Climate Change and the Uncertainties Facing Farming Communities in the Middle Belt Region of West Africa

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1] Summary

The Middle Belt Region (MBR) is the most productive agricultural part of West Africa. This is partly becaues of the inherent high fertility of the soils, and the moderate and variable climate. Being an ecological transition zone between the Sahel and the southern forest region, crops characteristic of these two surrounding regions are also cultivated in the MBR. With with incraesing global concern about climate change, this paper examines relative importance of climatic influences vis-à-vis the myriads of other uncertainties that confronts the farming communities of the area.

Data collection involved field observation and reconnaissance as well as in-depth survey, in which questionnaire was admnistered to the farmers in three (3) communities. These communities were selected from the southern, central and northern parts to cover the major ecological variations in the region. The questionnaire (in form of a checklist containing 52 questions) was admnistered to 20 randomly selected farmers in each community. Data analysis involved principal components analysis (PCA).

On the average, none of the five highest rated uncertainties is weather/climate related. Principal components analysis was used to reduced the 52 uncertainties into three

components namely weather/climate, agronomic/economic/institutional and infrastructural uncertainties. Climate change uncertainties mainly relate to the occurrence of extreme events.

2] Introduction

Agriculture is the dominant sector, which contributes the highest Gross Domestic Product (GDP) of the countries of the West African region. The dependency of the various sectors of agriculture to weather and climate is a commonly known fact. Thus, with the increasing concerns about climate change, several studies have considered its (potential) impacts on agriculture (e.g. Campbell, 1999; Adejuwon, 2006; Washington *et al.* 2006; Mozny *et al.,* 2009).

With respect to agriculture (particularly crop production), the most important aspect of the climate of West Africa is its seasonal character, which sets the basis for the farming calendar in most parts. Given that agriculture in the region is largely non-mechanised, weather/climate assumes significance in every phase including the timing of cultivation, planting and harvesting operations, variety selection and transplanting (Odekunle, 2004; Adejuwon, 2006; Nnamchi *et al.,* 2009). This is because, most crops are sensitive to weather conditions at various stages of their growth up to harvesting, evident for example in the definite moisture range in which field preparation could be feasible, and for sowing and harvesting of various crops.

The farmer therefore, is faced with uncertainties associated with the variations of the climate/weather elements, and traditionally, they tend to realise the need to time farm operations to correspond with specific weather patterns (Adejuwon *et al.,* 2007). The coming of the first rainfall, its amount/intensity, and the actual onset of the rainy season *etc* are speculated upon and expected with a great deal of anxiety. Based on this scenario, it appears readily taken that with intensified climate change, agricultural productivity will be drastically reduced (e.g. Deressa *et al.,* 2008). Yet, conclusions premised on projections using climatic parameters for West Africa (e.g. Adejuwon 2006) conclude

that there would be increases in yields for all crops across the ecological zones as the climate changes during the 21st century.

Does this mean that the food security of West Africa is assured during the 21st century? We assess the range of uncertainties that the farming communities face in the most productive part of West Africa – the Middle Belt Region. Here, we define uncertainties as those things that the farmers cannot predict or guarantee; they are unsure or doubtful about, and which constitutes a source of anxiety to the farmers. Climate change involves uncertainties in a number of dimensions (Heal and Kristrom, 2002). While climate variables represent a source of anxiety, we argue that these farming communities are faced with a myriad of other uncertainties, as in climate change impact assessment (e.g. Adger and Vincent, 2005). The overall aim of this paper is to characterise the relative importance of these range of uncertainties that confronts the farmers.

3] Research Methods

The study area is the Middle Belt Region (MBR) of West Africa. The climate of West Africa exhibits strong latitudinal variations from the Gulf of Guinea in the south to the Sahara in the north (Hayward and Oguntoyinbo, 1987; Olaniran, 2002). In general, moisture decreases from the southern part northwards. Three farming communities were selected for study to represent the southern, central and northern parts of the MBR. For logistic reasons, all the three communities sampled were selected from Nigeria as done in earlier studies (Adejuwon, 1989; Adejuwon, 2006; Adejuwon *et al.,* 2007). This is justified by the fact that all the major ecological divisions of West Africa are represented in Nigeria.

