African Journal of Agricultural Research Vol. 6(18), pp. 4277-4287, 12 September, 2011
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR10.1083
ISSN 1991-637X ©2011 Academic Journals

Full Length Research Paper

An analysis of the extent and determinants of crop diversification by cocoa (*Theobroma cacao*) farmers in Ghana

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Accepted 16 August, 2011

Agricultural diversification into non-traditional export crops has long been recognized as an important strategy by the Government to increase and stabilize export earnings for sustainable economic development and farmers' incomes. The main purpose of this study, therefore, was to analyze the extent and determinants of crop diversification by cocoa farmers to inform policy makers for policy adjustment. A socio-economic survey was conducted in six (6) cocoa growing districts (Nkawie, Goaso, Enchi, Oda, Twifo Praso/Assin Fosu and Hohoe) from March to May, 2006. A random sample of 300 cocoa farmers in the study areas was selected, using the multi-stage sampling approach and personally interviewed with a standard structured questionnaire because of low educational status of the farmers. The study demonstrated that cocoa farmers have diversified cocoa cultivation to some extent into growing other crops such as oil palm, citrus, cassava, cocoyam, etc. to expand their sources of income. This was confirmed by Simpson Index of diversification estimated to be 0.9. The proportions of farmers diversifying into other crops alongside cocoa were: 36.3% diversified into one crop, 26.7% cultivated two additional crops, 16.0%, three or more crops and 21.0% focused only on cocoa cultivation. The multinomial regression analysis suggested that age of cocoa farm, access to credit and cocoa growing region (Western, Brong-Ahafo and Central) were statistically significant ($P < 0.05$) determinants of cocoa farming diversification. It is recommended that Government should sustain cocoa production by convincing farmers to replant old cocoa farms and modernize traditional cocoa farming practices; improve access to credit facilities for farmers; and develop alternative livelihood improvement strategies of other crops in addition to cocoa for farmers.

Key words: Agriculture, diversification, survey, cocoa, farmers, Ghana.

INTRODUCTION

Agricultural diversification into non-traditional export crops has long been recognized as an important strategy by the Government to increase and stabilize export earnings for sustainable economic development. This was meant to avoid the risk (world price fluctuations, weather, crop pests and diseases) involved in over concentration of traditional export commodities such as cocoa and timber. This Government strategy led to the establishment of the Ghana Export Promotion Council (GEPC) in 1969 for export development and promotion. Agricultural production involves risks and farmers have adapted or adjusted their farming practices to avoid them. These risks include production risks such as erratic and sporadic rainfall distribution, diseases and pests, etc (Kadlec, 1985; Castle et al., 1987). Poor management of these risks can result in crop failures leading to low production and unstable income, making it difficult to plan. To deal with this problem, diversification into the production of other crops and livestock by farmers has been recognized as a means to ensure stable income (Ali, 2004).

Agricultural diversification means growing new and/or

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different crop/livestock in addition to an existing one, or engaging in off- and non-farm activities using farm resources (Kasryno, 1992; Ali, 2004). Farm resources include land, capital, paid farm labour, or management skills of the farmer that is used for agricultural purposes. There are two main forms of diversification: horizontal and vertical diversification. Horizontal diversification involves the cultivation of additional crops/livestock as opposed to one or two major crops/livestock while vertical diversification refers to the upstream and downstream activities of a particular crop or crops/livestock. The downstream activities or downward linkages involve the provision of services and other inputs for the production of the crop/livestock whilst the upstream activities or upward linkages entail processing, storage, marketing, etc. of the crop/livestock. This implies that cocoa farmers diversify their cocoa production when they cultivate additional crops or rear livestock alongside cocoa.

MASDAR (1998) reported that intercropping cocoa with food crops such as plantain (*Musa spp.)*, cocoyam (*Colocasia esculenta)*, cassava (*Manihot esculenta)*, maize (*Zea mays)* etc. during farm establishment for temporary shade can also ensure food security and income stability. In addition to intercropping, some cocoa farmers cultivate other crops on separate fields for subsistence and sale on the market, or engage in off- and non-farm activities to supplement their household incomes (Boahene, 1995; Aneani et al., 2007). Given Government's agricultural diversification policy, Ghana Cocoa Board (COCOBOD) has emphasized the need for cocoa farmers to diversify their household income sources. To address this policy issue, the study drew on information in the database of the baseline survey on cocoa production practices of cocoa farmers surveyed in the Ghana Cocoa Farmers' Newspaper Project commissioned by Cocoa Research Institute of Ghana in collaboration with Cadbury & Fry Ltd.

