



Farmers' Decision-Making Process under Climate Change: Developing a Conceptual Framework

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Abstract

In recent decades, climate change and frequent droughts have had great impacts on farming systems and have led farmers to become accustomed to these conditions, which are causing problems, especially, for smallholder farmers. With the severe weather events and their adverse effects, especially in arid regions, farmers' adaptation to these changes is indisputable and critical strategy. Thus, farmers need to make complex decisions about mitigating the adverse effects of climate change to take advantage of newer opportunities as possible. The understanding of the process by which farmers decide to stand facing climate changes and probing into the determinants of the process provide research evidence for policy makers to assist farmers to adapt to climate change effects. This article would establish a conceptual framework, inclusive of factors influencing farmers' decision-making to adapt to climate change, and would clarify causal relations among these factors. According to the results, household characteristics, economic factors, knowledge, motives and goals, perceived outcomes of adaptation, social, personal norms, perception of climate change, perceived risk and obstacles, attitude towards climate change, prospective perception of climate change, the evaluation of climate change, and adaptation initiatives could influence farmers' decisions to adapt to climate change.

Keywords:

Climate change; decision-making; farmers' adaptation; smallholder farmers

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INTRODUCTION

The global climate has been changing (Adger et al., 2003), and one of the main sequels of human-caused climate change (CC) is the extreme weather events with severe impacts on societies (Linnenluecke & Griffiths, 2010). Agriculture is highly dependent on weather situation and alteration in weather parameters such as temperature, precipitation and CO₂ as a result of CC influence farming system outputs (Dinar and Mendelsohn, 2011; Mercer et al., 2012). Climate change worsens crop growth condition but its effects are not just economic and environmental because it also causes social effect as it reduces job opportunity in the agricultural sector (Mestre-Sanchis & Feijoo-Bello, 2009). Some of the effects of CC are already appearing all over the world. For example, in the last decade, severe droughts and water shortages have occurred in many arid and semi-arid regions of the world (Keshavarz et al. 2013).

Studies revealed that agriculture is more vulnerable to climate change, particularly in developing countries that rely heavily on their environmental resources (Hayati et al., 2010; Limantol et al., 2016). The negative impact of climate change, resulting in changes in weather patterns, precipitation, as well as other related factors, can both lower yields and increase production risks. Consequently, farmers' livelihoods, food security, and health may all suffer (Azadi et al., 2019).

Climate change is a serious threat especially to smallholder farmers' livelihood, because they lack sufficient resources such as credit or crops insurance to adapt to this change and to cope with challenges (Barak, 2006; Eakin, 2005; Mubaya et al., 2012; Simoes et al., 2010). While there are multiple stressors in these farmers' life, climate variability is the most critical livelihood insecurity for them (Mubaya et al., 2012). Smallholder farmers, also called marginal farmers have complex, diverse and risk prone agriculture that in compare with industrial and green revolution agriculture, are featured by small and poor

farm households, low use of purchased inputs, complex farming system, high risk production, diverse environment and usually in rain fed areas (Chambers, 1990). In this situation of high vulnerability, CC effects is worse than other types of agriculture, therefore smallholder farmers face complex and insecure decision making to adapt to CC and maintain their performance.

Adaptation to current climate variability and potential CC is a prerequisite for sustainable development (Stakhiv & Stewart, 2010), and learning how to cope with anticipated changes is crucial for farmers (Adger et al., 2003). As a result, present research problem developed that what is an appropriate perceived conceptual framework to explain farmers' adaptation decisions. Farmers especially smallholder ones, need help and support to make better decisions in the face of climate change. By understanding, why certain groups of people habituate to certain behaviors can help them make better decisions (Fountas et al., 2006). Theories of decision-making can help us in the process of forecasting the behavioral patterns and cognitive obstacles (Suarez, 2005). Although a part of research body aims to answer research questions e.g., what are the causation and indicators of climate change regarding farmers' perceived climate change (Teshfahunegn et al., 2016), farmers' perception toward climate change uncertainties (Nguyen et al., 2016), and beliefs towards climate change and perceived agricultural risks (Menapace et al., 2015). There is a little research that indicate how farmers make adaptation decisions. However, this paper was intended to fill this gap by investigating not only explaining the smallholder farmers' adaptation to climate change but also determining farmers' adaptation decision making. Using archival research and analytical review of theories and empirical research conducted in this field around the world, this study has been done with the following objectives:

The study aimed to explain farmers' adaptation to CC and its various dimensions; to in-

investigate different decision making theories and to determine suitable one for farmer's decisions in CC situation by conductive methods; to determine influencing factors in farmers' decision making by inductive method; to present a conceptual model of farmers' decision making for adaptation to CC and to clarify the relationship between components in the model.

