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DETERMINANTS OF CLIMATE CHANGE ADAPTATION AMONG COCOA FARMERS IN SOUTHWEST NIGERIA

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Abstract

Cocoa production in Nigeria is vulnerable to climate change. This study analyzed the factors influencing different climate change adaptation choices by cocoa farmers in southwest Nigeria. We sampled 515 farmers from three cocoa producing states, using the multistage sampling procedure. We analyzed cocoa farmers' climate change adaptation choices with Probit regression. All the farmers have noticed climate change and 78.72 percent noted excessive rainfall in 2011. Years of education, age of farmers and cocoa land areas significantly reduces (p<0.10) the probability of engaging in crop diversification. It however increases with male headship, household size, member sick, age of cocoa, ownership of radio and bicycle. Also, years of education, number of cocoa farms and cocoa farm distance reduces the chance of noting weather (p<0.10). It also increases with member sick, ownership of radio, car, mobile phone and extension contact. The chance of adequately spraying cocoa pods significantly reduces (p<0.10) with number of cocoa farms and increases with farming as primary occupation, member sick, age of cocoa trees, ownership of radio, motorcycle, car, and mobile phone. We recommended that effort to address climate adaptation among cocoa farmers should be gender sensitive, among others.

Keyword: Climate change, adaptation, cocoa Nigeria.

Introduction

In Nigeria, increased agricultural production is a necessary impetus for rural poverty alleviation. However, climate change is notable among the major constraints that are to be addressed (FGN, 2004). This is so because adequate weather conditions are necessary for crop production. Recently, persistent droughts, flooding, off-season rains and dry spells have disrupted crop growing seasons in many Nigeria's agro-ecological zones (Medugu, 2009). This is pathetic for a nation that primarily depends on rain-fed agriculture. Also, as an oil rich country, avoidance of impending economic dooms that may result from international actions to address climate change requires that the country should diversify income source (FGN, 2004). This initiative has led to some actions by the government to revitalize cocoa production, as one of the leading sources of non-oil foreign exchange.

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The major direct impact of climate change on agricultural production in Nigeria will be through changes in temperature, rain, growing season, and timing of extreme or critical threshold events. Suitable weather condition is essential at every stage of cocoa production. Now, when farmers replant old cocoa farms, persistent drought is affecting their survival. Sensitivity of cocoa production to hours of sunshine, rainfall, soil conditions and temperature therefore makes it vulnerable to climate change. Changing climate can also alter development of pests and diseases and change the host's resistance. Unfavorable climate promotes pest infestation and disease outbreak on cocoa farms. Newly planted cocoa plants and some cocoa trees shrivel because of drought (Anim-Kwapong and Frimpong, 2005).

Because cocoa contributes significantly to farm income and rural employment, adaptation is necessary. It is a clear associate of impact mitigation. It seeks for workable adjustment alternatives to the expected impact of climate change. When changes occur rapidly and because of poverty, farmers cannot respond properly to the impacts of climate change. Effective adaptation needs to make vulnerable people resilient, and able to return to normal status quickly, even after a major hurt. Therefore, we have to identify some other causes of vulnerability such as low income, low assets, illiteracy, resource depletion, poor governance, economic instability, disease, demographic factors and poor risk management (UNEP, 2006).

The social and physical systems react to climate change through adaptation. These reactions may be involuntary spontaneous changes or can be deliberate adaptive strategies (Carter, 1997). Adaptation involves managing risks posed by climate change, including variability. Analysis of the social impacts of climate change considers the spontaneous impacts, through observation of household or individual behaviour when faced with present climate variability. The observation of adaptation through primary or secondary sources of information is the aim of *positive* socio-economic analysis. Integrating policy recommendations into impact analysis, leads the analysis (such as that of welfare economics) into the *normative* model. Making recommendations as to what should be done in adaptation to climate change inevitably involves the normative judgment that individuals should bear the cost or enjoy the benefits of such adaptation within the existing distribution of income and wealth (Adger, 1996).

