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Resource Allocation for Cocoyam and Coffee Production in Momo, North West Region of Cameroon

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ABSTRACT In the North West Region of Cameroon, cocoyam and coffee crops are simultaneously cultivated on the same piece of land creating an allocation problem of labour and capital resources. Hence, this study aims to determine the intensities and productivity in the usage of labour and capital for cultivating the two crops. Using a multistage random sampling design, 120 farmers were selected for the study. Data was collected on family size, age of respondent, level of education, farming experience, output of coffee and cocoyam, farm size and labour used in terms of mandays. The field data were analysed using descriptive statistics and Cobb-Douglas production function. Descriptive field results showed that, there was no significant difference in usage of labour and capital for cocoyam production, while coffee production was capital intensive. Output for cocoyam was dependent on labour and capital. Results from Cobb-Douglas production function showed an increasing return to scale for cocoyam and a decreasing return to scale for coffee with respect to both the labour and capital inputs. One percent increase in the intensities of labour and capital led to only 0.33% increase in coffee yield. Hence, the study recommends that labour and capital should firstly be allocated to cocoyam production where they are more productive.

1. INTRODUCTION

Like in most developing countries, the Cameroon's economy depends mainly on agriculture. About 60% of the country's population still lives in the rural areas with agriculture being their main occupation (World Bank 2009). Since the independence of the country in 1960, cash crops and food crops constitute the main speculations of the farmers in all regions of the country (Defranc 1995). In most households, the cash crop is cultivated to earn income for basic needs (schooling, health care, funerals, etc.) whereas the food crops are mainly cultivated for the subsistence of the family (Defranc 1995; Ministry of Agriculture 2002).

The North West region does not make any exception since farmers of this part of the country produce cocoyam as the main food crop for family survival and coffee as the main cash crop to be sold in order to solve family problems (schooling, health care, funerals, etc.) (Tempelman 1998; Ministry of Agriculture 2002). Hence, for a better living standard for the people in the area, the production of both cocoyam and coffee is important because cocoyam is the staple food crop and provides food for consumption, while coffee as the predominant cash crop, serves as the major source of income. Usually, the labour force of the population of this region is mainly devoted to cultivate these two main crops necessary for their survival and living dependence (Ministry of Agriculture 2002).

However, the high motivation of this labour force to cultivate the two main crops (cocoyam and coffee) is hampered by poverty that prevails among rural farmers. As a matter of fact, about 40% of the Cameroon's population (including people from North West region) lives below the poverty line thereby lacking capital to invest into agriculture (World Bank 2009; Ministry of Agriculture 2002). Poverty is really a serious problem to the region because, in spite of the willingness of the rural farmers to work in the farming sector, they lack enough money to invest in agriculture. Hence, capital remains another main limiting factor of production in this region (Defranc 1995; Ministry of Agriculture 2002).

The economics literature (Heady and Dillon 1961; Doll and Orazem 1978) already suggests labour and capital as the two main factors of production. However, the evidence from the field in the North West region rather finds the two resources as scarce. In the rare circumstances when the two resources are available, the problem of their allocation between the two main crops of the region (cocoyam food crop and coffee cash crop) remains a difficult challenge. Hence, it is a great problem for farmers to know where emphasis should be enforced in the allocation of labour and capital in order to secure

higher production from those two crops in the region. The study was therefore designed to analyse the resource allocation (especially labour and capital) in cocoyam and coffee production in Momo division of the North West region of Cameroon. In order to achieve that goal, the study addressed the following research questions:

1. What are the intensities in the usage of labour and capital resources in the production of cocoyam and coffee?
2. What is the effect of the increase in the intensities of use of labour and capital resources?

Study Objectives

In general, this study seeks to determine the intensities and productivity in the usage of labour and capital for cultivating the two crops. More specifically, the study aims to:

1. Calculate the intensities in the usage of labour and capital resources in the production of cocoyam and coffee.
2. Compute and analyse the returns to scale associated with the use of both labour and capital for cocoyam and coffee production.

