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RAIT ANALYSIS OF PENJA PEPPER (*PEPER NIGRUM L.*) PRODUCTION DETERMINANTS IN THE MUNGO DIVISION, LITTORAL REGION, CAMEROON

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Summary:-
This article seeks to identify and analyze the determinants of the Penja Pepper production. The survey focused 42 producers from whom data were collected and analyzed using Ordinary Least Squares method. The results of this analysis present the age of the producers and type of plants as the main factors having a negative impact on pepper production. They are significant at 10% and are negatively correlated with the production. In addition, on an average area of 1,675 ha, producers produce an average of 739.5 kg of dry Penja pepper and sell at an average price of 5084.37 CFA / kg. This production is well below the theoretically estimated amount that is 1500 to 2000 kg per hectare. The actors in the sector should use quality plant material, fight against the attacks using natural methods, and regularly monitor their plantation. This would reduce the risk of losing the label.

Keywords:- *Determinant, Production, Label, Penja Pepper (Peper nigrum L.), Littoral, Cameroon*

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1. INTRODUCTION

In Cameroon, agriculture represents 24% of GDP and employs about 50% of the workforce (Biligil, 2017). It is at the center of the fight against poverty and hunger and is instrumental in the development of the Cameroonian economy (Momo, 2011). Despite its importance in the economy, the performance of the agricultural sector in our country remains poor. In fact, there was -73.38%, variation in agricultural exports in 2014 is -102.24% in the industrial exports (and -82.67% in industrial imports. Thus, Cameroon should increase agricultural and industrial exports and imports (Ntsama Etoundi, 2014). Low yields in the agricultural sector and unfavourable prices on the international market contributed to the decline of traditional export crops, including coffee, sugar cane, cotton and cocoa.

The Penja pepper has become a new export product for Cameroon. Its culture is characterized by a young orchard (plantations are on average 7.1 years of age), many damage from some pests, lack of skilled labor force. Furthermore, 90% of producers are small artisans with only about 0.5 to 8 hectares orchard on which the archaic systems of production are carried out. These reduce potential outcomes (Gilbert, 2015).

To ensure the availability of quality Penja pepper on the market, control its traceability and preserve its label, the specifications details of the Pepper cultivation methods and techniques, written by producers and approved by the authorities have been established (Nzenewo, 2012). Despite the introduction of this document, producers in the sector continue to face production difficulties that come from the non-compliance with the said specifications and also from external factors influencing Penja pepper cultivation like climate change, insufficient financial means to better manage the acquisition of inputs (type of plants, fertilizers, insecticides and herbicides), limited human resources, pests, etc. (Nzenewo, 2012).

In addition, the use of rudimentary farming tools that restrict the work of stakeholders hinders the expansion of agricultural plots. In adequate materials required for post-harvest treatment of Pepper, makes the treatment process burdensome and causes many post-harvest products to get bad. The high production costs for the maintenance of the pepper farm, the low number of pepper feet per a hectare of averagely 200 feet, illiteracy and poor producers' organization does not allow them to access new markets.

Given the opportunities and challenges faced by Penja pepper producers, what are the factors influencing the increase in production of Penja pepper? This article seeks to identify and analyze the factors hindering the production of Penja pepper.

2. Materials and methods

This section discusses sampling, model specification and the expected sign of the different variables. The results and discussions have socio-economic characteristics of interviewed producers and the results of the regression.

2.1. Sampling

In Cameroon, the Penja pepper cultivation is practiced in the Mungo division, located in the Littoral Region. The plant used by the producers is *Piper nigrum L.* plants from this plant material are made provided to the producers of the geographically defined area. The production of plants and monitoring of the fields in production process is essentially carried out in the Nkongsamba Subdivision with geographical coordinates 4 ° 57'12 "N, 9 ° 55'57" E (in the municipalities of Manjo / Nlohé, Njombe / Penja, Mbanga and Loum), and in Tombel Subdivision (4 ° 45'6 "N and 9 ° 40'22" E).

