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DETERMINANTS AND EXTENT OF CROP DIVERSIFICATION AMONG SMALL AND MEDIUM SCALE FARMERS IN CAMEROON

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Abstract

The importance of crop diversification and its scope is underscored by the contribution that agriculture makes to the development of other economically productive industries. This study was conducted to evaluate the reasons behind crop diversification, its degree, and the variables affecting it among small and medium-sized farmers in Cameroon. Through a multi-stage sampling process, 457 small-scale farmers and 163 medium-scale farmers in total were sampled. The degree of crop diversity was evaluated using descriptive statistics, and the factors affecting crop diversification among small and medium farmers were identified using the Tobit regression model. The analysis revealed that crop diversification was high for both small and medium scale farmers, with a mean Herfindahl index of 0.44 and 0.38 respectively. As a result of the rising need for food production to address the problem of hunger, poverty, and malnutrition levels in the nation, the results also showed that the production of cassava and cocoyam, as well as the household size, had a positive and substantial effect on crop diversification. Credit usage and household size were found to have a favorable and significant impact on crop diversification for medium-scale farmers, suggesting that family labor and access to credit encourage farmers to diversify their crops and enhance their well-being. Emphasis on training and credit accessibility should be encouraged to increase cassava and cocoyam output.

Key words**:** *crop diversification, small and medium scale farmers, Herfindahl index*

INTRODUCTION

In the past decades, crop diversification is presented as an important solution to many problems in agricultural development [7]. These issues include high levels of specialization in farming systems that limit their ability to achieve economies of scale, agronomic issues like production stagnation or disease resistance, and insect concerns. [32]. Another key problem is the limited quality and quantity of input use, stemming from the small farm sizes and inadequate capital for investments to expand agricultural production. Rudimentary implements are still being used for all levels of agricultural production and the consumption of fertilizer per hectare is still far below 200 kg [22].

Studies from developing nations [25, 11, 20, 27, 17, 16] have investigated factors influencing crop diversification with explored factors affecting crop diversification with little or no emphasis on the difference between small and medium scale farmers. For some authors, Crop diversification can be impacted by both internal variables (such as farmer traits and farm structure) and external ones (such as territorial features such as regional and geographical patterns) [25].

The diversification of crop production systems is an essential factor for national strategy of rural development in Cameroon [26]. This has created a vacuum. It is based on the backdrop that this study intends to fill the research gap by analyzing factors influencing crop diversification among small and medium farmers. This study hypothesizes that there is significant difference in crop diversification between small and medium scale farmers.

In agriculture, farmers practice crop diversification to mitigate the rick related to monoculture farming and to minimize the climatic and natural uncertainties [33] by maximizing the use of land and other resources [30]. Small farms, in other words, are less subject to output losses and more

resistant to environmental variations by diversifying their crops [21]. It is possible to mitigate the hazards associated with low agricultural output income, food insecurity, and nutritional insecurity [24]. Diversification of agricultural holdings consists in cultivating more than one variety of crops in the form of diverse output [29]. Diversification is intended to boost agricultural income at the farm level, even though risks associated with management systems are permanent. Diversification is meant to ensure national self-sufficiency and is carried out at the regional level [33].

Diversification can be an effective strategy for farmers' financial security and greater integration into local markets. Some analysts feel that improving linkages between agriculture and other sectors of the economy can stimulate agricultural diversification and so contribute significantly to long-term rural development [23]. The foundation of sustainable agriculture is the use of technology to increase output while attempting to have as little of an adverse environmental impact as possible. Therefore, diversification helps farmers to take part in putting the idea of "Sustainable Agricultural and Rural Development" into practice [13].

Agriculture sector diversification is a significant source of employment. According to the European Parliament's Resolution on How the Common Agricultural Policy Can Improve Job Creation in Rural Areas, held on October 27, 2016, the European Parliament advocate the use of agricultural diversification as solution for employment in rural areas, through entrepreneurship, innovation and products specialization for particular given areas. Additionally, small farms that diversify their crops would benefit from increased economic efficiency, which would help stabilize their relative income [34].

Traditionally grown less profitable crops are phased out in favor of more profitable ones as part of crop diversification. Rain-fed regions use crop diversification and an increase in the number of crops to reduce the risk of crop failures brought on by drought or insufficient precipitation. Crop diversification can be a useful strategy for farmers to manage several sorts of risk, including price risk (the farmer can utilize what he knows about the mean and variations of the prices for each crop to select a mixture of crops that have a low correlation of profitability) [30].

