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Farm level adaptation decisions to face climatic change and variability: Evidence from Central Chile

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ABSTRACT

Climate change represents one of the biggest threats to agriculture today. The aim of this paper is to analyze the decision and intensity of adaptation to this phenomenon among farmers in Central Chile and to identify the factors that influence the adoption of adaptation measures. The list of adaptation practices was created with the assistance of a panel of experts. A two-part hurdle model was used to identify the adoption and intensity of adoption. The decision to adapt is strongly influenced by land tenure security and access to weather information, which increase the probability of adaptation by 13% and 30%, respectively. The intensity of adaptation is highly influenced by affiliation to a farm organization or association, which tends to boost intensity by 72.2%. Land tenure also increases intensity by 44.5%. Years of experience in agriculture and the income obtained from crops in the previous season also have a positive impact. Empirical results reveal that the most effective way to reduce barriers to adaptation is to improve access to information, while a highly relevant mode to increase the intensity of adaptation is to encourage social networking.

1. Introduction

The evidence on changing climatic conditions across the globe is becoming increasingly compelling. Data from all continents show that many natural systems are being affected, particularly by increases in temperature that are likely to be associated with anthropogenic sources. The inherent uncertainties surrounding farming operations have become accentuated by the global warming trend, which has serious direct and indirect impacts on crop production (Pathak and Wassmann, 2009), affecting food prices, food security, and decisions associated with land use (Lobell and Field, 2007).

The aim of this study is to provide a quantitative analysis of demographic and productive factors associated with the ability to adapt to climatic variability based on a sample of Central Chilean farmers. Chile is an interesting case study in South America, given its high vulnerability to climate change and heavy reliance on intensive agriculture. The country has a variety of ecosystems – a low-lying coastline, arid, semiarid and forest areas with susceptibility to natural disasters, and areas prone to drought and desertification (Chilean Ministry of

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Environment, 2011). Approximately half of the area in continental Chile (51.6 million ha) is used for agriculture or forestry (ODEPA, 2013) and in the last three decades there has been a shift in land use toward specialized export oriented crops with increasing reliance on purchased inputs (Bengoa, 2013). Despite these changes, various challenges remain that constrain agricultural development and sustainability. For example, recent results reveal a low level of adoption of water and soil conservation practices (Jara-Rojas et al., 2012; Roco et al., 2012) and limited access to financial capital (Reyes and Lensink, 2011), leaving the sector vulnerable to climate change.

All global circulation models predict a more arid future for the country (IPCC, 2007, 2014; AGRIMED, 2008). This prediction is especially important in the Central zone, since it constitutes approximately half of the arable land in the country (ODEPA, 2013) and it is expected to experience a decrease in precipitation of up to 40% and a rise in temperatures between 2 and 4 °C in the next 40 years (Chilean Ministry of Agriculture, 2012). These projections highlight the importance of understanding not only the dynamics of climate change in the country, but also the subtleties of human adaptation.

The rest of the paper is organized as follows: Section 2 gives an overview of the recent literature on climate change adaptation in agricultural systems; Section 3 contains a description of the data used in the study, the methodological framework, and the model selected; Section 4 presents and discusses the empirical results; Section 5 describes the policy implications, summarizes and concludes.

2. An overview of the recent literature

Adaptability is the capacity of actors to manage change and is considered mainly a social phenomenon (Walker et al., 2004). Adaptation is also the response or the ability of economic agents and societies to remain functional under mayor shocks such as climate change on the basis of extra efforts (Zilberman et al., 2012; Rose, 2007). In agriculture, adaptation will imply pushing the production frontier outward (Rose, 2007), which results in modifying prevailing practices to cope with growing climatic variability. Although adaptation has been persistent over the centuries, the occurrence of extreme events, such as droughts, floods and frosts, has become more prevalent making adaptation an essential feature in current agricultural systems (Clements et al., 2011).

As recognized by Zilberman et al. (2012), adaptation can be defined as changes in the private and public decision making process in resource allocation; therefore, we can expect that adaptation strategies will include public and private actions. According to Brechét et al. (2013), some adaptation measures have public good characteristics while others are motivated by the self-interest of individual economic agents. In the first group we can cite public investment in irrigation infrastructure, and the breeding of drought, heat-tolerant and early maturing plant varieties (Deressa et al., 2009). The second group includes the adoption by individual farmers of practices such as increased irrigation, crop diversification, tree planting, and soil and water conservation measures, among others (Hageback et al., 2005; Gbetibouo, 2009; Manandhar et al., 2011; Di Falco et al., 2011; Sofoluwe et al., 2011; Tambo and Abdoulaye, 2012). Practices in the second group can be divided in three main categories: water and soil conservation practices; changes in crops; and improvement in irrigation systems (Bryan et al., 2009; Deressa et al., 2009; Gbetibouo, 2009). As expected, adaptation practices vary locally depending on particular agro-ecological and socio-economic conditions (Gbetibouo, 2009; Deressa et al., 2009; Di Falco et al., 2011).

The literature suggests that even though alternative adaptation strategies are available in different locations, various types of barriers reduce or even prevent adaptation. The 2001 and 2007 IPCC reports noted significant financial, cultural and policy barriers. From the financial point of view, recent studies in Africa show that farm size, used as a proxy for capital, could be an important barrier as this variable has exhibited a positive and significant association with the adoption of climate change adaptation practices (Gbetibouo, 2009; Di Falco et al., 2011). Likewise, another relevant barrier to adapt could be low access to credit as pointed out by Bryan et al. (2009), Sofoluwe et al. (2011), Di Falco et al. (2011) and Piya et al. (2012). Below et al. (2012) and Silvestri et al. (2012) claim that a low level of education also decreases the chances of adaptation to climate change. In addition, land tenure insecurity can have a negative effect on the decision to adapt to climate change, as reported by Yegbemey et al. (2013) in their analysis of maize farmers in Benin.

However, public policies may accelerate the speed of adaptation. For example, extension services and training can have a positive effect on adoption of climate change adaptation practices (Bryan et al., 2009; Di Falco et al., 2011; Silvestri et al., 2012). Therefore, as the public sector encourages the development of appropriate extension and training programs, the capacity of the agricultural sector to adapt to current climatic change rises. The flow of relevant information may also facilitate adaptation. Research shows that access to climatic information has a positive effect on the decision to adopt practices to cope with climate change. In Ethiopia, Di Falco et al. (2011) argue that such information had a positive connection with the decision to use adapted crop varieties, soil and water conservation practices, and tree planting. Recent findings by Bryan et al. (2013) highlight the effect of the use of weather forecasts on adaptation. Similarly, Piya et al. (2012) confirm that climate information is relevant for the adoption of soil conservation practices, diversification measures, varietal selection, water accumulation, and changing planting times in Nepal. A recent study carried out in Nigeria by Tambo and Abdoulaye (2012) notes that the decision to adopt a new variety of maize is positively correlated with climate change awareness.

As already stated, the role of policy makers in aiding the adaptation process could be relevant to generate effective long-term and location-specific adaptation strategies (Manandhar et al., 2011). Several authors argue that policy makers need to have a good understanding of local conditions as well as local adaptive strategies and capacities before they can promote technologies to help farmers (Wang et al., 2013; Osbahr et al., 2011; Deressa et al., 2009; Mertz et al., 2009). The preceding review of literature reveals that most of the adaptation studies have been done in Africa; therefore, little is known about this phenomenon in South America.