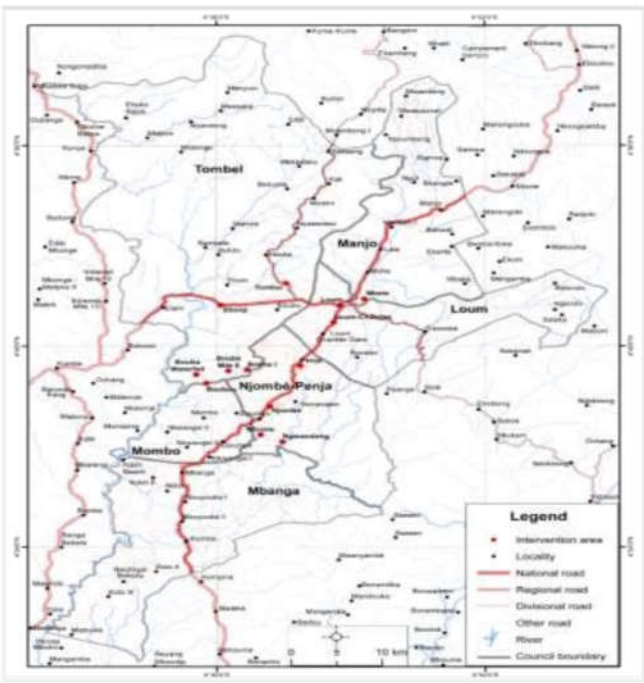

Figure1: Location of survey areas in Mungo and areas of cultivation of Penja Peper

Data on the amount of fertilizer used, pesticides, exploited area, age of producers, pests frequency etc. were collected from primary sources. While the data from secondary sources have been extracted from the information received from the Executive Secretary of the Penja Pepper Protected Geographical Indication (PPPGI) and the available documentation (agro PME report, Internet, etc.). They deal mainly with Penja Pepper cultivation techniques.

Of the 140 registered producers in the association within the study area, 58 sampled, but only 42 were available, and actually were administered the questionnaire. This sample size was determined based on the theory of Le Maux (2010). According to Le Maux, in theory, methods for scientific calculations of the sample size apply only to the samples obtained by the probabilistic method. In practice, the calculation methods are still used for those non-probabilistic. He acknowledges that, when the size of the parent population is below 10,000 or near, the following equation can be used to determine the sample size:

$$n' = \frac{n}{1+\frac{1+n}{N}} \approx \frac{n}{1+\frac{n}{N}}$$

With an error margin of less than 10% in the estimate of the proportion of the population and a confidence level of 95%; the following formula is generally used:

$$n' = \frac{97}{1+\frac{97}{N}}$$

Where N is the population size and n' the sample size. Thus, in terms of population sample, we will use the above equation of Le Maux.

$$n' = \frac{97}{1+\frac{97}{140}} = 58{,}04$$

2.2. Expected signs of the variables

Data collection was obtained through direct interviews on the scene of the activity. Data coding, entry and analysis was carried out using SPSS Version 20. These data were eventually processed by other software (Stata Version 12 and Excel from Windows Office pack 2013) for appropriate analyses.

In the context of this article, the target variable is represented by the amount of produced Penja pepper, measured in kg/ha. Furthermore, it considered two types of independent variables. Quantitative variables relate to:

- The amount of mineral fertilizers used in kg/ha:it represents the quantities of NPK (20 10 10) and urea used in pepper farms. This amount represents the sum of urea and NPK employed by an operator in his pepper farm,
- The amount of insecticide and herbicide used l/ha: it represents the amount of herbicides used in pepper farms. Measured in litres, it is obtained by summing these two figures.
- The number of plants used for replacement measured in number of plants/ha: it represents the number of plants used to replace certain diseased or dried pepper feet.
- The cultivated area in hectares: this variable is the representation of the land factor in the production function. In our study, the area was assessed in ha.
- The labour used expressed in h_j/ha: it consists of family labour and hired labour. It is obtained by the sum of these two sources of labour in the different activities encountered in the pepper plot (preparing the land, picketing, maintenance of pepper farm, harvesting, post-harvest).
- Producers Age measured in years.
- The frequency of Pepper bio aggressors attacks.

The independent variables are:

- The education level corresponding to school level. It is coded as follows: "1" never enrolled "2" primary, "3" secondary, "4" higher education level.
- The gender of producers will be coded as: " 0 " for woman and " 1 " for man;
- The type of plants: in this study, it will be coded " 0 " for plants from orthotropic cuttings, " 1 " for others.
- The specification is coded as follows: "1" for compliance with the specifications and "0" for non-compliance with the specifications.

