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Simultaneous modelling of the determinants of the partial inputs productivity in the municipality of Banikoara, Northern Benin

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A B S T R A C T

This study aims at assessing the determinants of the agricultural productivity through the partial productivities of the main production factors (land, labor and capital), using primary data collected from a sample of 210 farmers randomly selected in two villages belonging to the municipality of Banikoara in Northern Benin (West Africa). The partial land, labor and capital productivities are 163643.90 francs CFA/ha, 1716.92 francs CFA/Man.Day, and 2.48 respectively, implying that land is the most productive factor. The seemingly unrelated regression model is highly significant at 1% and revealed factors such as the household head gender, experience in agriculture, off – farm income employment; the household size; the sizes of land under maize, sorghum, and cotton cultivation; the household's capital; and the maize fertilisation as determinants of the partial land productivity. The partial labor productivity is influenced by the household head gender, his experience in agriculture, an off – farm income employment, the household size, the sizes of land under rice and cotton cultivation, the household's capital, and the access to credit whereas the household size, the land size under cotton cultivation, and the household's capital affect the partial capital productivity. These factors need to be taken into account by policy to design agricultural projects that aim to improve agricultural productivity. The land size to be allocated to different crops has to be at the centre of agricultural policy as it has influenced all partial agricultural productivities.

1. Introduction

Agriculture is the backbone of the economy in many countries, especially the least developing ones (UNDP, 2007). With a majority of the world population living in rural areas in developing countries, agriculture remains a key activity for providing people the capacity to feed themselves by producing their own food or the source of employment and income to access to food supplies (Andzo-Bika and Kamitewoko, 2004). In Africa, agriculture accounts for about 30% of the Gross Domestic Product (GDP), employs more people than any other sector with about 75% of total employment (World Bank, 2007), supplies the bulk of basic food, and provides subsistence and other incomes. Subsequently, agriculture is an important sector for sustaining growth and reducing poverty in Africa, especially in West African countries.

According to (Andzo-Bika and Kamitewoko, 2004), the role of agriculture is to provide adequate outputs to ensure the global food security and enhance the economic development prospects. However, for years in many countries in West Africa including Benin, the local production – coming from the local farming systems – is not enough to meet the local demand, implying huge importation of foods. With the current population growth, this situation is rather getting worse. Indeed, as argued by Malthus (1798), the human population increases geometrically while the food supply – at most – can only increase arithmetically. Therefore, the ability of agriculture to support growing population has been a concern for generations and continues to be high on the global policy agenda as the global food security will remain a worldwide concern for the next 50 years and beyond (Rosegrant and Cline, 2003). By considering the main dimensions of food security which concern the availability, the access, the utilisation and the stability of food, production is an important component of food security in Sub-Saharan

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Africa. As a result, agricultural productivity is critical determinant in Sub-Saharan Africa's ability to meet food security and economic development objectives in times of rapid population growth (Wiebe et al., 2001). It is expected that an increase in crops production (including key household staple crops) can lead to an increase in food availability and also to an increase in access to income if more crops are to be sold for profit. An increase in food production can also contribute to the long run households' food stability. In this context and considering the predicted adverse impacts of climate change threat to food security goal, increasing agricultural productivity is a major challenge for meeting food security goal. Assuming so, policy actions have to focus on the determinants of agricultural productivity.

In this line, many studies have intended to highlight factors that might influence agricultural productivity, regarding the total productivity of the farm. However, considering the different constraints on the production factors – land, labor, and capital for instance – the total productivity might hide some information, making difficult to set up specific policy recommendations aiming to address the main production factors.

In Benin, a West African country, despite the existence of favourable agro-climate potentialities for high agricultural output, production is insufficient to achieve food security goal. Furthermore households' incomes and agricultural productivity are still low. Agricultural productivity has decreased by 31.68% between 1990 and 2008 (Labintan and Ding, 2012). As a matter of fact food security issue remains a big concern and policy actions are to be designed to overcome the situation. Therefore this paper aims at assessing the determinants of the farm productivity level through the partial productivities of the main production factors in the municipality of Banikoara in Northern Benin; one of the municipalities that produce an important share of the agricultural production of the whole country.

