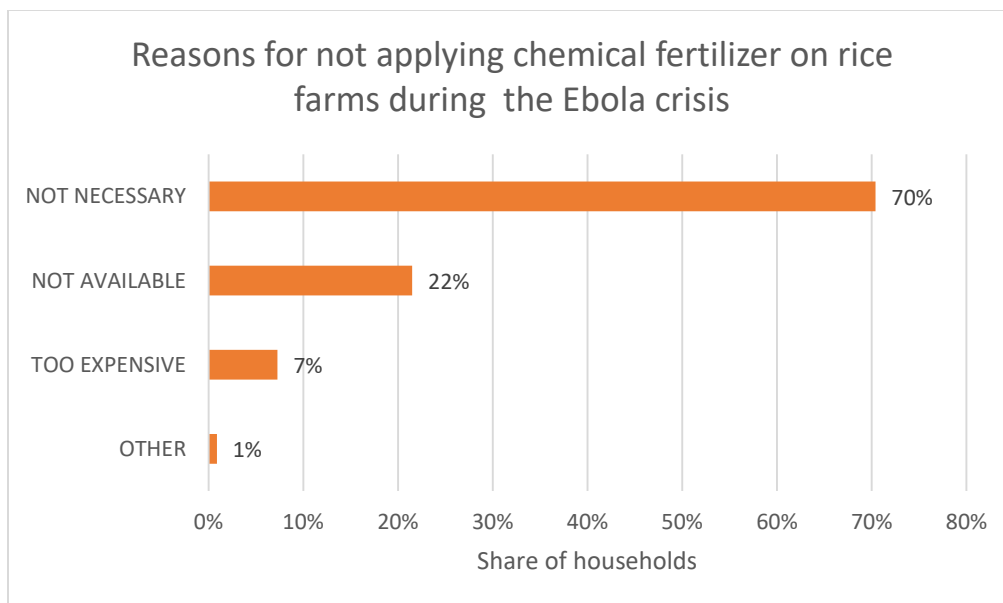


Figure 17. Effects of the Ebola crisis on chemical fertilizer application on rice farms

The Ebola crisis has also some effects on rice harvesting activity. In fact, one third of farming households that made rice farm during the Ebola crisis did not harvest all the rice planted because labor was not available (Figure 18). Ebola sickness in community was the main reason for not harvesting all the rice planted for half of the farming households that make rice farm. The labor price was also a challenge for 18 percent of them.

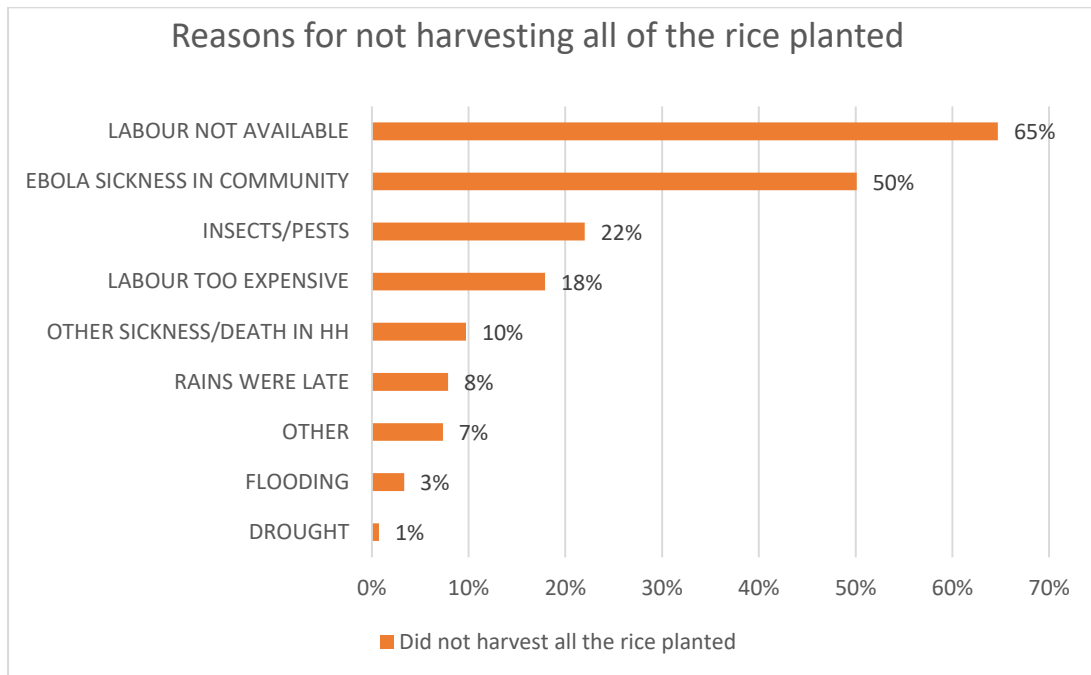


Figure 18. Effects of the Ebola crisis on rice harvesting

Close to three fourth of farming household that made rice farm reported that they harvested later than usual du the unavailability of labor du to the Ebola crisis (Figure 19).

