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Factors Influencing Rice Productivity by Different Ecosystems: A Case Study on Prefecture of Faranah, Republic of Guinea

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Abstract
Rice growing regions in Guinea are mainly located in three types of land zones (lowlands, plains, and Hillsides). Rice cultivation is concentrated in Kankan, Kouroussa, Siguiri and Faranah in upper Guinea, where the rice field is poorly cultivated due to insufficient labor input causes by the migration to fluvial-marine industry. The research area has a diversified natural ecological endowment, such as inland flood plains and lowlands with a great diversity of water resources. The aims of the study are to analyze net income and profitability of rice production on households by different ecosystem features in the prefecture of Faranah. Data were collected with 270 respondents selected in eight rural communes and the Faranah center randomly; first hand data were obtained using structured questionnaires. The linear regression analysis showed that lowland farmers 'capital inputs, net income, and fertilizer were highly significant (P<0.01); however, gender, labor cost and household size were significant (P<0.05). For the farmers in the plain area, it was indicated that, rice production profit was not highly significant due to the higher production input costs, but training, capital inputs, gender and age of farmers were significant (P<0.05); In the hillsides, the result shows that the net income and capital inputs were highly significant related (P<0.01) whilst farm size and labor cost are significant at 5%, where the input of fertilizer is less significant. The gross margin analysis shows that net incomes of each land types are **3773** to 8993 US$/ha in the lowland areas compared to the plains areas (3892 to 11348 US$/ha) and the hillsides with (3863 to 9708 US$/ha) respectively. Based on these findings, the authors recommend to the government and private organizations to help rice producers improve the inputs and influencing factors based on the various ecosystems in different land zones.
Keywords: Ecosystem rice production, lowlands, plains, hillsides, arable land, revenue.

1. Introduction

Guinea is a country with long history rice farming. The story of Eustace from the Pit "Journey to the western coast of Africa" (1479 - 1480) testifies that the cultivation of rice in Guinea on a large scale already started long before the introduction by the Portuguese of varieties of Asian rice Oryza sativa. A research carried out in Guinea found out that Steude created the African species of cultivated rice, Oryza glaberrima as early as in 1885 (Godon 1991). Today, with some 600,000 ha, rice occupies more than 40% of the cultivated area of the country. Rice is also a stable food for Guinean people. It is estimated that per capita rice consumption in Guinea is about 90 kg / year, making Guinea as the highest rice consumer in Africa. While national needs are increasing rapidly, production growth is slow and mainly depending on the expansion of cultivated areas other than from the increase in yields (ORIZA-Guinea, 2005). Rainfed rice cultivation, in clearing-burning systems, is the most widespread type with 65% of rice-growing areas. It is practiced in morphopedological cultivated area of the country. Researches carried out by Food and Agricultural Organisation, National Directorate of Rural Engineering and Ministry of Agriculture, Livestock and Waters and Forests (2001), due to the unique geographical location and ecosystems almost all types of rice crops can be found in the country, and that rice is grown in all types of lands with different soil features, including, rainfed land with very different soil fertility levels. In general rice can be growing in all regions of the country but with 2 regions of predilection: Forest Guinea (FG) and Middle Guinea (MG). The freshwater rice cultivation with a great diversity of irrigation schemes, possibly modified by cultivation types has a very important place in Upper Guinea and in Guinea Maritime or Lower Guinea (LG). "Mangrove" rice cultivation, with all its variants depending on the adaptation made to control a more or less marked salinity, accounts for 16% of rice-growing areas and is limited to the Lower Guinea (Boun et al., 2001).

The alluvial plains are large spaces located along major rivers such as Niger, Milo or Tinkisso. These plains, concentrated in Upper Guinea (Kankan, Kouroussa, Siguiri and Faranah), are poorly cultivated due to low population density. Some of them were built during the colonial period, but these field infrastructures no longer work. Their topography and flood frequency determine the location selection of the rice fields, the choice of varieties and the dates of sowing.

The level of flooding increases from the highest parts to the lowest parts. In the latter, floods arrive early and withdraw late. Late varieties of floating type capable of growing with floods are grown, with early varieties grown in the highest parts. Soil preparation and seeding are generally carried out in harness or tractor, and for this reason the average area cultivated per farm is relatively high (on average 6 ha) (Boun et al., 2001). These plains are subject to three main hazards: the unpredictability of floods, the importance of weeds and the low soil fertility (Béavogui, 2004). Depending on the degree of water control, two cropping systems can be distinguished: the managed lowland rice system and the undeveloped lowland rice cultivation system. Of the two, the undeveloped system is the most important in terms of cultivated areas. However, the surface areas of the low-land system developed increase year by year thanks to the intervention of the State or NGOs. These systems are found in the 4 natural regions in particular in Guinea forests and in Middle Guinea (the two most mountainous regions).Traditional varieties are dominant in undeveloped lowlands, whereas in improved lowlands, improved varieties predominate (Boun et al., 2001). In general, rice is sown on the fly in undeveloped shoals and transplanted into lowlands on manual Plowing or, very rarely, to the tractor. Weeds and ferrous toxicity are the main constraints of this type of rice cultivation (Kamano. P, 2003)

Rainfed rice cultivation is practiced in all the natural regions of Guinea, on the mountains (from the foot of the mountains to the summit), the hills and plateaus and plains. Rainfed rice is fed exclusively by rainfall, grown on ever-drained and naturally drained soil, and productivity depends on the distribution of rainfall, with the rainy season ranging from April to November per year. Culture is, in the vast majority of cases, itinerant. Rainfed cultivation is done after clearing or deforestation, drying and burning of a fallow from 5 to more than 10 years after the first rains. According to (van Dijk, 2002), the varieties are of relatively early vegetative cycle compared to those grown in flooded ecosystems; those of O. Glaberrima are still well represented.

