Cash Income Diversification in Rural Small Holder Cassava Producing Households of Nigeria

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Summary

The issue of poverty alleviation for the people of less developed nations of the world has currently assumed the status of a recurring decimal. This is particularly critical for sub-Saharan Africa, because, the region contains a growing share of the world's absolute poor, with most of these found among rural farm households. High variability in crop yield and thus income variability arising from the vagaries of weather makes income diversification important for these households in order to improve their economic status. This paper, based on primary data collected as part of the Collaborative Study of Cassava in Africa, identified factors that drive cash income diversification decisions among rural farm households of Nigeria. Using Heckman's two-stage model, it separates the first discrete decision of whether or not to engage in non-crop income activities from the continuous decision of how much non-crop income is needed by the household. While the level of formal education of the household head, good market access conditions and availability of initial liquidity stimulate the first decision to start non-crop income activities, only household characteristics (also including the level of formal education of the household head) drive the extent of non-crop cash income earned by the household. These observations further underscore the need for investing in people – education, and in infrastructure – improving market access, as potent tools for economic empowerment.

Résumé

La diversification des revenus chez les ménages cultivateurs de manioc en milieu rural au Nigeria
La question de la réduction de la pauvreté pour les peuples dans les nations en voie de développement dans le monde est actuellement à la une. Ceci est particulièrement crucial pour l'Afrique sub-Saharienne, parce que la région renferme une part croissante des pays moins développés et pauvres dans le monde. Et la plupart des pauvres se trouvent parmi les cultivateurs ruraux. Une grande variabilité des rendements agricoles et donc du revenu variable suite aux caprices du climat rend important la diversification du revenu pour les familles afin d'améliorer leur statut économique. Cet article est basé sur des données primaires collectées comme faisant partie de l'Etude Collaborative du Manioc en Afrique. On a identifié les facteurs qui entraînent la décision de diversifier les revenus chez les cultivateurs ruraux de manioc au Nigeria. Se servant du modèle à deux étapes de Heckman, il distingue la première décision discrète de s'engager, qu'il en soit ainsi ou non, des activités qui procurent des revenus non agricoles, des décisions permanentes de combien de revenus non agricoles sont exigés par la famille. Tandis que le niveau d'éducation formelle acquise par le chef de famille, l'accès aux marchés et la disponibilité de capital initial incitent à la première décision de débuter des activités qui procurent des revenus non agricoles, ce sont seulement les particularités du ménage (y compris le niveau d'éducation formelle du chef de ménage) qui déterminent le degré de réalisation des revenus non agricoles de la famille. Ces observations en outre soulignent la nécessité d'investir dans l'éducation des gens et dans l'amélioration de l'infrastructure d'accès aux marchés comme des outils importants pour le renforcement économique des ménages.

Introduction

Probably no less than a quarter of the world population belongs to the farm households, and most of this is in the less developed countries of the world (5). In addition, world poverty is also disproportionately found among them, particularly in sub-Saharan Africa (19), which makes understanding the determinants of their welfare a prime concern in any strategy of poverty alleviation (16). One of the primary factors militating against the welfare of farm households is unstable income. High income variability is almost part of life among farming households in developing countries (4). In Africa for instance, the farming systems are inherently risky because they are fundamentally dependent on the vagaries of weather. Weather variation, the incidence of diseases, pests, fire and a host of other less obvious factors cause farming yields, and thus income to fluctuate unpredictably. Moreover, crop insurance and consumption credit markets are generally non-existent in most African farming communities. According to Binswnager and Rosenzweig (2), only to the extent that risk is not insurable will risk be reflected in *ex-ante* production decisions, and weather risk appears to be uninsured in most low-income settings.