The impacts of climate change on agricultural systems

Climate change is a threat to many communities throughout the world. It will continue to be a recurring issue of debate across different countries (Bulla et al., 2017). The world's agricultural systems are experiencing this climate change. The reduction of ground and surface water and the increase of arid areas are the explicit sign of climate change in agricultural systems (Wreford et al., 2010).

Agriculture sector with consuming approximately 90 percent of the total water is the main water-consuming sector in compare of other sectors (Keshavarz & Karami, 2014). The number of farmers affected by climate change and drought, especially who are unable to cope with their impacts, reveal the seriousness of this crisis (Wreford et al., 2010). The loss of crops and livestock, the reduction of income and job opportunities, the decrease of farm's input and investment, and general impoverishment are the negative consequences of climate change and drought on agricultural systems (Keshavarz et al., 2013; Keshavarz & Karami, 2014).

Mirjalili and Motaghian Fard (2019) examined the impact of climate variables namely temperature and precipitation on the yield of fruits, rice and corn in 14 selected OIC countries (Algeria, Bangladesh, Benin, Indonesia, Iraq, Iran, Malaysia, Mauritania, Mozambique, Nigeria, Pakistan, Philippines, Senegal and Turkey) for 24 years (1992 to 2015). Their finding showed that, rising temperatures reduced the returns on these products. In addition, reducing precipitation because of climate change reduced agricultural prod-

ucts, and water shortage in some of these countries.

Based on the study of Karimi et al., (2018) climate change is expected to greatly affect agricultural practices through changes in precipitation, temperature, carbon dioxide fertilization, climate variability and surface water runoff. Therefore, there is a concern about the potential of climate change to disrupt farmers' livelihoods and to prevent the countries from achieving sustainable development.

Farmers' adaptation to climate change

Climate change has different effects on agricultural sector in different regions and countries in the World. Developing countries with small farms and subsistence agriculture are more vulnerable to the consequences of climate change, because smallholder farmers lack the resources to buffer themselves against adverse effects and benefit from the opportunities in climate change situation (Barak, 2006; Beg et al., 2002), therefore adaptation to climate change is the most serious issue in these countries.

Farmers frequently adapt various strategies to cope with climate change and drought risks (Crane et al., 2011). In the context of climate change, adaptation means the modification of ecological and social systems to accommodate with climate change impacts so that systems can persist over time (Barnett, 2001). Ngigi (2009) argued, "Adaptation involves the action that people take in response to, or in anticipation of, projected or actual changes in climate to reduce adverse impacts or take advantage of the opportunities posed by climate change". Iglesias et al. (2007) defined adaptation "as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities". Therefore, we can consider adaptation to CC as a long-term process of learning and adjusting that include both social and environmental systems and if it has not been sufficiently rapid both sys-

tems will damage (Barnett, 2001). Some researchers (Below et al., 2010; Fankhauser, 1999; Iglesias et al., 2007; Smit & Skinner, 2002) classified adaptation to CC activities into diverse groups. Regarding these studies, adaptation activities can be divided into the two general categories:

- 1) Individual and farm level activities,
- 2) Governmental and beyond farm level activities,

Also, farm level activities that are more debated in this study can be divided into the three subgroups;

Technological development such as: adopting new technologies in farm, cultivating different varieties of crops, and changing irrigation method

Farm production practices such as: farm fallow, using water reservation pool, and changing husbandry to livestock

Farm financial management such as: buying or leasing land in other area for farming, taking loan for drought, and doing the non-farm activities

