Climate Services for Smallholder Farmers Using Mobile Phones: Evidence from a Pilot Randomised Controlled Trial in North Benin

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Introduction

Climate services are broadly acknowledged to have the potential to support decision-making and improve resilience to climatic shocks. Nevertheless, providing such services comes with several challenges such as the format, timing, costs, etc. In agriculture, climate services can help farmers to take informed production decisions such as the best timing of farming activities (e.g. sowing or planting and application of fertilisers or pesticides), type of seeds to use, etc. Despite this importance, there is limited high-quality and rigorous evidence on how climate information could be provided to smallholder farmers. Against this backdrop, we tested the impact of climate services for smallholder farmers using mobile phones. We conducted a pilot theory-based experiment, using a randomised controlled trial (RCT) design that involved a treatment group and a control group with randomisation at the village level. Farmers in the treatment group were provided with weather information through a mobile phone Short Message Service (SMS). We used the exogenous variation created by the random assignment to estimate the impact of climate services on the farmers' production decisions and performance.

In sub-Saharan Africa smallholder farming systems that rely on rain-fed agriculture remain the main source of livelihoods and food for most of the population. Changes in rainfall and temperature patterns are affecting agro-climatic conditions with important alterations in the growing seasons (Ngaira 2007; Waha et al. 2013), the planting and harvesting calendars (Rosegrant et al. 2008; Waha et al. 2013), and processes such as evapotranspiration, photosynthesis and biomass production (Rosegrant et al. 2008). It is projected that crop yields in West Africa for instance might fall by about 10 to 20 per cent by 2050 due to climate change (Thornton et al. 2002). Net crop revenue could fall further by about 90 per cent by 2100 (Boko et al. 2007). These impacts will exacerbate both food insecurity and poverty issues.

Considering the reduction of climate change impacts, adaptation is now recognised as a key policy option (Kurukulasuriya and Mendelsohn 2008). In agriculture, farmers currently use several adaptation strategies that are well documented in the literature. Common strategies include crop diversification, the use of short cycle or drought-tolerant seed varieties, crop rotation and farming techniques such as adjustments of the timing of farm operations and the dosages of fertilisers (Abid, Schneider and Scheffran 2016; Assan et al. 2018; Below et al. 2012; Bryan et al. 2009; Hassan and Nhemachena 2008; Hisali, Birungi and Buyinza 2011; Shepherd and Godwell 2019; Twagiramaria et al. 2017; Yegbemey et al. 2013). Yet, the lack of adaptive capacities is one of the major limiting factors in smallholder farming systems (Waongo, Laux and Kunstmann 2015). A good illustration is the lack of relevant climate-related information to inform adaptation decisions. At the scale of the production systems, farmers typically shape their adaptive response to climate change based on their past weather knowledge and experience that form their expectations for future weather. While we strongly acknowledge the importance of farmers' experience and endogenous knowledge, we argue that traditional weather forecast knowledge systems are now challenged with higher and higher levels of uncertainty about future variability. Previous studies (e.g. Roudier et al. 2014; Yegbemey et al. 2014) found that providing farmers with relevant climate information is likely to help them to (better) shape their adaptive response. According to Douxchamps et al. (2016), adaptation strategies to reduce smallholder farmers' vulnerability to climate variability and seasonality are particularly needed in West Africa. However, there is still a paucity of policy-oriented research exploring innovative interventions to provide smallholder farmers with climate services.

Within the framework of CODESRIA's Making Research Initiative (MRI), we were awarded a research grant (MRI/CTR 7/2017) to conduct a study to explore *ex ante* the impact pathways of a hypothetical intervention which consists in providing smallholder farmers with weather-related information. Additionally, we design a pilot field experiment (i.e. an RCT) to analyse quantitatively the impact of weather forecasts (provided to smallholder farmers through a mobile phone SMS) on self-reported labour costs, yield and income. Our experiment was recently registered with the RCT ID AEARCTR-0005039 in the American Economic Association's registry for RCTs. It is important to note that we wrote two research papers based on the current projects. Both papers are under review for publication by CODESRIA.

Research design

Our intervention consisted in providing climate-related information through mobile phone SMS. Our targets are maize farmers that own a mobile phone and can read French or have someone in their household who can read French. The intervention was implemented by a local NGO, Bureau de Recherche et de Développement en Agriculture (BReDA). Using a mixed-methods approach, we designed a pilot theory-based RCT to test the impact of climate services for smallholder farmers on their production decisions (i.e. labour allocation) and performance (i.e. yield and income). RCTs are experimental approaches viewed as the most rigorous method to estimate the impact of an intervention when both internal and external validities are met. In a typical RCT, some people/units are allocated at random (by chance only) to receive the intervention whereas some people/units are also allocated at random to not receive the intervention. The former group of people is the treatment group and the latter group is the comparison or control group. The impact is assessed by comparing the average change in the outcome variables of interest (i.e. labour allocation, yield and farm income in our study) between the treatment and control groups.