Farm households face the risk of welfare losses because of climate change due to less adaptation capacity. Carter (1997) found food shortages in one out of every five years for the average farmer in the Sahel region of Burkina Faso. He noted that farmers in the bottom quartile of land holdings experience shortfalls in four out of five years, while the top quartile of farmers experiences food

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shortfalls in only one out of ten years. Severe food problem often makes farm households to sell productive assets such as livestock or land, default on loans, and occasionally withdraw children from school.

Selvaraju *et al* (2006) analyzed the livelihood adaptation to climate change in a drought-prone area of Bangladesh. The findings reveal the forms of climate change as change in the seasonal cycle and rainfall pattern, frequent droughts, increased incidence of pest and disease and the average temperature has increased in the summer, with shortened winter. Also, Nhemachena (2007) used a multivariate discrete choice model to identify the determinants of farm-level coping strategies against climate change in Southern Africa. Results confirm that access to credit and extension and awareness of climate change are some of the important determinants of farm-level adaptation. This study seeks to analyze the determinants of cocoa farm households' adaptation choices to climate change. In the remaining parts of the paper, we have presented the materials and methods, results and discussions and conclusion.

Materials and Methods

Data sources and sampling procedures

We collected the data for this study from cocoa farmers in three states in southwest Nigeria. We conducted interviews with farmers using structured questionnaires and multistage sampling procedure. At the first stage, we randomly selected three cocoa growing states (Ondo, Osun and Ekiti). The second stage involved selection of some major cocoa producing Local Government Areas (LGAs). In Ondo state, we randomly selected Ile-Oluji/Oke Igbo, Owo and Idanre LGAs. In Osun state, we selected Aiyedaade, Irewole, Isokan Atakumosa West LGAs. In Ekiti state, we selected Ise/Orun, Gbonyin, Ekiti East and Ikole LGAs. At the third stage, we compiled a list of cocoa growing villages from each of the LGAs and sampled cocoa farm households in proportion to the total population. As the largest cocoa growing state, we administered 282 questionnaires in Ondo state, while we administered 106 and 125 in Ekiti and Osun states, respectively.

Determinants of cocoa farmers' climatic change adaptation choices

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To analyze the factors influencing coping options chosen by the farmers, Probit regression method was used. This is because of the binary nature of the dependent variable. The model is stated as:

$$Y_i = \eta + \beta_i \sum_{i=1}^{n} Z_i + e_i \qquad 1$$

The adaptation methods (Y_i) were categorized into three. These first is diversification into non-farm enterprises or the crop combinations with values of 1 if yes and 0 otherwise. The second is monitoring weather through indigenous methods or media with values of 1 if yes and 0 otherwise. The third is proper spraying of cocoa pods with values of 1 if response is yes and 0 otherwise. Also, we estimated β_j as the parameters, while Z_i are the explanatory variables (see column 1 of table 4).

Results and Discussions

Cocoa farmers' socio-economic characteristics

The descriptive statistics of the socio-economic characteristics of cocoa farmers are presented in tables 1 and 2. In table 1, average age of cocoa farmers is 55.01 years, while average year of farming is 32.25 years. The farmers, on the average have high family size (7.28), while average dependency ratio is 0.66. Table 2 also shows that majority of the cocoa farmers (91.81 percent) are males, while 86.94 percent are engaged in cocoa agriculture as primary crop. Also, radio, television, motorcycle, bicycle, vehicle and mobile phone were owned by 87.13 percent, 56.73 percent, 61.01 percent, 13.64 percent, 14.42 percent and 74.46 percent of the farmers. Only 25.53 percent have access to extension services, while

Perceived forms of climate change

Table 3 shows the different form of changes that cocoa farmers in southwestern part of Nigeria have noted in prevailing weather over the past three years (2009-2011). The results show the diversities in weather exposure, and/or experiences and the view by the farmers across the three selected states

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about these changes. Across the states and the time covered, too much rainfall was widely noted as a cause of cocoa production decline. Specifically, Nigerian Meteorological Agency (NIMET) (2011) noted that in August 2010, some places in the southwest zone including Ondo recorded rainfall values that were 200-300 percent higher than normal. Because of too much rainfall and inability of the farmers to buy chemicals to combat black pod disease, cocoa production is likely to reduce by 15-20 percent in 2011 (Oredein, 2011).