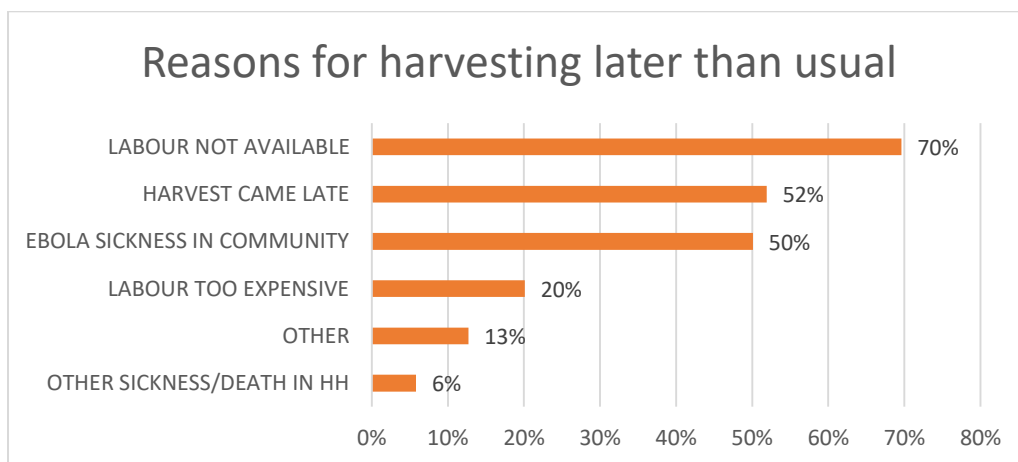


Figure 19. Effects of the Ebola crisis on the timing of rice harvesting

The harvest came late for 52 percent of farming households potentially because the Ebola crisis has delay their planting.

Looking at the reason for not selling crops output in the Figure 20 below, the Ebola crisis seems to have limited impact on the sales of crops. The vast majority of farming household did not sell crop output during the Ebola crisis because they either wanted to have more food in store or did not harvest enough to sell. Less than one third of farming households reported that they did not sell crop output because it is too risky to go to market and 10 percent reported that the market was closed.

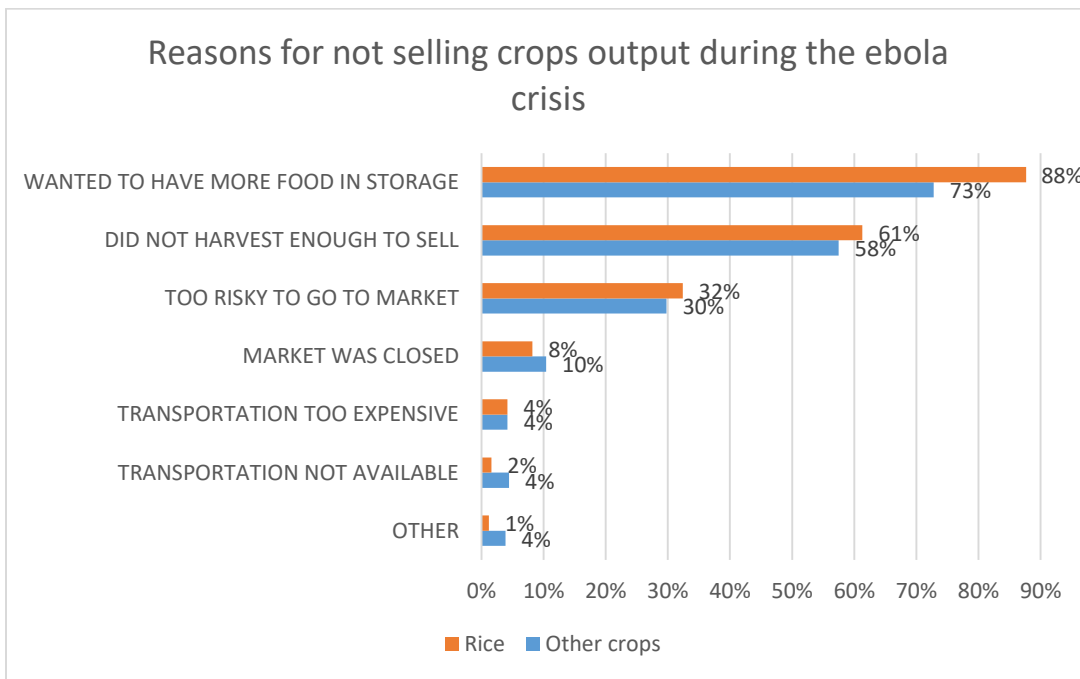


Figure 20. Reasons for not selling crops output during the Ebola crisis

6.5 Crop commercialization

Rice and cassava production is mainly for home consumption for the vast majority of Farming households. Only 12 percent of rice growers and 37 percent of cassava growers report selling a portion of their harvest (*Figure 21*). This is close to the incidence of sales of crops during the Ebola crisis report in *Figure 22*.

