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Information provision, policy support, and farmers' adaptive responses against drought: An empirical study in the North China Plain

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ABSTRACT

As an important agricultural production region in China, the North China Plain (NCP) is an ecologically vulnerable region that frequently is hit by drought. Faced with drought and other extreme climate events, policy makers have given top priority to the formulation and implementation of adaptation policies. This paper assessed the effectiveness of adaptation policies, including the provision of early warning information and policy supports, on farmers' adaptive decisions regarding the planting of the wheat crop in the NCP. Based on a unique dataset from a large-scale village and farm survey in five provinces in the NCP, an econometric model of farmers' adaptation practices is estimated. Results show that when faced with a more severe drought, farmers change their management practices to mitigate its effects by adjusting seeding or harvesting dates and enhancing irrigation intensity. The provisions of early warning and prevention information and policy supports against drought facilitate farmers to make farm management adaptations. However, the effectiveness of early warning and prevention information or policy supports differs by their provision channels or types. The findings of this study have policy implications in coping with the rising frequency and seriousness of extreme weather events in China as a whole and in ecologically more vulnerable NCP in particular.

1. Introduction

As an important agricultural production region in China, North China Plain (NCP) is one of the ecologically vulnerable regions frequently hit by drought. The NCP is a large alluvial plain developed by intermittent flooding of the Huang, Huai and Hai rivers (Thomson et al., 2006). Seventy-five-percent of China's wheat, 32% of maize, and 19% of rice are supplied by the farmlands of the NCP (NSBC, 2012). Despite its importance to China's food security, sustainable development of this region has been challenged by frequent and severe drought disasters. In the past three decades (1980–2011), on average, about 7.4 million ha of crop areas per year in the NCP has suffered the effects of drought. In 2000, losses attributed to drought were as high as 13 million ha, with half of the crops suffering yield losses of more than 30% (MWR, 2012). The drought caused large socio-economic losses, which amounted to 1.4 billion USD in 2008 (MWR, 2009). Not only does drought impact agricultural production, it also degrades the region's ecological system, as evidenced by its dried up rivers, declining groundwater table, deteriorated water quality, and disturbed riparian habitats (Xia et al., 2004; Mishra and Singh, 2010). Future climate change promises to increase the severity and frequency of droughts (IPCC, 2007; Mishra and Singh, 2010; Dai, 2011).

Research results show that taking appropriate adaptive measures are essential to mitigate some negative impacts of drought on agricultural production. For example, Zhang et al. (2011) found that implementing comprehensive adaptive measures in the field (such as changing varieties, adjusting seeding and/or harvesting dates, implementing precision irrigation approaches, and applying other farm management measures) decreased yield loss due to drought by 15% in the NCP. As summarized by the IPCC (2012), in the event of a 1–2 °C increase in the local temperature, changing crop varieties, modifying seeding and/or harvesting dates, and applying other farm management measures can reduce yield losses by 10–15%. Tian et al. (2014) pointed out that farmers can compensate for the negative influence of climate warming or even increase

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crop yield by choosing the most suitable crops, cultivars and cropping systems. The effectiveness of adaptive measures for drought mitigation and the management of other climate-related risks has been studied by some scholars (Kantolic et al., 2007; Di Falco et al., 2011; Xiao and Tao, 2014).

Frequent droughts and their resulting negative impacts on the NCP region have concerned policymakers, who question how they may mitigate these impacts through appropriate adaptive measures. In recent years, both international and domestic policymakers have accorded top priority to formulating and implementing adaptation policies in their respective policy agendas (World Bank, 2010; IPCC, 2012). In addition to issuing white papers on national adaptation policies, China also has introduced some specific policies on coping with droughts (NDRC, 2007, 2012). For example, the Chinese government issued the *Drought Control Regulation* in 2009 and *National Drought Control Planning* in 2011. These policies not only define the responsibilities for drought control but also promote technical, physical, and financial policies to help farmers deal with drought. In addition, the establishment of an early warning and prevention information system at the national and local level also has been noticed by policymakers in China (Chen et al., 2014).