However, in this study the focus is on diversification into other crops instead of off- and non-farm activities. Therefore, the pertinent questions one would want to ask are: Are cocoa farmers substantially diversifying cocoa production into other crops? If so, what are the diversified crops? What is the extent of diversification of cocoa farming? What are the determinants of cocoa farming diversification? Simpson index for the estimation of the extent of crop diversification in this study has been employed in some studies (Roonnaphai, 2006; Jha et al., 2009). The multinomial logistic regression analysis for the investigation of the determinants of a phenomenon or relationship between categorical dependent variable and a set of explanatory variables (Hosmer and Lemeshow, 1989; Chan, 2005) will be used in this study to identify the key determinants of cocoa farming diversification. This study was to analyze the extent and determinants of crop diversification by cocoa farmers to inform policy makers for policy adjustment. The specific objectives were to:

1. Estimate the proportion of cocoa farmers cultivating other crops alongside cocoa;
2. Estimate the land area devoted to cocoa production as compared to other crops and determine the degree of diversification;
3. Analyze the demographic and socio-economic factors that influence diversification of cocoa production into other crops.

METHODOLOGY

The study was carried out in six (6) cocoa growing districts: Nkawie, Goaso, Enchi, Oda, Twifo Praso/Assin Fosu and Hohoe (Figure 1). The average rainfall in the selected districts ranged from 107,743 mm to 178,459 mm and temperature ranged from a minimum of 22°C to a maximum of 34°C. Altitude ranged from 61 m to 890 m above sea level. The vegetation was moist semi-deciduous rain forest and savanna. The main socio-economic activities in the districts were farming, trading, logging, small-scale mining and quarrying (Table 1). Moreover, the key crops grown in the districts, with their respective mean farm sizes in parentheses, comprise of cocoa (*Theobroma cacao*; 3.0 ha), coffee (*Coffea spp.*; 1.2 ha), citrus (*Citrus spp.*; 1.8 ha), oil palm (*Elaeis guineensis*; 2.2 ha) and food crops such as maize (*Zea mays*; 1.1 ha), cassava (*Manihot esculenta*; 0.8 ha), rice (*Oryza sativa*; 1.2 ha), yam (*Dioscorea spp.*; 0.4 ha), and plantain (*Musa spp.*; 1.2 ha). The rest of cultivated crops include pineapple (*Ananas comsus*, 1.0 ha), cocoyam (*Colocasia esculenta*, 1.1 ha), groundnut (*Arachis hypogeal*, 0.2 ha), ginger (*Zingiber officinalis*, 1.2 ha), okro (*Hibiscus esculenta*, 0.9 ha), banana (*Musa paradisiacal*, 0.8 ha), coconut (*Cocos nucifera*, 0.8 ha) and Teak (*Techtona grandis*, 0.8 ha). The most prominent farming activities undertaken by cocoa farming households include farm establishment involving land clearing and preparation as well as planting of seeds (seedlings); farm maintenance entailing weeding and control of pests and diseases; crop harvesting; and storage and sale of farm produce.

Sampling and data collection

A random sample of 300 cocoa farmers in the study areas was selected, using the multi-stage sampling approach. The sample size was determined by using the standard deviation of 16.3 years obtained from the age variable of a previous survey (Aneani and Asamoah, 2004) to achieve a precision of 0.94 (standard error of the mean) for the current study. The cocoa farmers were selected from households in 30 farming communities in the study areas (Table 2). The multistage sampling procedure entailed selecting six cocoa growing regions, one district per region, five villages per district and ten farmers per village as the sampling units in each stage. A list of names of farmers of the Licensed Buying Companies (LBCs) served as the sampling frame from which a sample of cocoa farmers was selected.

Data collection involved individual personal interviews with selected farmers using a standard structured questionnaire since most of the farmers had low educational status. The questionnaire covered issues such as demographic data, farm management practices, farm income, credit, technology adoption, constraints to cocoa production and extension**.** The questionnaire was pre-tested with a group of farmers to address fundamental problems in the survey design such as difficulties in question wording, problems