2. MATERIAL AND METHODS

2.1 The Study Area and Data Collection

Momo Division, North West region of Cameroon is the case study area. It is located between latitudes 5° 45' and 6° 45' N and longitudes 9° 40' and 10° 10' E. It is made up five subdivisions namely: Batibo, Mbengwi, Ngie, Njikwa and Widikum. Food crops include cocoyam, yam, banana, plantain, maize, cassava, groundnut and vegetables. It has the pattern of rainfall that dictates the farming season. Cash crops include coffee, oil palm and kola nuts.

Multistage random sampling was used for the study. In stage one, there was a random selection of two cocoyam and coffee producing subdivisions out of five divisions In stage two, three villages (Efah, Guzang, Mbunjei, Bessi Fomunkong, Nchum, and Nforya) were selected randomly from each of the two sub divisions (Batibo and Mbengwi) initially selected. In stage three, 20 farmers were chosen randomly from each of the three villages. This gave a total of 120 respondents/farmers for the study. A set of structured and pre-tested questionnaires was used in data collection. The questionnaires provided information on sources of land for cocoyam and coffee production, labour allocation for the different farming operations in cocoyam and coffee production and the tools/equipment used in cocoyam and coffee production amongst others.

2.2 Data Analysis

The economic model commonly used to determine the relationship between the various factors and the output in agriculture is a production function. A production function is a mathematical equation showing the maximum amount of output that can be realized from a given set of inputs (Doll and Orazem 1984).

The economics literature suggests three main types of production function: linear, semi-log and Cobb-Douglas (Heady and Dillon 1961; Doll and Orazem 1984). The three types were firstly tried in this study and among them, the Cobb-Douglas was preferred mainly due to its convenience in estimation which employs an Ordinary Least Squares (OLS) technique, its simplicity in the interpretation of coefficients (the coefficients of this function represent the elasticities of production, easier to interpret) and its perfect inputs substitution property (Doll and Orazem 1984).

The mathematical form of the Cobb-Douglas production function used here is given by the following formula:

$$Y = b_o X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} X_7^{b_7} X_8^{b_8} U$$

Implicitly, the equation may be expressed as:

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8) + U$ ..... (2)

where,

- Y = output of cocoyam or coffee (physical terms);
- X_1 = age of the respondent (farmers)
- X_2 = Family size
- X_3 = Level of formal education of the farmer (years)
- X_4 = Farming experience (years)
- X_5 = size of the farm (cocoyam or coffee) (ha)
- X_6 = Labor used on the farm (cocoyam or coffee) (Mandays) and
- X_7 = Capital
- X_8 = coffee type; 0 for arabica, 1 for robusta.
- b_o = constant term
- $b_{1,2}$ = Elasticities of output with respect to X_i where i = 1, 2, …,8
- U = random disturbance term

The coefficients b_1 to b_8 of the model in equation (1) represent the production elasticities of co-

coyam/coffee yield with respect to the factor inputs. Hence, each coefficient b_i is defined as the percent change in output for 1 percent change in the i^{th} factor. In a Cobb-Douglas production function, the sum of these coefficients $\sum_{i=1}^{8} b_i$ is the degree of homogeneity, which measures whether the production function undergoes constant, increasing, or decreasing returns *to scale*. Three possibilities might exist:

$\sum_{i=1}^{8} b_i = 1$, there is constant return to scale of cocoyam/coffee production to inputs;

$\sum_{i=1}^{8} b_i < 1$, there is decreasing returns to scale of cocoyam/coffee production to inputs and

$\sum_{i=1}^{8} b_i > 1$, there is increasing returns to scale of cocoyam/coffee production to inputs.