The accessibility of credit, in this case, it is about producers having subscribed a credit or not. Access to credit is coded "1" and the inaccessibility "0".

All the expected signs of the explanatory variables in the producers are presented in Table 1.

Table 1: Expected Signs of explanatory independent variables from the producers.

Survey variables and units of measurement	Code	expected theoretical signs
Penja Pepper production in kg / ha	YP	+
The amount of fertilizer used in kg / ha	ENGRAIS	+
The amount of insecticide and herbicide used in L / ha	PHYTO	+
The number of plants used for replacement	REPLA	+
The area harvested in hectares	SUP	+
Manpower measured in Hj / ha	MO	+
The age of Penja Pepper producers	AGE	-
The frequency of attacks by Pepper bio aggressors	ATTAQ	-
Quantity losses during harvest	PERTRECOL	-
Quantity of post-harvest losses	PERTPOST	-
Experience	EXPE	+
Age of the pepper plot	AGEPOI	-
Dummy variables		
The instruction level of Pepper producers	INSTRU	+
The gender of pepper producers	GENRE	+
The type of plants	TYPLANT	+
Specifications	CC	+
Cultures found in the parcels	CULTP	-
Access to credit	CREDIT	+

The expected signs are positive, in this case, there is an increase in Penja Pepper production each time there is an increase in one of the independent variables, as the respect of specifications and access to credit. This situation is different from age and frequency of bio aggressors.

2.3. Specification of the analysis model: ordinary least squares Method

The determination of Penja Pepper production factors is done through an estimation of the producers production function. In this study, the Cobb Douglas General production function was chosen. In economic modelling, the following particular function is frequently used:

$$Y = A .K^{\beta1} .L^{\beta2} \ (1)$$

Where K is capital, L labour, β_0 the intercepted value, β_1 the capital output elasticity, and $\beta_{2\ the}$ labour production elasticity. This form of the Cobb-Douglas function is generally used in the case of a production function of two variables. In this particular case, the scale efficiency are constant returns to ($\beta1 + \beta2 = 1$), which means that if the input level is increased by a certain percentage, that of the outputs will be the same. Rewritten in the form of an equation for k variables as follows:

$$\hat{Y} = A_0.X_1^{\beta1} .X_2^{\beta2} .X_3^{\beta3} X_k^{\beta k} \ldots (2)$$

Equation (2) expressed in the general form, is written as follows:

$$Y=A0\prod_{j=1}^{k} XjAj.\prod_{j=1}^{k} XjAj. \quad (3)$$

This equation can also be expressed in the logarithmic form. This is done by introducing the natural logarithm of both sides of the equation (2). Indeed according to Stadelmonn, (2003) "the logarithmic function is often easier to treat than the normal function (Equation 3)." The function (3) transformed in the form of the natural logarithm gives us the following equation for the three types of players:

$$Ln\ Y_t = Lna_0 + \sum_{j=1}^{k} aj \sum_{j=1}^{k} aj\ .Ln\ Wji + v_i \quad (4)$$

Where Y_t is the production of Penja pepper of the producer; Wj represents the number of independent quantitative variables from 1 to k; j = 1, 2, 3... n representing the number of producers interviewed in the study area, a_0 the constant to be estimated; a_j is the vector of parameters to be estimated. It also represents the partial elasticity of each input variable as the production function is a Cobb-Douglas, and v the error term (Jaza, 2007).

By introducing the qualitative variables (*dummy variables*) in our equation (4), it becomes:

$$Ln\ Y_t = Lna_0 + \sum_{j=1}^{k} aj \sum_{j=1}^{k} aj\ Wji\ Ln + \sum_{j=1}^{6} aj \sum_{j=1}^{6} aj\ Dj + v_i \ (5)$$

Where Dj represents the number of independent variables or "*dummy variables* "ranging from 1 to 6. By combining the equations (4) and (5) and by specifically addressing our study variables and representing our socioeconomic variables, our covariance analysis equation model is as follows:

$LnY_p = Lna_0 + a_1$ Ln (ENGRAIS) + a_2 Ln (PHYTO) + a_3Ln (REMPLA) + a_4 ln (SUPER) + a_5Ln (MO) + a_6Ln (AGEPRO) + a_7Ln (ATTAQ) + a_8 Ln (PERTRECOL) + a_9 ln (PERTPOST) + a_{10}Ln (EXPE) + a_{11} ln (AGEPOI) + a_{12} (CC) + a_{13} (CREDIT) + a_{14} (CULTP) + a_{15} (INSTRU) + a_{16} (GENRE) + vi. (6)

At the end, this regression analysis allowed us to identify the variables responsible for the production of Penja pepper. The estimate and analysis will be presented in the next section.

3. Results and discussion

The identification and description of socio-economic characteristics of producers will be done prior to the presentation of regression results.

3.1. Producers' Socio-economic characteristics

The analysis resulting from socioeconomic characteristics allows us to see if the theoretically analyzed socioeconomic factors are subject to production risks and prove their significance in the Ordinary Least Square regression.

3.1.1. Distribution of farmers according to age groups

The average age of farmers in our sample was 48.31 years (Table 2)

Table 2: Age structure of the sample of Penja pepper producers in the study area.

Age groups (years)	Total sample (N = 42)		
	Numbers	Percentage (%)	accumulated percentage
<45	16	38.1	38.1
[45-60]	17	40.5	78.6
[60-75]	7	16.7	95.2
> 75	2	4.8	100
Minimum age		30	
Maximum age		79	
Average age		48,31	
Standard deviation of ages		10.692	

Table 2 shows that the most representative age group with a rate of 40.5% in the sample is between 45 and 60 years. This shows that this population is relatively young. Penja Pepper's quality and most importantly its price on the international market prompted many young people to be interested in its cultivation. The least represented age group consists of the older (between 60 and 75 years) with a representation of 16.7% for the former and 4.8% for the latter in the sample. This is explained by the fact that they do not have enough energy (low physical strength) to practice this activity due to their age. It could also be explained by the fact that they focus their attention on other activities less restrictive but equally profitable, including those related to food crops. The standard deviation associated with this variable is 10.692. The difference between the standard deviation and the mean could be explained by the fact that the sample of Penja pepper producers is young and more willing and able to adapt to new farming methods and techniques.

3.1.2. Distribution of producers by gender

Penja Pepper Producers are mainly men, with 92.6% of the workforce against only 7.14% for women. The distribution of Penja Pepper producers based on gender is mostly male. Women are interested in the cultivation of other crops, equally as profitable as Pepper. This high concentration of men in the pepper industry is justified by the fact that pepper production process extends over a long period (despite the difficulty of its implementation and its intense technical and financial maintenance for the first 4 years), also requiring substantial financial resources that rural women do not have. The producers interviewed engage in Penja Pepper cultivation as a way to prepare for retirement.

3.1.3. Distribution of producers per educational status

7.14% have never been to school, while 45% have completed secondary education and 12% attained higher education. As a result, the low education level of Penja Pepper producers can hinder productivity, as their ability to adopt new farming techniques is limited. This result confirms the analysis of Nuama (2006), which states that low level of farmers' education affects their agricultural productivity/.

3.1.4. Distribution of producers based on the size of their plot

From the results obtained, cultivated plots are usually small in size. Infact, the average area used by our study sample is 1,675ha (Table 3).

Table 3: Cultivated area (ha) by producer sampled in the study area

	Producers (N = 42)
Minimum	0.5 ha
Maximum	8 ha
average	1,675ha
Standard deviation	1.4126

Source: Calculated from data collected

The average size is less than 1.80 ha that represent the average size of agricultural holdings in Cameroon (Jaza, 2007). This could be explained by the fact that farmers lack the technical and financial resources to develop new plots. This does not give room for plot expansion, hence, limiting the realisation of desired output by producers.

3.1.5. Distribution of producers based on their experience

The average years of experience per producer are 8.40. However producers having 5 to 9 years of experience represents 33.3% of the sample. Producers have only 1 year of experience and the most experienced producer has cultivated Penja Pepper for 19 years (Table 4)

Table 4: Distribution of producers based on years of experience.

