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Conference Paper

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Proceedings of the German Development Economics Conference, Berlin 2011, No. 19

Provided in cooperation with:
Verein für Socialpolitik

Suggested citation: Chiwaula, Levison; Waibel, Hermann (2011) : Does seasonal vulnerability to poverty matter? A case study from the Hadejia-Nguru Wetlands in Nigeria, Proceedings of the German Development Economics Conference, Berlin 2011, No. 19, http://hdl.handle.net/10419/48285

Does seasonal vulnerability to poverty matter?
A case study from the Hadejia-Nguru Wetlands in Nigeria

By

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Abstract

Applying research on vulnerability to seasonal data, we assess seasonal vulnerability to poverty using panel data from the Hadejia-Nguru Wetlands in Nigeria involving 260. We find that both observed poverty and vulnerability to poverty vary seasonally and that these variations are related to household livelihood strategies. Basing on our findings policy interventions should aim at increasing crop productivity (both food and cash crops) and returns to crop sales as well as promoting income diversification to off-farm activities. Safety net programs should be implemented only after productivity-enhancing interventions have been implemented. Further research is proposed to particularly assess the influence of seasonal variation on household livelihood choices.

Keywords: Vulnerability to poverty; Seasonality; Social protection; Nigeria

1 Introduction

Seasonality in household income and consumption in rural agrarian societies of developing countries is a common phenomenon. This is of concern to those interested in the living standards, nutrition, and health of individuals in these countries (Paxson, 1993). The observed seasonality in consumption is said to be largely explained by seasonal variation in income that emerge from poorly functioning credit markets (Chaudhuri and Paxson, 2002). Household income and consumption tends to be high during the harvesting seasons and low during lean seasons when crop stocks are depleted. Although households are observed to be non-poor at a given time of the year, they still face the risk of falling into poverty at other times of the year. Households in rural agrarian communities mostly rely on informal mechanisms to manage this risk but these mechanisms are hardly effective mainly when the shocks are big or affecting the entire community. Risk management involves coping and prevention strategies. Both risk coping and prevention strategies affect households' production and saving decisions. Households could go for low returns-low risk production technologies in place for high returns-high risk production technologies (see Fafchamps, 2010). The annual hungry season are predictable such that households plan for (by developing various insurance mechanisms) and, by and large, 'cope with', by adopting a variety of adaptive responses and coping mechanisms. These might include selling off surplus animals, mild rationing, and seasonal migration (Devereux, 2009). The ineffectiveness of these mechanisms makes seasonal fluctuations in welfare to persist. Policy interventions are therefore required to help improve the ability of households to manage the risk (see Perdana, 2005). Effective policy interventions can be designed if there is clear understanding of the extent of the risk and also identification of the households that face the risk.

A lot of research has been carried out on the seasonal fluctuations in household welfare (Paxson, 1993; Dercon and Khrishnan, 2000; Chaudhuri and Paxson, 2002; Suryahadi, et al. 2003; Chambers, 2009). Since these studies have conducted ex *post* poverty assessments they are of limited use for the design of social protection programs. Existing e*x ante* poverty assessments on the other hand, are based on annual data thereby generating annual aggregates of expected poverty (see Chaudhuri, 2003; Christiaensen and Subbarao, 2005; Günther and Harttgen, 2009; Chiwaula et al., 2011) thereby ignoring intra-annual variations. The contribution of this paper is therefore to establish the connection between research on seasonality and research on *ex ante* poverty assessments (vulnerability). We believe that for many of the subsistence oriented rural household systems in Africa measures of vulnerability need to take shorter periods into account in order to reflect the seasonal variation stemming from dependence on natural resources and seasonal rainfall patterns.

This study therefore assesses seasonal variations in expected poverty (vulnerability) of households in the Hadejia-Nguru Wetlands in North Eastern Nigeria. The production system of the Hadejia-Nguru Wetlands is a flexible and highly seasonal matrix of income generating activities (Sarch, 1997; Neiland et al, 2000) whose main livelihood activities include crop production, fishing, livestock rearing and petty trading (hawking). This has enabled us to also assess the relationship between seasonal variations in expected poverty and household livelihood strategies.

The rest of the paper is organized as follows: section 2 presents the analytical framework that is used in the study. Section 3 describes the study site and data collection issues while section 4 describes empirical estimation techniques. The results of the paper are presented and discussed in section 5 and the paper is concluded in section 6.