The rain-fed rice growing system is infertility crisis. Indeed, the duration of fallow land, the only means of renewing soil fertility, has fallen sharply in recent years. It has increased from 10 years in the 1980s to 6 years (Boun et al., 2001). This decline in fertility is systematically associated with increased weed pressure. In general, farmers abandon the rice crop as soon as the fallow period is under 5 years to move towards the flooded system (basins or lowlands, depending on availability or to other dry crops such as groundnut or fonio (Berthome et al, 1999).

Lowland rice cultivation system accounts for 10% of the rice area in Guinea. The yields are between 1.5 and 2.5 t / ha. Guinea Forester has the largest extent in the lowlands, compared to other natural regions of the country. According to the National Directorate of Rural Engineering, the overall potential in bottom for the area would be about 121760 hectares with 5% of areas having been developed (Godon P. et Lecomte Y., 1996).

Plains rice cultivation system is especially prevalent in Upper Guinea and in the prefectures of Gaoual and Koundara (Middle Guinea). It represents 9% of the surface area and yields vary between 500 kg and 2 t / ha depending on the flooding of the Niger River and its tributaries. The area of the developable plains is estimated at about 120 000 ha, of which 80 000 ha is in Upper Guinea. Agriculture Development Policy Letter (LPDA II, 2001).

Currently mangrove rice accounts for 16% of the rice area and yields are between 1.5 and 3.5 t / ha. 20 to 60% of total production is marketed according to systems. In fact, the fertility of these areas can be stable if sea water, rich in salt, is transported to the plots in the dry season. According to Support Program for Food Security (SPFS, 2001) this system is traditional among the Baga populations of the lower coast, which cross the mangrove areas with bunds separating the rice traps and preventing the intrusion of salt water. During the colonial period, the plans for the development of the lower coast provided for 40,000 ha of mangrove rice fields, of which 8,000 ha still has effective working irrigation infrastructures (primary and secondary canals). (Guilavogui Koly, CNOP, 2004)

For several decades, Guinea, like other countries in the region, has developed and introduced a large number of improved varieties (Dalton and Guei, 2003). The National Institute of Agronomic Research of Guinea (IRAG) has selected and disseminated varieties with high production potential for all types of rice in all natural regions of the country. From 1996, IRAG, in liaison with the National Rural Promotion and Extension Service (SNPRV) and the West African Rice Development Association (WARDA), undertook a wide-ranging participatory evaluation and dissemination of new varieties of rainfed rice created by WARDA. These varieties from crosses of O. sativa and O. glaberrima are known under the generic name of NERICA, New Rice for Africa (Jones et al., 1997). Traditional rainfed rice cultivation, also known as dry rice cultivation, is by far the most widespread (65% of the area for about 1 tonne / ha). Indeed, it is found on slopes, on mountains, on slashes of forests after a recent clearing. Cultivation is done by hand. There is no intake of fertilizer. Yields (500 to 900 kg / ha) vary according to natural fertility and regular precipitation. Short-cycle varieties (90-110 days) are most commonly used (Diwawa S, 1997)

2. Methodology

2.1 The research design

The aims of the study are to analyze net income and profitability of rice production on households by different ecosystem features in the prefecture of Faranah., Republic of Guinea. Specifically, the study intends to : (a)

Identify and analyze the costs associated with the production and post-harvest; (b) Assess the level of rice producers' income by ecosystems; (c) Identify with producers all challenges related to their production activities.

2.2 Study areas

The prefecture of Faranah is located 482 km from the capital Conakry. It is between 10 degrees 10 of the North attitude and the 10 degrees 42 and 11 degrees 50 west longitude with an average altitude of 340 m. It covers an area of 18994 km^2 with a population of 280511 people, of which 136100 men and 144411 women. The average population density is 15 inhabitants per km^2 (Prefectural plan of Faranah, 2016).The prefecture of Faranah is one of the 8 prefectures of Upper Guinea. It is bounded to the Northwest by Dabola, Northeast by Kouroussa, and Southeast by Kissidougou, to the West by the Republic of Sierra Leone, and to the South by Kissidougou and Gueckedou. This region is the most endowed in terms of rice growing potential because of the large arable land area esteemed at 443443 ha. In spite of all this great natural attributes, the prefecture has little land under cultivation, making it as one of region with lowest per capita income in the country. According to Ministry of Agriculture, Agricultural Productivity Program in West Africa (PPAAO 1 C – Guinea, 2015), only 102469 ha of all crops were grown in 2014, the rice alone made 59055 ha., 80% of its farmland is mainly rain-fed and its multiple consequences (floods) leading to devastation of crops. It is also geographically located near the Niger River and its tributaries which could facilitate irrigation of the vast plains compared to the rest of the country.