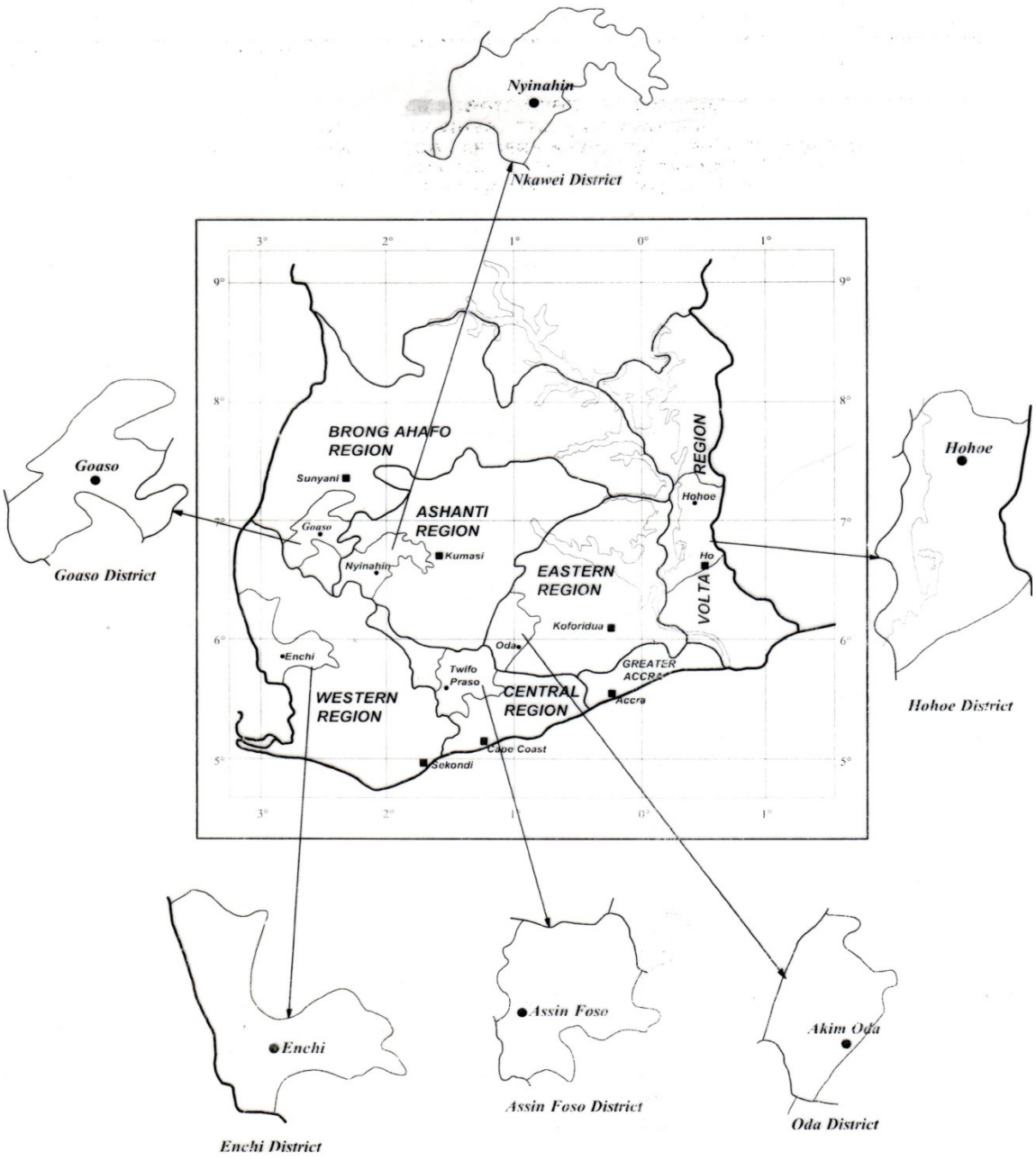

Figure 1. Map indicating the various districts where the base line survey on the Ghana cocoa farmers newspaper as conducted.

with leading questions and bias due to question order. Six enumerators and three supervisors were selected and trained in how to administer the questionnaires efficiently. The professional background of the interviewers included agricultural economist, biometrician and technical officers. The duration of the actual survey was from March to May, 2006. The response rate was 100%. Descriptive and inferential analyses of the survey data were performed. Specifically, data were summarized in forms of frequency, mean and percentage. Multiple regression analysis was used to examine factors affecting diversification.

Analytical framework

Simpson Index (SID)

To quantify the degree or extent of current crop diversification of cocoa farming, SID (Roonnaphai, 2006) of the crops grown by the cocoa farmers surveyed was measured using the planted area as follows:

$SID = 1 - \sum_{i=1} w_i^2$, (i = 1, 2, 3,..., n)

Table 1. Profile of the districts selected for the survey, 2006.

Feature	District					
	Nkawie	Goaso	Enchi	Oda	Twifo/Assin Fosu	Hohoe
Region	Ashanti	Brong-Ahafo	Western	Eastern	Central	Volta
District capital	Nkawie	Goaso	Enchi	Akim Oda	Twifo Praso	Hohoe
Land area (km^2)	894.2	1,093.7	2,638.0	1,090.0	1,199.0	1,403.0
Rainfall (mm)	107,743	110,827	142,959	178,459	107,787	152,627
Temperature (^oC)	27 – 31	23 – 33	22 – 34	25 – 27	26 - 30	22 – 34
Altitude (m)	77	305	300	61	91	890
Vegetation	Semi-deciduous rain forest	Semi-deciduous rain forest	Moist semi-deciduous rain forest	Semi-deciduous rain forest	Semi-deciduous rain forest	Moist semi-deciduous rain forest and savanna
Socio-economic activities	F and C	F and C	F, L, SSM and C	F, L, SSM, Q and C	F, L, SSM, Q and C	F and C

F = Farming, C = Commerce, L = logging, SSM = small-scale mining, Q = quarrying.

Table 2. Cocoa farmers selected for the survey.

Region	District	Number of Villages per District	Number of Cocoa Farmers
Eastern	Oda	5	50
Ashanti	Nkawie	5	50
Brong-Ahafo	Goaso	5	50
Central	Twifo /Assin Fosu	5	50
Western	Enchi	5	50
Volta	Hohoe	5	50
Total		30	300

$W_i = X_i / \sum_{i=1}^{n} X_i$

Where, X_i = Planted area of ith crop; W_i = Proportionate planted area of the ith crop in the total planted area.