2 Methodology

2.1 Measuring vulnerability and its variation

There are many definitions and approaches to measuring vulnerability (Chaudhuri et al., 2002; Ligon and Schechter, 2003; Calvo and Dercon, 2005; Günther and Harttgen, 2009; Povel, 2010; Chiwaula et al., 2011) but we define vulnerability as expected poverty, the approach that has become most prominent probably due to its direct link with the traditional Foster-Greer-Thorbecke (FGT) poverty measures (Foster et al, 1984). In this definition, a household's vulnerability to poverty is defined as the probability that the household will have consumption level below the poverty line at a given point in time in the future irrespective of the current poverty status. Formally, vulnerability level of household, *h* in season *t*, v_{ht}, is defined as:

$$\begin{aligned} v_{ht} &= \Pr(c_{ht} \leq z) \\ &= \int_{-\infty}^{z} f(c_{ht}) d(c_{ht}) \end{aligned} \tag{1}$$

where c_{ht} is the per capita consumption expenditure for household *h* in season *t*; *z* is the poverty line; and *f(.)* is the probability distribution function of consumption in season *t*. This definition involves estimating the *ex ante* probability distribution *(f(.))* of *ex post* consumption (Christiaensen and Subbarao, 2005). To derive these probability measures, there is need for (an estimate of) the probability distribution of what consumption expenditures would be in the future. Following Chaudhuri et al (2002) and Christiaensen and Subbarao (2005), we directly assumed that household consumption is log-normally distributed and that household characteristics can predict household specific expected probability distribution of consumption expenditure. The probability that a household will be poor in season *t* is estimated by the following cumulative density function of the standard normal distribution:

$$v_{ht} = \Pr(\ln c_{ht} < \ln z | X_{ht}) = \Phi\left(\frac{\ln z - \ln c_{ht}}{\sqrt{\text{var}(\ln c_{ht})}}\right) \quad (2)$$

Where X_{ht} is the vector of household characteristics; $\Phi(.)$ denotes the cumulative density of the standard normal; and $\text{var}(\ln c_{ht})$ is the household specific variance of consumption expenditure in season *t*.

An index of seasonal variation in vulnerability (SVV) was used to measure the variation in the risk of poverty between seasons. The index was computed as:

$$SVV = 1 - \left(\frac{VTP_{\min}}{VTP_{\max}}\right) \quad (3)$$

Where VTP_{min} stands the minimum seasonal vulnerability to poverty estimate for a given household while VTP_{max} stands for the maximum seasonal vulnerability to poverty estimate for the same household. The index measures the range between the highest risk of poverty and lowest risk of poverty between seasons. The index varies between 0 and 1. When SVV is equal to zero, it means that there is no variation in the risk of poverty for the households. On the other hand, an SVV that is equal to 1 means that the variation in vulnerability between seasons is very high.

2.2 Empirical model

Empirical estimation of equation 2 required us to have the estimates of expected level of consumption and its variance apart from the poverty line. To estimate these, we specified and estimated the following household seasonal consumption function:

$$c_{ht} = c(X_{ht}, S_{h,t-1}, \varphi_t, \theta_h, u_{ht}) \quad (4)$$

where X_{ht} stands for observed household and community characteristics; $S_{h,t-1}$ stands for reported covariate and idiosyncratic shocks the household has been faced with in the past seasons[1]; φ_t stands for parameters that describe the returns to the household and community variables and the effects of shocks; θ_h stands for unobserved time invariant household effects and u_{ht} is the unobserved idiosyncratic shocks. Functional specification of equation 4 followed Just and Pope (1979) which has been widely used in production risk analysis (for example see Tveterås, 1999 and McCarl et al, 2008) and also in analyzing consumption risk analysis mainly as they relate to vulnerability analysis (Christiaensen and Subbarao, 2005). This consumption function is a composite of the mean consumption function, $c(.)$ and the variance (risk) function $h(.)$. With the log-normality assumption, the consumption function is specified as

$$\ln c_{ht} = X_{ht}\beta + S_{h,t-1}\gamma + \theta_h + h^{1/2}(X_{ht}\alpha)u_{ht} \quad (5)$$

with $u_{ht} \sim \mathrm{N}(0, \sigma^2_{\mathrm{u}})$. This functional form enables us to assess the effects of the explanatory variables on both the level of expected consumption and the variance of expected consumption. Allowing the variance to depend on household characteristics makes the specification heteroskedastic which is a less restrictive than a standard OLS specification which assumes homoskedasticity. A three-step feasible generalized least squares (3FGLS) procedure proposed by Just and Pope (1979) was used to obtain the parameter estimates. The first step involved OLS estimation of consistent parameters by regressing $\ln c_{ht}$ on X_{ht} and $S_{h,t-1}$ from which residuals are obtained. In the second step, the logarithm of the squared residuals is regressed on the same covariates except for the shock variables. The predicted values of the residuals from the second step, which are computed by finding the antilogarithm of the predictions in this equation gives consistent estimates of household specific variances of consumption $[\exp(X_{ht}, \alpha)]$. In the last step, the first equation is re-estimated and it is weighted by $[\exp(X_{ht}, \alpha)]^{-1/2}$ to correct for heteroskedasticity. This yields efficient estimate of β, γ, and φ.

Panel data estimation techniques were employed to obtain estimates which mean that we assumed that the coefficients are stable during the three seasons. Econometric tests supported the random

[1] The study used the shocks the households reported to have experienced in the previous year which means that past seasons here refer to previous year

effect model[2] such that each of the steps of the 3FGLS technique was estimated by the use of a random model estimator.