2.3 Data collection and analysis

Data were collected from January to June, 2016 in the eight (8) rural communes plus Faranah center (Bagna, Beindou, Heremakono, Nialia, Passayah, Sandenia, Songoyah, Tiro and Faranah center) through interview schedule through intensive survey using a sampling composed by 132 male and 138 female respondents by the researchers' team using quantitative and qualitative methods. The data were collected from rice farmers with the aid of interview which was found to be appropriate because more than the majority of the farmers were illiterate, the agricultural offices and local offices and were checked, coded and entered into computer for analysis and interpretation using Word, Microsoft excel statistical package for the social sciences (SPSS), and origin8. Statistics like mean, standard error, were used to describe the selected characteristics of the respondents. Linear regression model was used to find out rice production factors significance. We used also the economics analysis through the gross margin to determine net income and benefit cost ratio (BCR) in the study area

2.4 *Theoretical considerations and empirical model*

Theoretical considerations and empirical model: Linear regression model

The multiple regression studies involve the nature of relationship between a dependent variable and two or more explanatory variables. The techniques produce estimates of the standard error of multiple regression and coefficients of multiple determinants. In implicit form, the statement that a particular variable of interest (Y) is associated with a set of the other variables (X) is given as:

$Yi = f(X_1, X_2 ...)$ (1).

Where:

Yi is the dependent variable and X_I, X_2 ---X_n, is a set of a key variables. The coefficients of multiple determination measures the relative amount of variation in the dependent variable (Y_i) explained by the regression relationship between Y and the explanatory variables (X_1).

Linear regression was used because it provides the best fit. The choice of the best functional form was based on the magnitude of the R^2 value, the number of significant variables, the size and the sign of the regression coefficients as they are in line with the a priori expectations.

The model linear regression was adopted thus in accordance with Nwaobiala, 2010.and Hoque &Hague, 2014.

The four functional forms were specified implicitly as follows:

Linear Function used for lowlands in this study was:

$Yi = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_8x_8 + b_9x_8 + ei$ (2)

Kg/ha; X_4 = Labor cost in US5; X_5 = Experience/ year; X_6 = Household size in Number; X_7 = Education/ year, X_8 =Age in year; X_9 = Gender; ei = error term.

Linear Function used for Plains land:

$Yi = \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4x_4 + \beta_5x_5 + \beta_6x_6 + \beta_7x_7 + ei$ = error term (3)

Where:

Yi= Output of rice in Kg/tons; x_1=Training / day; x_2= Household income in US$/ha; x_3 = Capital inputs in US$, x_4=Fertilizer in kg/ha; X_5 = Household size in number, X_6 =Age in year, X_7 =Gender +ei =error term

Linear Function used for Hillsides land.

$Yi = \mu_1x_1 + \mu_2x_2 + \mu_3x_3 + \mu_4x_4 + \mu_5x_5 + \mu_6x_6 + \mu_7x_7 + \mu_8x_8 + \mu_9x_9 + ei$ (4)

Where: Yi= Output of rice in Kg/tons; x_1= Household income in US$/ha; x_2= Capital inputs in US$; x_3=Fertilizer in kg/ha; x_4 == Labor cost in US$; x_5= farm size/number; X_6 = Household size in number,

X_7 = Education in yeas, X_8 = Age in year; X_7= Gender +ei =error term

The Gross margin analysis

The gross margin analysis was also adopted in this research (Nwaobiala, Ezeh (2010)). The following expression was used in order to understand profitability from each land category per production zone

$$GM = \Sigma p_i (Q_i - \Sigma p_j X_i) \quad (1)$$

Where:

GM = Gross Margin; P_i = Unit price of output; Q_i = Quantity of each output; P_j = Unit of each input; X_i = Quantity of each input.

$$NR = GM - TC \quad (2)$$

$$BCR = TR / TC \quad (3)$$

Where:

NR = Net Revenue; TC = Total fixed costs derived by depreciation of fixed costs;
TR = Total Revenue; TC = Total Costs.
BCR = Benefit Cost Ratio

3. Results and discussion

3.1 Socio-economic features of the respondents

Table 1: Land types by production area

Production area	Total lands(ha)	Lowlands (ha)	Plains (ha)	Hillsides (ha)
Bagnan	48675	3276	5134	40265
Beindou	59575	2681	8673	48221
Urban common	23050.29	390.50	767.48	21892.31
Heremakono	14775	4097	4341	6337
Nialia	19695	834	3902	14959
Passayah	38558	2846	6385	29327
Sandenia	18925	408	2773	15744
Songoyah	20100.34	724.34	2879	16497
Tiro	19800	1472	4157	14171
Total	**220,003**	**15,614**	**38,244**	**185,521**

Source: calculated from survey data (2016)

The study shows in this table 1 that the prefecture of Faranah has many agricultural opportunities in terms of lands. Thus, through all 9 communes, it was revealed that rice was produced in three land categories such as lowland, plains, and hillsides. The area like Beindou, Bagna, Passayah, Urban commune and Songoyah were mostly endowed with (59575, 48675, 38558, 23050.29 and 20100.34 hectares) respectively. Whereas, the areas such as Heremakono, Sandénia were not significantly endowed (14775 and18925 hectares) and on this basis, it was indicated that the total land opportunity in these nine (9) communes was estimated at 220,003 hectares composed in lowland (15614 ha), plains (38244 ha) and hillsides (185521 ha). From the point of view of the category and amount of the land used per area, it was observed that Heremakono, Bagna, Passayah and Beindou (4097, 3276, 2846 and 2681ha) respectively had the large lands in lowlands; however, Beindou, Passayah, Bagnan and Tiro were mostly endowed in plains with (8673, 6385, 5134 and 4157 ha) respectively.