The contribution of diversity on agricultural output and opportunity cost is explained in this paper. As a result, the particular goals are to evaluate crop diversification's degree and identify the endogeneous variables affecting Cameroonian small- and medium-scale farmers' crop diversification.

MATERIALS AND METHODS

The Study Area

The study was carried out in Cameroon, which covers a total land area of 475,442sq km and located in the Central part of Africa within latitudes 2 and 13 North and longitude 9 and 16 East of the equator. The country has ten regions: Centre; Littoral; Adamawa; Far-North; North; South; East; West; North-West, and South-West [12, 10]. A major amount (about 60%) of the country's economically active population is employed in the agricultural sector, which also contributes to 30% of the nation's gross domestic product (GDP) and provides around 15% of the government's revenue [6]. Moreover, agricultural is the main activity inducing most of the spread effects on other sectors of the economy [18]. Diversification of crops in Cameroon is dominated by local ecological factors and local preferences for specific foods, which sometimes reflect the ethnic affiliation and history of the people [9].

Sample size and Sampling procedure

The study adopted the multistage random sampling technique. The first stage involved the purposive random selection of three (3) regions (South-West, West and far-north) based on the fact that these regions are agricultural based and having high number of small and medium farmers. Four (4) villages were chosen at random from each region in the second stage, for a total of twelve (12) villages. Following this, respondents were chosen from each of the chosen villages after

being divided into small farmers and middle farmers. Structured questionnaires were used as instrument for collecting data from individual farmers.

For the selection of sample, list of all registered farmers were obtained from the Sub Divisional delegates. The sample sizes of 457 small scale and 163 medium scale farmers were obtained using [36] formula. The formula is expressed as follows:

$$n = \frac{N}{1+N(e^2)} \quad \text{.....(1)}$$

where:

n = sample size; N = real or estimated size of the population; e = level of significance (5% or 0.05). For the purpose of distribution of samples according to strata [31] Kumaisons (1997) formula was adopted thus:

$$n_h = \frac{nN_h}{N} \quad \text{.....(2)}$$

where:

n = sample size; N_h= population size in each stratum; n_h = number of questionnaire needed for each stratum.

Method of Data Collection

The questionnaire was given to agricultural farming families chosen for primary data in each village that was chosen. A structured questionnaire and interview techniques were used to gather this main data from the 620 respondents in the study region. In the study region, information was gathered on the degree of crop diversification among small and medium farmers as well as on internal factors that affect this practice.

Techniques of Data Analysis

Descriptive and inferential statistics were used to analyze the data that were gathered for this study. A Tobit regression model was used to identify the internal determinants driving crop diversification among small and medium scale farmers, and descriptive analysis was utilized to quantify the degree of agricultural diversity among these farmers. Finally, a t-test was employed to assess the claim that there is no discernible difference between small- and medium-scale farmers in terms of crop diversity.

Theoretical Foundation and Method of Estimation

Tobit Regression model

The determinants of crop diversification were investigated using a Tobit regression model. The choice of this model lie on the fact that crop diversification index has both the lower and upper bounds (from 0 to 1). Moreover, this model has the main advantage of using the maximum likelihood estimation (MLE) procedures to estimate errors in the presence of non-normal distribution, which is the most efficient estimator for asymptotically distributed dependent variable [31, 35]. According to [14] Gujarati (2010), using the ordinary least squares (OLS) method in this case would cause major violations of the assumptions of the OLS model (normality of distributions, homoscedasticity of errors, and exogeneity of independent variables) and lead to inconsistent parameter estimates.

The Tobit model used for this study is defined as:

$$Y_i^* = \lambda_0 + \lambda_1 V_{1i} + \lambda_2 V_{2i} + \ldots\ldots\ldots\ldots + \lambda_8 V_{8i} + \lambda_9 V_{9i} + \rho_i \quad \text{.....(3)}$$

where:

$Y_i = 0$ if $Y_i^* < 0$

$Y_i = Y_i^*$ if $0 \le Y_i^* \le 1$

$Y_i = 1$ if $Y_i^* \ge 1$

With, $Y_i^* =$ crop diversification index, λ_0 = intercept, the value of TE_i when others variables are null. λ_i = are the parameters to be estimated, V_1 = cassava output, V_2 = maize output, V_3 = cocoyam output, V_4 =cassava price, V_5 = maize price, V_6 =cocoyam price, V_7 = experience, V_8 = household size, V_9 = Credit use, ρ_i is an error term which is assumed to be independent and identically distributed.

