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Farmers' decision-making process under drought

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ABSTRACT

Although a large body of research exists discussing the subject of drought management and the mechanisms that are employed by farmers to formulate decisions during such an event, the farmers' response to drought remains poorly understood due to the oversimplified assumptions about farmers' behavior in response to drought. Furthermore, little is known about the potential efficacy of the coping strategies that are adopted by farmers. To gather this knowledge, a mixed method, qualitative-quantitative study was conducted in Fars province, Iran. A survey of 255 farmers, selected through a multistage stratified random sampling method, revealed that farmers' decisions to manage a drought were the result of a complex web of natural, economic, structural, and cognitive factors. Additionally, an analysis of decision models revealed that there were different patterns of coping responses utilized in the different stages of drought that expanded from short-term adjustment to long-term adaptation. Furthermore, a decision tree analysis indicated that although a large percentage of farmers made some adjustments in response to drought, they were not able to overcome the increasing impacts of the drought. In this respect, it was recommended to consider various economic incentives, promote affordable coping strategies, and combine agricultural interventions with social support services.

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1. Introduction

Farmers frequently cope with risks due to the uncertainty of climatic conditions (Crane et al., 2011). Population growth (Le Gal et al., 2010), changes in agricultural policies, environmental regulations (Risbey et al., 1999) and the degradation of natural resources such as soil and water (Riebsame et al., 1991) also present farmers with numerous challenges. Although farmers have experience in coping with a certain degree of uncertainty, increased climate variability and changes may cause severe problems. Drought in particular is a climatic disaster that creates substantial costs for farmers and affects their agricultural systems extensively. Drought is the most complex of all natural hazards (Wilhite et al., 2007), making the arid and semi-arid regions of the world vulnerable. Although drought has not been well documented (Wilhite and Pulwarty, 2005), the resource-dependent sectors such as agriculture are the most vulnerable to the impact of this phenomenon.

A review of the long-term annual precipitation trends indicated that drought had a worldwide return frequency of every 20–30 years (Eskandari, 2001). However, in the last 50 years, some countries such as Iran and Bangladesh have experienced approximately 27 (Amirkhani and Chizari, 2010) and 19 (Habiba et al., 2011) drought events, respectively. Therefore, for arid and semi-arid regions, drought is a recurrent feature that could lead to the loss of crop production, food shortages and starvation (Paul, 1998) if not managed appropriately. According to Keshavarz et al. (2010), drought impacts could be managed at macro (national), meso (local) and micro (village and household) levels. However, the micro-level management (i.e., what the farmers do in response to drought) is of great importance (Keshavarz et al., 2010).

A review of the studies of farmers' decision-making in response to climate variability (e.g., Comoe and Siegrist, 2013; Comoe et al., 2012; Ingram et al., 2002) revealed that most research has focused on the decision event and not on the entire process (Orasanu and Connolly, 1993). Keshavarz et al. (2010) argued that the wrong assumption of farmers' homogeneity neglected different aspects of decision-making in response to drought. Studies by Gibbons and Ramsden (2008) and Keshavarz et al. (2010, 2011) also indicated that farmers made different decisions when utilizing the same data. Additionally, many studies have focused on single strategies that were used to mitigate drought (e.g., Easdale and

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Rosso, 2010; Eriksen and Silva, 2009; Hosseini et al., 2009; Osman-Elasha et al., 2008). However, there is a lack of knowledge about the combination (Toft and O'Hanlon, 1979) and sequence (Roncoli et al., 2001) of coping strategies that are used to mitigate drought. Concentrating on the decision-making process could help policy makers assess the needs and prioritize interventions, as well as enable farmers to efficiently manage drought.

Farmers utilize various strategies to reduce the impacts of drought. Some strategies have a limited impact on drought mitigation. Some practices also increase farmers' woes during drought (Burton et al., 1998). In addition, when resources (natural, physical and financial) are scarce, the need for an accurate appraisal of coping strategies becomes acute. Therefore, outcome prediction (i.e., the efficacy of mixed coping strategies) is a critical issue in drought management. Consequently, this study is concerned with the description of the farmers' decision-making process and decision outcomes. First, the impacts of drought on the agricultural production in arid or semi-arid countries, specifically Iran, are described. Then, the farmers' decision-making process during drought is explained. The focus then shifts to the design and explanation of the proposed research methodology, followed by an analysis of the results and concluding remarks.

1.1. Recent impacts of drought on agriculture: the case of Iran

Agriculture is the main water-consuming sector in Iran, accounting for approximately 93 percent of the total water consumption (Ardakanian, 2005). However, only 44 percent of Iran's agricultural land is irrigated (FAO, 2008), while the rest is rain-fed and is directly affected by rainfall scarcity and its spatial and temporal variability. The long-term average annual rainfall is in the range of 224–275 mm/year, of which 70 percent occurs in the northern and western regions of Iran. Other regions receive only 30 percent of the rainfall (Forouzani and Karami, 2010). Moreover, Iran is not well-endowed with water; the per capita water endowment is approximately one-fourth of the world average (Alyasin, 2005). Due to the water scarcity and seasonal rainfall variability in the recent decade, more intense and longer-lasting droughts have occurred in the central, eastern and southern regions. Consequently, millions of people residing in both the urban and rural areas have been affected.