Data collection was conducted in two phases. First, there was a reconnaissance field survey in the three communities. In each community, five farmers were asked to enumerate the variables affecting their production they were uncertain about. Their responses were homogenised to produce a total of 52 variables in the final instrument for data collection.

The questionnaire for data collection is an interview schedule in two parts. The first part seeks to elicit background information on the characteristics of the farmer; the second contains the 52 variables in a 5 point Likert scale. For each uncertain variable, the farmers were requested to indicate the extent (ranging from 5 = to a very great extent to 1 = to no extent at all) they considered each variable an uncertainty that could affect (limit) their farming activities. Twenty farmers were interviewed in each of the three communities.

Basic statistics and multivariate techniques were employed for data analysis. All missing values were substituted with mean values. Principal component analysis (PCA) was then used to explore the 52 variables in order to identify the underlying structure. A further use of PCA is to simplify these variables into smaller of components (Greiner *et al.,* 2009). Consistent with the approach of earlier authors (e.g. Lien *et al.,* 2006; Greiner *et al.,* 2009), several component solutions were examined until the most representative model was identified and adopted. Varimax orthogonal rotation was applied to the components. Twenty seven (27) items in the questionnaire were removed due to not significantly loading onto any of the factors (loading < 0.4) or more commonly, for loading on multiple factors.

4] Results and Discussions

a) Rating of the uncertainties

The survey of uncertainties required the respondents to rate the importance of the 52 variables that constitute a source of anxiety to their farming activities. The five most highly rated variables are shown in Fig. 1, each has an average value above 4.000. They include limited availability of land for farming, non-availability of fertilizer, bad condition of the roads, high cost of farm labour and lack of government incentives. Interestingly, none of these is weather/climate-related.

Bad condition of the rural roads is ranked clearly above all other sources of anxiety. For most of the farmers, their farms and/or markets are located quite far away. They need to travel long distances for farm work, and to sell or process farm produce or to buy inputs.

Similarly, inputs purchased from the markets need to be transported home or directly to the farm. The concern about bad road conditions is occasioned by the delays and difficulties in transporting inputs, process or travelling to the market, farm or processing facilities. The impacts could be very drastically felt where perishables e.g. fruits or vegetables are concerned. A second point to illustrate the effects of bad roads is the several incidences of collapse of trucks while conveying agricultural produce. This often leads to serious economic losses and explains why the farmers consider it an issue of priority concern.