Cash income diversification is a major avenue through which farm households compensate for crop yield variability (1, 13). Available literature on cash income diversification among farm households in Africa have tended to concentrate on the Semi-Arid Tropics. The problem has largely been ignored for farm households in other agricultural zones of Africa. This does not necessarily imply the absence of unstable crop income problems and hence the need for diversification in these other zones. The much talked about declining per capita food output and poverty is in relation to the whole of sub-Saharan Africa and not just the semi-Arid Tropics. The World Bank (19) reports, for instance, growing poverty, particularly consumption poverty and widening income inequality in Nigeria. Nweke (9) reports that non-crop cash income accounted for 25% of the total household cash income among rural cassava producing households in Nigeria. Cassava is produced mostly in the humid and moist savanna tropics. In addition, about 60% and 25% of the villages in the humid climate zones that were surveyed during the Collaborative Study of Cassava in Africa (COSCA), cited weather, pests/diseases respectively as cassava production risks (10).

This paper, based on primary data collected within the framework of COSCA examines the factors that drive cash income diversification in cassava producing households of Nigeria. Diversification is defined here to mean percentage of total household cash income that came from livestock and non-farm activities. Livestock is included here because farmers in Africa keep livestock as alternative source of income (7, 14). One of the classical assumptions of utility maximization theory is that household preference relation is characterized by local nonsatiation. As long as this holds, extra cash income takes the household to a higher indifference curve and is preferred; hence the basis for this analysis. This is further underscored by the fact that within the households under study, per capita food expenditure was on the average higher among those that earned non-crop cash income (96 Nigerian naira) than among those that did not (60 Nigerian naira).

Method of the study

(i) Site and sample selection
Climate, human population density, and market infrastructure formed the bases for sampling. Following Carter and Jones (3), four basic climate zones were defined from temperature and duration of dry periods within the growing season (Table 1). Information on market access conditions (all-weather roads, railways, navigable rivers), and human population data, derived from available secondary sources were used to respectively divide a market access infrastructure map of

Nigeria into good and poor zones (according to the density of the roads, railways, or navigable waterways), and a population map of Nigeria into high demographic-pressure zones with 50 or more persons per km^2, and low, if less.

The three maps of climate, human population density, and market access infrastructure were overlaid to create zones with homogeneous climate, demographic pressure, and market-access conditions. Each climate/population density/market-access zone with less than 10,000 ha of cassava was excluded, given that the study was primarily that of cassava. The remaining areas were divided into grids of cell 12' latitude by 12' longitude to form the sample frame for site selection. Sixty-five grid cells distributed among the climate/population density/market-access zones in proportion to the zone size, were selected by a random method; a village was selected in each grid, again by a random method. In each selected village, a list of farm households was compiled and grouped into "large", "medium" and "small" farm-holder units with the assistance of key village informants. One farm unit was selected from each stratum to make a total of 195 households. However, due to the sensitive nature of divulging all the sources of household income to researchers, only 59 households were able to give all the information necessary for this analysis and were therefore used.

(ii) Data Collection
Leaders in cassava research in the national agricultural research systems administered survey questionnaires to local farmers and took various measurements.

Table 1
Definitions of climatic zones

Climatic zone	Temperature (°C)		Months of dry season
	Daily mean	Range	
Lowland humid	>22	<10	<4
Highland humid	<22	<10	<4
Subhumid	>22	>10	4-6
Non-humid	>22	>10	6-9

Table 2
Definition of variables

Variables	Mean (Std deviation)	Unit or type	Explanation
NONFM*	0.28 (0.29)	Continuous	Percentage of household cash income earned from non-crop income
AGEHH	55.91 (16.25)	Continuous	Age of the household head
EDUCHH	4.27 (4.93)	Continuous	Number of years of formal education of the household head
HHSIZE	10.60 (6.88)	Continuous	Number of persons living in the household
DPDRATIO	0.49 (0.17)	Continuous	Proportion of the household size whose age is either less or equal to 15 or greater than 65
NUMWIVES	1.68 (1.05)	Continuous	Number of wives in the household
MIGASSET	2.70 (1.83)	Continuous	Number of household members living abroad who remit money or goods back to the household
FDPRICE	8.08 (8.76)	Continuous	Price of staple food crops
NTRCROPS	5.24 (3.09)	Continuous	Number of tree crops owned by the household
FMSIZE	1.81 (2.80)	Continuous	Size of the household farm in hectares
ACCESS	0.90 (0.21)	Binary	1, if market access was with vehicle or on foot with a distance of within 10 km; else 0
HUMID	0.24 (0.43)	Binary	1, if climatic zone is humid; else 0

* = Dependent variable

A rapid rural appraisal technique was employed to collect village-level information during the Phase I survey. Farmer groups consisting of men and women with wide age range were constituted and interviewed in each village. A structured questionnaire was used to collect qualitative information on production practices and market access conditions among many others. This survey was conducted in 1989-1991.