When SID shows a value of zero, it implies that cocoa farming is least diversified while a value of one indicates the most diversified.

Empirical model: Multinomial logistic regression analysis of the factors of diversification of cocoa production

Multinomial logistic regression model (Hosmer and Lemeshow, 1989; Chan, 2005) was used to investigate the factors that affect the diversification behaviour of the cocoa farmers. This model was chosen because it handles the case of a dependent variable with more than two categories (Salasya et al., 2007; Adekunle and Henson, 2007) as compared to the probit model which deals with only dependent variables with only two categories (Chirwa, 2003; Jatoe et al., 2005). Farmers' decision in the choice of farm enterprises are influenced by environmental, socio-economic and cultural factors, as well as political climate Truong Thi Ngoc Chi et al., 2003; Barghouti et al., 2004)

The model involved a categorical dependent variable, the diversification decision variable (D) and a set of explanatory/ independent variables that might influence the final probability, P_i, of diversification of cocoa farming. These explanatory variables could be thought of as being in vector X_i and the model then took the form:

$P_i = E [(D_i/n_i) \setminus X_i]$

The logits of the unknown binomial probabilities (That is, the logarithms of the odds) were modelled as a linear function of the X_i :

$Logit (P_i) = in [(P_i/1-P_i)] = \beta_o + \beta_1 X_{1i} + \ldots + \beta_k X_{ki}$

Where, i = the ith category of the dependent variable; β_j = the unknown parameters (j = 1, 2, 3…k); k = number of explanatory variable considered in the model.

The unknown parameters were estimated by maximum likelihood method.

It was hypothesized that cocoa farmers do diversify cocoa cultivation into other crops, and that diversification of cocoa cultivation is influenced by demographic and socio-economic factors.

To analyze the determinants of diversification, the following general model or function, f (.), is specified:

D = f (A, AF, CR, E, F, FS, G, H, M, P, R, T, W, Y, e)

Where, D = Diversification measured as the number of different crops cultivated as separate farms; in addition to cocoa, not as intercrops, and then categorized as: 0 = no diversification, 1 = diversification into one crop, 2 = diversification into two crops, and 3 = diversification into three or more crops.

A = age of cocoa farmer in years, (-). As the age of farmer increases, his physical strength tends to reduce and this is assumed to impact negatively on the cultivation of additional crops alongside cocoa.

AF = age of cocoa farm in years, (+). With aging farm, there is the likelihood that the yield and income from cocoa would decline. This can lead to the cultivation of other profitable crops in addition to cocoa by the farmer.

CR = access to credit (1 = no credit, 2 = received credit), (+). Here access to credit in the form of cash is predicted to have a positive influence on crop diversification since the farmer receiving credit would have the capability to purchase the necessary resources for the cultivation of the other crops in addition to cocoa.

E = educational status (1 = illiterate, 2 = literate), (+). Educational status is assumed to influence crop diversification positively because with higher level of education the farmer would be in a position to technically and economically assess the new crop or technology to clear doubts and uncertainties associated with it and enhance its adoption.

F = frequency of extension visit (1 = very frequently, 2 = weekly, 3 = monthly, 4 = rarely, 5 = never, 6 = can't tell), (+). Frequent visits to the farmer by the extension agent would provide the farmer with necessary information about the availability of needed resources, market and prices as well as the profitability status of the new crop to clear any doubts and uncertainties concerning the crop, so as to increase the probability of its adoption. There could be a linkage between this variable and number of farms, since the more frequent the extension officer's visit, the more likely the farmers will adopt more crops.

FS = cocoa farm size in hectares (ha), (-). This variable is expected to have a negative effect on crop diversification since as the farmer devotes more of his total available land to cocoa cultivation, there is the likelihood that little or no land would be available for the cultivation of other new crops alongside cocoa. Generally, suitable land for cocoa cultivation is scarce in Ghana. Although land is owned by individuals, land sales are not frequent due to land scarcity. Given that a farmer is expanding his cocoa farm from the fixed area of land available to him/her, he/she can only apportion a smaller area to the other crops into which he/she might prefer to diversify. Thus, the extent of diversification would be limited by the cocoa farm expansion.

G = gender (1 = male, 2 = female), (+). Since cocoa farming is dominated by male farmers, it is expected that more male cocoa farmers would diversify their cocoa cultivation than their female counterparts, other things being equal, in response to the Government's agricultural diversification policy. MASDAR (1998) noted that women have less access to credit than men because of having less land as collateral. MASDAR also indicated that women rely mostly on hired labour which is scarce due to migration of the rural youth to the urban areas to seek for jobs with relatively better remuneration.

H = household size (number of adults helping on the cocoa farm), (+). It is assumed that the more adult household members a farmer possesses, the more household labour would be available to him for farm activities in the cultivation of additional crops alongside cocoa.

M = migration (1 = native, 2 = migrant), (+). Here it is expected that migrant farmers are likely to introduce the growing of new crops or the use of new technologies into the farming community and promote their adoption by the natives of the area.

