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Contingent valuation study of the benefits of seasonal climate forecasts for maize farmers in the Republic of Benin, West Africa

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A B S T R A C T

This study aims to assess the economic benefits of seasonal climate forecasts in West Africa based on a random survey of 354 maize farmers and to use the contingent valuation method. Results indicate that farmers need accurate seasonal climate forecasts between 1 and 2 months before the onset of rains. The most desirable dissemination channels are radio, local elders, local farmer meetings and extension agents. The most likely used farming strategies are change of: planting date, crop acreage, crop variety, and production intensification. The vast majority of farmers are willing to pay for seasonal climate forecasts, and the average annual economic value of seasonal climate forecasts are about USD 5492 for the 354 sampled farmers and USD 66.5 million dollar at the national level. Furthermore, benefits of seasonal climate forecasts are likely to increase with better access to farmer based organisation, to extension services, to financial services, to modern communication tools, intensity of use of fertilizer and with larger farm sizes. Seasonal climate forecasts are a source of improvement of farmers' performance and the service should be integrated in extension programmes and in national agricultural development agenda.

Practical Implications

Our study analyses the economic benefits of seasonal climate forecasts for small farmers in the Republic of Benin in West Africa and shows a clearly expressed need of these farmers for seasonal climate forecasts from public and community-based agencies to improve their production and increase their incomes. We also show that available seasonal climate forecasts can lead to improved benefits for farmers. The most important forecasts requested by farmers are those related to the onset, distribution and amount of rainfall preferably forecasts that are available one to two months before the onset of rains. Many farmers would like to receive these seasonal climate forecasts through radio dissemination and also through meeting with extension and other local farmers. This suggests that national and local government authorities need to prioritise the establishment of public radio stations that can reach local farming areas with information on farming including weather and climate forecasts.

We also show that the majority of farmers respond to the availability of seasonal climate forecasts by adopting various strategies such as change of planting date, change of crop acreage, change of crop variety, change of crops planted and increase of fertilizer. Uncertainty in getting the information on time and continuously, and difficulties in understanding the information, are the main factors that influence the usefulness of forecasts. Access to extension services increases the likelihood of using seasonal climate forecasts significantly. Membership of a farmer based-organisation, access to credit, access to extension services, the intensity of

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fertilizer and the ownership of a mobile phone, help in the more effective utilisation of seasonal climate forecasts ensuring that overall benefits are increased to farmers.

We conclude by noting the key areas that need to be emphasised by government include improved extension services that have components of seasonal climate forecasts in their programmes, the need for national meteorological agency to produce locality-specific seasonal climate forecasts which are relevant to various farming communities with respect to the major crop and farming activities undertaken. Staff of national meteorological agencies need to be more proactive in seeking information from farmers in specific localities with regards to their needs of climate and weather forecasts. Lastly, it is important to note that farmers do not expect perfect seasonal forecasts and would be happy with an accuracy of around 80% that is eight seasonal forecasts out of ten seasonal forecasts issued that are useful.

1. Introduction

Over the last decades meteorological scientists have improved forecast technologies and models based on an improved understanding of the interaction between atmosphere and oceans and their link with certain climatic patterns (Ingram et al., 2002; Mjelde et al., 1998; PytlikZillig et al., 2010; WMO, 2015). Meteorologists can currently provide enhanced data and information on past, present and future states of the atmosphere. Climate forecasts are characterized to last for periods greater than two weeks (Mjelde et al., 1998; WMO, 2015). In this study, seasonal climate forecasts refer in this study to the provision of improved seasonal forecasts to farmers before the starting of the farming season.

Seasonal climate forecasts are assumed to speed up the adoption rate of high yielding and climatic risks reducing technologies and activities (Kenkel and Norris, 1995; Mjelde et al., 1998; Shankar et al., 2011; WMO, 2015). These forecasts are assumed to alleviate poverty. Seasonal climate forecasts are also assumed to help farmers (to) adjust their daily decisions (input timing and use, sowing period, marketing decisions), take advantage of favourable conditions and better choose which crop(s) to produce and in addition efficiently manage inputs such as land, labour, fertilizers, financial assets devoted to each crop (Hammer et al., 2001; Hansen et al., 2011; Kenkel and Norris, 1995; Mjelde and Hill, 1999; Phillips et al., 2002; WMO, 2015). The benefits of seasonal climate forecasts are likely to be higher in developing countries, like Benin, because of the large difference between current agricultural performance and the optimal potential agricultural performance and of the high-climate dependency nature of the agricultural sector in these countries (Vogel, 2000; World Bank, 2015).