Crop Diversification Index (CDI)

The Crop Diversification Index (CDI) was developed to gauge crop diversification

levels. It was calculated by deducting the Herfindahl index (HI) from one and had a direct correlation with agricultural diversity, with a zero value indicating specialization and a trend towards one indicating a greater degree of crop diversification.
The CDI index was calculated as follows:

$$P_i = \frac{A_i}{\sum_i^n A_i} \quad \text{..... (4)}$$

where:
P_i = proportion of i^{th} crop
A_i = area under ith crop
$\sum_i^n A_i$ =total crop area, $i = 1,2, \dots n$ (number of crops)
Herfindahl index has the formula:

$$\text{Herfindahl index } (\boldsymbol{HI}) = (\sum_i^n \boldsymbol{P_i})^2 \quad \text{.....(5)}$$

Crop diversification index (CDI) has the formula:

$$\text{CDI = 1-}(\boldsymbol{HI}) = \mathbf{1} - (\sum_i^n \boldsymbol{P_i})^2 \text{.....(6)}$$

When CDI shows a value of zero (0), it means that the farmer is least diversified while a value of one (1) indicates the most highly diversified

RESULTS AND DISCUSSIONS

Extent of crop diversification

Herfindahl index (HI) results from Table 1 revealed that all farmers were involved in crop diversification (HI<1). This suggests that the research area has a high level of diversification. The HI specifically varies between 0.25 and 0.5 for medium-scale farmers, with a mean and standard deviation of 0.38 and 0.044, respectively, whereas it varies between 0.34 and 0.83 for small-scale farmers, with a mean and standard deviation of 0.44 and 0.063, respectively. These findings imply that medium scale farmers had higher level of crop diversification. A high level of crop diversification confirmed the results of [8] who found almost a same level of diversification (0.46) in Delta State of Nigeria. This situation might be explained by the uncertainty of farmers to resistant to environmental changes [21], the reduction of the risks associated with low agricultural income, food and nutrition insecurity, or the need to generate more employment. However, this finding is in contradiction with the result of [28], who reported a low level of crop diversification for small and medium scale farmers in Benue State, Nigeria.
The difference level of crop diversification between small scale and medium farmers is likely reflecting their bigger farm size [4], as well as their facility to get access to credit.

Table 1. Crop diversification Index (CDI)

Herfindahl index (HI)	**Small Scale**		**Medium Scale**	
	Frequency	Percentage	Frequency	Percentage
<0.35	1	0.2	39	23.92
0.35-0.40	186	41	78	47.85
0.41-0.46	55	12	32	19.63
0.47-0.52	179	39	13	8
0.53-0.58	2	0.4	1	0.6
0.59-0.64	32	7		
0.65-0.70	2	0.4		
Total	457		163	
Maximum	0.83		0.50	
Minimum	0.34		0.25	
Mean	0.44		0.38	
Standard deviation	0.063		0.044	
CDI Index = (1-HI)	**0.56**		**0.62**	

Source: Field survey, 2022.

On the specificities, 23.92% of medium scale farmers have less than 0.35 HI, 47.85% of medium scale farmers have between 0.35 to 0.4 HI, 19.63% have between 0.41 to 0.46 HI, 8% have between 0.47 to 0.52 HI, and 0.6% have between 0.53 to 0.58 HI.

For small scale farmers, 0.2% less than 0.35 HI, 41% have between 0.35 to 0.4 HI, 12% have between 0.41 to 0.46 HI, 39% have between 0.47 to 0.52 HI, 0.4% have between 0.53 to 0.58 HI, 7% have between 0.59 to 0.64 HI, and 0.4% have between 0.65 to 0.70 HI.

Determinants of crop diversification

To determine the internal factors influencing small and medium farmers' crop diversification in Cameroon, Tobit regression model was estimated. The findings were presented in Table 2.

The sigma revealed the fitness of the model at 1% ($p < 0.01$) level of significance. The likelihood ratio chi-square of 0.062 and 0.083 with a p-value of 0.0001 and 0.0001 respectively for small and medium scale farmers, tells us that our models as a whole are statistically significant. That is to say that it fits significantly better than a model with no predictors. Three out of the nine variables were shown to have a substantial impact on small-scale farmers' crop diversification, according to the model's findings. These factors were household size, cocoyam and cassava output. The crop diversification of medium-scale farmers, however, was found to be significantly impacted by household size and loan utilization.