We conducted field work in six villages of the municipal area of Bembèrèkè in North Benin, West Africa. Villages were selected so that they are similar in terms of the importance of maize farming, production systems, maize production, average farm size, etc. To ensure this, agricultural extension officers were involved in the selection process. Furthermore, a field exploration visit was organised to confirm that the selected villages are actually similar. Following our RCT design, three villages (clusters) were randomly assigned to the treatment group (treatment villages) and the other three to the control group (control villages). Randomisation was conducted through a public lottery attended by representatives from all six villages. A total of 331 eligible and volunteer maize producers were randomly selected in the six villages. Farmers eligibility criteria include: a) farmers should be maize producers, b) farmers should plan to produce maize during the rainy season of 2017–18) farmers should own a mobile phone with a valid and functional line number, and d) farmers should have the ability to operate (i.e. read SMS) their mobile phone or have someone in the household who can do so. Following our design, farmers in villages assigned to the treatment group received the intervention whereas farmers in villages assigned to the control group received no intervention.

We conducted a baseline survey and an endline survey before and after the intervention respectively. In addition, we conducted a total of seven monthly follow-up surveys to collect monitoring data. Each data collection was designed as a household survey based on semi-structured interviews, using a questionnaire pre-programmed in KoboCollect. Primary data collected include: a) farmers' socio-economic characteristics such as location, gender, age, level of education, household size, main and secondary activities, contact with an extension agent, access to credit, etc.; b) treatment status (i.e. treatment versus control); c) production decisions such as inputs allocation; and d) inputs and output quantities and prices. Before the baseline survey, we conducted an extensive qualitative survey to understand better the possible impact pathways of the intervention.

Impact pathways of weather information for smallholder farmers

We used a qualitative research design based on focus group discussions with smallholder farmers and agricultural extension officers to build a Theory of Change (ToC) of our intervention. By definition, a ToC is a description of how a desired change is expected to happen in a particular context due to the intervention of interest. Our results support the premise that climate services have the potential to help farmers in taking informed production decisions. More specifically, we find that providing farmers with weather-related information can help them better allocate production resources and eventually record higher yields and incomes. Farmers who enjoy these impacts might end up having better lives through improvements in their livelihoods. Our study suggests that several types of weather-related information can be useful for smallholder farmers. These include rainfall and wind forecasts. There are also several dissemination channels that can be used to provide famers with climate information, ranging from the social network of the local communities, to information and communication technologies. We show that each dissemination channel comes with both strengths and weaknesses. In that respect, we argue that the best dissemination channel will depend largely on the socio-economic context of the intervention area. Regardless of the socio-economic context of the intervention area, weather-related information needs to be accurate, available in a timely manner, understandable, and easy to use by smallholder farmers.

Impact of weather-related information on labour costs, productivity and farm income

Thanks to our pilot field experimental design, we compared the self-reported labour costs, yield and income between treatment and control farmers. Following the ToC of our intervention, we expect that farmers provided with weather-related information will better allocate their production resources and therefore record higher agricultural outputs. We acknowledge that our sample size is rather small and to account for this, we used three regression specifications: Ordinary Least Squares (OLS); Generalized Estimating Equations (GEE) model with small sample correction; and Randomisation Inference (RI). The balance tests on the outcome variables and key co-variates at baseline show that the control and treatment groups are well balanced. Our impact estimates suggest that farmers in the treatment group record a lower level of labour costs but higher levels of yield and income. These patterns are consistent with our theoretical expectations. Furthermore, both the signs and the values of the impact estimates are consistent across the three regression specifications but significant with the RI model only (for labour costs and yield) or with the RI and GEE models (for income).

Conclusion

There are several adaptation strategies mostly developed by smallholder farmers themselves or introduced by development agencies, government and/or research institutions. These include new seed varieties, crop diversification, adjustments of the farming calendar, changes in input allocations and off-farm activities. While these adaptations could help adjustment to clear long-term changes in climate, they can show limitations as far as day-to-day weather variability is concerned. Considering that agricultural production is mostly seasonal, we acknowledge that adaptation to climate change is vital for smallholder farmers but adaptation to more uncertain climate variability is urgent. Through climate services, smallholder farmers can have access to weather information. Then, they can use the information to adjust farming practices. As this will be new to most rural areas, initiatives should engage with farmers to inform the main features of climate services such as the content, language, communication channels, timing, etc. As a matter of fact, our findings suggest that there are several options to design climate services and each option has strengths and weaknesses.

Our field experiment shows that weather-related information through mobile phone SMS has positive impacts on labour, yield and income. Despite the pilot nature of our experiment, the findings will encourage researchers, practitioners and policy makers in their efforts to design and offer climate services for smallholder farmers. Yet, larger experiments are expected to generate more rigorous and high-quality evidence on the impact of climate services.

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