P = cocoa production in kilogramme (kg), (+). It is predicted that increase in cocoa production would have a positive impact on crop diversification because the resultant increased cocoa income can enhance the ability of the farmer to purchase the necessary inputs for the cultivation of the new crop in addition to cocoa.

R = cocoa growing region (1 = Eastern, 2 = Ashanti, 3 = Brong-Ahafo, 4 = Central, 5 = Western, 6 = Volta), (+). Here it is assumed that since agricultural diversification is an important promoted strategy of the Government, the farmers in all the cocoa growing regions of the country are expected to make an effort to diversify their cocoa cultivation into other crops to ensure stable income and food security.

T = tenurial arrangement (1 = owner, 2 = "abunu", 3 = "abusa"), (-). Land tenure system is assumed to have a limiting effect on crop diversification due to insecure land rights associated with lands for cocoa cultivation. "Abunu" is a tenancy arrangement in which the proceeds are divided into two between the farm owner and the tenant whereas "abusa" is where the proceeds are divided into three with two parts allocated to farm owner and one part to the tenant.

W = working experience (number of years in cocoa production), (+). Farmers with more experience in cocoa cultivation would be able to apply their cropping experience in the cultivation of other crops and this would increase their ability to diversify the cocoa cultivation.

Y = cocoa yield in kilogramme per hectare (kg/ha), (+). It is predicted that increase in cocoa yield would have a positive impact on crop diversification because the resultant increased cocoa income can enhance the ability of the farmer to purchase the necessary inputs for the cultivation of the new crop in addition to cocoa.

e = error term

Water availability is an important factor in farmer choices in crop diversification. Since the water requirement of a crop may differ from that of other crops, a water-loving crop would not do well in drought-prone areas where drought-resistant crops would thrive. Pest threats are also important in the cocoa farming diversification. There are differences in risk of return from the crop available due to potential pests. For instance, cocoa is affected by pests and diseases such as capsids and black pod diseases which do not affect crops like cassava, plantain, cocoyam and so on. As such failure of cocoa resulting in low cocoa production and income can be compensated for by income from the other crops not attacked by cocoa pests and diseases. However, the data could not allow the researchers to include these variables in the model.

Age of the cocoa farmer may interact with age of the farm, education status of the farmer, farm size, household size and working experience. Age of the cocoa farm could interact with educational status of the farmer, farm size, cocoa production and working experience. Educational status of the farmer could interact with frequency of extension visits, household size, gender of the farmer and working experience. Farm size could also interact with household size, migration, cocoa production, tenurial arrangement, working experience and cocoa yield. Household size may interact with cocoa production, region, working experience and cocoa yield. Migration could interact with region and tenurial arrangement. Also, region might interact with tenurial arrangement and cocoa yield. It can be deduced from these interactions that age of the cocoa farm could correlate with region.

RESULTS

Information of crops planted in farmers' fields was

Table 3. Distribution of cocoa farmers diversifying into other crops.

Item	Frequency	Percentage (%)
Diversification into one crop	109	36.3
Diversification into two crops	80	26.7
Diversification into three or more crops	48	16.0
No diversification/ sole cocoa	63	21.0
Total	300	100

Table 4. Summary statistics of farm size of crops planted by cocoa farmers.

Crop	Mean farm size (Ha)	Standard deviation	Minimum (Ha)	Maximum (Ha)	Number of farms (N)	Percentage
Cocoa	3.0	3.7	0.4	36	296	43.8
Food crop:						
Plantain	1.2	1.77	0.2	4.4	97	14.3
Cassava	0.8	1.04	0.2	3.2	62	9.2
Banana	0.8	-	0.8	0.8	1	0.2
Cocoyam	1.1	1.65	0.4	4.4	25	3.7
Maize	1.1	1.84	0.4	4.4	35	5.2
Groundnut	0.2	-	0.2	0.2	1	0.1
Ginger	1.2	-	1.2	1.2	1	0.1
Okro	0.9	0.4	0.8	1.0	2	0.2
Pineapple	1.0	-	0.8	1.2	2	0.2
Rice	1.2	-	1.2	1.2	1	0.1
Yam	0.4	-	0.4	0.4	2	0.2
Sub-total	1.1	1.59	6.6	22.4	229	33.9
Other tree crop:						
Coffee	1.2	-	1.2	1.2	1	0.1
Oil palm	2.2	5.16	0.1	18.0	117	17.3
Citrus	1.8	2.35	0.4	8.0	31	4.6
Coconut	4.0	-	4.0	4.0	1	0.1
Teak	0.8	-	0.8	0.8	1	0.1
Sub-total	2.1	4.72	6.5	32.0	151	22.3
Total	2.2	3.46	0.1	36.0	676*	100.0

* The total sample size of crop farms is more than 300 because some farmers had more than one farm. – The standard deviation could not be calculated due to very small sample size (one or two cases observed). Ha = hectares.

collected during the survey. In terms of diversification of the farm enterprise, cocoa farmers interviewed cultivated other crops in addition to cocoa. Cocoa, oil palm, cassava, citrus and cocoyam were cultivated extensively. The proportions of farmers diversifying into other crops in addition to cocoa are summarized in Table 3 with 79% of the farmers growing at least one additional crop and 21.0 % planted sole cocoa.