Specifically, 17.02 percent, 47.52 percent and 78.72 percent of the respondents from Ondo state perceived too much rainfall in 2009, 2010 and 2011, respectively. In Osun state, 79.20 of the respondents noticed too much rainfall in 2011, while 80.19 percent and 82.08 percent noticed it in 2010 and 2011 respectively in Ekiti state. In the combined data for all the states, the proportion of cocoa farmers that perceived higher than normal rainfall increased from 9.75 percent in 2009 to 43.86 percent in 2010 and 79.53 percent in 2011. However, in 2010, 78.30 percent of the farmers in Ekiti state reported lower than normal rainfall. Also, 28.37 percent, 11.20 percent and 59.43 percent of the farmers from Ondo, Osun and Ekiti states respectively reported more stormy rainfalls, especially at its start in 2011.

Also, 88.68 percent of the cocoa farmers that were interviewed in Ekiti state noticed high temperature in 2009. This proportion declined to 3.77 percent and 2.83 percent in 2010 and 2011, respectively. In Ondo state, 17.02 percent, 20.92 percent and 17.38 percent of the farmers noticed high temperature in 2009, 2010 and 2011, respectively. In Osun state, fewer proportions of the respondents noticed extreme weather condition in the form of high temperature. Also, in Ondo, Osun and Ekiti states, 78.72 percent, 79.20 percent and 82.08 percent respectively noticed low temperature in 2011.

The study also probed into the timeliness of rainfall start and stopping. The results suggest that in 2009, 79.24 percent of the respondents in Ekiti state noted late start of rainfall. Those with the same responses in Ondo and Osun states constitute 12.06 percent and 4.8 percent, respectively. In 2010, 23.05 percent, 9.6 percent and 17.92 percent in Ondo, Osun and Ekiti states respectively noted late start of rainfall. However, in 2011, none of the respondents in Ekiti state pointed out late start of rainfall, but 33.33 percent and 51.2 percent in Ondo and Osun states respectively indicated same. Also, 66.98 percent of the farmers from Ekiti state pointed out that rainfall delayed to stop in 2010, while 20.56 percent and 3.2 percent pointed out same in Ondo and Osun states, respectively. However, in 2011,

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42.55 percent, 52.00 percent and 78.30 percent of the respondents from Ondo, Osun and Ekiti states respectively noted delay in rainfall stopping.

Determinants of Cocoa Farmers' Climate Change Adaptation Choices

The choices that households are making to adapt to climate were model with Probit regression. The adaptation choices of the farmers fall into three groups. They are crop and income diversification (CISD), weather monitoring through media and indigenous knowledge (WMMIK) and adequate spraying of the farm (AS). Table 2 contains the results for each of the groups. The model produced good fit for the data as shown from the Chi-square values that are statistically significant ($p<0.01$).

In the results, the parameter of sex for CISD model is statistically significant ($p<0.01$). It also shows that men have higher chance of diversifying their crops and income sources, compared with women. This confirms arguments in literature that women are less able to diversify income sources and adapt to climate change because of other domestic responsibilities and less control of financial resources (Röhr, 2007; Seebens, 2009). Female cocoa farmers, most of the time, will have to depend on labor by men laborers or their husbands to perform some farm works. Some delays may set in due peak farm work because men are also busy on their farms. The traditional role of women as home caregiver also compounds their problem and lessens their involvement in other crop and income diversification.

The results further imply that as house head years of education increase, the chance of crop and income diversification and weather monitoring decreases. Deressa *et al* (2008) associates greater access to climate change information, improved technologies and higher productivity to higher education. However, we discovered during the survey that because they inherited the farms, educated farmers took farming as secondary occupation. Therefore, because their livelihoods do not mainly hang on their cocoa farms or farming, they may not see the need for weather monitoring or growing more crops.