A number of explanatory variables were included in the estimated models. These variables included household demographic characteristics such as age of the household head and its square, household size, dependency ratio, and education of the household head. Dependency ratio was defined as the ratio of the number of family members that are less than 14 years to the total number of family members in the household. Education level of the household head was measured as a dummy variable for whether the household head had attended formal education or not because of low levels of education attainment among household heads in the study area. Productive assets included re-sale value of cropping assets, fishing assets, and livestock measured in Nigerian Naira and land holding size measured in hectares. The household size in the baseline survey was used to compute the per capita values for the productive assets in all the three survey rounds to avoid the problem of multicollinearity that could be introduced if non-time varying variables are divided by a common time varying variable. Dummy variables for some of the important shocks that were reported to have affected the households in the year prior to the baseline survey were also included. A dummy variable that identified households that resided closer to the major trading town (Hadejia) in the area was included to capture heterogeneities in infrastructure and access to services. Table 1 below presents the descriptive statistics of the variables used in the model.

{Insert Table 1 here}

The descriptive statistics show that on average households experienced highest levels of consumption during the harvesting period and lowest levels of consumption during the dry season. It is also shown that only about 27% of the household heads had attained some formal education implying very low literacy levels in the area. On average, household sizes are high and they vary seasonally with an average household size of 7.30 individuals per household during the dry season, 7.97 individuals per household during the cropping season and 8.22 individuals per household during the harvesting season. The fluctuations in number of individuals per household between the seasons may be mainly explained by the presence of seasonal migration which has

[2] The Breusch and Pagan Lagrange Multiplier test showed that the two-way error component model was suitable while the Hausman test supported the random effects estimator.

been found to be one of the mechanisms households use to cope with seasonal hunger (see Devereux, 2009, Mukherjee, 2009, and Oluwatayo, 2009 among others). Household members may migrate into the area during the harvesting season and migrate out during the dry season when there is little food and also limited opportunities. That is why the dependency ratio is declining from the first follow up survey to the last survey implying that adults are being added to the households. On average, each individual held about 1.06 hectares of land which may be considered large compared to many African countries. In terms of shocks, most households reported to have been affected by health shocks followed by field pests and social conflict with the nomadic livestock herders.

3 Study site and data

We collected data from four waves of surveys conducted between April 2007 and March 2008 in the Hadejia-Nguru Wetlands in North Eastern Nigeria. The Hadejia-Nguru Wetland has a size of about 3,500km^2 is located in the Komadugu-Yobe Basin which is part of the Lake Chad Basin (see Figure 1). The major livelihood activities of the wetland (cropping, livestock rearing, fishing, hawking and trading[3]) are heavily linked to weather and natural resources which make seasonality an important aspect of welfare in the livelihood. The wetland is characterized by distinct dry and wet seasons. Most of the rainfall occurs in 3–4 months from June–September, the wettest month being August. This rainfall pattern dictates the flooding regimes of the wetland most of which happens between August and September (Schuyt, 2005; Chiwaula et al., 2011).

{Insert Figure 1 here}

The first (baseline) survey which mimicked the Living Standard Monitoring Surveys (LSMS) that are conducted by many statistical agencies of developing countries with assistance of the World Bank in that it collected comprehensive household socioeconomic data for the previous one year, was conducted in April 2007. Three follow up surveys were then conducted to collected information on the changes in household structure, consumption, income, and productive activities. The follow up surveys followed important seasons in livelihood activities and

[3] Hawking and trading are related to seasonality because of seasonal changes in demand and availability of raw materials.

outcomes in the region. These surveys were conducted in August 2007 (Dry season), November 2007 (Cropping/Rainy season) and March 2008 (Harvesting season). The study is composed of a sample of 260 randomly selected households from 11 randomly selected villages.

Seasonal vulnerability measures were computed only for the seasons when the follow up surveys were conducted because similar questionnaires were used to collect consumption data for the surveys in these periods. The observed (nominal) seasonal consumption expenditure values were converted to real values at March 2008 prices.

4 Results

4.1 Seasonality in consumption

The descriptive statistics above have shown that household consumption expenditure in the study area fluctuated between the seasons. The seasonal fluctuations in household consumption expenditure as well as household income were further explored by plotting lowess smoothing curves of consumption levels on their deciles showing seasonality for different income and expenditure groups. Figure 2 presents the lowess curves for real per capita consumption while figure 3 presents the lowess curves for real per capita incomes.

{Insert Figure 2}

{Insert Figure 3}

The two figures show that there are slight differences in the seasonal patterns in income and consumption. On average both household income and consumption expenditure was highest during the harvesting seasons. Income is lowest during the dry season for all households (Figure 3). For consumption, it is lowest during the dry season for the high consumption households (non-poor) and the cropping season for the poor households (Figure 2). The seasonal consumption pattern for the poor households follows seasonal food availability from own production. Our assessment showed that about 91% of the households had food from own production during the harvesting season, 78% during the dry season and 50% during the cropping season. Seasonal pattern in consumption expenditure for non-poor households is similar to the seasonal pattern in household income.