Table 2: The Socio-economic profiles of the study areas

Villages	Population	Households	Arable land per capita/ha	labor	Male	Female
Bagna	36445	4403	1.33	3828	1828	2000
Beindou	16521	2031	3.6	3413	1748	1665
Urban commune	78108	9107	0.29	5358	2482	2876
Heremakono	12890	1745	1.14	1539	725	814
Nialia	15221	1655	1.29	1420	731	689
Passayah	19849	2954	1.94	2772	1255	1517
Sandenia	17454	2121	1.08	1923	878	1045
Songoyah	13432	1756	1.49	1665	818	847
Tiro	18982	1956	1.04	1870	914	956
Average	25,434	**3081**	**1.47**	**2495**	**1264**	**1379**

Source: calculated from survey data (2016)

Rice production is based on the availability of arable land in the study areas of which we did the investigation. It was found in our field there are three types of lands, namely: lowlands, plains and hillsides that have been practiced by rice producers for the decades but unfortunately have not experienced major changes in the significant improvements allowing achieving highly qualified returns. The average of rural population in these communes was about 25,434 persons with an average of 3081 households for 2495 labours in the study area in which it was identified 1264 male and 1379 female. It should be noted that the land management is about family-heading, so these lands are often reserved for the heads of the family or depend on the status of the farmer (whether he is married or not).

The particular situation of each rural commune by arable land per capita/ha explains that Beindou's households had an average of 3.6 ha, judged the larger arable land in the study area. It was also observed others higher Land average per capita /ha are such as Passayah, Songoyah, Bagna, (1.94; 1.49; 1.33; 1.29; 1.14) respectively. Comparing the average of the labor force to the number of households, only 8% are available at the time of major farm work to each household. This low average is explained by the displacement of young people for the mining areas in search of the easy money, but also due to the rural exodus of the young people towards the cities where they try to find a better life. This balance sheet clearly demonstrates the possibility of investing in rice production in all these areas.

In the study area, it was observed that the labor force were largely supplied, although the producers were recognized largely illiterate and prefer their places; so, it should also be noted that these households prefer the agricultural activities in which they are born and intend to improve the welfare of their families.

3.2 The land resources profile in Faranah Prefecture

Table 3: Ecosystem features of different types of land used

Types	Land Categories		
	Lowlands	Plains	Hillsides
Soil	Hydromorphic Ferrallitic and sandy clay	Semi-humid and shallow Ferrallitic Silty clay	No deep Ferrallitic leached Stony clay
Vegetation	Grassy vegetation Adventives	Grassy vegetation Adventive	Wooded Savannah Grassy savannah
Fertility	Very good	Good	Fairly good
Occupation of land by Household	10 % of households	40 % of Households	50% of Households
Water	Water throat Rainfall	River bank Rainfall	Rainfall Rainfall
Yield (T/ha)	1.5 - 2.5	1.5 - 2	1-1.5

Source: calculated from survey data, 2016

It was observed through this table 3, that rice production was basically focused on the three lands categories (lowlands, plains and hillsides) characterized in hydromorphic land, semi-humid shallow and no deep. Typically, the soil categories of each land were mostly constitute in Ferrallitic soil; in the lowlands, it was sandy clay, while, for the plains, finding identified the presence of Silty clay and at the end, on the hillsides, the stony clay was popular. In terms of vegetation, it was Lowlands and plains possessed the same plants composition (grassy vegetation and adventives), but, on the highland it was observed two categories (Wooded Savannah and Grassy savanna) dominated that vegetation.

It was revealed that fertility in these three different lands was very good for the lowland because it contains more water which can cover all crop grow time and many nutrients, while the plains were judged good, where it should be noted that rice cultivation required many issues such as (land improvement, water regime and fertilizer availability), challenges which are not so easy to resolve and needs more investment.

Continuing our observation in this Table 3, it was identified that the occupation of land by household in the study area was managing by the type of land used, so, it should indicated that10 % of household are using lowland to their crop activities due to the rarity of this category of land and generally reserved for the heads of families who inherited from their parents. In upper Guinea, plain are largely located and are using by many rice producers in general, particularly, in our study area which is Faranah prefecture, the rate of household using was estimated at 40% due to the presence of river Niger and his tributaries which, at the time of the great rains, through the floods spreads the vegetable debris and contribute to the enrichment of the land. After these two first land categories, it was indicated that the half of the households cultivate on the plateaus, i.e. 50 % due to the fact, this category of land exist everywhere and is managed by local officials who should not pose problems to those who need to work.

Water availability was generally appreciated because it was revealed that in the lowlands size, the full water was identified in many places and help more in land preparing. The households are making drainage and also, if there no many water, the annual rainfall can cover the rest which they expect for their rice cultivation. Unlike to the plains, it was noted thus that, water resource was fundamentally based on river bank (Niger River and its tributaries) and the annual rainfall. The hillsides are one of land where water availability was totally based on the annual rainfall and which should be a big difficult at some times when are happen climate change problems.

In terms of yield profile, the finding shows that lowlands mostly provided in nutrient and should be the best land in the study area where yields were between 1.5 to 2.5 tons/ha compared with the plains which was between 1.5 to 2 tons/ha. Hillsides yields were measuring at 1 and 1.5 tons/ha due of the non-improvement of these lands.