2. Theoretical framework

In order to analyse the factors affecting agricultural productivity, a multiple linear regression model is broadly used. It is a function which represents the production factors that correspond to a given productivity level. This function is expressed as followed:

$$P_i = F(X_i) \quad (1)$$

where P_i stands for the ith farmer productivity level and X_i stands for a set of factors – capital, labor, fertilisers, etc. – used by the ith farmer. Depending on X, such model may refer to the production function, estimated in most of the case by using a Cobb-Douglas specification. This functional form is the most popular in applied research because it is the easiest to handle mathematically (Koutsoyiannis, 1979; Okoye et al., 2008). Evidence from most studies depicts that the Cobb-Douglas functional form gives the best results than other functional forms (Okoye et al., 2008). However, in rural areas, the ecological conditions and the availability of resources are not the only ones factors taken into account while farmers are setting their agricultural production system. Indeed, considerations related to the socio-economic and demographic environment are much important in farmers' decision making. Moreover, it has become obvious that the social, economic and demographic factors influence the choice of farming systems and farming practices – including crops pattern – as well as the economic results achieved (CIRAD-GRET, 2002). Taking into account these considerations, Hussain and Perera (2004) observed that agricultural productivity change might be explained by land and water related factors, climatic, agronomic, socioeconomic, and farm management factors. That is, Eq. (1) should take into account more than the inputs, becoming:

$$P_i = F(Z_i, X_i) \quad (2)$$

where Z_i stands for socio-economic and demographic characteristics of the ith farmer. This equation is the one adopted and estimated in this study considering three levels of productivity.

3. Material and methods

3.1. Study area

The Republic of Benin is located in tropical West Africa, between 6°30 and 12° North Parallels and 1° and 3°40 East Meridians. Data were collected in two villages belonging to the municipalities of Banikoara, (11°18′0″ North and 2°25′60″ East), situated in the Northern region of Benin (Fig. 1). This zone has been chosen because of its importance in agriculture in Benin. The area is considered as the basket of food and cash crops, implying the major role of agriculture in the livelihoods of population in the study zone (Kokoye et al., 2013a,b).

3.2. Data collection

The data collection was organised as a field study consisted in semi-structured one-on-one interviews with respondents. A two stage sampling technique was used to select the survey respondents. First of all, with the support of agricultural extension officers, a purposeful sampling method was used to select two representative villages (Kokiborou and Kokey) belonging to two different districts (out of 8 districts in the whole municipality). The selection criteria were the relevance of the subject for the village, the easiest accessibility during the survey time and the availability of financial resources. Then in a second stage, a random sampling method was used to select households in the two villages. To ensure the random characteristic of the sample, all farmers were listed and numbered through a rapid census in each village. Later on, the respondents were selected by using the table of random numbers.

As a result, the primary data of this study were collected from a total sample of 210 farmers. The distribution of the respondents in the study area is presented in Table 1. The sample size in each village is considered to be satisfactory as it covers at least 10% of the overall village's households. Data were collected between July and August 2007 and are related to the farmers' socio-economic and demographic characteristics, and the inputs – land, labor, capital involved in the production process and outputs – crops yields obtained by farmers during a cropping season 2006–2007 (Table 2).

3.3. Data description

3.3.1. Farmers' socio-economic and demographic characteristics

As shown in Table 3, agricultural production in the study zone in mainly led by men (91.47%).This could be explained by the dominance of cotton production which is the main cash crop in the study area. Traditionally men are responsible for cash crops with high market value but women tend to be involved at all stages, with men becoming more active close to market time (IFAD, 2000; Kokoye et al., 2013a,b). The off-farm income employment becomes nowadays important in rural area as it contributes to the income generation and by then allows farmers to meet food security goal. In this line 34.29% of farmers have off- farm income employment which allows them to gain extra revenue for their subsistence. 39% of farmers declare belonging to farmers' group and 40% of them benefit support from extension services. The average age of farmers is 43 years old. The average household size is 10 persons. Farmers have an average of 9 years of experience in agriculture whereas they have low level of schooling.