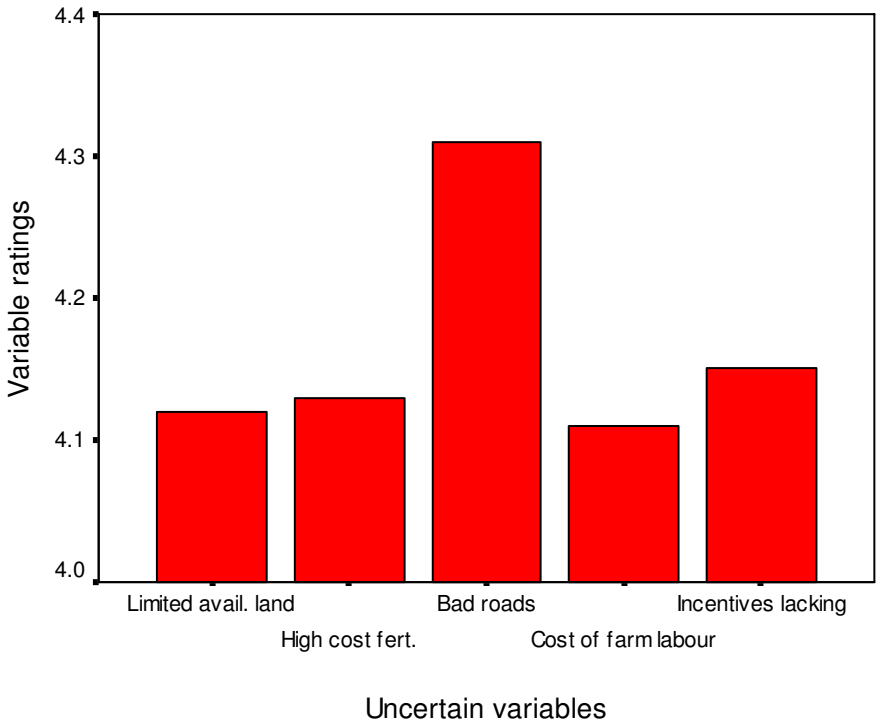

Fig. 1: The five most highly rated uncertainties

Government incentives to farmers could come in the form of subsidies on fertilizers, improved varieties and other inputs, or through the provision of agricultural loans. Indirectly, most rural development programmes such as the provision of good roads and other infrastructural facilities, including markets would impact positively on agriculture. These are largely lacking and so the farmers would easily take every opportunity to express this. Even where/when fertilizers are available they are out of reach of most

farmers. Related to this are illiteracy and the very low level of agricultural extension services, which tend to limit the farmers' access to relevant information.

Other sources of serious concern to the farmers are the cost of farm labour and limited availability of land for farming. Largely, farming operations are not mechanised – crude implements e.g. cutlass, hoe, axe *etc*. are used so that farming is really labour intensive. Rural-urban migration is a major factor that tends to deplete farm labour especially as the dominant migrating populations constitute the productive age bracket. It is partly this fact that drives the cost of farm labour up.

The urban populations and industries mainly depend on the food surplus of as well as other raw materials from the rural communities. With the rapid population growth which drives a rather very rapid rate of urbanisation in West Africa, the dependency on the rural farming communities is further stretched. This also means competition of agricultural land with other uses, one them being urban development. The best example in the MBR is perhaps Abuja the new federal capital of Nigeria which was previously a major farming. An agricultural land dispute are a manifestation of the pressure on farming lands and is a common occurrence in the area of which the most significant is Tiv-Jukun crisis at the turn of the 21st century.

b) Relative importance of the major uncertainties

The list of 52 sources of anxiety was collapsed into three components by PCA. Similar to Maybery *et al.* (2005) and Greiner *et al.* (2009), we found a three component model to provide the best fit of the data. This model explains approximately 50% of the observed variance. We label the three components *weather/climate*, *agronomic/economic//institutional* and *infrastructural uncertainties* – components I, II and III respectively. Wile the farmers did not identify weather/climate-related variables among the five most important, PCA result shows that weather/climate uncertainties explain the highest variance of 19.155%. This is followed closely by economic/institutional, and then, infrastructural uncertainties.

Table 1: Component loading matrix of the uncertainty items: three component model