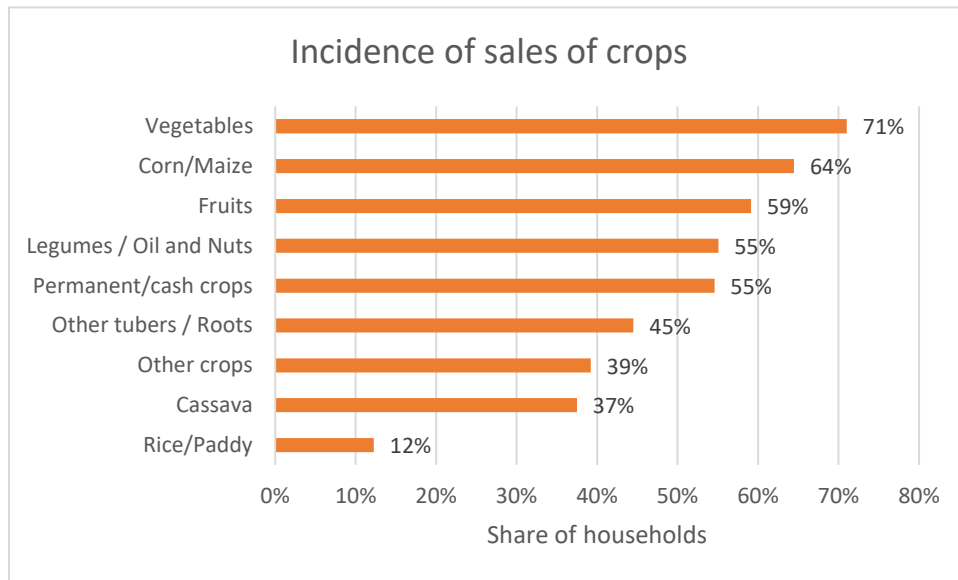


Figure 21. Incidence of sales of crops

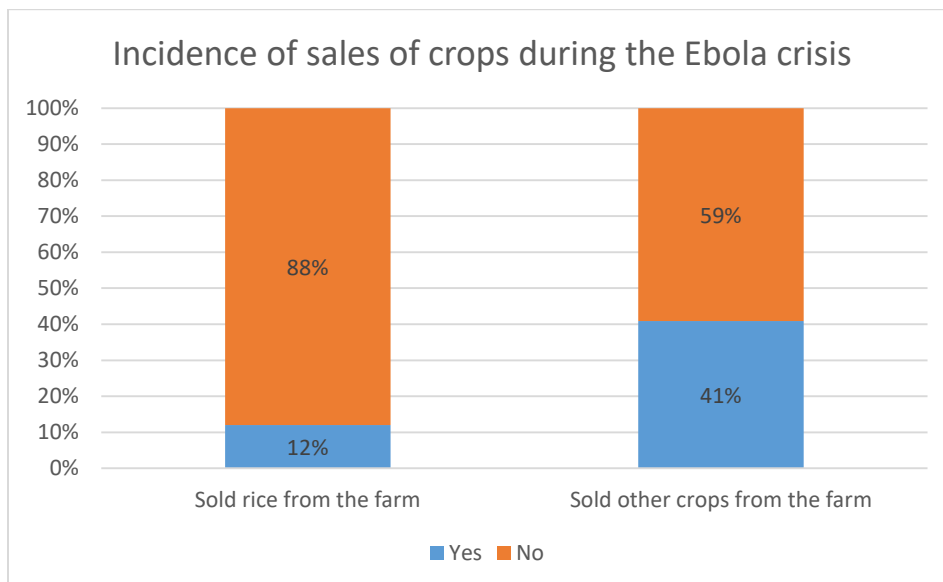


Figure 22. Incidence of sales of crops during the Ebola crisis

The breakdown of the incidence of sales of rice and cassava by county is presented in *Table 19* below. Gbapolu and Lofa counties have a relatively higher share of households reporting selling a portion of their rice production (33 and 26 percent respectively). More than half of farming households in Bomi, Grand Gedeh and Lofa counties reported selling a portion of their cassava production.