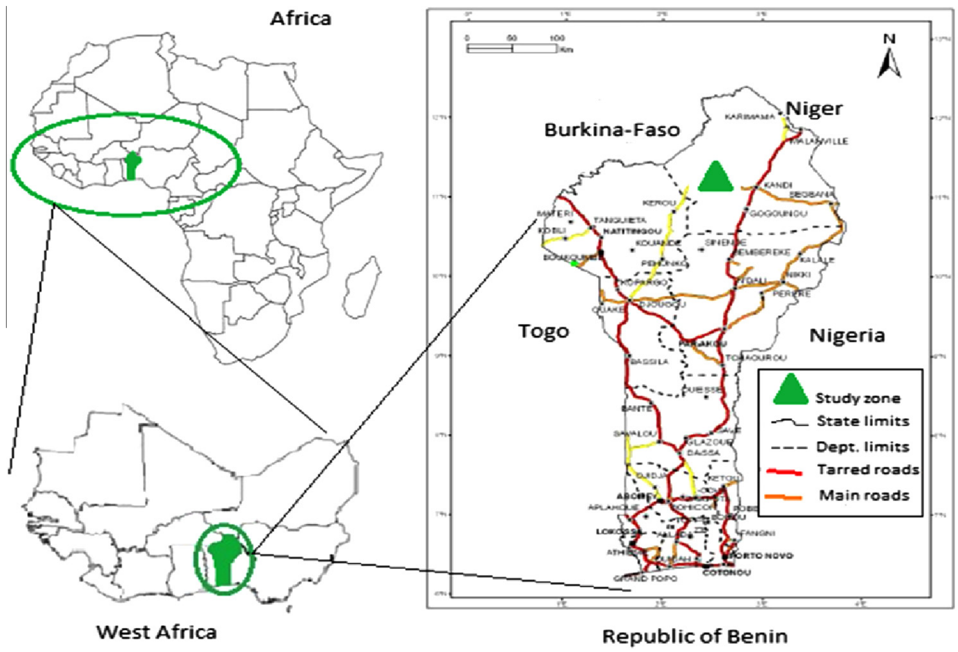

Fig. 1. Study area.

Table 1
Distribution of the respondents in the study area.

Administrative unit (district)	Villages	Village households	Sample size	Percentage of households surveyed
Kokey	Kokey	918	104	11.32
Kokiborou	Kokiborou	226	106	46.90
Total	2	1144	210	18.35

3.3.2. Farming system

In the study area the average farm size in terms of land amount under cultivation is 11.01 (±8.51) hectares per farm. This total amount of land is allocated among main crops grouped into cereal crops (maize, rice, and sorghum), legume crops (beans, groundnut, and soybean) and cash crop (cotton for instance) (Table 4). Land is mostly allocated for cash crops – cotton for instance –, followed by cereal crops. Indeed, the survey zone belongs to the Agro-Ecological Zone II, known as "Cotton Zone of the North-Benin". In this region, agriculture has been dominated over the past three decades by cotton production. Within the cereal crops, maize and sorghum are the most important ones in terms of land size under cultivation.

In addition to land, labor, capital and fertilisers are production factors much value in the production process (Table 5). The labor sources are the household members working in agriculture or the agricultural wage labor. The capital might include the household's assets (materials and machines of production, cash, etc.) and extra money from credit. Rice, maize, sorghum, and cotton are fertilised by 66.67%, 95.24%, 2.95%, and 100% of farmers, respectively. The fertilisers dose applied are 193.30 (±101.29), 135.41 (±106.70), 46.66 (±5.16), 241.19 (±121.19) kg per ha for rice, maize, sorghum, and cotton, respectively.