Years of experience	Total sample (N = 42)		
	Numbers	Percent age (%)	Cumulative percentage)
<5	10	23.8	23.8
[5-10 [	14	33.3	57.1
[10-15 [	9	21.4	78.5
≥15	9	21.4	100
Minimum years of experience		1	
Maximum years of experience		19	
Average years of experience		8.40	
Standard deviation years of experience		5.329	

In view of the above, many producers were involved in Penja pepper cultivation before labelling. This means most of them participated in the labelling process and thus, embody the spirit of the Pepper tradition in this Region.

3.2. Regression Results

Table 5 shows in detail the estimated function. It is clear that all model variables were not considered because of multi collinearity problem.

Table 6: Summary of the estimated production function.

exogenous variables	endogenous variables of Penja pepper production: Yp				
	coefficients	coefficients values	Values of Statistics " t "	probability p.sig	significance
ENGRAIS	a1	.1144	0.07	0,946	-
PHYTO	a2	-33.46	-0.52	0.607	-
SUPER	a4	4084.306	8.39	0,000	1%
AGEPRO	a6	-110.26	-1.98	0.058	10%
EXPE	a10	64.63	0.56	0.582	-
AGEPOI	a11	-153.97	-1.07	0.294	-
TYPLANT	at 12	-754.72	-1.94	0.062	10%
CC	a13	-1,298.153	-0.97	0.340	-
CREDIT	a14	-1,193.138	-1.00	0.326	-
CULTP	a15	524.85	1.06	0.297	-
Constant	a0	4562.465	1.01	0,321	-
F (10, 30) = 11.29; sig = 0.0000, significant at 1%, R2 = 0.7901, R2ajusté = 0.7202, n = 42					

From the above analysis, the total production of Penja Pepper for the sample under consideration is explained at 79.01% (determination coefficient) and 72.02% (adjusted determination coefficient), by the explanatory variables ENGRAIS, PHYTO, SUPER
AGEPRO, EXPE, AGEPOI, TYPLANT, CC, CREDIT, CULTP retained in the model.

Generally, the specification of the model is correct (in fact, the determination coefficient is greater than 0.5). In addition, from the overall significance test, it is found that the Fisher statistic is equal to 11.29 with P (sig) = 0, 000 <1%. It is significant at the 1% level, implying that the data relating to the study variables are adjusted significantly to the regression line.

The value of Student t (t = 0.000) reveals that the coefficient of the variable operated area (SUPER) is significant at a threshold of 1% and is the highest (a_4= 4084.306) of all other factors in our regression model. This shows that this explanatory variable is the most productive input of our regression model and acts effectively on the production of Penja Pepper. Infact, its coefficient suggests that an increase of 1% on the surface area would be associated with a yield increase of 4084.306% of Penja Pepper in the geographically defined area. Moreover its sign confirms our forecasts.

In addition to the area farmed, quantitative variables such as the age of the producers and the type of plants are significant and negative at a rate of 10%. They therefore represent the low yield factors as far as they do not allow producers attain their production objectives.

The explanatory variables: quantity of pesticides used (PHYTO), types of plants (TYPLANTS), getting credit (CREDIT), and cultures present in the plots (CULTP) produced signs contrary to our forecasts. They result in a negative influence on the production level.
Moreover, despite the fact that our model is well specified, we see that seven (7) of our variables are not significant. This is not a major concern since the agricultural economist aims to measure the response of output due to changes in the production factors identified in advance. During the analysis, they may not be significant.

3.2.1 Specific analysis of the various production variables linked to input variables

a) Harvested area (SUPER)

The coefficient a_4 = 4084.306 and statistical p.sig = 0.000 attached to the variable exploited areas (SUPER) shows that the sign of the parameter of this variable is consistent with the expected sign. It is significant at 1%. The extent of cultivated land has a positive impact on increasing productive Pepper Penja yields in the area. This result is consistent with those obtained by Alvarez and Arias (2004); Nyemeck et al (2004); Umoh (2005) and Okike's (2000) for which the farm size has a positive and significant effect on the farms' level of productivity. This would mean that all other things being equal, a 1% increase in the area planted in the area would be associated with an increase of 4084.306% of Penja pepper yield.
The significant impact of cultivated areas for Penja Pepper production could mainly be attributed to the gradual increase in usable areas in the study zone. It can also be explained by the fact that the product labelling attracted investors in Penja Pepper in order to make profits and increase the level of production to meet the problems of supply on the market. This variable is an asset to the production; it is not a risk factor and is indispensable asset to the protection and sustainability of the Penja pepper label.