Household size parameter has positive sign and statistically significant ($p<0.10$) for CISD. This shows that as household size increases, chance of crop and income diversification increases. We expected this because the food and income needs of large households are higher than those with smaller sizes. Similarly, Deressa *et al* (2008) noted the tendency of larger households to adapt to climate change is expected to be higher probably due to their higher endowment of labour.

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Also, as the age of household head increases, the chance of diversifying crop and income significantly reduces ($p<0.01$). Deressa *et al* (2008) explained that age increases adaptation to climate change. In this study, aged household heads were fragile and unable to explore many coping alternatives. The usual practice is that younger cocoa farmers will migrate to far villages where virgin forestlands can be found as cocoa production begins to decline in their early farms.

Also, those that pointed out cocoa as the primary crop have significantly lower chance of diversifying their crops and income sources ($p<0.10$). This is because of ability to earn high profits from large cocoa farms with good harvest. Cocoa farmers that are mainly into farming have higher chances of monitoring weather and adequately spraying cocoa pods ($p<0.10$). We expected this because the farmer has to produce enough crops to earn income that can meet household's needs.

The chances of diversification, weather monitoring and adequate cocoa spraying is associated with illness of other household members ($p<0.01$). Although Winchester and Szalachman (2009) agreed that good health could improve adaptive capacity of the households to climate change, our findings are buttressing the primary role that household heads play in adaptation. Household heads allocate available labor for optimum farm production even in situations when some household members are sick. Another vital finding that buttresses this is that missing of regular cocoa spraying due to illness significantly reduces the probability of diversifying crops and income sources ($p<0.01$). Probabilities of engaging in diversification, weather monitoring and adequate cocoa spraying increase among farmers that have their health affected by climate change ($p<0.05$). We expect the opposite, though the finding could be due to other climate change impact mitigation.

As the number of cocoa farms increases, the chances of monitoring weather and adequately spraying cocoa farms significantly reduce ($p<0.01$). We expect this because when a farmer has many cocoa farms, the tendency of rectifying unexpected climate situations that can make cocoa spraying ineffective decreases. However, increase in the land areas cultivated to cocoa significantly reduces the probability of crop and income diversification ($p<0.05$) but significantly increases probability of adequately spraying the farm ($p<0.10$).

As the age of cocoa trees increases, the farmers' chances of diversifying crop and income and adequately spraying cocoa significantly increase at ($p<0.01$) and ($p<0.10$) respectively. As the distance of cocoa farm increases, there is significant reduction in the probability of monitoring weather ($p<0.05$).

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We expect this because with distant farms, weather monitoring is ineffective as a result of occasional sudden changes in weather.

IPCC (2001) submitted that the main factors influencing community or region's adaptive capacity include economic wealth, technology, information and skills, infrastructure, institutions, and equity. Our results show that ownership of radio, which is rural people's major source of information, significantly increases the probabilities of diversifying crop and income, monitoring weather and adequately spraying cocoa at ($p<0.05$), ($p<0.05$) and ($p<0.01$) respectively. However, it is only for adequate spraying model that ownership of motorcycle show statistical significance ($p<0.05$), while ownership of bicycle significantly increases probability of crop and income diversification ($p<0.10$). Ownership of vehicle significantly increases the probabilities of monitoring weather and adequately spraying cocoa pods at ($p<0.01$) and ($p<0.05$) respectively. Ownership of mobile phone also increases probabilities of monitoring weather ($p<0.10$) and adequately spraying cocoa ($p<0.01$). Access to extension services also significantly increases the probability of monitoring weather ($p<0.05$).