A pertinent question is whether the government's efforts on issuing adaptation polices significantly influence farmers' adaptive decisions and help them improve their adaptive capacity. Moreover, how is the information from the early warning and prevention system delivered to farmers? What are major policy supports for farmers to deal with extreme weather events? Have the early warning information system and various policy supports against extreme weather events improved adaptive capacity of farmers? In practice, what kinds of adaptive measures are taken by farmers to fight drought? In addition to adaptation policies, what other factors influence farmers' adaptive behavior? In recent years, a growing body of literature has analyzed the determinants of farmers' adaptive decisions, both qualitatively (Ju et al., 2008; Su et al., 2012; Sjögersten et al., 2013) and quantitatively (Deressa et al., 2009; Di Falco et al., 2011; Chen et al., 2014; Huang et al., 2014; Wang et al., 2014). However, most studies have focused on the effects of physical and socioeconomic factors while only a few studies have quantified the influence of some adaptation policies on farmers' adaptive behavior (e.g., Di Falco et al., 2011; Chen et al., 2014). Importantly, no study has analyzed farmers' adaptive behavior against drought in the NCP. Increasingly extreme weather events have turned the spotlight on the importance of effective measures taken by farmers not just in China but also in other developing countries (Mendelsohn et al., 2006; Seo and Mendelsohn, 2006).

The overall goal of this paper is to assess the effectiveness of major adaptation policies on farmers' adaptive decisions in the NCP. Specifically, we focus on two kinds of adaptation policies. The first policy is provision of early warning and prevention information against drought, and the second is provision of technical, physical and financial policy support. Not only do we focus on the provision status, but we also identify the effectiveness of provision channels and types of policy supports, respectively, that are used to implement the above mentioned adaptation policies. As revealed by Chen et al. (2014), the major adaptive measures taken by farmers are non-engineering measures, or farm management measures (such as adjusting crop varieties, changing seeding and/or harvesting dates, adjusting production inputs, or other management measures relevant to crop production). Therefore, this paper also focuses on farm management measures. Finally, adaptive farm management measures likely differ by crop. In this study we select wheat, the most important crop in the NCP, as the target crop.

To meet the above objectives, the rest of this paper is organized as follows. The next section briefly introduces the data used in this study. Section 3 discusses the farm management measures taken by farmers. Section 4 presents the results of the descriptive statistical analysis on the correlation among information provision, policy support and farm management measures taken by farmers against drought. Econometric analyses in Section 5 include the influence of information provision, policy supports and other factors on farmers' adaptive responses in terms of farm management measures. Section 6 concludes with policy implications.

2. Data

The data used in this study are based on a large-scale household and village survey conducted in nine provinces of China from the end of 2012 to the early 2013. These nine provinces include Hebei, Henan, Shandong, Jiangsu, Anhui and Jilin in northern China, and Jiangxi, Guangdong and Yunnan in southern China. Of these nine provinces, five provinces (Hebei, Henan, Shandong, Jiangsu and Anhui) are located in the NCP and therefore used in this study (Fig. 1). While the NCP also covers Beijing and Tianjin, wheat production in above five provinces accounted for 99% of wheat production in the NCP and 75% of China's total wheat production in 2012 (NSBC, 2012).

During the survey, the following strategies were used for sample design and selection in each province. First, three counties in each province were randomly selected from those counties that met the following two conditions in the past three years (2010–2012): (i) had experienced a year with severe drought or flood (or disaster year); and (ii) had experienced a relatively normal weather year. A relatively normal year here is considered as a year when severe drought or flood did not occur at the county level. Many fewer farmers experience drought or flood in a relatively normal weather year (for convenience, the term normal year is used thereafter). By collecting data from one year with an extreme weather event and the other year having normal, we can identify the impact of extreme weather and differences in adaptation between extreme weather year and normal year. The selection of these counties is possible because there are about 100 counties in each province, and at least 20% of them experienced a severe drought and flood during the past three years.

Stratified random sampling was used to select three townships from each selected county and three villages from each township. Townships were stratified into three groups according to their rural water infrastructure: above average, average, or below average. Then one township from each of these three groups was randomly selected. The same approach was used to select three villages from each of the selected townships. Finally, ten farm households were randomly selected in each village, and in each farm household, two plots that were planted to major crops were chosen for the survey. In total, the samples in the five selected provinces included 2700 plots, 1350 households, and 135 villages in 15 counties. For more detailed sampling rules, please refer to Huang et al. (2014). Since our research focuses on how farmers' planting practices help wheat adapt to drought, we deleted questionnaires obtained in the flood counties and from households that did not plant wheat in the past three years. The final sample included 1626 plots and 870 households in 89 villages in 10 counties. The collected data for each plot included data for both a normal and a drought year.

While the household and village level survey covers a wide range of issues, our analysis used only data relevant to this study. For the household level surveys, we used the following data: (i) farm management measures taken by farmers at their plots to cope with drought, such as planting drought-resistant varieties, adjusting dates of seeding and/or harvesting, reseeding, enhancing irrigation intensity, and increasing production inputs (such as fertilizer, labor, and pesticide); (ii) household characteristics, such as farm size, number of family members, age, education and farming experience of household head, number of relatives, distance to the

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