In climate change situation, the dominating challenge is how rural societies respond or adapt to changes in ways that reduce the vulnerability of their livelihoods. The studies of farmers' decision-making in response to climate variability frequently has focused on the decision event and not on the entire process. In this regard, Keshavarz et al. (2010) mentioned that the wrong assumption of farmers' homogeneity neglected different aspects of decision-making in response to drought. Additionally, many studies have focused on single or narrow strategies that were used to cope with drought (Keshavarz & Karami, 2014).

for better understanding the farmers' adaptation decisions, decision-making theories could be useful. In the next part of this paper, some important decision-making theories will be reviewed, and regarding their characteristics, the suitable one for farmers' adaptation decision-making behavior will be suggest.

Decision making theories

With regard to the studies in this field, in a general view, decision-making theories can be divided into 3 main categories:

- 1) Normative theory, 2) Descriptive theory, and 3) Prescriptive theory.

Normative theory: The basic assumption of a normative theory, also known as economic or rational theory, is that people acquire logical guidance for their decisions. In such a theory, people are considered as rational actors who are able to estimate the probabilistic outcomes of decisions and select the decision, which maximized their well-being (Ayele, 2008). The question in this theory is how people should make decisions if they want to obey certain laws and principles that are considered as a logical or rational behavior (Mellers, 1990).

Some assumptions of economic theory have been criticized, such as:

- Ideal decision making conditions cannot be met by the humans who implement them (Brown & Vari, 1992).
- Incomplete information in real world makes the decision-making process more complex (Ludewigs, 2006).
- Time and financial constraints will have effect on information accessibility (Reid, 2003).

Descriptive theory: The main character of a descriptive theory, also known as positive or behavioral theory, is observing how decision makers actually make decisions in real life (Brown & Vari, 1992; Suhonen, 2007). It attempts to consider human real traits such as inability to process large amounts of data and simplifying the decision process (Reid, 2003), and rejects normative theory assumption that decision makers can rank all the available decision alternatives (Ayele, 2008). This theory tries to identify decision criteria which is employed under various situations (Ayele, 2008), and to clarify why people make decisions in particular ways and why the suggested normative rules for decision-making are not followed (Riabacke, 2006). It explains how people talk about their perceptions and

choices (Bell et al., 1988).

Prescriptive theory: This theory describes the concerns of decision-making consultants and practitioners who want to help people make better decisions (Mellers, 1990; Suhonen, 2007). In contrast to the previous theories, it supports the development of decision aids which are applicable and useful (Brown & Vari, 1992). Since people are different regarding their needs, capabilities, and emotional makeups, a good prescriptive advice has to be tuned to the individuals, who the advice is intended (Bell et al., 1988). This theory attempts to incorporate rationality of normative theory with real world situation of decision makers that are not included in the normative theory (Mellers, 1990).

These three theories have been evaluated by different criteria (Bell et al., 1988): Descriptive theory is evaluated by its *empirical validity*, the extent that it is conform to observed choices. Normative theory is evaluated by its *theoretical adequacy*, the degree to which it supplies acceptable idealizations or rational choice. Prescriptive theory is evaluated by its *pragmatic value*, by its ability to help people make better decisions. These theories are not mutually exclusive and all of them can be useful in real life decision-making studies (Suhonen, 2007). Overall, in the field of CC studies, descriptive theory in the phase of recognizing farmers' real life behavior in facing the CC and prescriptive theory for helping farmers to make better decision to adapt to CC are more suitable. Normative theory is also applicable when an actor with own information would like to select an option from multiple options. Therefore, all the third theories can be used to explain farmers' adaptation decisions in theory-triangulation manner. As a researcher can view a research problem in two manners, i.e. inductive and deductive, firstly, we reviewed grand theories, as remarked above-mentioned, that can help us explain adaptation decision and secondly we reviewed determinants of farmers' adaptation decision-making in detail. As a result, we benefited from an inductive way.

This research assumed farmers as rational agents who can apply best strategy to make appropriate response under climate change. Based on descriptive theories, present study reviewed past field researches about farmers' decision-making under climate change and drought over the world. Finally, researchers' attempts to prescribe decision making model can be useful for empirical studies and action plans.