In order to achieve the study objectives, two sets of hypotheses were formulated in this study:

(1)-All the factor inputs have a positive impact on cocoyam/coffee production. The hypothesis can be stated as:

H_o: $\sum_{i=1}^{8} b_i = 0$ *against* H_a: $\sum_{i=1}^{8} b_i > 0$

(2)-The sum of the coefficients of technological inputs (labor and capital) is equal to unity. This hypothesis can be formulated as:

H_o: $b_6+b_7=1$, *against* H_a: $b_6+b_7>1$

In order to test these hypotheses, simple descriptive statistics and more importantly a double-log regression analysis was performed on the data to estimate the relationship between cocoyam/coffee and the different factor inputs. Hence, the estimated regression equation directly identifies the returns to scale of cocoyam/coffee production by summing the coefficients of labor and capital.

3. RESULTS AND DISCUSSION

3.1 Descriptive Field Results

Land for cocoyam and coffee production can be inherited, purchased, leased, obtained as a gift or is communal (Fon 2011). The distribution of cocoyam and coffee farmers according to the source of farmland for cocoyam and coffee production is presented in Table 1. Results from the table shows that most of the land used in cocoyam production (93.1%) and coffee production (85.4%) was inherited. Communal land is not used for coffee production because of its relatively long gestation period. Since coffee requires relatively large plots of land and it is not an annual crop, which can be changed at the end of one farming season, the source of land for its production was principally through inheritance and purchase. In cocoyam production, leasing was an important source of land.

Table 1: Distribution of respondents according to their source of farmland for cocoyam and coffee production

Source of farmland	*Cocoyam*		*Coffee*	
	Frequency	*Percentage*	*Frequency*	*Percentage*
Inherited	108	93.1	99	85.4
Purchased	41	35.4	39	33.6
Leased	30	25.9	01	0.09
Gift	19	16.4	06	05.2
Communal	05	04.3	00	00.0

Number (n=116*)
*: Multiple responses were recorded

Labour allocation for the different farm operations for cocoyam is shown in Table 2. Results show that weeding was the most important farm operation in cocoyam production in terms of labor requirement (31.4%). This was followed by ridge making (21.6%) and harvesting (19.6%). These results are in line with those of Tambe (1994) and Ezedinma (2000) that weeding, land preparation and harvesting is the most

Table 2: Labour allocation (mandays) per hectare for different farm operations on cocoyam based crop enterprise

Farm operation	*Mandays*	*Percentage*
Land clearing	14	13.7
Ridge making	22	21.6
Planting	14	13.7
Weeding	32	31.4
Harvesting	20	19.6
Total	102	100.0

Table 3: Labour allocation (mandays) per hectare for different farm operations on a coffee based crop enterprise

Farm operation	*Mandays*	*Percentage*
Weeding	20	29.4
Pruning	07	10.3
Spraying chemicals	01	01.5
Fertilizer application	04	05.2
Harvesting	36	52.9
Total	68	100.0

labour intensive activities in yam and cassava production. Planting and land clearing required the least mandays. All the operations carried out on the cocoyam farms were done manually.

Table 4: Farm tools / equipment used on cocoyam farms and their annual values

Tool/ Equipment	*Average cost (FCFA)*	*Total life span (Years)*	*Annual value (FCFA)*
Hoe	1345.0	3	448.3
Cutlass	2404.0	3	801.3
Knife	221.5	1	221.5
Axe	3317.0	5	663.4
Basin	2395.5	5	479.2
Basket	600.0	2	300.0
Total	-	-	2913.7

Note: FCFA = African Financial Community (Franc) or "Francs Communaute Francaise Africaine" in French language. This currency is pegged to the Euros at 1 Euro=655.957 FCFA US$1=500 FCFA (This rate fluctuates a lot)

Table 5: Farm tools / equipment used on coffee farms and their annual values

Tool/ Equipment	*Average cost (FCFA)*	*Total life span (Years)*	*Annual value (FCFA)*
Hoe	1345.0	3	448.3
Cutlass	2404.0	3	801.3
Pruning Scissor	2653.0	5	530.6
Sprayer	17090.0	10	1709.0
Jute Bags	500.0	2	250.0
Tarpaulin	5200.0	5	1040.0
Basket	175.0	2	87.5
File	600.0	1	600.0
Total	-	-	5466.7