4.2 Determinants of vulnerability

As shown by equation 2 the first and second moments of the expected consumption expenditure are the required variables for the estimation of vulnerability. This means that the factors that influence either one or both of these determine the level of household vulnerability. Variables that increase the expected mean consumption are expected to reduce household vulnerability while variables that increase the variance of future consumption expenditures are expected to increase household vulnerability. Therefore one needs to look at variables that affect expected consumption (last step of the 3FGLS) and its (second step of the 3FGLS) in order to identify the determinants of vulnerability. Table 2 below presents the results of the vulnerability model.

{Insert Table 2 here}

The results show that variance of consumption model shows the usual poor statistical fit in concordance with other studies (see Christeansen and Subarrao, 2005; Makoka, 2008).

On the other hand, many variables are found to influence the expected household consumption. The parameter estimates on seasonal dummies show that consumption levels are expected to be significantly higher during the dry and harvesting seasons than during the cropping season. A larger coefficient for the dummy variable for the harvesting season than the coefficient for the dummy variable on cropping season implies that consumption is also expected to be higher during the harvesting season than during the cropping season. This means that it is expected that consumption expenditure will be highest during the harvesting season and lowest during the cropping season. In terms of vulnerability to poverty, the results show there is the greatest risk of experiencing poverty during the cropping season and the least risk during the harvesting season.

The results also show that land holding size and fishing assets have significant positive effects on household consumption implying negative influence on vulnerability to poverty. It is also found that when household heads belong to many associations (more social capital), have attained some formal education and are more aged the expected consumption levels is higher. On the other hand, household size and dependency ratio significantly reduces expected mean consumption. These findings imply that increase in access to physical productive capital, social capital, and human capital reduces the risk of falling into poverty at any season in the year. On the other hand, demographic factors such as household size and dependency ratio increase the risk of falling into poverty at any time of the year.

Shocks are also found to play an important role in determining the risk of falling into poverty. Households that reported to have suffered from drought and illness of the household head are found to have a lower expected consumption than households that did not report to have suffered from these shocks in the previous year. On the other hand, households that experienced social conflict and flooding had high expected consumption. Flooding in the area is both a peril and ‘a blessing. It causes destruction to physical and natural assets but can also make the area more productive by increasing fishing and cropping opportunities as reflected by the positive sign of the shock variable.

4.3 Evidence of seasonal vulnerability

The US$1.25 per person per day poverty line was adopted to compute the probability that a household will have its consumption below poverty line. Using the PPP exchange rate and consumer price indices this poverty line was converted to March 2008 prices in Nigerian Naira. This resulted in a poverty line of 85.16 Nigerian Naira per person per day. Table 3 below presents the static poverty incidence levels and estimated vulnerability levels for different seasons.

{Insert Table 3 here}

The results show that observed poverty head count ratio varied between the seasons but, these variations are not statistically significant. However, the probability of experiencing poverty (vulnerability) differed significantly between the seasons. Mean vulnerability is significantly lower during the harvesting season than it is during the dry and cropping seasons. Mean vulnerability levels in the two latter seasons were not significantly different. There are strong policy implications of this result. If seasonal poverty assessments were based on *ex post* indicators, the findings would undermine the presence of seasonality in the risk of poverty. This would make policy makers to treat different seasons homogenously yet the households will treat the different seasons differently because the expected poverty in the different seasons is different. The likely effects of such a homogenous policy would be perverse.

In absolute terms, the vulnerability to poverty estimates during the harvesting period is still high considering the fact that this is the period when households are expected to have the highest levels of consumption during this season. Defining the vulnerable households as those whose vulnerability level is at least 50% (see Chaudhuri, 2003) our findings show that 72% of the households are vulnerable during the dry season, 68% during the cropping season and 58% during the harvesting season. The households that are expected to be poor during the harvesting season will likely be expected to be poor throughout the year. This means that about 58% of the households in the area are vulnerable throughout the year which is a large proportion.

4.4 Seasonal vulnerable and household livelihood strategies

The results presented discussed above give an aggregated picture of the presence of seasonal vulnerability in the study area which may not be the case for households with different livelihood strategies. Seasonal vulnerability to poverty for households with different livelihood activities was estimated to assess the relationship between household livelihood strategies and seasonal vulnerability. Major household livelihood activities were defined as fishing, cropping and off-farm activities[4] based on the income contribution of that livelihood activity to the household. A major livelihood activity for a household was the one that contributed the largest share of income to total household income in the year. The results are presented in Table 4 below.

{Insert Table 4 here}

The results show that fishing households are least vulnerable during the dry and cropping seasons while cropping households are least vulnerable during the harvesting season. Households that obtained most of their incomes from off-farm activities are the most vulnerable in all the three seasons. These are resource poor households that have limited or no resources for farming and fishing and hence must rely on off farm income sources. The results also reveal that the pattern of variation in vulnerability levels for cropping and off-farming households are similar save for the fact that off-farming households are consistently more vulnerable in all seasons than cropping households. The pattern is different for fishing households which means that fishing and cropping can complement each other in reducing seasonal vulnerability.