Table 19. Incidence of sales of rice and cassava by county

Incidence of sales of crops (share of households)		
County	Rice	Cassava
Bomi	10%	56%
Bong	9%	39%
Grand Bassa	7%	49%
Grand Cape Mount	3%	25%
Grand Gedeh	19%	54%
Grand Kru	10%	39%
Lofa	26%	52%
Margibi	5%	29%
Maryland	6%	46%
Montserrado	0%	35%
Nimba	10%	27%
River Cess	9%	43%
Sinoe	17%	44%
River Gee	10%	48%
Gbarpolu	33%	45%
National	12%	37%

Agriculture sector in Liberia is characterized by a fair level of commercialization⁹.

Nearly three in four farming households sold a portion of their harvested crops (*Figure 23*) while an average of 27 percent of farming households are fully subsistence oriented. Only one

⁹ To analysis the degree of Farming households' engagement with the market, we measure the relative portion of agriculture production effectively sold on the market. This indicator known as household commercialization index was introduced by Strasberg et al (1999) and Govereth et al (1999) and seemed to be one of the most objectives to measure the intensity of household engagement with the market. Household commercialization index (HCI) is defined as the ratio of gross value of crop sales and gross value of all crop production. $HCI = \left[\frac{\text{Gross value of crop sales (in LD)}}{\text{Gross value of all crop production (in LD)}} \right] \times 100$. The index measures the extent to which household crop production is oriented toward the market. A value of zero would signify a totally subsistence oriented household and the closer the index is to 100, the higher the degree of commercialization.

fourth of households sold more than 50 percent of their production and the national average share of sales over total production (all crops combined) is 26 percent. The share of sales over total production varies minimally across counties (Table 20).

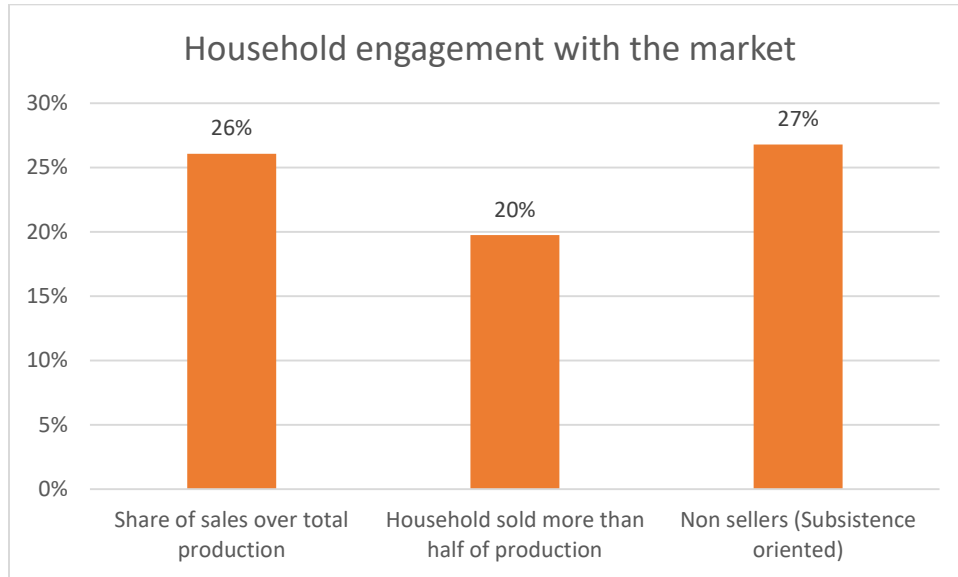


Figure 23. Household engagement with the market

The share of crop output sold raise with the land area cultivated only between 4 and 6 hectares (Figure 24). This suggests that there is no linear relationship between land area cultivated and the level of household’s engagement in the market.