3.3 Linear regression model applied on ecosystems rice production

Table 4: The socio-economics factors influencing lowlands rice production

SI N0	Independents variables	Regression coefficients (β value)	Std. Error	t Value	level of significance (P value)
1	Gender	76.303	99.735	0.765	0.007**
2	Age	-2.207	4.018	-0.549	0.141
3	Education	11.06	11.219	0.986	0.010**
4	Household size	49.387	32.943	1.499	0.050*
5	Experience	-0.319	81.922	-0.004	0.000***
6	Labor cost	-0.87	0.66	-1.319	0.001**
7	Fertilizer	1.146	0.414	2.766	0.000***
8	Capital inputs	0.532	0.396	1.344	0.000***
9	Household income	0.345	0.172	2.004	0.000***

Source: calculated from survey data, 2016: R=0.679; R^2=0.462; F. change =8.574; * =significant at 10%; ** = Significant at 5%, *** = significant at 1%.

In terms of lowland rice productivity and economic return in our study area, it was identified in the table 4 that through linear regression model, R and R^2 values were (0.679 and =0.462), where F. change =8.574*** was judged highly significant at 1 %. This would means that the corresponding R^2 was at 67.9 % of the variance in the profitability of lowland farmers' rice production over all factors selected. It is revealed that household income, capital inputs, fertilizer, and experience are highly significant at 1% level. The analysis shows that, gender, education, farm size and labour cost were significant at 5% level and had to explain also the good correlation in this ecosystem production. From these results, it should conclude that rice production in lowland system seems to be one of the most favourite for the producers in all the production areas because of the work of rice in these perimeters was largely followed by the households although this type of arable land is not located in large part of Upper Guinea, dominated basically by the plains and hillsides.

Table 5: The socio-economics factors influencing Plain rice production

SI N0	Independents variables	Regression coefficients (β value)	Std. Error	t value	Level of significance (P value)
1	Gender	222.007	218.574	1.016	0.061*
2	Age	18.330	11.823	1.550	0.067*
3	Household size	-20.586	109.918	-.187	0.110
4	Fertilizer	1.262	1.001	1.261	0.007**
5	Capital inputs	.365	.682	.535	0.014*
6	Household income	-.163	.230	-.710	0.227
7	Training	-161.423	92.719	-1.741	0.024*

Source: calculated from survey data, 2016: R= 0432; R^2 = 0.232; F. change = 2.162; *=Significant at 10 %; **=Significant at 5 %;

Figures in table 5 indicate that, the factors such as capital inputs, gender, Age and training were significant at 5% level. However, fertilizer was highly significant at 1% level. The finding shows that R= and R^2 values were 0432 and 0.232 respectively and where F. change = 2.162* significant at 10%. The corresponding R^2 value was 0.232; which means that all socio-economic factors accounted for 23.2% of the total variance in profitability of plains production relative to the total of (7) selected socio-economic factors. These factors were not very significant, which should explain why the correlation was not effective due to certain weaknesses such as the still muddy production systems due to the influence of weeds and the non-adaptation of land management to the system of cultivation based on the quantity of rainfall but also the poor post-harvest management which given the low income to households. The relevant conclusion is that family farms working on the lowlands spend much more on inputs and labor cost, as well as not mastering land improvement techniques or Ways to make improvements on vast land that they exploit.

Table 6: The socio-economics factors influencing Hillsides rice production

SI NO	independents variables	Regression coefficients (β value)	Std. Error	t values	Level of significance (P value)
1	Gender	-83.626	54.468	-1.535	0.128
2	Age	.673	2.719	.247	0.805
3	Household size	29.539	21.918	1.348	0.180
4	Experience	5.035	10.646	.473	0.301
5	Farm size	368.118	118.311	3.111	0.002**
6	Labor cost	-1.018	.507	-2.009	0.047*
7	Fertilizer	-1.848	1.304	-1.417	0.159
8	Capital inputs	1.390	.387	3.589	0.000***
9	Household income	.665	.151	4.415	0.000***

Source: calculated from survey data, 2016: R = 0897; R^2= 0.807; F change = 51.025, *=Significant at 10%, **Significant at 5%, ***= Significant at 1%.

The finding shows that the socio-economics factors in hillsides rice production where influencing after using the regression model, the corresponding values of R = 0897, R^2 = 0.807 and F change = 51.025 were (significant at 1 % level). It is observed that the factors such as household income and capital inputs, were significantly highers at 1%, Farm size and labor cost were significant at 5% respectively because of this ecosystem provided to producers the half of the arable land availability in our study area; there are located on the plateaus and mountain; this situation was a major opportunity for producers to obtain areas the fact of lowlands and plains were generally properties and therefore difficult to obtain. For the hillsides rice farmers, the corresponding R^2 value is 80.7% of the total variance in the profitability. It's necessary to understand that more than half of the rice producers are small producers (0 to 2.5 ha) and which expects find easily land and implement their annual production projects. The labor cost were not highly significant (5%) level due to the fact that rice producers on hillsides do not spend much in the labor force, they use small lands and their practice of cultivation consists mainly to make clearing and burning, plowing, herbicide using and harvest. All these activities were carried out by themselves and rainfall was generally between 5 and 6 months in the years and this is one of the reasons why these households sowed short-cycle varieties to the detriment of varieties long cycle to avoid the scarcity of the rain at a given moment.