Note: FCFA = African Financial Community (Franc) or "Francs Communaute Francaise Africaine" in French language. This currency is pegged to the Euros at 1 Euro=655.957 FCFA. US$1=500 FCFA (This rate fluctuates a lot)

Labour allocation for the different farm operations on coffee farms is presented in Table 3. The table shows that harvesting was the most important farm operation in coffee production in terms of labor requirement (52.9%). This supports the findings of Waller et al. (2007). Weeding was next in importance with a labor allocation of 29.4%, followed by pruning (10.3%). This may be due to the fact that timeliness in farm operations counts. For instance, harvesting of the coffee beans at the appropriate period enhance the yield both in quantity and quality and Calo and Wise (2005) affirms that coffee productivity is very sensitive to regular upkeep.

In a production process, there are usually inputs in the form of land, labor and capital of which managerial skill is added to give the expected result. In the study area, cocoyam and coffee production are considered to be processes whereby inputs like land, labor and capital are combined by the farmers in the best way they can to produce cocoyams and coffee beans.

Capital includes cash, farm tools/equipment and structures. Farm structures were virtually absent and such physical structures like buildings in which farmers keep their farm tools/ equipment and outputs, were ignored because they were primarily used for residence.

The farm tools/equipment used by farmers in the study area included hoes, cutlasses, knives axes, basins and baskets for cocoyam production while cutlasses, pruning scissors, sprayers, baskets, jute bags, tarpaulins and files were used for coffee. Tables 4 and 5 show the annual values of the farm tools/equipment used by the farmers on cocoyam and coffee farms.

An average cocoyam farmer has four tools: hoes, cutlass, knife and basket, while an average coffee farmer has five tools namely: hoe, cutlass, basket, jute bag and file. However, it is rare to find a cocoyam or coffee farmer in possession of all the mentioned tools /equipment outlined in Tables 4 and 5. A total annual value of 2913.7 FCFA and 5466.7 FCFA could be obtained for any cocoyam or coffee farmer in possession of all the farm tools /equipment listed and a lesser amount otherwise.

3.2 Results of the Estimated Crops Production Functions

The effects of socio-economic variables, which were investigated using the production function model had correlation matrix that showed that none of the independent variables was statistically linearly correlated, that is, there was no multicollinearity. A summary of the regression analysis (of the best fit form) for cocoyam and coffee production is shown in Table 6. The mean values of the variables are presented in Table 7 the double-log form(out of the three functional forms tried), gave the best fit in terms of the overall F-Ratio, coefficient of multiple determination (R^2), the statistical significance of

Table 6: Summary of the multiple regression analysis for cocoyam and coffee (the double log form)

Variable	*Cocoyam*	*Coffee*
Age (X_1)	-1.83*(	0.12
	(0.54)	(0.27)
Family size (X_2)	0.34	0.24*
	(22)	(0.11)
Educational	0.35*	-0.003
level (X_3)	*(0.15)	(0.07)
Farming experience (X_4)	0.96*(	0.38**
	*(0.41)	(0.23)
Farm size (X_5)	0.08	0.47
	(0.16)	(0.07)
Labour (X_6)	0.84*)	0.07
	(0.10)	(0.40)
Capital (X_7)	0.98*	0.26
	*(0.20)	(0.07)
Dummy Variable (X_8)	0.19*	
	(0.06)	
Constant (b_0)	-6.67	- 2.30
R-Square (R^2)	0.42	0.74
Overall F	11.32	38.50

α= 5%; $t_{0.025,\ 120} = 1.96$
α = 10%; $t_{.05,\ 120} = 1.645$
* Statistically significant at 5% level
** Statistically significant at 10% level
All others: insignificant at 10% level
Values in parentheses represent standard error