Table 2
Explanatory variables considered in the model.

Variables	Types [a]	Modalities	Expected signs
Socio-economic and demographic characteristics (Z)			
Village	D	0 = Kokey; 1 = Kokiborou	±
Age	C	–	±
Gender	D	0 = Female; 1 = Male	±
Educational level	C	–	±
Experience in agriculture	C	–	
Off-farm income employment	D	No = 0 ; Yes = 1	±
Household size	C	–	±
Contact with extension	D	No = 0 ; Yes = 1	±
Group membership	D	No = 0 ; Yes = 1	±
Farming system characteristics (X)			
Land under rice cultivation	C	–	–
Land under maize cultivation	C	–	–
Land under sorghum cultivation	C	–	–
Land under cotton cultivation	C	–	–
Land under soybean cultivation	C	–	–
Land under beans cultivation	C	–	–
Land under groundnut cultivation	C	–	–
Available household's workers	C	–	+
Agricultural wage labor use	D	No = 0; Yes = 1	+
Household's capital	C	–	+
Access to credit	D	No = 0; Yes = 1	+
Rice fertilisation	D	No = 0; Yes = 1	+
Maize fertilisation	D	No = 0; Yes = 1	+
Sorghum fertilisation	D	No = 0; Yes = 1	+
Cotton fertilisation	D	No = 0; Yes = 1	+

[a] Types: D = discontinuous variables; C = continuous variables.
Source: Authors' specifications.

3.4. Partial land, labor, and capital productivities

Productivity is a very old concept, defined as the ability of a unit of an input to produce a given level of output (Harsh et al., 1981). Measuring the partial land, labor, and capital productivities refers to measuring the contribution of each individual production factor to the total output. Doing so, the productivity of different resources used is quantified. In this line, the partial land productivity ratio

Table 3
Socio-economic and demographic characteristics.

Qualitative variable	Frequency	Percentage
Village	–	–
Kokey	104	49.52
Kokiborou	106	50.48
Gender	–	–
Female	18	08.57
Male	192	91.47
Off-farm income employment	72	34.29
Group membership	76	39.19
Contact with extension service	86	40.95
	Mean	Standard deviation
Age	43.24	12.22
Educational level	00.94	02.08
Household size	10.03	04.18
Experience in agriculture	09.20	07.94

Source: Authors' calculations from field study data.

Table 4
Land distribution according to the crop items.

Crop groups	Mean (in hectare)	Standard deviation
Cereal	4.51	3.18
Maize	3.06	2.27
Rice	0.36	0.39
Sorghum	1.51	1.19
Legume	0.67	0.92
Beans	0.47	0.44
Groundnut	0.83	0.66
Soybean	0.28	0.16
Cash (cotton)	5.82	5.87
Total	11.01	8.51

Source: Authors' calculations from field study data.

Table 5
Descriptive statistics of labor and capital.

Qualitative variable	Frequency	Percentage
Agricultural wage labor use	108	51.43
Access to credit	42	20.00
Rice fertilisation	140	66.67
Maize fertilisation	209	95.24
Sorghum fertilisation	06	02.86
Cotton fertilisation	210	100
	Mean	Standard deviation
Household's workers in agriculture	07.79	03.89
Household's capital (in Franc CFA)	826844.6	718178.9

Note: 1 Euro = 655.95 Franc CFA.
Source: Authors' calculations from field study data.

that is widely used in numerous studies in sub-Saharan countries measures the total output per unit of land. Following Rija (2004) and Yegbemey et al. (2012), the partial land productivity (PP_L) is mathematically defined as:

$$PP_L = \frac{\sum_{i=1}^{n}(Q_i \times P_i)}{\sum_{i=1}^{n} L_i} \quad (3)$$

In this equation, Q_i stands for the harvested quantity of the ith crop in the selling unit, P_i for its price, L_i its land size, and n the total number of crops under consideration. Subsequently the labor productivity (PP_w) and the capital productivity (PP_c) are:

$$PP_W = \frac{\sum_{i=1}^{n}(Q_i \times P_i)}{\sum_{i=1}^{n} W_i} \quad \text{and} \quad PP_C = \frac{\sum_{i=1}^{n}(Q_i \times P_i)}{\sum_{i=1}^{n} C_i} \quad (4)$$

where Q_i stands for the harvested quantity of ith crop in the selling unit, P_i for its price, W_i and C_i are respectively the quantities of labor and capital used for its production, and n the total number of crops under consideration.