[4] Livestock rearing households were excluded from this analysis because they were too few to compute reliable statistics.

In terms of variation in seasonal vulnerability, fishing households experienced the largest seasonal variation in vulnerability while the resource poor households that obtained most of their income from off-farm activities experience the least variation in seasonal vulnerability. The relationship between seasonal variation in vulnerability and household livelihood strategies were also explored by the use of lowess smoothing curves. The curves are presented in Figure 4 below:

{Insert Figure 4 here}

In the figure, it is shown that increase in the share of household income from fishing and livestock rearing increases the variation in the risk of falling into poverty. Since fishing is seasonal, it is easy to explain the positive relationship between high dependency on fishing and high variation in the vulnerability to poverty between seasons. On the other hand, it comes as a surprise that increase dependency on livestock is associated with increased variation in seasonal vulnerability to poverty because livestock has been considered as a buffer in income and consumption variation literature (Sheikh and Valdivia, 2009). Our results confirm those of Fafchamps et al (1996) who found that livestock transactions play less of a consumption smoothing role than is often assumed in West Africa. On the other hand, share of income farming and off-farm activities have negative relationships with seasonal variation in the risk of poverty. Most of the households that have large share of income from crop production are involved in winter cropping through irrigation and also those who produce adequate output that can be spread throughout the year. Both of these conditions depend on households having enough and quality land and farming equipment such as irrigation pumps. Apart from increasing productivity, Devereux (2009) added the increase in returns to crop sales as an alternative intervention for addressing the food gap at some times of the year. This problem can also be alleviated by growing non-seasonal crops such as cassava (Strange, 2009). On the other hand, dependency on off-farm activities is negatively associated with seasonal variation in the vulnerability to poverty because of its weak link with weather. The off-farm activities though they generate limited income have the potential to smooth consumption thereby reducing seasonal variation in vulnerability to poverty. These results imply that seasonal variation in vulnerability to poverty can be reduced by increasing productivity of existing livelihood activities and also diversifying income sources to off-farm activities. This is the basis for social protection programs that promote diversification of livelihood activities away from farming.

5 Conclusions and policy implications

We have estimated household seasonal vulnerability to poverty in the Hadejia-Nguru Wetlands in North Eastern Nigeria. We find that both observed poverty and vulnerability to poverty in the study area varies seasonally; capital assets (physical, social, human) reduces the level of vulnerability mainly through their influence on expected consumption; increase in household income contribution of fishing and livestock rearing increases seasonal variation in vulnerability while the increase in household income contribution of farming and off-farm activities reduce the seasonal variation in vulnerability; and households with more diversified income sources experiences less seasonal variation in vulnerability.

When households are at risk to fall into poverty during several critical periods of the year, they may resort to low risk and low productivity strategies (see Fafchamps, 2010) which may jeopardize long-term options to get out of poverty. For example, households may abandon general asset accumulation activities that may result in reduction in vulnerability in the long term in favor of activities that will reduce fluctuations in vulnerability in the short run. If social protection programs reduce the short run variations in vulnerability, households would continue in their pursuit of long term plans to get out of poverty. Basing on our results, policy interventions that can reduce seasonal variations in vulnerability should aim at increasing crop productivity (both food and cash crops) and returns to crop sales as well as promoting income diversification to off-farm activities. Livelihood diversification minimizes risks and helps to overcome vulnerability (Merkhejee, 2009). Since most of the households are economically active and the wetland itself is very productive (Schuyt, 2005), policy interventions should aim productivity-enhancing before safety net programs are implemented (see Devereux, 2009). Productivity enhancing programs in productive system should aim at increasing the poor's control over assets (Devereux, 2001; Chiwaula et al., 2011). The households that are expected to experience seasonal variation in vulnerability even after the implementation of the productivity enhancing strategies are the ones that would need safety net programs in terms of cash transfers or food transfers which have been found to be effective in other countries (Khaleque et al., 2008; Devereux, 2009). Further research is proposed to particularly assess the influence of seasonal variation on household livelihood choices.