Table 7: Mean values of variables in regression equation

Variable	*Mean value*
Age (X_1)	4.43
Family size (X_2)	8.64
Educational level (X_3)	2.76
Farming experience (X_4)	4.32
Farm size (X_5)	1.24*
	1.55**
Labour (X_6)	102.05*
	67.34**
Capital (X_7)	2761.10
	581296.00**
Output (Y)	200.50*
	6.56**
Dummy Variable (X_8)	0.77

*: Cocoyam; **: Coffee

the regression coefficients and the signs on the regression coefficients, see Tables 8 and 9. The effect of capital and labor was derived by substituting the mean values of the variables except for capital and labor in the double-log form of the equations for both cocoyam and coffee.

Table 8: Summary of multiple regression analysis for cocoyam production

Variable	*Linear*	*Semi log*	*Double log*
Age (X_1)	-207.99**)	-799.85	-1.83*
	(125.74)	(548.64)	(0.54)
Family size (X_2)	105.12*	366.90	0.34
	(33.60)	(244.99)	(22)
Educational level (X_3)	70.46	140.96	0.35*
	(66.55)	(149.77)	(0.15)
Farming experience (X_4)	10.41	180.26	0.96*
	(109.42)	(416.77)	(0.41)
Farm size (X_5)	-171.22	-120.98	0.08
	(148.42)	(164.49)	(0.16)
Labour (X_6)	9.94*	1065.92*	0.84*
	(3.13)	(401.13)	(0.40)
Capital (X_7)	-0.10	-62.26	0.98*
	(202.45)	(0.20)	(0.07)
Constant (b_0)	-560.38	-4151.70	-6.67
R-Square (R^2)	0.23	0.14	0.42
Overall F	4.65	2.41	11.32

α = 5%; $t_{0.025,\ 120} = 1.96$
α = 10%; $t_{.05,\ 120} = 1.645$
* Statistically significant at 5% level
** Statistically significant at 10% level
All others: insignificant at 10% level
Values in parentheses represent standard error

Table 9: Summary of multiple regression analysis for coffee production

Variable	*Linear*	*Semi log*	*Double log*
Age (X_1)	-0.083	-3.81**	0.12
	(0.48)	-3.81**	(0.27)
Family size (X_2)	0.14*	1.09	0.24*
	*(0.11)	(0.98)	(0.11)
Educational level (X_3)	0.17	0.83	-0.00
	(0.26)	(0.64)	(0.07)
Farming experience (X_4)	0.51	2.42	0.38**
	(0.45)	(1.99)	(0.23)
Farm size (X_5)	2.53*	1.63*	0.47*
	(148.42)	(164.49)	(0.16)
Labour (X_6)	0.021	0.55	0.07
	(3.13)	(401.13)	(0.40)
Capital (X_7)	0.00*	2.54*	0.26*
	(0.00)	(0.48)	(0.07)
Dummy Variable (X_8)	2.38*	2.05	0.19*
	(0.49)	(0.57)	(0.06)
Constant (b_0)	-5.13	-18.79	-2.30
R-Square (R^2)	0.66	0.55	0.74
Overall F	25.57	16.21	38.50

α = 5%; $t_{0.025,\ 120} = 1.96$
α = 10%; $t_{.05,\ 120} = 1.645$
* Statistically significant at 5% level
** Statistically significant at 10% level
All others: insignificant at 10% level
Values in parentheses represent standard error

For cocoyam;

$$LogY = \beta_0 - 1.83 \log \bar{X}_1 + 0.34 \log \bar{X}_2 + 0.35 \log \bar{X}_3 + 0.96 \log \bar{X}_4 + 0.077 \log \bar{X}_5 + 0.84 \log X_6 + 0.98 \log X_7$$