Recommendations

This study has brought to limelight several policy issues that should be addressed in order to mitigate the impact of climate change adaption among cocoa farmers in southwest Nigeria. Nigerian government should ensure that fungicides (ridomil) for fighting cocoa black pod disease and other pesticides of high potency are made available to farmers at affordable prices. Adequate arrangements for distributing the product to farmers at regulated prices should be made to facilitate access and timely spraying of cocoa pods.

There is need to provide adequate education to facilitate farmer's adaptation. More of media involvements in providing weather forecasts and other useful information for impact mitigation will be welcomed. Majority of the farmers, having already developed habit of listening to radio in order to get farm-related information can greatly benefit from such programmes.

Also, our results show that expansion of coverage of mobile telephone networks to rural areas can facilitate access to vital information which will enhance climate change adaptation. Mobilization of resources towards expansion of extension agent coverage to those rural areas is also vital for promoting adaptation through weather monitoring.

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Since farmers are suffering the brunt of climate change problems, a special intervention fund that focuses on assisting them to mitigate the impacts will go a long way in soothing the pains inflicted on them by climate change. This can come in form of mobilizing younger school leavers to go into cocoa production. Such initiative should also target female cocoa farmers due their lower probability of income source diversification.

In conclusion, cocoa farmers in southwest Nigeria are witnessing different forms of climate change. This is affecting different aspects of their social and economic activities. Top on the impacts of climate change as related to cocoa agriculture is its adverse influence on cocoa yields through the popular black pod disease. Addressing the menace is greatly reducing farmers' profit. The onus therefore rests on government to provide adequate sensitization on impact mitigation mechanisms as may be required by the cocoa farmers.

Table 1: Descriptive statistics of cocoa farmers' socio-economic characteristics

Variable	Mean	Standard Deviation
Years of education	6.296296	5.684918
Household size	7.276803	3.791616
Dependency ratio	.6599986	.7582216
Age	55.00585	16.74434
Year of farming	32.25926	18.03212
Number of cocoa farms	2.699805	1.943423
Years of cocoa farming	30.38402	17.92003
Number of time sick	1.984405	2.808982
Cocoa land area	7.977193	11.83782
Proportion of land covered with cocoa	79.39766	13.44599
Age of cocoa trees	33.45322	18.98894

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Year of cocoa farm rehabilitation	1.005848	3.391448
Cocoa farm distance to village	6.664133	42.67846
Number of sprayers	5.922027	88.21658
Cocoa market distance	2.539086	4.677602

Table 2: Percentage Distribution of some socio-economic variables of the farmers

Socio-economic variable	Percentage
Sex (Male)	.9181287
Cocoa as primary crop	.8693957
Primary occupation is farming	.8362573
Climate affects health	.5633528
Ownership of radio	.871345
Ownership of television	.5672515
Ownership of motorcycle	.6101365
Ownership of bicycle	.1364522
Ownership of vehicle	.1442495
Mobile phone	.7446394
Access to extension services	.2553606
Malaria as sickness	.6003899
Other member sick	.6081871
Missed cocoa spraying due to illness	.4152047

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Personal farm ownership	.8109162

Table 3: Frequency distribution of observed forms of changing weather by cocoa farmers in southwest Nigeria

Observed climate changes	Ondo	Osun	Ekiti	All	Ondo	Osun	Ekiti	All	Ondo	Osun	Ekiti	All
Extremely high temperature	48	11	94	153	59	6	4	69	49	8	3	60
Extremely low temperature	28	3	1	32	25	1	89	115	24	5	89	118
Too much rainfall	48	1	1	50	134	6	85	225	222	99	87	408
Too low rainfall	27	2	83	112	22	2	3	27	21	12	0	33
Delay in rainfall commencement	34	6	84	124	65	12	19	96	94	64	0	158
Delay in rainfall stopping	33	2	0	35	58	4	71	133	120	65	83	268
Too stormy rainfall	31	0	5	36	49	0	21	70	80	14	63	157
Thicker cloud covers	41	0	4	45	63	0	55	118	65	2	43	110
Total	282	125	106	513	282	125	106	513	282	125	106	513