3.4 Economic performance of rice production in different ecosystems

Table 7: Economics performance of rice production by ecosystems (in US$/ha)

Items	Production area								
	Bagna	Beindou	Commune	Heremakono	Nialia	Passayah	Sandenia	Songoyah	Tiro
Lowlands									
Total cost	6634	11822	7948	9605	13411	10404	9524	8814	13610
Gross margin	10759	17117	11721	14557	17711	17233	16234	17807	17807
Net income	**4125**	**5295**	**3773**	**4952**	**3823**	**6832**	**6710**	**8993**	**4197**
BCR	**1.62**	**1.45**	**1.47**	**1.52**	**1.32**	**1.66**	**1.7**	**2.02**	**1.31**
Plains									
Total cost	10559	12617	10753	13754	9749	11687	10788	11936	12705
Gross margin	14860	21845	14646	25103	19729	20672	18314	17419	21940
Net income	**4300**	**9000**	**3892**	**11348**	**9979**	**8985**	**7525**	**5482**	**9234**
BCR	**1.41**	**1.73**	**1.36**	**1.83**	**2.02**	**1.77**	**1.7**	**1.46**	**1.73**
Hillsides									
Total cost	7920	4940	7619	5472	6677	7941	7995	6539	6879
Gross margin	16030	10173	11482	12481	13416	15948	17703	14815	13881
Net income	**8110**	**5233**	**3863**	**7257**	**6739**	**8007**	**9708**	**8276**	**7002**
BCR	**2.02**	**2.06**	**1.51**	**2.28**	**2.01**	**2.01**	**2.21**	**2.27**	**2.02**

Source: calculated from survey data (2016)

It was revealed in the table 7, that the economic performance indicators by ecosystem and production areas such as the labor cost, gross margin, net income and benefit cost ratio. The finding shows that the labor cost average in Tiro, Nialia and Beindou (13610; 13411; 11822 US$) were very high due to the high price in those rural communes and moderate in Passayah, Heremakono, Sandenia, and Songoyah (10404, 9605, 9524, and 8814 US$) respectively. On the other hand, the places like Bagna and the center of the Commune of Faranah with respectively 7948 and 6634 US $, the report was that the hands of works have cost less because of their opening which favours the flow of workers towards these localities during the moments of the large farmer's work.

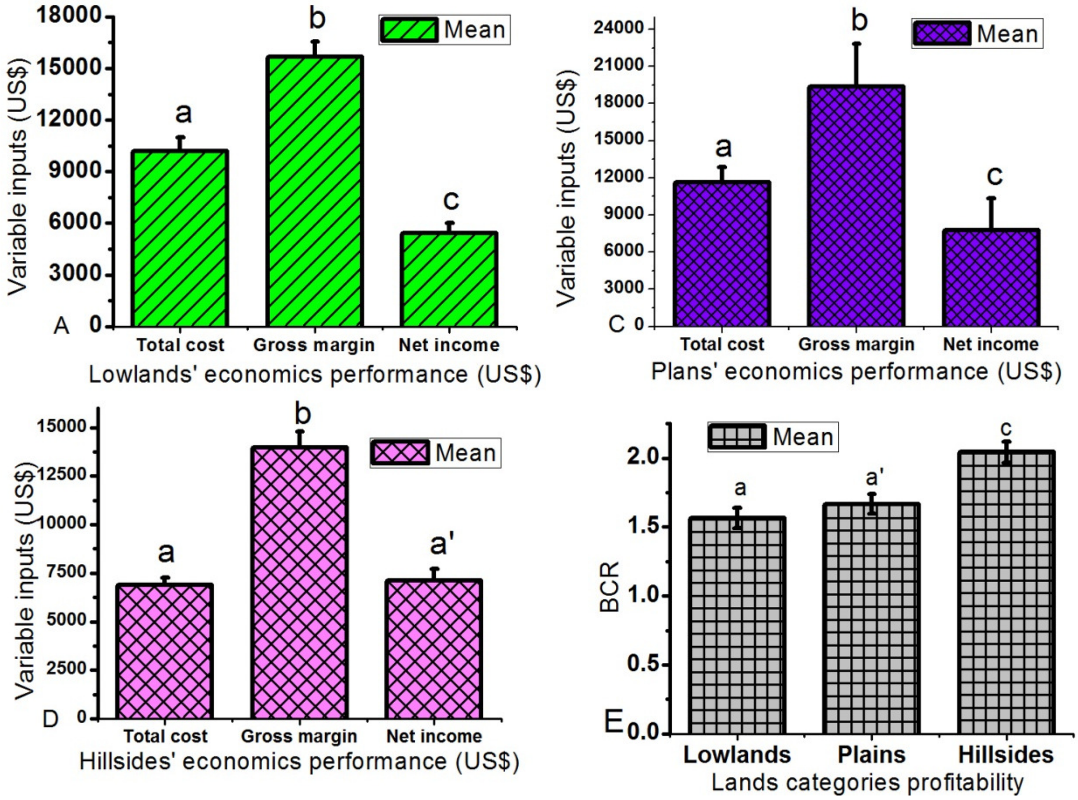
It should necessary understanding that the gross margin was highly significant in Tiro, Songoyah, Nialia, Passayah, Beindou and Sandenia (17807; 17807; 17711; 17233; 17117 and 16234 US$/ha) inclusively due to the quantity produced and paddy rice prices on the market in these places. Whereas, Heremakono, Commune, and Bagna with respectively (14557, 11721 and 10759 US$/ha) were moderately significant due to the high cost of the production supported, and the bad market management.