Source of uncertainty	Components I	II	III
Limited availability of land for farming	0.008	***0.865***	-0.087
Abrupt/unexpected cessation of the rainy season	***0.800***	-0.254	-0.058
Non-availability of storage facilities	0.149	0.147	**-0.527**
Non-availability of fertilizer	0.235	**0.570**	-0.299
Effects of bush fire	-0.233	**0.439**	0.031
Too early rainfall that is not sustained	***0.753***	0.001	0.034
Too low rainfall in a year	**0.558**	0.003	0.002
High temperatures during the planting season	***0.712***	0.079	0.017
Soil erosion	0.246	0.139	***0.834***
Unpredictable harmattan/dryness	0.711	-0.090	0.369
Poor credit facilities	0.145	**0.600**	0.146
Non-availability of improved crop and animal varieties	-0.362	**0.611**	0.399
High cost of processing	-0.371	**0.674**	-0.141
Non-availability of farm labour	-0.147	**0.699**	0.140
Poor transport facilities	-0.303	0.001	**0.610**
Bad roads	0.101	0.117	***0.810***
Heavy rainfall occurring in few days/weeks	**0.597**	0.147	0.328
Poor extension services	0.329	**0.669**	0.038
High cost of farm labour	0.305	**0.469**	0.010
Lack of government incentives	0.365	**0.461**	0.098
Poor market pricing of produce	0.089	**0.506**	0.298
Limited access to portable water (boreholes, pipe borne)	0.097	0.357	**0.554**
High transport cost	-0.239	**0.613**	0.387
Inadequate recreational facilities	-0.089	-0.274	***0.745***
High population	0.144	0.081	**0.466**
Variance explained (%)	19.155	19.048	11.740

Component scores ≥ 0.4 are in bold. Component scores >0.7 are in bold italics.

Component I –Weather/climate uncertainty

The climatic characteristics of great concern to the farmers are mainly aspects of rainfall, that border on extremities. They include abrupt /unexpected cessation of the rainy season, too early rainfall that is not sustained, too low rainfall that in a year, heavy rainfall occurring in a few a few days/week, and unpredictable dryness. The only temperature characteristic retained in the final analysis is high temperature during the planting season.

Because the occurrence of these extreme events causes great damages to the crops, it constitutes a source of anxiety to the farmers. The length of the growing season may be considered important by the farmers (see Odekunle, 2004). However, the onset, cessation and duration of the rainy season, the day to day frequency, intensity and duration of rainfall events are of utmost importance to the crops. Periods of extended dryness during the main rainy season could be as damaging to the crops as sudden occurrence of high intensity rainfall. The former could lead to withering or stunted growth of the crops; latter often aggravates the incidence of soil erosion.

Component 2 –Agronomic, economic and institutional uncertainty

These include limited availability of land for farming, non-availability of fertilizer, effects of bush fire, poor credit facilities and non-availability of improved varieties. Others are high cost of processing, non-availability of farm labour, poor extension services, high cost of farm labour, poor market pricing of produce, high cost of transport and lack of government incentives. These have already been highlighted in Section 3a above.

Component 3 –Infrastructural uncertainty

Included in this category are non-availability of storage facilities, soil erosion, poor transport facilities, and bad roads, limited access to potable water, high population and inadequate recreational facilities. Added to the constraints lack of infrastructural facilities pose to the farmers is the fact that their absence constitutes a major 'push' factor that drives rural urban migration. Lack of potable drinking water is known to be related to epidemic of water borne diseases. If and when this happens, the productivity of the farmer is adversely affected.

5] Conclusions

We have attempted to analyse the range of uncertainties that confronts the farming communities in the Middle Belt Region of West Africa. Of the 52 uncertainties identified, five were highly rated by the farmers (mean rating >4.000 on a 5.000 scale).

They are limited availability of land for farming, high cost of fertilizer, bad conditions of the rural roads, high cost of farm labour, and lack of government incentives.

Principal component analysis was used to collapse the 52 uncertainties initially identified into three components. These are weather/climate, agronomic/economic/institutional and infrastructural uncertainties. Weather/climate uncertainty is the leading component explaining 19.155% of the total variance.

The loading of the weather/climate uncertainties is mainly on the occurrence of extreme characteristics of rainfall. Already, there is a reasonable scientific consensus that global climate is changing (Solomon *et al.,* 2007). As has been demonstrated by Trenberth *et al.,* (2003), as climate changes, the main changes in rainfall will likely be in the intensity, frequency and duration of events. This would translate into increasingly uncertainties for the farming communities. In this context, optimistic projections of the agricultural productivity of West Africa during the 21st (e.g. Adejuwon, 2006) is put to question.

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