Generally alongside cocoa, 17.3% of the farms were planted to oil palm, 14.3% to plantain, 9.2% were cassava farms, 5.2% maize farms, 4.6% were citrus farms, 3.7% cocoyam farms whereas 1.3% were planted to other crops. The mean cropped area of each farmer was 2.2 ha with a standard deviation of 3.46 and a range from 0.2 ha (Groundnut) to 4.0 ha (Coconut) for the single farms (Table 4). The estimate of the degree or extent of crop diversification of cocoa farming (Simpson Index) was 0.9.

The descriptive statistics indicate that there was high variation in the cocoa production and yield figures (Table 5). The cocoa output variable with mean value of 797.4 kg had a bigger standard deviation or variance which might be due to the differences in farm management practices of the cocoa farmers soil fertility variation and

Table 5. Descriptive statistics of the variables used in the multinomial logistic regression analysis.

Variable	Mean	Std Dev.	Min	Max	N
Age of cocoa farm (yrs.)	16.9	12.48	1	85	291
Age of cocoa farmer (yrs.)	51.5	15.22	15	86	300
Working experience (yrs.)	19.61	13.65	2	65	297
Adult family labour	3.26	2.76	1	19	197
Cocoa farm size (ha)	2.7	2.3	0.6	13.6	285
Cocoa production (kg)	778.9	692.3	125.0	4375.0	229
Cocoa yield (kg/ha)	362.7	297.7	104.2	1,953.2	217
Gender	(Male = 80.0%, Female = 20.0%)				300
Migration	(Native = 43.7%, Migrant = 56.3%)				300
Access to credit	(Yes = 22.3%, No = 77.7%)				300
Region	(Eastern = 17.7%, Ashanti = 15.7% , Brong Ahafo = 15.7%, Central = 17.7%, Western = 16.7%, Volta = 16.7%)				300
Educational status	(Literate = 21.5%, Illiterate = 78.5%)				298
Tenure	(Owner = 63.5%, Abunu = 3.4%, Abusa = 33.1%)				299
Extension visit	(No visit = 55.3%, At least one visit = 44.7%)				293

varying rainfall amounts and its distribution patterns experienced over the years. Although the survey interviewed 300 farmers, the different figures of the total numbers of farmers (n) used in the summaries occurred because there were missing values and these led to the pairwise elimination of some of the cases during the analysis.

The correlation matrix of the independent variables is presented in Table 6. The variables which were significantly correlating were eliminated from the model to prevent multicollinearity. The results of the resultant multinomial regression model are shown in Table 7.

From the regression results (Table 7), a log likelihood of 349.985 was statistically significant ($P < 0.01$), showing that the model existed. The pseudo R^2 was 0.41, indicating that 41.0% of the variation in the diversification variable was jointly explained by all the independent variables included in the model. Also, the model was able to classify correctly 48.4% of the respondents into the diversification categories.

Concerning model 1, none of the included explanatory variables was statistically significant ($P > 0.05$). From model 2, the statistically significant variable was region without the expected positive sign (Western, $P < 0.05$). The region where cocoa is cultivated was likely to influence diversification. Specifically, farmers in the Western Region relative to those in Volta Region (reference category) were less likely to diversify their cocoa farming into two crops as compared to those who did not. Being a farmer in the Western Region decreased the odds of diversification into two crops by 0.035 time.

As regards Model 3, the statistically significant variables were age of cocoa farm with the expected positive sign ($P < 0.05$), access to credit with the expected positive sign ($P < 0.05$), and region with the expected positive sign (Brong-Ahafo and Central Regions, $P < 0.05$). The age of the farm was highly probable to affect cocoa farming diversification. It is a factor more likely to differentiate farmers diversifying into three or more crops from those who were not. A unit increase in age of farm increased the odds of diversification by 1.09 times. Access to credit emerged to be a possible factor of crop diversification. A farmer receiving credit in the form of cash was more likely to diversify by cultivating other crops in addition to cocoa as compared with one who did not, and this increased the odds of diversification by 5.8 times. Region was a possible determinant of diversification of cocoa farming. Farmers in the Brong-Ahafo Region were more probable to diversify into three or more other crops than those in Volta Region, with the odds of diversification increased by 54.8 times. The same situation applied to farmers in Central Region compared to those in Volta Region with the odds of diversification increased by 53.1 times.

DISCUSSION

In general, this survey found that a greater percentage of farmers (79.0%) diversified cocoa farming into alternative crops whilst 21.0% focussed mainly on cocoa; as compared to a study by MASDAR (1998) which reported that 69.0% of the interviewed farmers intended to expand their alternative crop area and 25% intended to plant more cocoa. According to MASDAR the reasons they quoted most often for the expansion of the alternative crop area were the greater continuity of income throughout the year, perceived higher prices compared with cocoa, significant problems with the rehabilitation of existing cocoa farms and the fragmentation of cocoa

Table 6. Correlation coefficients among the independent variables+ considered in the multinomial regression analysis.