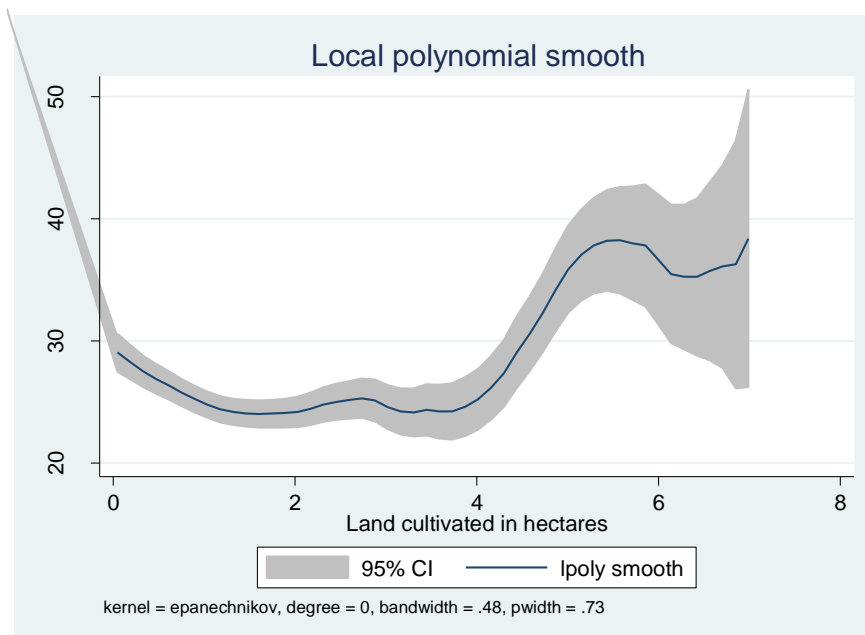


Figure 24. Local linear non-parametric regression of crop commercialization on land cultivated area

Table 20. Share of sales of crop over total production

County	Rice/ Paddy	Corn/ Maize	Cassava	Other tubers / Roots	Legumes / Oil and Nuts	Fruits	Vegetables	Permanent cash crops	Total
Bomi	5%	48%	46%	29%	24%	42%	45%	37%	37%
Bong	3%	46%	28%	20%	26%	64%	52%	66%	28%
Grand Bassa	1%	47%	34%	48%	74%	67%	52%	35%	24%
Grand Cape Mount	1%	46%	23%	20%	29%	38%	42%	29%	19%
Grand Gedeh	7%	52%	39%	39%	26%	42%	48%	88%	20%
Grand Kru	2%	42%	31%	26%	70%	47%	41%	69%	18%
Lofa	7%	40%	41%	35%	48%	55%	44%	88%	28%
Margibi	1%	49%	24%	12%	47%	45%	38%	39%	22%
Maryland	1%	28%	32%	34%	3%	47%	32%	21%	21%
Montserrado	0%	57%	29%	31%	48%	43%	51%	16%	39%
Nimba	3%	32%	24%	42%	42%	62%	45%	74%	26%
River Cess	2%	42%	25%	43%	43%	58%	46%	58%	20%
Sinoe	4%	41%	28%	35%	37%	47%	45%	42%	23%
River Gee	4%	42%	36%	27%	19%	50%	36%	79%	18%
Gbarpolu	9%	40%	32%	40%	30%	41%	47%	83%	23%
National	4%	42%	29%	33%	41%	54%	46%	67%	26%

7. Livestock

7.1 Livestock participation and ownership

Agricultural sector in Liberia is characterized by high participation in livestock activity. Nearly 50 percent of Farming households reported participating in livestock activity (Table 21). The participation rate raise with household wealth from 41 percent for the poorest households (first quintile) to 49 percent for the richest households (fifth quintile). We observed that the poor keep mainly poultry and relatively wealthier households keep more small and large ruminants.

Table 21. Livestock participation by wealth quintiles

	<i>Per capita expenditure quintiles- Farming households</i>					
	Q1(Poorest)	Q2	Q3	Q4	Q5 (Richest)	Total
Percentage of households with animal holdings	40.6%	41.9%	46.3%	44.2%	48.5%	44.3%
<i>Household owning (Livestock keepers only)</i>						
Cattle	0.4%	0.4%	0.4%	1.0%	0.5%	0.5%
Calf	0.0%	0.1%	0.0%	0.4%	0.1%	0.1%
Sheep/Goats	24.9%	29.6%	30.2%	27.1%	32.2%	28.9%
Goats	20.9%	23.1%	22.9%	21.3%	21.5%	22.0%
Sheep	7.6%	11.4%	9.9%	8.2%	15.3%	10.6%
Pigs	3.9%	3.3%	6.6%	7.3%	4.0%	5.1%
Poultry	89.8%	90.5%	87.0%	90.8%	88.0%	89.2%
Chickens	86.0%	89.9%	86.2%	89.6%	85.5%	87.4%
Ducks	9.8%	9.1%	6.3%	9.8%	13.1%	9.7%
Guinea fowls	0.0%	0.0%	0.0%	1.7%	0.0%	0.4%
Other animals	0.2%	0.0%	0.0%	0.1%	0.5%	0.2%

Female-headed households have lower level of participation in livestock activity than male-headed households (Table 22). When considering livestock keepers only, it clearly appear that female-headed households participle less in sheep and goat rearing than their male counterpart. However, the level of participation in poultry rearing is higher for female-headed households than male-headed household. This is consistent with the figures in the previous table given the fact that female-headed households are in general poorer than male-headed households.