b) Plants or seeds type (TYPLANTS)

The coefficient (a_{12} = - 754.72) of the variable and the statistic P.sig = 0.062 attached show that it is significant at 10% level. The resulting sign of this variable is different from the expected sign; it appears as potentially harmful as a poor control of this variable would cause low productivity at maturity. In addition, this factor is transverse to the extent that it affects both production and marketing. This is as a result of the poor quality of the plants identified in nurseries. The negative sign of the coefficient for this variable indicates that it is negatively correlated with Penja Pepper production. The plants made using cuttings from the vine of a sick pepper foot cause significant losses in the production. This has as consequences: death of some pepper feet, stunted growth of the plant, low pepper production and per hectare, low postharvest production and poor pepper quality on the market. These impacts may cause the loss of label or of product awareness. This variable represents an essential pepper production factor. Viewing the context, the significance of this parameter aligns with the result of Umoh (2005), who noted that the seeds have a significant influence on urban farms in South-eastern Nigeria if they are of good quality.

c) Age of producers (AGEPRO)

The expected sign of this variable is consistent with our predictions. Statistic p.sig = 0.058 <10% and the coefficient attached to it (a_6 = -110.26) shows that it has a significant influence on the production of Penja Pepper. This suggests that the age of the producers may be considered a risk even though they appear young (average 48.31 years). This would imply that the increase in age of the producers by 1% will reduce the production of Penja Pepper by -110.26%. This result is consistent with those obtained by several researchers including Coelli and Fleming (2004), for whom "*the older farmers are less effective than young producers since they believe the former do not have enough contact with extension services and are reluctant to adopt new technologies contrary to young people who are able to look for the necessary information and adopt new technologies.*" It would therefore, be important to involve young people in the production of pepper in order to rejuvenate its population and promote the sustainability of the sector. In addition, a young population, effective and efficient, with its work force could promote protection through production quality and quantity.

4. Conclusion

At the end of our analysis, it appears that the cultivation of Penja pepper focuses on quality production to preserve its label on the market. But this goal is sometimes influenced by many factors involved in the entire production chain: the quality of cuttings fragments, the type of plants used in pepper plots, the final quality of pepper etc. These factors can have a negative or positive effect on the production of Penja Pepper. Thus, goal, to identify and analyze the determinants of the production of Penja pepper as pursued by this article has found its justification on the direction of management decisions and minimizing post-harvest losses.
The results show that the producers of the sample are predominantly male. 7.14% of the interviewed producers are women and 92.6% are men. In addition, they have a low level of education as 45%, 12% and 7% respectively have a secondary, primary education level and the rest has never been to school. Producers have an average of 8.40 years of experience and operate 1.67 ha for an annual production of 2039, 5 kg.
Furthermore, the analysis of the factors' productivity has identified that the variable 'types of plants used', appears as a transversal production factor. Its significance suggests that a misuse of quality cuttings at the nursery causes a wrong type of plants that will require huge expenditures for monitoring and ultimately ending with a small quantity and poor quality produced. In addition, the significance of the variable 'age' shows a population of producers tending to old age with an average age of 48.31 years. Hence the need to integrate youths in the sector.
It is important to note that of all the explanatory variables, the amount of fertilizer used and the quantities of pesticides used are not significant. This could be due to the fact that producers receive a loan in kind of these products with deferred

repayment. In addition to this, other variables such as respect of the specifications and experience of the producers are not significant. Therefore, they do not have a significant influence on the level of production. Finally, the producers, to avoid the risk of loss of label, must:

- Follow the instructions of the specifications to better learn about techniques and monitoring of pepper plots,
- Sell their products to licensed producers to facilitate the traceability of the chain and the fight against the usurpers,
- Encourage youth and women to become interested in the production of Penja pepper presenting their practical importance of this crop in the markets.
- Use a quality plant material with a view to preserving the quality of product on the market.

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