	A	AF	CR	E	F	FS	G	H	M	P	R	T	W	Y
A	1													
AF	0.368**	1												
CR	-0.030	-0.107	1											
E	-0.283**	-0.121*	-0.047	1										
F	0.060	-0.029	0.081	0.141*	1									
FS	0.163**	0.284**	-0.099	-0.041	-0.036	1								
G	0.041	-0.068	0.028	-0.226**	-0.068	-0.102	1							
H	0.141*	0.080	-0.126*	-0.125*	-0.050	0.143*	-0.021	1						
M	-0.100	0.016	-0.053	-0.081	-0.140*	0.145*	0.020	0.056	1					
P	0.111	0.198**	-0.112	-0.050	0.006	0.605**	-0.081	0.274**	0.097	1				
R	-0.196**	-0.111	0.109	0.063	0.078	-0.028	0.034	-0.142*	-0.221**	-0.085	1			
T	-0.074	-0.114	-0.021	-0.028	0.040	0.128*	-0.108	-0.078	0.205**	0.071	-0.230**	1		
W	0.588**	0.533**	-0.049	-0.177**	0.066	0.290**	-0.075	0.132*	-0.015	0.290**	-0.065	-0.084	1	
Y	-0.034	-0.007	-0.111	-0.005	0.006	-0.169**	-0.057	0.219**	0.020	0.459**	-0.156*	-0.002	0.039	1

**Correlation is significant at the 0.01 level (2-tailed), *= Correlation is significant at the 0.05 level (2 tailed). + A, AP, CR, etc. are independent variables considered in the model.

Table 7. Results of the multinomial logistic regression model of cocoa farming diversification.

Variable	Model 1: Diversification into one crop				Model 2: Diversification into two crops				Model 3: Diversification into three or more crops			
	B	Std error	Sig.	Exp(B)	B	Std error	Sig.	Exp (B)	B	Std error	Sig.	Exp(B)
Intercept	0.490	1.294	0.705		0.609	1.305	0.641		-3.362	2.134	0.115	
Age of cocoa farm	0.050	0.028	0.072	1.051	0.046	0.027	0.090	1.047	0.091	0.032	0.005***	1.095
Adult family labour	-0.142	0.115	0.215	0.868	0.056	0.096	0.558	1.058	-0.051	0.119	0.667	0.950
Gender	-0.451	0.739	0.541	0.637	-0.814	0.750	0.278	0.443	-0.207	0.906	0.819	0.813
Access to credit	0.254	0.716	0.723	1.289	1.210	0.737	0.101	3.353	1.761	0.864	0.042**	5.819
Eastern	0.977	1.095	0.372	2.656	0.560	1.106	0.612	1.751	1.225	1.747	0.483	3.403
Ashanti	0.395	1.031	0.701	1.485	-0.029	1.044	0.978	0.971	0.132	1.659	0.937	1.141
Brong-Ahafo	0.342	1.362	0.802	1.407	1.723	1.173	0.142	5.603	4.003	1.783	0.025**	54.752
Central	1.702	1.148	0.138	5.486	0.961	1.152	0.404	2.614	3.971	1.780	0.026**	53.054
Western	-0.688	1.175	0.558	0.503	-3.359	1.558	0.031**	0.035	-19.991	0.000	-	2.080E-9
Tenure (owner)	-0.751	0.583	0.198	0.472	-1.027	0.612	0.093	0.358	-0.328	0.744	0.659	0.720
Tenure (‘abunu’)	-20.338	0.000	-	1.471E-9	-1.362	1.592	0.392	0.256	-0.993	1.796	0.581	0.371

Table 7. Contd.

-2Log Likelihood	349.985
Chi-square	76.511
Significance level (Sig.)	0.001***
Pseudo R^2 (Nagelkerke)	0.41
% Classification	48.4
Sample size (N)	159

**$P < 0.05$, ***$P < 0.01$. B = coefficient of explanatory variables, Exp (B) = exponential value of B. – Values were not reasonable.

farms to the point where the cocoa /food combination was no longer financially viable as well as bush fires which can make the cultivation of tree crops untenable. However, farmers' main reason for growing cocoa was security in old age in addition to a guaranteed market and known prices. That is, they acknowledged the lower risk associated with growing cocoa compared to other crops more prone to the weather, uncontrolled prices and unpredictable marketing system that frequently cause high post-harvest losses (MASDAR, 1998). The Simpson Index, which approached one (1), implies that cocoa farmers mostly diversified cocoa farming into other alternative crops such as food and tree crops. Jha et al. (2009) noticed a high Simpson index of 0.89 in their study in India and they interpreted this as cultivation of considerable acreage of land under variety of crops.