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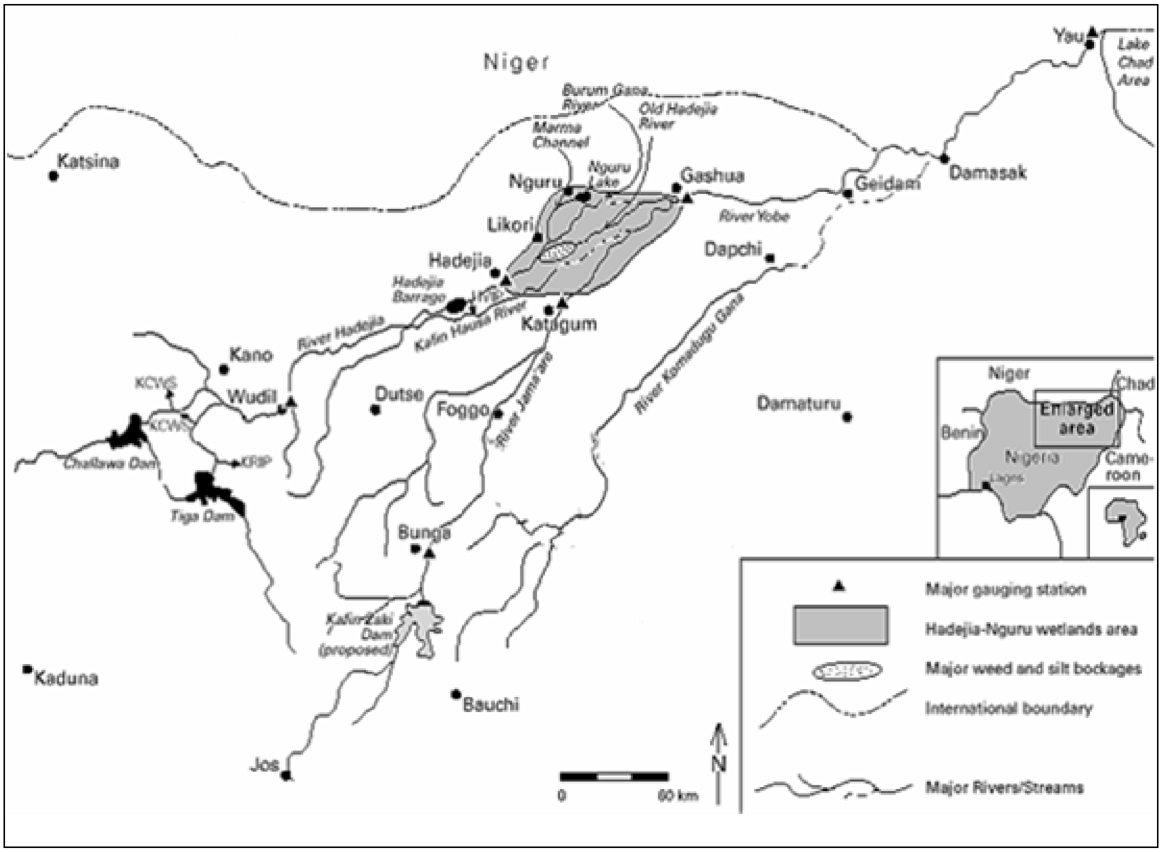

Figure 1: Map of Nigeria showing the location of the study area

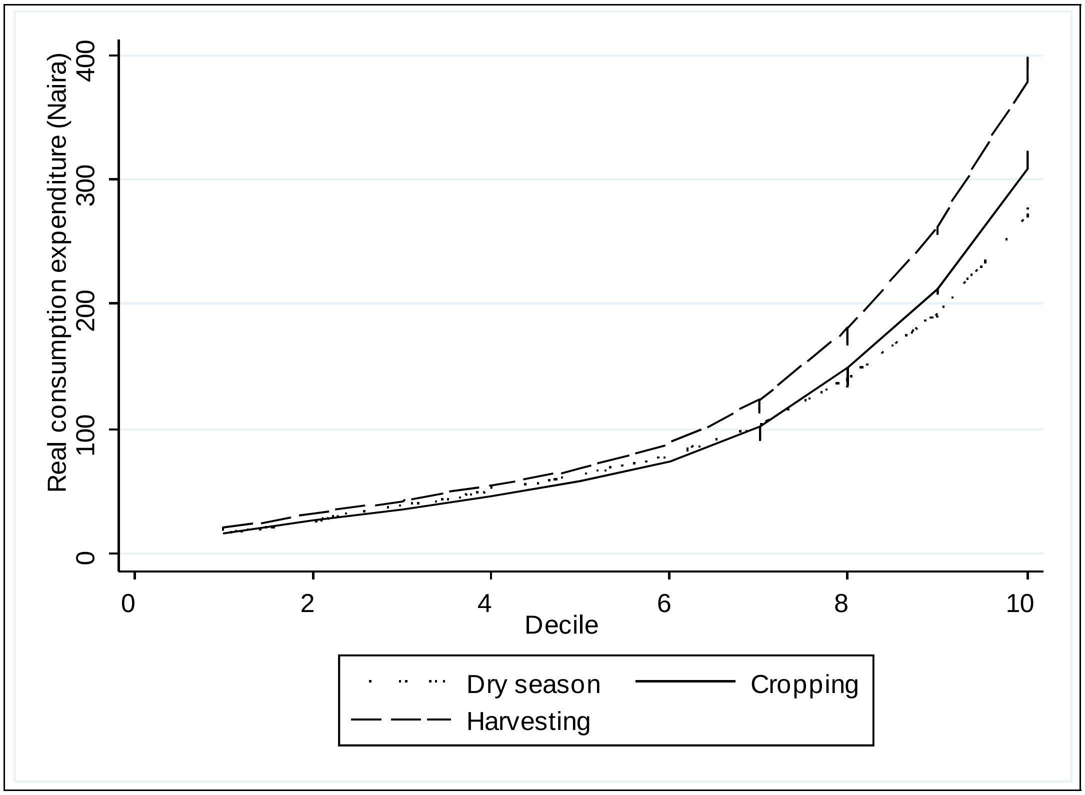

Figure 2: Distribution of household per capita consumption by season in the Hadejia-Nguru Wetlands, Nigeria