Regarding net income of the rice producers in our study areas, it was observed that the highers were visible in Songoyah, Passayah, and Sandenia (8993; 6832 and 6710 US$/ha) respectively because of the low production cost and market managing, however, Beindou, Heremakono, Tiro, Bagna (5295, 4952, 4197 and 4125 US$/ha) were judged moderate and acceptable in the production areas. After determining per production area, it was necessary for us to see if the producers had got the best profitability of their crop activities? Through the gross margin analysis, the benefit cost ratio (BCR) was used to determine the level of the profitability of all ecosystems (lowlands, plains and hillsides). Specifically, in lowland rice production, the BCR high level was observed in Songoyah (2.02) followed by the rural communes of Sandenia, Passayah and Bagna (1.7; 1.66 and 1.62); it was moderately significant in Heremakono, commune and Beindou with the values of 1.52; 1.47 and 1.45.

Plains rice production in the study area has raised many problems in terms of net income and profitability. Infrastructure needs to be achieved before planting crops, but this is not the case, land management efforts are huge and therefore cannot be fully supported by the producers themselves. The economic performance analysis has the values judged weak in the plain, nevertheless, the producers, because of the great lands opportunities, will have a great interest for the production of rice insofar as, the prefecture of Faranah is part of the upper Guinea which is the best region in the country endowed in the plains. It was indicated that Heremakono, Nialia, Tiro, Beindou and Passayah realized the high net income (11348, 9979, 9234, 9000, 8985 US$/ha) respectively. In terms of benefit-cost ratio, it was found that only the rural commune of Nialia have got 2.02, the other communes values were comprised between 1.36 and 1.83 that means plains rice producers need to be improved more all production systems. These few benefits were far from covering the financial need of households and are not related to the size of the cultivated area (prediction zone of the middle and large producers due to the availability of vast arable land.

The rice production in the Hillsides is totally based on the duration of rainfall in our study area and so, the system is popularly because of the availability of arable land and adaptable to the small producers (0-2 ha) where the production costs were inexpensive compared to the other ecosystems (plains and lowland). Thus, the finding shows that in each production area, the gross margin and net income were highly significant except urban commune (3863 US$) as net income and 1.51 as benefit cost ratio generated.

Sandenia, Bagan, Tiro, Songoyah and Nialia with the averages of gross margin (17703; 16030; 13881; 14815 and 13416 US$/ha) inclusively were judged very well. The highers net income were identified in the areas such as Sandenia, Songoyah, Bagna, Passayah, Heremakono and Tiro (9708; 8276; 8110; 8007; 7257 and 7002 US$/ha) respectively. The benefit cost ratio (BCR) were also highly significant in the communes like Heremakono, Songoyah, Sandenia, Beindou, Bagna, Tiro, Nialia and urban commune (2.28; 2.17; 2.21; 2.02; 2.02; 2.01; 1.51) inclusively.



Graph: LSD test (0.05) for Ecosystem rice production's economic performance: Lowlands (A), Plains (C), Hillsides (D) and profitability or BCR (E) in US$

This graph represents, the LSD test composed by four figures: A (lowlands), C (plains), D (hillsides) and E (BCR). It was indicated that, for the lowlands ecosystem, there is a significant difference between the total cost (a) and the gross margin (b), also (a) is highly significant that the net income (c) due to the fact that in the lowlands, rice work is less tiring with the presence of water, but also linked to the minimum fertilization of fertilizers which allow a good yield with a relatively high cost of production; generated net income is appreciable for farmers. The figure (c) was explained in the same way as the preceding one, the difference was that the plain needs much improvement and financial means to succeed on the rice cultivation; a large significant difference between total cost (a) and gross margin (b) judged very high, but it was no significant different between (a) and (c). It should be very interesting to see that in the hillsides, rice production was significant despite these lands were not improved and the household does not have the support for aiding sometimes and there is a high significant different between (a) an (b), but no significant different between (a) and (a'). In order to explain profitability of hillsides rice production, le figure E was elaborate and in which it should observed no significant different between (a) (a') and (b) that means all of the land categories are significant in terms of profitability (BCR). It was concluded that the hillside rice producers spend very little in terms of production costs in the fields because on this ecosystem, producers prefer to work themselves to significantly reduce their costs compared to producers in the other two ecosystems. (lowlands and plains) where producers are in serious need of workers large amounts of chemical fertilizers, but also the quality of the infrastructure

Photo 1: Lowland rice transplanted **Photo 2: plain rice transplated**




Photo 3: Rice field in hillside by handy seeding **Photo 4: Rice field in hillside by handy seeding**

Figure 2: Illustration of the different categories of cultivated land in faranah prefecture

4 Conclusions and recommendations

The aims of the study are to analyze net income and profitability of rice production on households by different ecosystem features in the prefecture of Faranah., Republic of Guinea. Data were collected from January to June, 2016 in the eight (8) rural communes plus Faranah center (Bagna, Beindou, Heremakono, Nialia, Passayah, Sandenia, Songoyah, Tiro and Faranah center or urban commune of Faranah) through an interview schedule through intensive survey using a sampling composed of 270 respondents whose 132 male and 138. Linear regression model was used to find out rice production factors significance. The gross margin analysis was used to identify the economics performance by ecosystem. (M Z et al, 2014).