Table 22. Livestock participation by household head gender

	Male-headed households	Female-headed households	T-test
Percentage of households with animal holdings	45.8%	38.3%	**
<i>Household owning (Livestock keepers only)</i>			
Cattle	0.6%	0.4%	
Calf	0.1%	0.1%	
Sheep/Goats	30.2%	22.8%	***
Goats	22.6%	18.8%	***
Sheep	11.3%	7.2%	
Pigs	4.9%	5.9%	
Poultry	88.5%	92.4%	*
Chickens	86.5%	91.6%	**
Ducks	10.1%	7.7%	
Guinea fowls	0.4%	0.0%	
Other animals	0.2%	0.0%	

Note: Asterisks denote significant differences based on t-tests across Male and female-headed household as follows: * significant at 10%; ** significant at 5%; *** significant at 1%.

Herd composition in terms of animal headcounts is analyzed in

Table 23, overall and across Farming household wealth quintiles. The importance of smaller ruminants such as sheep and Goats and poultry is observed across wealth quintiles.

There is a positive correlation between ownership levels and wealth. However, the relationship is not linear for poultry and poorer household have comparative level of ownership to wealthier household. The correlation is somehow linear for Sheep and Goat.

Table 23. Livestock headcounts by wealth quintiles (averages for Livestock keepers only)

<i>Per capita expenditure quintiles- Farming households</i>						
	Q1(Poorest)	Q2	Q3	Q4	Q5 (Richest)	Total
	mean/sd	mean/s d	mean/s d	mean/s d	mean/sd	mean/s d
Livestock--Total count	9.11	10.82	10.36	10.34	10.08	10.15
	8.51	10.24	10.37	11.35	9.97	10.15
Cattle--Count	0.01	0.01	0.03	0.02	0.01	0.02
	0.11	0.15	0.56	0.24	0.19	0.30
Calf--Count	0.00	0.00	0.00	0.01	0.00	0.00
	0.02	0.08	0.00	0.11	0.05	0.06
Sheep/Goats--Count	0.71	1.16	0.97	1.07	1.28	1.04
	1.67	2.73	1.88	2.31	2.98	2.39
Pigs--Count	0.18	0.23	0.45	0.34	0.13	0.27
	1.34	1.51	2.36	1.90	0.88	1.68
Poultry--Count	8.21	9.42	8.92	8.89	8.59	8.81
	8.55	9.93	10.15	10.51	9.37	9.73

In term of livestock headcounts, the only statistical significant difference across gender that is observed is for sheep and goats (Table 24). This means that even if female-headed households have higher participation in poultry rearing, they own on average similar amount as male-headed households do.

Table 24. Livestock headcounts by household head gender (averages for Livestock keepers only)

	Male-headed households		Female-headed households		T-test
	Mean	SD	Mean	SD	
Livestock--Total count	10,23	10,62	9,83	7,57	
Cattle--Count	0,02	0,31	0,01	0,27	
Calf--Count	0,00	0,07	0,00	0,04	
Sheep/Goats--Count	1,07	2,33	0,91	2,64	***
Pigs--Count	0,29	1,82	0,16	0,72	
Poultry--Count	8,83	10,18	8,74	7,35	

Note: Asterisks denote significant differences based on t-tests across Male and female-headed household as follows: * significant at 10%; ** significant at 5%; *** significant at 1%.

7.2 Disease rates and vaccination

Table 25 reports the share of households reporting illness and the share reporting vaccination, among livestock keepers. The reported rates of disease are at an average of 31 percent overall, ranging from 18 percent among the third quintile to 38 percent among the first quintile of per capita expenditure. The vaccination rate is less than 3 percent on average with the second quintile reporting the highest vaccination rate (5 percent).

Table 25. Disease rates and vaccination by wealth quintiles

	<i>Per capita expenditure quintiles- Farming households</i>					Total
	Q1(Poorest)	Q2	Q3	Q4	Q5 (Richest)	
Any disease reported for livestock owned	38.1%	34.0%	18.3%	27.2%	32.1%	31.2%
Any vaccination reported for livestock owned	0.3%	4.6%	0.0%	3.4%	2.8%	2.3%

No statistical significant differences were found across gender for the incidence of livestock disease and vaccination (Table 26).

Table 26. Disease rates and vaccination by household head gender

	Male-headed households	Female-headed households
Any disease reported for livestock owned	30.9%	32.1%
Any vaccination reported for livestock owned	2.4%	1.8%

Conclusion

This report presents basic characteristics of farming household and provide some descriptive statistics on farm characteristics in Liberia, the use of modern input, agricultural productivity, the level of farming households' engagement in the market, the impact of Ebola on rice farming activities and participation in livestock activities.

The report show that most of farming household head in Liberia did not attend school and the nearly totally of those who attend school do not have more than primary education. Access to infrastructure and basic services is problematic for many farming households. The vast majority of them do not have access to clean water, electricity and public garbage collection services.

Agriculture sector in Liberia is dominated by smallholder farmers. The average land cultivated is less than 2 hectare per household and only few households cultivate more than 4 hectares. Female-headed households have less access to land. The use of modern input such as fertilizer and pesticide as well as access to extension services is very low.