3.5. Specification of the empirical model

Modelling a partial productivity following Eq. (2) would produce the following equation:

$$PP_i = \alpha Z_i + \beta X_i + e_i \quad (5)$$

where PP_i corresponds the partial productivity; α, and β stand for the coefficients of Z_i, and X_i respectively; e_i represent the terms of error. Considering m socio-economic and demographic factors and j inputs, the previous equation becomes:

$$PP_i = \sum_m \alpha_m z_{im} + \sum_j \beta_j X_{ij} + e_i \quad (6)$$

Considering that the land, labor, and capital productivities are partial components of the total farm productivity, the probability to predict the productivity of each production factor is likely to be correlated with the probability to predict the productivity of other production factors. Regarding the theoretical statements, the partial productivity of one input is determined by exogenous factors that might be the same or different from one input to another. Therefore, modelling the partial input productivity implies a set of equations that may be related not because they interact, but because their error terms are related. Following Zellner (1962), this leads to the following formulation:

$$\begin{cases} PP_{Li} = \sum_m \alpha_{Lm} z_{im} + \sum_j \beta_{Lj} x_{ij} + e_{Li} \\ PP_{Wi} = \sum_m \alpha_{Wm} z_{im} + \sum_j \beta_{Wj} x_{ij} + e_{Wi} \\ PP_{Ci} = \sum_m \alpha_{Cm} z_{im} + \sum_j \beta_{Cj} x_{ij} + e_{Ci} \end{cases} \quad (7)$$

In this system, α_m and β_j stand for the coefficients of Z_i and X_i respectively; e_i represent the terms of error.

The coefficients α_i and β_i were estimated using the OLS (ordinary Least Square method) through a "Seemingly Unrelated Regression" (SURE). From these coefficients and their levels of significance, the factors affecting the land, capital and labor productivity have been evaluated. In order to avoid autocorrelation, heteroscedasticity and multicollinearity errors in particular, it has been applied the estimation method by steps, which has eliminated progressively the variables highly correlated to others in the model until an errorless estimate of multicollinearity is obtained.

4. Results and discussions

4.1. Partial Land, labor and capital productivities

Land appears to be the most productive production factor, followed by labor and capital (Table 6). In other words, from one unit of land, farmers carry out more output than from one unit of labor or capital. Considering the partial labor productivity, a worker may gain more than 50,000 francs CFA – about 78 Euro – per month. This value is high than the minimum salary in Benin which is equivalent to 31,625 francs CFA – about 48 Euros per month.

4.2. Determinants of land, labor, and capital productivities

Both socio-economic and demographic characteristics, and inputs (land, labor, capital, use of fertilisers for instance) determine the partial land, labor, and capital productivities within the farms.

Table 6
Land, labor, and capital productivity.

Productivity of:	Mean	Standard deviation
Land (FCFA/ha)	163643.90	79169.02
Labor (FCFA/Man.day)	1716.92	1002.55
Capital (No unit)	2.48	2.11

Note: 1 Euro = 655.95 Franc CFA.
Source: Authors' calculations from field study data.

Before estimating the regression model, the variable cotton fertilisation was dropped because all farmers produced cotton and fertilised it. This variable does not bring any variability for explaining the partial land, labor, and capital productivities.