Source: Own illustrations based on own data

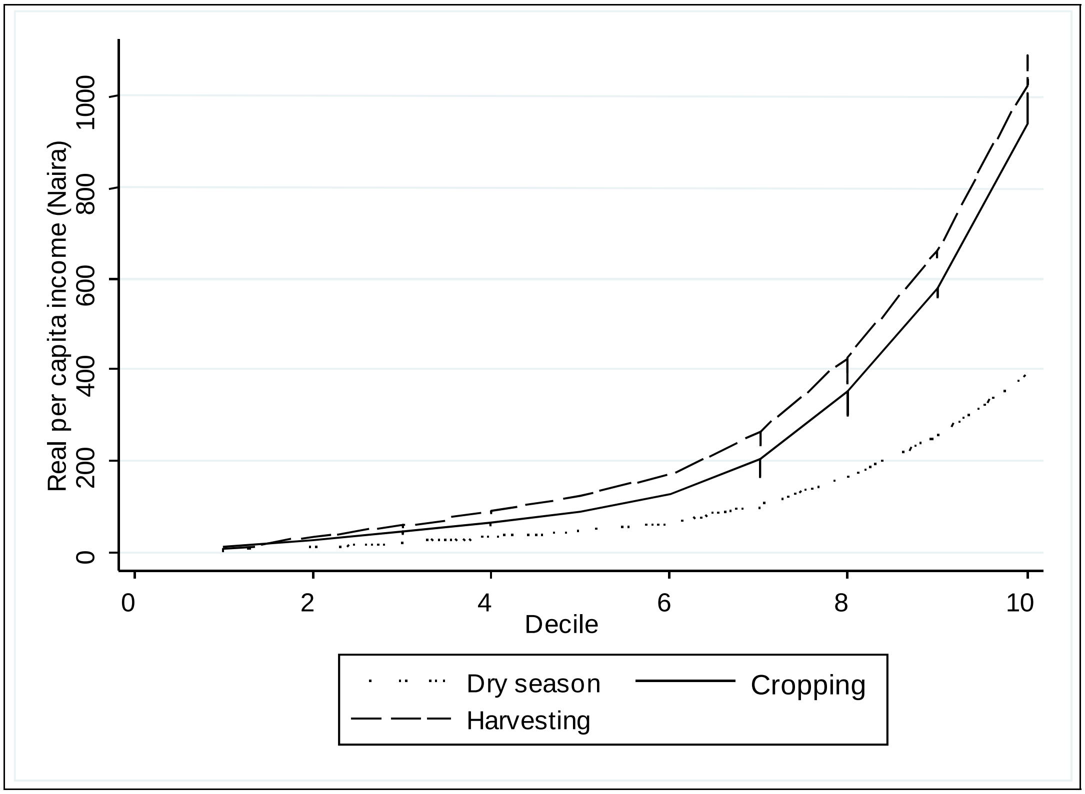

Figure 3: Distribution of household per capita income by season in the Hadejia-Nguru Wetlands, Nigeria