Source: Field survey, 2011

Table 4: Determinants of cocoa farmers' adaptation choice in southwest Nigeria

	Diversify crop and income		Monitor Weather		Adequate spraying	
Variable	Parameter	Standard error	Parameter	Standard error	Parameter	Standard error
Sex (male=1, 0 otherwise)	.6165885**	.2556257	.2191761	.2346994	.1713963	.2480518
Years of education	-.0273933**	.0131613	-.0220964*	.012805	-.0148429	.013623
Household size	.0304624*	.0171785	-.014067	.0181625	.0045281	.018495
Dependency ratio (less 15 years/ more than 15 years)	-.073891	.082513	-.0264768	.0890895	-.0309662	.0956576

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Age (years)	-.0160239***	.0048454	-.001935	.0048654	-.0020765	.0050862
Cocoa as primary crop (yes=1, 0 otherwise)	-.3649349*	.2056015	-.0291262	.2056531	.1270449	.2051137
Primary occupation is farming (yes=1, 0 otherwise)	-.0172414	.1933624	.3588311*	.1934277	.4838726***	.1942007
Number of time sick	.0185288	.0226745	-.020448	.0251418	.0270416	.0302269
Malaria as sickness (yes=1, 0 otherwise)	.0637718	.1369222	-.061438	.1350611	-.0370286	.1397893
Other member sick (yes=1, 0 otherwise)	.3690219***	.1461604	.6892648***	.1459201	.5583066***	.1496433
Missed cocoa spraying due to illness (yes=1, 0 otherwise)	-.4788831***	.1437175	-.226897	.1418308	-.1252537	.1514186
Number of cocoa farms	-.0565583	.0350049	-.0918492***	.0333287	-.1209112***	.0364809
Farm ownership type (personal=1, 0 otherwise)	-.139355	.1626428	-.0053973	.1627042	-.1341775	.1734978
Cocoa land area (acres)	-.0150065**	.0068439	.0012877	.0052276	.0128245*	.0076624
Proportion of land covered with cocoa (%)	-.0012514	.0050264	.00245	.0048542	.0047811	.0052359
Age of cocoa trees (years)	.0132977***	.0040526	.0058779	.004084	.0079596*	.0043702
Year of cocoa farm rehabilitation	.0147215	.0179864	-.0269161	.0194925	.0141996	.0235657
Cocoa farm distance to village (km)	-.0015344	.0015473	-.0030972**	.0014721	-.0005553	.0014118
Number of sprayers	-.0005895	.004831	-.0008864	.0032809	-.0143808	.082444
Climate affects health (yes=1, 0 otherwise)	.4124306***	.1290028	.6220493***	.1287912	.3178225**	.1362725

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Ownership of radio (yes=1, 0 otherwise)	.5295014**	.2360671	.4264633**	.2159637	.5990103***	.2219953
Ownership of television (yes=1, 0 otherwise)	.1343223	.1480815	-.2069651	.1457348	-.0282276	.1543296
Ownership of motorcycle (yes=1, 0 otherwise)	-.026835	.1459336	.0575952	.1444626	.3170888**	.1505637
Ownership of bicycle (yes=1, 0 otherwise)	.3310933*	.180731	.2412132	.183752	.0890925	.1942038
Ownership of vehicle/car (yes=1, 0 otherwise)	.1612032	.1880681	.509727***	.1910588	.4097884**	.2099901
Mobile phone (yes=1, 0 otherwise)	.2555664	.1714855	.319011*	.1665345	.4670256***	.1697855
Access to extension services (yes=1, 0 otherwise)	-.0107081	.1055385	.2399004**	.1017249	-.0448882	.1057557
Cocoa market distance (km)	.013776	.013599	.0057438	.0144643	-.0046343	.015699
Constant	-1.20229*	.6807623	-2.296445***	.6522509	-2.048555***	.7049167
Pseudo R^2	0.1486		0.1563		0.1721	
Likelihood ratio Chi Square	100.17***		110.94***		111.41***	

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