After estimation, both equations in the model are highly significant at 1% level. Moreover, from the Breusch-Pagan test of independence, it is assumed that the residuals are correlated (Chi^2 $(3) = 268.25$; $p = 0.000$), indicating the suitability of the simultaneous modelling. The seemingly unrelated regression results (Table 7) revealed that the variations of the explanatory variables considered in the model explain 22– 47% of the variations observed in the partial land, labor, and capital productivities. The non-explained variations of the partial productivities might be attributed to geo-climatic, historical, and political factors not considered in this study. The constant of both equations in the model are positive and highly significant at 1% level, confirming the partial nature of the computed partial land, labor and capital productivities.

4.2.1. About the land productivity

Land productivity is determined by factors such as the household head gender, experience in agriculture, off farm income employment; the household size; the sizes of land under maize, sorghum, and cotton cultivation; the household's capital; and the maize fertilisation.

Experience in agriculture, the household size, and the household's capital are factors with positive and significance effects on the partial land productivity at 1% level. On the one hand, experience in agriculture implies that farmers can manage more rationally their farm, as well as the land allocation. This goes in the line that learning from experience reduces allocative errors (Huffman, 1977). The household size has a positive and significant effect (at 10% level) on the partial land productivity. As argued by Wiredu et al. (2010), larger household size guarantees the availability of labor during the peak of production when hired labor is in scarcity, making farmers able to undertake all the production activities. On the other hand, the more means a household has, the more it is likely to invest in per unit land, making land more productive.

It is often argued that women's lower levels of human and physical capital result in lower productivity or inability to respond to economic incentives (Boserup, 1970). Moreover, there is a pervasive gender gap in asset ownership, with women owning less land than men, or land that is of lower quality (Doss, 2006). The findings of this study contrast these statements because women recorded higher partial land productivity than men. Women mainly focus on food crops production. Therefore, following Ellis (1993), the crop composition of the output might explain this result.

Off-farm income employment is an important indirect determinant of productivity via its effect on farm input acquisition and investments (Reardon et al., 1997). But the results of the regression model revealed that off-farm income employment as source of income leads farmers to invest less input per unit of land. This might indicate that the income coming from off-farm activity is mainly used for purchasing non-agricultural goods.

The sizes of land under maize (at 10% level), sorghum (at 5% level), and cotton (at 5% level) cultivation have negative and significant effects on the partial land productivity. This result is quite interesting for the fact that different studies highlighted the negative correlation or inverse relationship between farm size (in terms of land) and farm productivity, supporting the popular arguments in literature (Wu, 2005; Kimhi, 2003; Van den Ban and Hawkins, 1996). According to Masterson (2007), inputs, costs, and output per hectare seemed to decrease as farm size increased, while output per unit of input increased. Many authors conclude

Table 7
Results of the seemingly unrelated regression model.