For coffee;

$$LogY = \beta_0 + 0.12 \log \bar{X}_1 + 0.24 \log \bar{X}_2 + 0.0003 \log \bar{X}_3 + 0.38 \log \bar{X}_4 + 0.47 \log \bar{X}_5 + 0.19(0.767) + 0.065 \log X_6 + 0.26 \log X_7$$

Where $\bar{X}_i$ = mean values and i = 1-7

Substituting the mean values of the X_i except for capital and labor into the estimated production model and taking the antilogs for cocoyam gave $Y = 0.000000087 X_6^{0.84} X_7^{0.98}$. The results show that the output of cocoyam is dependent on labor and capital. The overall regression equation was statistically significant ($p<0.05$) with an F- Calculated (11.32) greater than the critical – F from table (3.06). The factor intensity ratio (b_7/b_6) is given by 0.98/ 0.84 = 1.2, that is intensity of use of capital and labor in cocoyam production is not significantly different, since the intensity ratio is close to one. The parameter estimates $b_6 = 0.84$ and $b_7 = 0.98$ give elasticity of output with respect to labor and capital. The marginal products of labor and capital were positive indicating that increases in labor and / or capital will yield positive marginal products. From the results of the estimated model, $b_6 + b_7$ was more than one (1.82) indicating the presence of increasing returns to scale. More precisely, this result showed that, a 1% increase in the intensities of both labour and capital altogether would be associated with an increase of 1.82% in cocoyam yield. Therefore, increasing the allocation of both labour and capital would be highly productive to cocoyam farmers in the study area.

The results of the regression analysis $Y = 0.03 X_6^{0.065} X_7^{0.26}$ ($P<0.01$) showed that the output of coffee was dependent on labor and capital. The factor intensity ratio (b_7/b_6) for coffee production was high (Falusi and Olayide 1980). This indicates the capital-intensive nature of the farming operations involved in coffee production. The parameters estimates $b_6 = 0.065$ and $b_7 = 0.26$ give the elasticities of output with respect to labor and capital. The marginal products of labor and capital were positive indicating that an increase in labor and / or capital will yield positive marginal products. From the results of the estimated model b_6 and b_7 was less than one (0.325), indicating the presence of decreasing returns to scale. One percent increase in the intensities of both the labour and capital would lead to 0.33% increase in coffee yield.

Hence, an increase in both the labour and capital is less productive in coffee farms compared to cocoyam farms. As a 1% increase in the intensities of both the labour and capital leads to an increase in cocoyam yield by 1.82%, it would lead to an increase in coffee yield by only 0.325%.

4. CONCLUSION

Most people in the North West region are dependent on coffee as the cash crop and cocoyam as the staple food crop. The production of these two crops suffers from the lack of appropriate allocation of both labour and capital resources in the region. Descriptive field results show that in cocoyam production, labor and capital intensities of use were on equal basis, that is, there was no significant difference in usage, while coffee production was capital intensive. Using a Cobb-Douglas production function (log-log function), this study proves that, the production of cocoyam undergoes an increasing returns to scale in relation to both labour and capital (*sum of elasticities equals to 1.82*) whereas the production of coffee crop rather undergoes a decreasing returns to scale with respect to the labour and capital inputs (*sum of elasticities equals to 0.325*). In conclusion, labour and capital should firstly be allocated to cocoyam farms where they are more productive.

5. RECOMMENDATIONS

For farmers and policy makers taking decisions for farmers, it would be recommended that labour and capital resources should firstly be allocated to cocoyam farms where they are more productive. Although labour has a significant effect on cocoyam output and coffee output depended on labor, the managerial efficiencies in the production of these commodities are very low and thus call for improved methods and techniques of production.

Furthermore, it would be recommended that cocoyam and coffee farmers of the North West Region (Cameroon) should organize themselves into cooperatives or common initiative groups in order to benefit:

(1) In terms of labour: the group work can speed up their work and increase their productivity.
(2) In terms of capital: to easily get access to credit/loans from agricultural banks in

order to finance cocoyam and coffee activities.

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