Land resources profile in the nine (9) communes were 220,003 hectares as the total land composed in lowland (15614 ha), plains (38244 ha) and hillsides (185521 ha) respectively. In terms of Ecosystem features it was observed through table 3, that rice production is basically focused on the three lands categories (lowlands, plains and hillsides) characterized by the hydromorphic land, semi-humid shallow and no deep. For each ecosystem, the rates of household were 10 %, 40 % and 50 %, respectively, while yield of the lowlands were estimated between 1.5 to 2.5 tons/ha compared with the plains which were comprised between 1.5 to 2 tons/ha. Hillsides yield were measuring at 1 and 1.5 tons/ha due of the non-improvement of these lands.

The results had shown in general that the combined effects of the socio economic variables have made positive and significant contribution to the rice output of different ecosystems and can be a good family enterprise for the producers in the study area The average of rural population in these rural communes is about 25,434 where 3081 are households for 2495 labours in which it was identified 1264 male and 1379 female. Using regression model and gross margin analysis, it was observed that lowland rice production was highly appreciated because of its easy management (wet and rich land and sometimes water throat, relatively affordable labor, availability of preferred varieties). It should be concluded that all economics factors of the different ecosystems categories had a good correlation with the successive corresponding values such as R2 = 4.62%, R2 = 2.32% and R2 = 8.07% respectively where F. Changes = 8.574 ***, F. change = 2.162 and F change = 51.025 inclusively. The selected correspondents such as household income, capital inputs, fertilizer, and experience are highly significant at 1% level in lowland production system, however, in plain production pattern, capital inputs, gender, age and training were significant at 5%, where it was identified on hillsides production system the factor like household income and capital inputs, highly significant.

The average of labor costs were between 6600 US$ to 13,000 US$, with the gross margins from 10, 759 to 17, 807 US$. At the same time, net income and benefit cost ratio shown that lowlands rice can become very satisfied agricultural activity in the near future with 3892 to 11348 US$ inclusively, significant at 1% and reasonably let conclude that the profitability in each study area presented by the benefit cost ratio (BCR) were successively 1.52; 1.47; 1.45; 1.32; 1.31; 1.62; 1.7; 1.66; 2.02.

Plains rice production was one of producer's motivations to enhance the deficit of staple food and creating more revenue which should allow improving their wellbeing in the rural communities. Based on these logics, it should conclude that in each production area, the gross margin and net income were highly Significant except urban commune (3863 US$) as net income and 1.51 as benefit cost ratio generated.

Sandenia, Bagna, Tiro, Songoyah and Nialia with the averages of gross margin (17703, 16030, 13881, 14815 and 13416 US$/ha) inclusively were notified as well. The higher net income were identified in the areas such as Sandenia, Songoyah, Bagna, Passayah, Heremakono and Tiro (9708, 8276, 8110, 8007, 7257 and 7002 US$/ha) respectively. The benefit cost ratio (BCR) presented in Heremakono, Songoyah, Sandenia, Beindou, Bagna, Tiro, Nialia and urban commune were (2.28; 2.17; 2.21; 2.02; 2.02; 2.01; 1.51) inclusively

Based on the duration of rainfall, the hillsides rice production system were popularly in the study areas because of the availability of arable land (18, 5521 hectares) and adaptable for the small producers (0 to 2 ha) where production costs are inexpensive compared to the other ecosystems which are (lowlands and plains). It was observed that the labor costs were between US$ 4940 to US$7995 while gross margin varied between US$ 10,173 to US$ 17,703. The net incomes, on the other hand, were between US$ 3863 to 9708 when the cost-benefit ratio estimated successively at 2.02; 2.06; 1.51; 2.28; 2.01; 2.01; 2.21; 2.27; 2.02 inclusively, depending on the production area.

The table 5 shows LSD figure composed in fore graphics namely: A (lowlands), C (plains), D (hillsides) and E (profitability). It was indicated that through these fore graphics, in Hillside ecosystem (D) a high different significant between (a) an (b) which is very high, but no significant different between (a) and net income (a') comparted to (A) and (C) where it exist a high different significant between total cost (a) and gross margin (b), also significant than Net income (c) due to the fact that in the production cost issues which is provide a moderate net income despite the high gross margin. It should observed with (E) that, no different significant between (a) (a') and (b) that means all of the land categories are significant in terms of profitability (BCR). Based on the abovementioned findings, following countermeasures for improvement of the rice productivity are recommended:

1. The government should ensure the improvement of rice production through mechanization of the system; increase the (fertilizer input, improved seed supply, and chemical products;
2. The government and private organizations should improve land management, especially lowlands and plains, to allow other small producers to leave the hillsides for the protection of the environment and ecosystem or to develop certain lands on the slopes for balanced benefit for all producers;
3. The government and communities should give priority to opening-up of all production areas in order to allow the flow of agricultural products to the large markets in order to hope for the high costs opportunities;
4. The households should be organized in producer cooperatives to enable them to cope with all difficulties of rice production, but also to be united and to be able to fix the prices of their products to buyers in order to maximize profits in the all production areas;
5. It would be especially interesting that agricultural credit could be a reality to support household production efforts in Faranah prefecture and across the country to enable producers to produce on the time and generate significant income and stabilize the need of national and regional consumption.
6. The government should be able to undertake agrarian reforms to reorient agricultural production policy based on the proper management of arable land to eliminate all forms of customary land appropriation in the Republic of Guinea;
7. The government must be able to increase the training of producers on agricultural techniques, post-harvest management, threshing areas and rice drying in production areas.

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