The limited ownership of assets and access to inputs present important obstacles to improving the living conditions of farming households, particularly of the poor. Ownership of the most basic productive assets is limited and the use of mechanization is rare. Households instead rely heavily on family and hired/kuu labor for all agricultural activities. A high level of crop diversification is observed, which is a good signal for food security. However, the level of the production per household is very low potentially du to poor productivity and limited size of land cultivated.

References

- Aguilar, A., Carranza, E., Goldstein, M., Kilic, T. and Oseni, G. (2015). Decomposition of gender differentials in agricultural productivity in Ethiopia. *Agricultural Economics*, 46, 311–334
- Christiaensen, Luc, Lionel Demery, and Jesper Kuhl. 2011. “The (Evolving) Role of Agriculture in Poverty Reduction: An Empirical Perspective.” *Journal of Development Economics* 96 (2): 239–254.
- Filmer, D., & Pritchett, L. H. (2001). Estimating wealth effects without expenditure Data—Or tears: An application to educational enrollments in states of India. *Demography*, 38(1), 115–132
- Karamba, R.W. and Winters, P.C. (2015). Gender and agricultural productivity: implications of the Farm Input Subsidy Program in Malawi. *Agricultural Economics*, 46, 357–374
- Loayza, Norman V., and Claudio Raddatz. 2010. “The Composition of Growth Matters for Poverty Alleviation.” *Journal of Development Economics* 93 (1): 137–51. Elsevier B.V.
- Pingali P, Khwaja Y and Meijer M. (2005). *Commercializing small farmers: Reducing transaction costs*. FAO/ESA Working Paper No. 05-08. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy
- Rao, N.P., Geleta, D. ,& Suryanarayana, N.(2015). An economic inquiry into commercialization of small holder agriculture: the case umbullo watershed. *International journal of multidisciplinary educational research*, Volume 4, Issue 4(1)
- Slavchevska, V. (2015). Gender differences in agricultural productivity: the case of Tanzania. *Agricultural Economics*, 46, 335–355
- Straberg P.J, Jayne T.S, Yamano T., Nyoro J., Karanja D. and Strauss (1999). Effect of agriculture commercialization on Food crop input use and productivity in Kenya. *MSU international Development Working paper No 71*.

Appendix

Appendix 1. Basic household characteristic by farming and non-farming households

	Farming Households mean/sd	Non- farming households mean/sd	National mean/sd	T-test
Household size	4.76	4.01	4.27	***
	2.12	2.36	2.31	
Household size in per adult equivalent	3.63	3.13	3.30	***
	1.63	1.85	1.79	
Dependency ratio	1.16	0.86	0.96	***
	1.01	0.93	0.97	
<i>Household head characteristics</i>				
Household head age	44.26	39.85	41.38	***
	15.01	13.49	14.19	
Female headed households	0.20	0.33	0.28	***
	0.40	0.47	0.45	
Married	0.57	0.36	0.43	***
	0.49	0.48	0.50	
Living together	0.23	0.27	0.25	***
	0.42	0.44	0.43	
Separated/Divorced/Widow	0.13	0.16	0.15	***
	0.34	0.36	0.36	
Never married	0.07	0.22	0.17	***
	0.26	0.41	0.37	
HH head years of schooling	3.85	6.49	5.57	***
	4.57	5.73	5.50	
<i>Dwelling characteristics</i>				
Flush Toilet	0.04	0.40	0.28	***
	0.21	0.49	0.45	
Flush toilet owned	0.03	0.20	0.14	***
	0.16	0.40	0.34	
Flush toilet shared	0.02	0.21	0.14	***
	0.13	0.40	0.35	
HH has acces to electricity	0.02	0.29	0.20	***
	0.15	0.45	0.40	
Main Cooking Fuel Biomass (Wood/charcoal)	1.00	1.00	1.00	
	0.07	0.06	0.06	
Drinking Water from pipeline	0.30	0.34	0.33	***

	Farming Households mean/sd	Non- farming households mean/sd	National mean/sd	T-test
Drinking Water from Borehole	0.46	0.47	0.47	
	0.37	0.34	0.35	**
Drinking Water from Well	0.48	0.47	0.48	
	0.10	0.09	0.09	***
Drinking Water from river/lake	0.30	0.28	0.29	
	0.22	0.04	0.10	***
Drinking Water from other source	0.41	0.20	0.30	
	0.02	0.04	0.03	***
Public garbage collection	0.12	0.19	0.17	
	0.01	0.11	0.07	***
	0.07	0.31	0.26	
Per capita total household food and non-food consumption expenditure	41562.94	86499.84	70881.92	***
	22758.81	101268.50	85605.20	
Per adult equivalent total household expenditure	58741.64	108859.20	91440.74	***
	30526.43	103211.10	88560.14	