The impacts of drought on agriculture have been identified as the most serious in terms of the number of affected people and the severity of impacts on those who are unable to cope with drought (Wreford et al., 2010). Droughts affect farmers and their families through, for example, 1) the loss of assets in the form of crops, livestock and productive capital damages; 2) the reduction of income and job opportunities; 3) the decrease of input and investment in the farm; and 4) malnutrition and general impoverishment (Hosseini et al., 2009; Keshavarz et al., 2013a, 2011). Droughts also significantly influence 1) governmental policies, 2) food imports and 3) provisions of subsidies and credit to affected productive sectors of Iran (Keshavarz and Karami, 2013). However, in severe cases (e.g., the 2008–2012 drought years) the negative consequences of drought are intensified.

From 2008 to 2012, the contribution of agriculture to the GDP decreased due to the ensuing drought. While agriculture contributed to 12.05 percent of the GDP during the 2007 normal year, it decreased to approximately 10 percent in 2008 (Statistical Center of Iran, 2013). As a result of this drought, the value of farming production was also diminished.

According to the FAO (FAOSTAT, 2013), wheat production decreased from 16 million tons in 2007 to 8 million tons in 2008 due to drought, causing $775.6 million in losses. Likewise, from 2007 to 2008, decreased rice production caused an economic loss of approximately $84 million. Under such conditions, Iran imported significant amounts of wheat and rice, and it seemed likely that continuous drought would lead to import expansion. Furthermore, dairy production also experienced a decrease of 8.2 percent during this same period (FAOSTAT, 2013).

The drought of 2008–2012 was one of the worst on record. This drought drastically reduced the cultivation area, even in irrigated lands. During this time, the river waters fell to critical levels. Most of the traditional ground water irrigation systems (*qanats*) either completely dried up or experienced a reduced water release (Keshavarz et al., 2013a). In the central and southern regions of Iran, the cultivation areas were reduced by half during the spring-summer seasons due to these low water levels. During this period, farmers experienced rising costs due to the use of management strategies such as deepening wells and constructing water storage in order to cope with the drought. Other economic impacts that were experienced by the farmers were increased livestock feeding expenses, increased interest rates, and increased debts (Keshavarz et al., 2013a). These depleted resources and diminished incomes forced those in rural areas to migrate to the cities in pursuit of jobs (Keshavarz et al., 2013a, 2010).

1.2. Farmers' decision-making under risk: response to drought

There is a large body of literature that has analyzed the decisions of farmers under such uncertainties. The literature includes several approaches. One such approach, crop production and economic modeling, has been widely used to study the adoption of farm management activities. Crop models provide a systematic means to map variations in climatic and other environmental inputs, such as temperature and precipitation, to variations in the crop yields. This approach has been criticized for its inability to adequately simulate the market and create policies that could affect the yield and returns (Risbey et al., 1999). In addition, using an economic model simply assumes that adaptation decisions are based on perfect rationality to maximize profit (Güth and Kliemt, 2004). It is then assumes that farmers would make smooth and costless transitions (Risbey et al., 1999) from one strategy to another in order to minimize the negative consequences and maximize the outputs. A number of problems with this approach have been identified. Because this approach ignores the complexity of human behavior (Karali et al., 2011), the link to real-world decisions is poor. Theories other than those that are documented in the economic literature assume that humans do not solely aim at profit maximization (Hansen et al., 2004). Instead, humans tend to follow different decision-making pathways and make sub-optimal choices that are products of a complex web of factors, such as economic, demographic, social, cultural, psychological, technological, biophysical and ecological issues (Karali et al., 2011; Risbey et al., 1999; Vignola et al., 2010).

Additionally, both approaches have simplifying assumptions about farmers. These approaches assume that farmers are either naive as in crop models or clairvoyant as is implicit in economic models (i.e., farmers knew the drought consequences and exactly what the coping strategies meant) (Kandlikar and Risbey, 2000). These approaches ignore the heterogeneity of the farmers' coping behavior, which leads to a various set of response possibilities (Keshavarz et al., 2010). In reality, the farmers' decisions that are implemented during a drought are greatly influenced by cognitive aspects, such as prior values, beliefs and experiences (van den Berg et al., 2000), as well as by a reflection of the individual's needs (Eckert and Bell, 2005), along with the history of previous changes (Hansson and Ferguson, 2011). Drought management programs that do not consider the values, beliefs, previous farming decisions

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