Source: Own illustrations based on own data

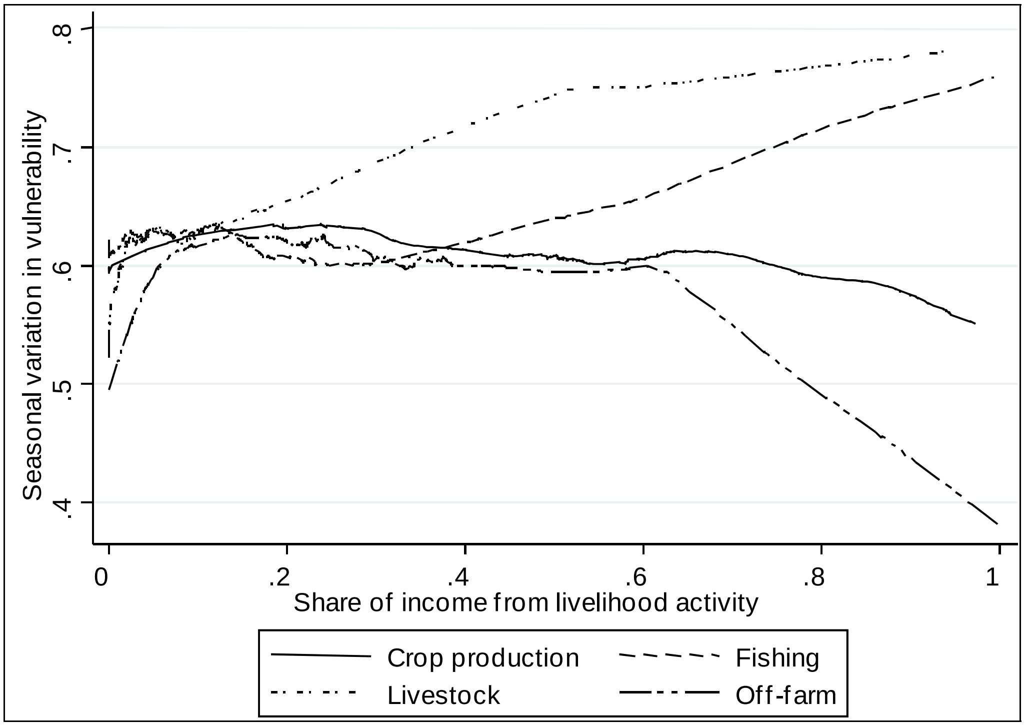

Figure 4: Seasonal variation in vulnerability and household income source in the Hadejia-Nguru Wetlands, Nigeria

Table 1: Descriptive statistics for variables used in assessing seasonal in the Hadejia-Nguru Wetlands, Nigeria

	Dry season		Cropping season		Harvesting season	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Real consumption expenditure (Naira)	91.08	83.68	93.83	101.18	113.82	132.42
Age head (years)	42.56	14.46				
Education head (1/0)	0.27	0.44				
HH size	7.30	3.33	7.97	4.07	8.22	4.13
Dependency ratio	0.54	0.18	0.53	0.20	0.51	0.21
Associations	0.62	0.74				
Land holding (ha)	1.06	1.16				
Farming assets (Naira)	2661.61	3550.52				
Fishing assets (Naira)	475.16	1014.61				
Livestock value (Naira)	11593.45	19836.45				
Drought (1/0)	0.08	0.27				
Field pests (1/0)	0.30	0.46				
Health (1/0)	0.50	0.50				
Conflict (1/0)	0.23	0.42				
Flood (1/0)	0.06	0.24				
Hadejia (1/0)	0.30	0.46				
N	260		260		260	

Note: All quantities and amounts are measured in per capita

Source: Own computations based on own data

Table 2: Regression results of the consumption and variance equations in the Hadejia-Nguru Wetlands, Nigeria

Variable	Log (variance of consumption expenditure)		Log (per capita consumption expenditure)	
	Coef.	Absolute z	Coef.	Absolute z
Age head	-0.0172	0.50	0.0558	4.40***
Age head squared	0.0004	1.09	-0.0005	3.72***
Education head	-0.0326	0.14	0.1999	2.71**
Associations	-0.1800	1.36	0.0750	1.78*
Family size	0.0081	0.33	-0.1185	19.32***
Dependency ratio	-0.3973	0.84	-0.3542	3.08***
Log (land holding size)	0.0036	0.13	0.0186	2.12**
Log (farming assets)	-0.0035	0.03	0.0268	0.66
Log (fishing assets)	0.0473	1.75*	0.0246	2.82**
Log (livestock value)	-0.0186	0.60	-0.0138	1.37
Drought shock			-0.2337	2.12**
Pests shock			-0.0543	0.82
Health shock			-0.1193	1.93*
Conflict shock			0.1488	1.93*
Flooding shock			0.2713	2.11**
Harvesting season	0.2810	1.38	0.1564	3.38***
Dry season	0.0855	0.42	0.1087	2.38**
Location dummy	0.1376	0.66	-0.0234	0.32
Constant	-3.0706	3.48***	3.7221	12.09***
Wald Chi2		20.38*		618.74***
R-sqd		0.01		0.44
N		780		780

Note: *** denotes statistical significance at 1%; ** denotes statistical significance at 5%; denotes statistical significance at 10%.

Table 3: Seasonality in poverty and vulnerability in the Hadejia-Nguru Wetlands, Nigeria

Variable	Season		
	Dry	Cropping	Harvesting
Poverty head count (%)	62.3	64.6	59.6
Vulnerability (%)	69.4[c]	68.6[c]	57.6[a,b]

Note: [a] significantly different from pre-harvesting season; [b] significantly different from the harvesting season; [c] significantly different from the post-harvesting season. Statistical significance compared at 10% level

Table 4: Major income source and household seasonal vulnerability in the Hadejia-Nguru wetlands, Nigeria

Major income source	Season			Seasonal variation in vulnerability
	Dry season	Cropping	Harvesting	
Farming	0.71[c]	0.69[c]	0.56[a,b]	0.60
Fishing	0.54	0.55	0.62	0.64
Off-farm	0.72	0.76	0.62	0.56

Note: [a] significantly different from pre-harvesting season; [b] significantly different from the harvesting season; [c] significantly different from the post-harvesting season. Statistical significance compared at 10% level