Variables	Land productivity Coefficient$^{P>z}$	Labor productivity Coefficient$^{P>z}$	Capital productivity Coefficient$^{P>z}$
Socio-economic and demographic characteristics (Z)			
Village	−12513.67 (12379.06)	−109.25 (163.28)	−0.035 (0.282)
Age	−7923.65 (5615.88)	−5.67 (7.40)	−0.004 (0.012)
Gender	−65063.01*** (22035.54)	531.68* (290.65)	−0.320 (0.503)
Educational level	−4.243.68 (2611.59)	−38.91 (344.48)	0.019 (0.059)
Experience in agriculture	2034.38*** (734.51)	21.20** (9.68)	0.009 (0.016)
Off-farm income employment	−39549.14*** (12141.57)	−354.28** (160.15)	−0.408 (0.277)
Household size	7507.84** (3275.73)	−72.82* (43.20)	−0.156** (0.074)
Contact with extension	−14352.30 (12295.19)	−51.93 (162.17)	−0.030 (0.280)
Group membership	8882.22 (12672.95)	74.38 (167.16)	0.461 (0.289)
Farming system characteristics (X)			
Land under rice cultivation	−8710.76 (17661.76)	−424.72* (232.96)	0.170 (0.403)
Land under maize cultivation	−5746.73* (3486.24)	−3.32 (45.98)	0.203*** (0.079)
Land under sorghum cultivation	−11353.16** (5650.73)	−26.73 (74.53)	0.396*** (0.129)
Land under cotton cultivation	−3871.54** (1700.71)	−87.67*** (22.43)	0.091** (0.038)
Land under soybean cultivation	−39316.82 (35707.44)	−405.39 (470.99)	−173.530** (0.815)
Land under beans cultivation	26399.72 (17685.6)	328.00 (233.28)	0.612 (0.403)
Land under groundnut cultivation	2439.84 (11540.83)	153.72 (152.22)	0.084 (0.263)
Household's workers	4673.33 (3645.64)	30.19 (48.08)	0.054 (0.083)
Agricultural wage labor use	9557.01 (11033.6)	21.55 (145.53)	−0.347 (0.251)
Household's capital	0.04*** (0.011)	0.0003*** (0.0001)	−1.10e-06*** (2.51e-07)
Access to credit	19685.34 (14967.71)	465.85** (197.43)	0.390 (0.341)
Rice fertilisation	−1548.97 (14546.07)	−39.94 (191.86)	−0.052 (0.332)
Maize fertilisation	−68334.82*** (24482.15)	−14.93 (322.93)	−4.660*** (0.558)
Sorghum fertilisation	−15715.22 (32796.38)	−80.76 (432.60)	−0.336 (0.748)
Resume of the model			
Constant	375216.4*** (34615.84)	3156.43*** (456.59)	8.100*** (0.790)
Observations	210	210	210
Parameters	23	23	23
R-square	0.29	0.22	0.47
Chi^2 (Probability)	83.31 (0.0000)	60.34 (0.0000)	187.68 (0.0000)

NB: The values in bracket are the standard-errors.
Source: Authors' estimations from field study data.
* Significant at 10%, respectively.
** Significant at 5%, respectively.
*** Significant at 1%, respectively.

that the inverse relationship is a result of differential factor use intensity (Carter, 1984; Newell et al., 1997). Moreover, land quality differences may also contribute to the inverse relationship (Masterson, 2007), as well as the crop composition of the output (Ellis, 1993).

Over the past 25 years, chemical fertilizers have been the primary means of enhancing soil fertility in small farm agriculture (Byerlee et al., 1994). The results of the regression model indicate that only maize fertilisation has an unexpected negative and significant effect on the partial land productivity. This sign might be the result of an under fertilisation situation. For good maize harvest the research recommends the use of 200 kg of NPK (14-23-14) per ha but the report has shown the use of 135.41 kg of NPK per ha.

4.2.2. About the labor productivity

The partial labor productivity is affected by almost the same factors that determine the partial land productivity. Indeed the partial labor productivity is mainly determined by the household head gender, his experience in agriculture, off-farm income employment, the household size, the sizes of land under rice and cotton cultivation, the household's capital, and the access to credit.

As previously for the partial land productivity, experience in agriculture and the household's capital have positive and significance effects on the partial labor productivity but at 10% and 1% level respectively. The explanations provided before for the partial land productivity are still applicable here. In addition to the farmer's experience in agriculture and the household capital, the access to credit also has a positive and significance effect on the partial labor productivity but at 10% level.

The gender – sex – has a positive and significance effects on the partial labor productivity at 10% level. This goes in line with the common view of women being physically weak than men. But this statement needs to be nuanced given that various researches conducted on the contribution of women to agricultural development in the country suggest that women contribution to farm work is as high as between 60% and 90% of the total farm task performed according to Damisa and Yohanna (2007) quoted in Oladejo et al. (2011). The study considered the gender of household head, the composition of the household has not been considered, this may explain the result obtained. As for the partial land productivity, the partial labor productivity is also negatively and meaningfully affected by off-farm income employment, the household size and the land size under rice and cotton cultivation. While a farmer has off-farm income employment, it is obvious that he has to share his time between this activity and his farm. Therefore there are opportunity costs that the farmers are willing to forgo or gain.