Phase II survey was carried out at field level. The information collected included field size and history, inputs applied, among many others. The field-level information was collected in 1991 from the same villages as above.

Phase III survey was at the household level, also in the same villages. Relevant male and female household members were interviewed with structured questionnaires. The household information which included composition and characteristics, cash income earned as well as the sources of income, among many others were collected in 1992.

Hypotheses and estimation procedure

(i) Hypotheses

The drive to diversify the income base of a household may be related to the characteristics of the household head (AGEHH and level of formal education (EDUCHH)), who is usually the director of the farm household enterprise (18). Because of enhanced entrepreneurial and management skills often acquired through education, the expected direction of the relationship of education with income diversification is positive. However, the relationship of diversification with age is an empirical question. It is possible that experience, which comes with age could be an asset in managing diversified portfolios of the household. On the other hand, increased age could also imply lower entrepreneurial motivation and risk taking behavior (15).

The household income diversification needs could also be related to the size (HHSIZE), the level of dependency ratio (DPDRATIO) and the number of wives (NUMWIVES). Larger households would most often demand greater income needs, which invariably requires greater diversification as an insurance against crop income variability. Similarly, high dependency ratio is expected to propel the household into more income diversification in order to cater for the needs of the dependents. On the other hand, it is hypothesised that the number of wives in a household will be negatively related to the farm household's diversification into non-crop income. This is because cropping labor constraints could sometimes compel farmers to divert resources into non-cropping projects which does not require as much labor. Some African farmers however solve this problem by marrying many wives (11). The dependent variable could also be related to the number of household members residing outside (MIGASSET) who remit money or goods back to the household.

Income diversification may be related to the household's farm size (FMSIZE) and number of tree crops (NTRCROPS). These two measures could index the level of wealth of the household as crop farmers. Reardon *et al.* (13) reports that households with less land or non-landed assets would be more risk averse and hence more sensitive to the need to diversify to lower overall income variability.

Price of staple food crops (FDPRICE) is also specified and expected to be negatively related with the dependent variable. This is because favorable food prices could be a disincentive for income diversification.

Climate (HUMID) and market access (MKTACCESS) conditions may also be related to income diversification. The riskier the agriculture (as expected in the relatively agroclimatically poor non-humid zones in comparison with humid zones), the more the need for income diversification (13). Moreover, the condition of market access could determine the development of non-farm institutions and activities which creates opportunities for non-farm income. The variables are defined in table 2.

(ii) Estimation procedure

The subject being investigated here involves a two stage decision problem for the household. The first is a discrete decision of whether or not to engage in activities that will generate non-cropping cash income, while the second is a continuous decision of how much non-cropping cash income is needed by the household, conditional on a positive first decision. If unobserved preferences and characteristics affect both the discrete and continuous decisions involved, the error terms in the two respective equations are correlated. In addition, the household's non-crop cash income will most likely give rise to censored data, and Ordinary Least Squares (OLS) will yield biased parameter estimates. Moreover, the variables affecting the two decisions may not be exactly the same. There could be fixed-cost type variables affecting the first decision of whether or not to engage in non-cropping activities but not the extent of non-cropping income needed. Once the first decision is made, they do not affect the second decision. Heckman's (8) two-step model, also called Tobit II model therefore becomes appropriate. First, the equation on the discrete decision of whether or not to engage in activities that will yield non-cropping income is estimated, and second, the equation on the extent of non-cropping income needed is estimated with the inverse Mill's ratio (INVMILS) obtained from the first estimation included as an independent variable. The procedure is as follows: whether or not to engage in activities that will generate non-cropping cash income is modelled as:

$$Z = \alpha X + e \text{ --------------- (a)}$$

Where $Z = 1$ if a household earns non-cropping cash income, $Z = 0$ otherwise.
Extent of non-cropping income earned equation is

$$Y = \beta X + u \text{ ------------------ (b)}$$

Where X is a vector of exogenous variables. $Y > 0$ if $Z = 1$, and $Y = 0$ if $Z = 0$,
$e, u \sim N(0, \sigma_i)$ with correlation ρ.
Equation (b) can be estimated as

$$E[Y/Z = 1] = \beta X + \rho \sigma_u \lambda_e + \omega$$

Where $\lambda_e = \phi(\alpha X)/\Phi(\alpha X)$, and ϕ and Φ are standard normal pdf and cdf respectively of the first decision. Equation (b) is thus estimated including λ as an explanatory variable. For purposes of comparison, we also estimate the one-stage Tobit or the standard Tobit model and test the difference with the two-stage model using the likelihood ratio test: $\chi^2 = 2(logL_{dh} - logL_t)$, where $logL_{dh}$ is the log likelihood of the two-stage model (dh) and $logL_t$ the log likelihood of the standard Tobit (t) model (17).

Results and discussion

Table 3 presents the results of the analysis. The likelihood ratio test comparing the standard Tobit model with the two-stage model gave a χ^2 value of 13.06. The 5% critical value taken from the asymptotic Chi-squared distribution with one degree of freedom is 3.84, thus showing that the one stage Tobit model was restrictive. The Heckman's two-stage model was therefore used for interpretation.
The level of education of the household head affected both the decision of whether or not to earn non-crop cash income and the extent of income earned from diversification. The

Table 3
The standard Tobit and Heckman's two-stage models estimation results

Variables	Std estimation	Heckman two-stage estimation	
		Tobit Selection	Level of non-crop income earned
AGEHH	0.0234 x 10^{-3}	0.0117	-0.0032
	(0.009)	(0.925)	(-1.311)
EDUCHH	0.0418	0.3969	0.0268
	(4.096)***	(2.620)***	(2.923)***
HHSIZE	0.0151	-0.0747	0.0279
	(1.727)*	(-1.291)	(3.074)***
DPDRATIO	0.3774	2.2168	0.3205
	(1.823)*	(0.877)	(1.664)*
NUMWIVES	-0.1116	0.0398	-0.1390
	(-2.229)**	(0.114)	(-2.769)***
MIGASSET	0.0242	-0.3480	0.0667
	(1.139)	(-1.760)*	(3.007)***
FDPRICE	-0.0003	0.2876	-0.0021
	(-0.088)	(2.888)***	(-0.802)
NTRCROPS	-0.0240	0.1155	-0.0252
	(-1.872)*	(1.315)	(-2.197)**
FMSIZE	-0.0153	-0.0534	-0.0207
	(-0.684)	(-0.373)	(-1.022)
MKTACCESS	0.1087	2.4966	0.0902
	(0.775)	(2.705)***	(0.735)
HUMID	-0.2449	-3.3383	-0.0874
	(-2.441)**	(-2.876)***	(-0.971)
INVMILS			-0.2345
			(-9.657)***
INTERCEPT	0.0084	-4.0662	0.2258
	(0.029)	(-2.665)***	(0.858)
Log likelihood	-10.4198	-3.8910	
Prob> chi^2	0.0031	0.0001	
No. of observations	59	59	