*Note: Asterisks denote significant differences based on t-tests across farming and non-farming households as follows: * significant at 10%; ** significant at 5%; *** significant at 1%.*

Appendix 2. Incidence of crop cultivation (share of households) by gender of the household head

Crops	Male-headed households	Female-headed households	Total	T-test
	mean	mean	mean	t
[11] Rice/Paddy	0.756	0.667	0.738	4.759604***
[12] Cassava	0.744	0.702	0.736	3.146201***
[13] Corn/Maize	0.349	0.281	0.335	2.502909**
[14] Eddoes	0.089	0.090	0.089	.8125402
[15] Ginger	0.000	0.002	0.001	-.4800938
[17] Onions	0.000	0.003	0.001	-1.223417**
[18] Sweet Potatoes	0.134	0.140	0.135	.7182382
[19] Yams	0.025	0.018	0.023	.5097656
[20] Beans	0.072	0.063	0.070	-.5403921
[21] Bread Nut	0.000	0.005	0.001	-1.867586***
[22] Peas	0.001	0.004	0.002	-.6793581
[23] Palm nuts	0.041	0.014	0.035	.7328064
[24] Sesame/Beneseed	0.063	0.054	0.061	.2490483

Crops	Male-headed	Female-headed	Total	T-test
	households	households		t
	mean	mean	mean	
[25] Groundnut	0.025	0.039	0.028	-1.04571
[26] Kola Nut	0.011	0.011	0.011	-1.433434*
[27] Banana	0.123	0.095	0.117	1.909483*
[28] Avocado	0.003	0.012	0.005	-2.035452***
[29] Bittersweet	0.000	0.000	0.000	1.000154
[30] Bread fruit	0.000	0.006	0.001	-1.577143***
[31] Golden Plum	0.007	0.001	0.006	-.5080696
[32] Grapefruit	0.005	0.007	0.005	-.9757318
[33] Guava	0.002	0.000	0.001	2.237793
[34] Lemon	0.002	0.000	0.001	1.732852
[35] Lime	0.001	0.003	0.001	-.6793581
[36] Mango	0.014	0.009	0.013	.1443785
[37] Monkey Apple	0.001	0.000	0.001	1.41465
[38] Orange	0.019	0.015	0.018	-.7736858
[39] Papaw	0.033	0.020	0.031	-.2943728
[40] Passion Fruit	0.000	0.000	0.000	1.000154
[41] Pineapple	0.078	0.046	0.072	2.534465**
[42] Plantain	0.221	0.170	0.210	4.832512***
[43] Sour Sour	0.006	0.003	0.005	-.6919624
[44] Sour Plum	0.000	0.001	0.000	-.7326192
[45] Water Melon	0.002	0.001	0.001	.2016256
[46] Bitterballs	0.418	0.341	0.402	3.568245***
[47] Cabbage	0.003	0.000	0.003	2.451758
[49] Collard Greens	0.001	0.003	0.002	-.8554644
[50] Cucumber	0.140	0.119	0.135	1.970547*
[51] Egg Plant	0.110	0.098	0.108	.1723542
[52] Fever Leaf	0.011	0.010	0.011	-.4977657
[53] Kitilay	0.041	0.033	0.040	.6099879
[54] Lettuce	0.001	0.000	0.001	1.41465
[55] Okra	0.287	0.281	0.286	2.242471**
[56] Pepper	0.474	0.385	0.456	3.878788***
[57] Plato	0.058	0.084	0.063	-.8963432
[58] Pumpkins	0.119	0.101	0.115	1.18779
[60] Tomatoes	0.024	0.017	0.023	1.483547
[61] Water Greens	0.040	0.077	0.047	-2.045844**
[62] Calabash	0.000	0.000	0.000	1.000154
[63] Cashew nut	0.007	0.002	0.006	-.0143921
[64] Cocoa	0.116	0.071	0.107	2.982768***
[65] Coconut	0.018	0.022	0.019	.3038286
[66] Coffee	0.047	0.040	0.046	.4387915
[67] Cotton	0.001	0.000	0.001	1.41465

Crops	Male-headed	Female-headed	Total	T-test
	households	households		
	mean	mean	mean	t
[68] Oil Palm	0.047	0.015	0.041	3.512973***
[69] Rubber	0.149	0.043	0.127	7.126053***
[70] Sugar Cane	0.076	0.099	0.080	-.2358727
[90] OTHER	0.008	0.011	0.009	-1.363581*
Observations	4042			

*Note: Asterisks denote significant differences based on t-tests across Male and female-headed household as follows: * significant at 10%; ** significant at 5%; *** significant at 1%.*