The multinomial logistic regression analysis suggests that age of cocoa farm, access to credit and cocoa growing region (Western, Brong-Ahafo and Central) are statistically significant determinants of cocoa farming diversification. The likelihood to diversify cocoa production increases with increase in age of cocoa farm. As the cocoa farm ages, the cocoa yield declines resulting in less profitability, assuming other things being equal. The alternative crops to cocoa compete with cocoa for resources. Thus as the profitability of cocoa declines relative to the other crops due to, for instance, a fall in cocoa yield or price, the farmer is expected to divert resources into the production of those crops (Boahene, 1995). According to this reasoning the establishment of oil palm, plantain, cassava and maize farms has been seen as evidence that cocoa farming is not attractive. However, not all the crops are alternatives to each other. These crops differ in terms of their revenue generation capability and cost of production. However, the diversification or conversion of cocoa to another tree crop is also a slow process since both crops are fixed assets from which an income can be derived for over 20 years. Therefore unless the benefits of the other tree crops are higher for longer period of time, the farmer will not convert his cocoa farm into that activity (Boahene, 1995). Diversification can be constrained by market availability and size, land suitability and rights, infrastructure, labour supply, water and other resources. Where output demand is relatively elastic, the returns from investments in land, technology, and time spent in learning about new crops, are relatively high (Petit and Barghouti, 1992; Pingali, 2004). Pingali also reported that the process of diversification is triggered by rapid technological change in agricultural production.

The results indicated that a cocoa farmer receiving credit is more likely to diversify by cultivating other crops alongside cocoa as compared to a farmer who has not. This can be explained by the fact that there is the need for capital in the form of credit to finance the establishment and maintenance stages of cocoa farming in Ghana (MASDAR, 1998). A farmer without credit may find it difficult to maintain the existing cocoa farm let alone cultivating additional crops. Also, for a cocoa farmer to diversify cocoa production into other crops, he/she requires money to purchase extra land if he/she has no excess land, and other inputs such as seeds, agro-chemicals, labour and equipment for the cultivation of these other crops. Therefore, the availability of credit in the form of loans or in kind to the cocoa farmers could expedite the diversification process. Pingali (1992) reported that changing from rice monoculture to diversified farming requires substantial investments and operating expenses that need long-term and seasonal credit arrangement. Kasryno (1992) also found access to credit as a key constraint to the movement of farmers and rural firms towards diversification because of inadequate capital.

The cocoa growing region variable emerged to be a possible determinant of cocoa farming diversification. For instance, Western region farmers as compared with those in Volta region are less likely to diversify cocoa production. This is because the farms in the Western region might be on average relatively younger as compared to those in the other cocoa growing regions with the cocoa production frontier shifting from Eastern, Ashanti and the other regions to the Western part of Ghana. However, farmers in Brong-Ahafo and Central, compared with Volta region farmers, are more likely to diversify cocoa cultivation. This can be attributed to the relatively older farms and incessant bushfires in these regions. Petit and Barghouti (1992) argued that the extent of diversification is affected by the ability of each region in a country to specialize in specific enterprises based on comparative advantage. According to Petit and Barghouti regional diversification can be influenced by technical factors including agroclimatic conditions such as soil, weather and water suitable for expanding crop production.

This study could not take into consideration the off- and non-farm activities of diversification of the livelihood strategies of cocoa farmers. Also, the data did not allow inclusion of environmental, political and some socio-economic factors into the modelling of agricultural diversification. Therefore, a further study should be conducted to consider these factors.

CONCLUSION AND RECOMMENDATIONS

This study has shown that cocoa farmers have diversified cocoa cultivation to some extent into growing other crops such as oil palm, citrus, cassava, cocoyam, etc. to expand their sources of income. This is confirmed by the estimated Simpson Index of diversification of 0.9. The proportion of farmers diversifying into other crops alongside cocoa was higher (79%) than those who focused only on cocoa cultivation (21%). The multinomial regression analysis suggests that age of cocoa farm, access to credit and cocoa growing region (Western, Brong-Ahafo and Central) are statistically significant determinants of cocoa farming diversification, indicating their importance in crop diversification.

The following recommendations are made from the findings:

1. The Government, for that matter COCOBOD, should develop a policy framework to sustain cocoa production through the provision of incentives for replanting of old cocoa farms using cocoa technologies recommended by Cocoa Research Institute of Ghana (CRIG) and the modernization of indigenous agricultural and cocoa farming practices to attract the youth into cocoa cultivation;

2. The Government should develop alternative livelihood improvement strategies of other crops in addition to cocoa for farmers;

3. Finally, the Government should also improve access to credit facilities for cocoa farmers.

ACKNOWLEDGEMENT

The support provided by the technical staff, Mr. L. K. Akuffo, Mr. S. Duodu, Mr. Fredric Agyapong and Mr. Patric Zeal, all of the Social Science and Statistics Unit (SSSU) of Cocoa Research Institute of Ghana (CRIG) is gratefully acknowledged. This paper, CRIG/02/2011/045/003, is published with the permission of the Executive Director, CRIG, Tafo.

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