decision to delve into non-crop income activities for the crop farmer could be like delving into the unknown with its attendant risks. Educated household heads may better understand and process information provided by different sources regarding new investments, thereby increasing their allocative and technical efficiency (12). Education could also enable the household head get part-time jobs in non-farm establishments; the pay of which usually depends on the level of education. Household size did not affect the discrete decision to earn non-crop cash income, but positively affected the extent of non-crop income earned. This could imply that all household members contribute to the degree of non-crop income earned while the first decision rests with the head. It is also consistent with our hypothesis that larger households would generally require greater income (whether crop or non-crop). Similarly, dependency ratio did not affect the first decision of whether or not to earn non-crop income but positively affected the extent of income earned. The first relationship in this case is surprising. However, households with higher number of dependants could attract more remittances from relatives abroad, thereby cushioning the effect of crop income variability. This could also partly explain its significant effect on the extent of non-crop income earned, although it could be that a higher burden of dependants compels households to strive harder to earn more income as hypothesised. The number of wives per household did not affect the decision of whether or not to earn non-crop income but negatively affected the extent of income earned from diversification. This is consistent with our hypothesis that farmers marry many wives to provide labor for expansion in cropping activities. The number of

household members (residing abroad) remitting money or goods back to the household was negatively related with the discrete decision of whether a household earned non-crop income but positively related with extent of income earned. This is to be expected because the receipt of money or goods from household members abroad would serve as a disincentive to investments that would earn non-crop income. But the money or goods they remit back should naturally augment the non-crop income of the household.

Ignoring the variable on migrants, we note that of all the demographic factors considered, none but the educational level of the household head affected the first decision of whether or not a household earned non-crop income. However, all but the age of the household head affected the extent of non-crop income earned. This suggests a dominating influence of education in overcoming the state of inertia often associated with first moves into new ventures.

The price of food crops was positively and significantly related with whether a household earned or does not earn non-crop income but negatively, though not significantly, related with the extent of non-cropping income earned. The first relationship is contrary to our hypothesis. However, this suggests the presence of credit constraints on non-cropping activities, forcing households to supply their own liquidity to start them. But once started, they generate enough liquidity to maintain them. This does not necessarily contradict the above observation on remittances from migrants because human behaviour towards earned and unearned income is generally different.

This is similar and also explains the relationship with number of tree crops owned by the household. Tree crops a good source of crop income for the household, was positively though not significantly related with the first decision of whether a household earned non-crop income but negatively and significantly related with extent of non-crop income earned. In other words, although income from tree crops could help start up non-cropping activity, it would most probably also curtail the extent of diversification. Reardon *et al*. (13) report that wealthier households could rely on their own liquidity resources to enter into non-farm activities.

Household farm size, although it had the expected sign (negative in both relationships), was neither important for the decision of whether a household earned or does not earn non-crop income, nor important for the extent of non-crop income earned.

Easy access to the market centre was positively related to both the discrete decision of whether or not to earn non-crop cash income and the continuous decision of how much non-crop income earned. While the relationship with the first decision was highly significant, that of the extent of non-crop income earned was not statistically significant. Economic activities are more diversified in areas closer or with easy access to the market centres than those farther away or with poor access (9). There is therefore more and better opportunities for non-crop cash income in good than in poor market access areas. This could stimulate households into those activities that would yield non-farm cash income. The non-significance of the second relationship could be because better market access also enhances crop income (6), thereby dampening the extent of the drive for non-crop income.

In comparison with the non-humid climate zone, the dummy for humid zone was negatively related to both decisions, with the first (discrete) decision of whether or not to earn non-crop income being statistically significant. Both agriculture and agro-related services are likely to be more developed in the agroclimatically better humid zone than in the non-humid. This is likely to discourage farm households in the humid zone from delving into ventures for income diversification. Reardon *et al.* (13) noted that diversification is more outward-looking in the poor Sahelian agricultural zones than in the Guinean zones with richer agricultural base.

Conclusion

High variability in crop yield and thus income variability arising from the vagaries of weather makes income diversification important for the rural poor farm households in Africa in order to improve their economic status. Identified in this study are factors that drive cash income diversification decisions among rural farm households in Nigeria. Using Heckman's two-stage model, it separates the first discrete decision of whether or not to engage in non-crop income activities from the continuous decision of how much non-crop income is needed by the household. While the level of formal education of the household head, good market access conditions and availability of initial liquidity stimulate the first decision to start non-crop income activities, only household characteristics (also including the level of formal education of the household head) drive the extent of non-crop cash income earned by the household.

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