The household size effect on the partial labor productivity is also relevant. Indeed, exploring the determinants of labor productivity on small-holder cocoyam farms in Anambra State (Nigeria), Okoye et al. (2008) found out that the household size were negative and significantly related to labor productivity. One of the reasons is that farmers with large household size tend to dissipate most of their resources on upbringing and education of their children (Okoye et al., 2008). The size of land under rice cultivation, factor which does not affect the partial land productivity, has a negative and significant effect on the partial labor productivity. This implies an inverse relationship between the size of land under rice cultivation and the partial labor productivity.

4.2.3. About the capital productivity

The household size, the land size under cotton cultivation, and the household's capital that determine the partial land and labor productivities, affect also the partial capital productivity. Here the household size has a negative and significant effect. While ensuring the availability of labor (Wiredu et al., 2010) large household sizes allow farmers to expend less capital for hiring workers.

Table 8
Factors determining the partial productivities.

Factors	Partial land productivity	Partial labor productivity	Partial capital productivity
Gender	Negative	Negative	–
Experience in agriculture	Positive	Positive	–
Off-farm income employment	Negative	Negative	–
Household size	Negative	Negative	Negative
Land under rice cultivation	–	Negative	–
Land under maize cultivation	Negative	–	Positive
Land under sorghum cultivation	Negative	–	Positive
Land under cotton cultivation	Negative	Negative	Positive
Land under soybean cultivation	–	–	Negative
Household's capital	Positive	Positive	Negative
Access to credit	–	Positive	–
Maize fertilisation	Negative	–	Negative

Source: Authors' summary from field study data.

The size of land under cotton cultivation has a positive and significant effect on the partial capital productivity at 5% level. In other words, larger cotton farms have higher capital productivity that might be a scale result. In addition, the land sizes under maize and sorghum cultivation as well as the maize fertilisation that affect the partial land productivity, determine also the partial capital productivity. However, while the land sizes have a negative impact on the partial land productivity, the impact on the partial capital productivity is positive and significant a 1% level, implying a positive correlation. This is somehow obvious because for cultivating more land, having more capital is a prerequisite.

The maize fertilisation has the same effect on both partial land and capital productivities. As in the case of the partial land productivity, the previous explanation according to which most of the farmers are under fertilisation might stand here too. In contrast with the effect of the land size under cotton, maize, and sorghum, the land size under soybean cultivation affects significantly and negatively the partial capital productivity, however without significant effect on the partial land and labor productivities. This implies that cultivating more land of soybean requires less capital. Soybean is a legume crop which has the capability to fix nitrogen and by then improve the soil fertility. This characteristic avoids the use of fertilizers. Therefore its cultivation even on large scale requires less capital.

To summarize, some factors determine one, two, or all partial land, labor, and capital productivities (Table 8). The remaining variable included in the model – farm location (village for instance), household' head age, educational level, contact with extension, group membership, sizes of land under beans and groundnut cultivation, number of household members working in agriculture, Agricultural wage labor use, and rice and sorghum fertilisation - have no significant effects on the partial land, labor, and capital productivities.

5. Conclusion

The findings highlighted that land is the most productive factor. The seemingly unrelated regression revealed that both socio-economic and demographic characteristics and the farming system characteristics determine the partial productivities. Depending on the crop, land size might have inverse relationship with agricultural productivity, for instance the partial land and labor productivities. By comparing land productivity and capital productivity the land under maize, sorghum and cotton cultivation influence both productivities – land and capital productivities -- but in the opposite way – negatively and positively respectively--. Soybean one of the main crops requires less capital for its cultivation since it is able to improve the soil fertility and therefore does not need an investment in terms of fertilizers.

Land management, soil fertility conservation practices should be at the centre of agricultural policy in order to maintain the level of land productivity. To promote land productivity, the small size farms, with production intensification, seem to be more appropriate.

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