In spite of the improvements of the climate predictions and their potential benefits to farmers in developing countries like Benin, the use of seasonal climate forecasts by farmers remains low (Clements et al., 2013; Ingram et al., 2002; O'Brien et al., 2000; PytlikZillig et al., 2010). Studies suggest that the National Meteorological Services (NMSs) in charge of the production of enhanced climate data and information and their dissemination in developing countries like Benin, lack both financial and human capacity to fully meet the international obligations and growing national needs and requirements for production of forecasts data and services (Clements et al., 2013; Lazo, 2015; WMO, 2015).

The building and sustaining of the capacity of NMSs, in order to ensure qualitative and continuous delivery of seasonal climate forecasts, require a scientific demonstration, through rigorous studies, of the economic benefits of the use of seasonal climate forecasts (Clements et al., 2013; Freebairn and Zillman, 2002; Rollins and Shaykewich, 2003; WMO, 2015). The evaluation of the benefits is necessary because it will offer quantitative arguments which can help to put the use of seasonal climate forecasts on the agenda of debates of development institutions (national and international) (WMO, 2015). It can also help to get the technical and financial support of these institutions (WMO, 2015). The lack of awareness of the benefits of seasonal climate forecasts is another major reason limiting the adoption and use of seasonal climate forecasts by farmers (Clements et al., 2013). Researchers call for studies related to the economic valuation of seasonal climate forecasts, especially in developing countries (Clements et al., 2013; WMO, 2015).

Two broad methods are used to value seasonal climate forecasts. Some studies use evaluation of field or project experiments and state a preferred approach (Anaman and Lellyett, 1996; Di Vecchia et al., 2006; Hammer et al., 2001; Kenkel and Norris, 1995; O'Brien et al., 2000; Patt et al., 2005; Phillips et al., 2002) whereas other studies use simulation experiments or on *ex-ante* approach (Meza et al., 2008; Roudier et al., 2012; Sultan et al., 2010; Ziervogel et al., 2005; Zinyengere et al., 2011). This work analyses the economic benefits of seasonal climate forecasts for farmers in Benin. The study has chosen to use a stated preference approach, the contingent valuation method (CVM), to value the economic benefits of the seasonal climate forecasts.

2. Theoretical framework for contingent valuation of seasonal climate forecasts

CVM is widely recognised as one of the major tool used by researchers to assess the total value of non-market goods (Bett et al., 2013; Carlsson et al., 2005). The objective of the CVM is to measure an individual's monetary value for non-market goods by creating a hypothetical market where individuals are asked to express their Willingness to Pay (WTP) or their compensation for having or not having a well-defined product. We assume that the individual has a utility function $U(Z)$ (measured in terms welfare or total income), where Z is a vector of n goods consumed by that individual.

Following Zapata and Carpio (2014), it is assumed that an individual derives one part of his/her income from agricultural production (FY) and the other part from non-agricultural activities (NFY). The indirect utility function for user j can be specified as:

$$\mathrm{V}[FY, NFY, P_Z] \tag{1}$$

where P_Z is the vector price of n goods consumed (food, clothing and composite goods excluding the price of leisure). The agricultural income is a share of the profit of agricultural production and can be expressed as:

$$FY = n(\pi(P_y, Q_y, r, q)) \tag{2}$$

where P_Y is the price of the produced output, Q_y is the quantity of output produced, q is the good being valued (seasonal climate forecasts), $\pi(.)$ is a profit function, r is a vector of input costs and $n \in [0, 1]$.

The indirect utility function can be rewritten as:

$$V[n(\pi(P_y, Q_y, r, q)), NFY, P_Z] \tag{3}$$

The act of valuation implies a contrast between two situations: a situation in which the goods are valued (seasonal climate forecasts) and one in which the goods are not valued. Specifically, if q changes from q^0 to q^1; with $q^0 < q^1$; the agent utility will change from $u_0 \equiv V[n(\pi(P_y, Q_y, r, q^0)), NFY, P_Z]$ to $u_1 \equiv V[n(\pi(P_y, Q_y, r, q^1)), NFY, P_Z]$.