Cassava and cocoyam production for small-scale farmers was positive and statistically significant at the 5% level of probability, according to the results. This suggests that as cocoyam and cassava productivity rises, crop diversification rises as well. The positive effect of cassava and cocoyam production on crop diversification confirms the results of [19] who showed that the increase in crop production, due to population increase leads to higher crops diversification to respond adequately to the issue of national urgency related to the increasing of hunger, poverty and malnutrition levels. Thus, diversification and agricultural crop production system is the key for the smallholder farmers to respond to increasing demand for food products [1, 8]. Furthermore, this result also confirms the fact that farmers increase their output by intensive use of land and the adoption of specific land management method to avoid the negative effect of land use intensity on their productivity [2].

The coefficient of household size was found to be positive and statistically significant at 1% level of probability. This implies that crop diversification increases when the household size increases.

Table 2. Determinants of crop diversification

Variables	Small Scale		Medium Scale	
	Coefficient	t-ratio	Coefficient	t-ratio
Constant	0.432	13.07	0.45	5.83
Cassava output	0.0000105	2.45**	7.89e-06	1.04
Maize output	-0.00005	-1.61	-0.00005	-1.04
Cocoyam output	0.000062	1.79*	-0.000027	-0.66
Cassava price	0.000015	0.17	-0.0002	-0.92
Maize price	6.93e-06	0.04	0.00024	0.57
Cocoyam price	0.0000954	1.37	0.000124	0.76
Experience	-0.00033	-1.00	-.003266	-0.28
Household size	0.0032	2.97***	.003266	1.64*
Credit used	-1.85e-08	-0.78	1.02e-07	2.55**
Sigma	0.062	30.24***	0.083	16.02***
LR chi2(8)	22.31		16.54	
Prob > chi2	0.0079		0.056	
Log likelihood	619.769		121.27722	

***, **and * significant at 1, 5 and 10% respectively.

Source: Field survey, 2022.

That is to say that those farmers diversify their crop production to express their consumption needs.

More the household size is large more the need for crop diversification is high to ensure diverse dietary standard and nutritional status of the household [7, 15].

However, this result is in disagreement with the findings of [19] who found no significant relationship between household size and crop diversification in Zambia.

For medium scale farmers, credit used was found to have significant effect on crop diversification. The coefficient of credit used showed that an increase of credit boosts crop diversification. The results imply that famers that have better access to credit have every opportunity to practice crop diversification as an innovation or technology to improve their wellbeing.

The results are in agreement with the findings of [17] in Delta State of Nigeria, [3] in Jordan and [5] in the central region of Ghana. Also, the coefficient of household size showed that an increase of household size will increase the crop diversification as well.

Two samples t-test of crop diversification

A two-sample Student's *t*-test assuming unequal variances using a pooled estimate of the variance was performed to test the hypothesis that the means Herfindahl index for small scale and medium scale farmers were equal.

We reject the null hypothesis based on the data in Table 3 because the t-values (9.44) and (11.17) for equal and unequal variances, respectively, are significant at 1%. We therefore draw the conclusion that there is a significant difference between small- and medium-scale farmers' crop diversification and reject the premise that there is no discernible difference between CDI of small- and medium-scale farmers.

Table 3. Two samples t-test for difference in Herfindahl Index

		Test of Levene on equality of variances		**t-Test-t for egality of means**				
		F	Sig.	t	ddl	Sig.	Difference mean	Difference stand-dev
HI	Hypothesis of equal variances	20.038	0.000	9.443	618	0.000	.05082	0.00538
	Hypothesis of unequal variances			11.173	411.32	0.000	.05082	0.00455

Source: Author's computation.

CONCLUSIONS

This study hypothesized and validated that there is significant difference in the extent of crop diversification among small and medium scales farmers. Also, internal factors such as cassava and cocoyam output, and household size significantly affect small scale farmers crop diversification while credit used, and household size significantly affect medium scale farmers crop diversification. Therefore, policies that would encourage experienced and educated farmers, especially from sizable households to continue in cassava and cocoyam farming. Emphasis on household members' training on skillful farm practices and credit accessibility should be encouraged to increase cassava and cocoyam output given their contribution in crop diversification.

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