In the following sections, researchers surveyed literature to recognize the most important factors affecting farmers' adaptation decision-making, and to develop appropriate decision-making model.

Factors affecting farmers' adaptation decision-making

Cost-benefit analysis, cost-effectiveness analysis and multi-criteria analysis are widely used decision-making approaches in policy analysis when appraising projects. Cost-benefit analysis (CBA) and cost-effectiveness analysis generally uses economic variable, but multi-criteria analysis applies wide range of social, economic and cultural variables (Dittrich et al., 2016). Present study surveyed various research about farmer's decision-making under climate change. Based on multi-criteria analysis, economic, demographic, social, cultural, psychological, technological and ecological factors determine farmers' responses to environmental disasters like drought and climate change (Karali et al., 2011). According to Keshavarz and Karami (2014), cognitive aspects (such as prior values, beliefs and experiences) as well as individual's needs influence the farmers' decisions under drought. Therefore, management programs that do not consider the values, beliefs, previous farming decisions are less likely to be effective (Keshavarz & Karami, 2014).

A single adaptation option usually receives different attention and choice responses from various decision makers. With the same biophysical and socio-cultural situation, the selection likelihood of an alternative is

influenced by the characteristics of the specific decision maker and the relative values he or she attaches to the alternative (Ayele, 2008). Researches showed farm operation decision making is complex with many external and internal forces that influencing farm management (Reid, 2003). In this section, most important factors affecting farmers' decision-making, obtained from related studies reviewed.

Farmer (household) characteristics

Some factors that investigated in many studies as factors influencing farmers' decisions categorize as farmer (household) characteristics like age, education, gender, household/labor size, and farming experience (Ayele, 2008; Hisali et al., 2011).

Uddin et al., (2014) explained that factors including age, family size, farm size, education, family income and cooperative involvement are influential characteristics of farmers who adopt coping strategies to climate change effects.

Assets or economic factors

Farmers' assets like farm size and machineries along with access to credits that influence farm income and farmer's off-farm income play significant role to cope with CC effects like drought (Hisali et al., 2011; Sambodo, 2007; Van Tassel & Keller, 1991). These factors could have main function in perception of one's own capacity to adapt or self-efficacy that is important in farmers' adaptation (Frank et al., 2011).

According to Ajzen's Theory of Planned Behavior (TPB), Perceived behavioral control (PBC) is a person's opinion about the limitations that restrict the specific behavior, when the behavior is not wholly under volitional control of person (Chiou, 1998), it will be considered as perception toward adaptation obstacles. In fact, PBC is indirect measure of one's assets or financial capacity to respond an event.

Keshavarz et al. (2010) found socio-economic variables including farm size and in-

come have a significant role in farmers' decisions under drought. In addition, Grothmann and Patt (2005) argued that the farmers' responsive behavior to drought depend on their access to resources, and perceived capacity to respond.

According to Belay et al., (2017) the socio-economic models indicated that education, family size, gender, age, livestock ownership, farming experience, frequency of contact with extension agents, farm size, access to market, access to climate information and income were the key factors determining farmers' choice of climate change adaptation practices.

Based on Hassan and Nhemachena (2008) better access to markets, extension and credit services, technology and farm assets (labor, land and capital) are critical for helping farmers adapt to climate change. Government policies and investment strategies must support education, markets, credit and information about adaptation to climate change, including technological and institutional methods, particularly for poor farmers.

Perception of climate change

Farmers' adaptation and response to CC depend on their perception of CC and problems associated with it. If they do not view it as a serious threat then adaptation is less likely to happen (Mubaya et al., 2012; Reid et al., 2007). Understanding farmers' perception of CC and the amount of their damage is necessary to assist farmers in CC adaptation and promote their willing cooperation in programs that policy makers and managers planned for coping with CC (Patt & Schroter, 2008; Reid et al., 2007).

Research result of Patt & Schroter (2008) showed there are differences between farmers and policy makers' perception of CC. With respect to researches (Gandure et al., 2013; Mubaya et al., 2012; Rao et al., 2011), factors like psychological, social, cultural, political, institutional and agro-economic performance of crops influence farmers' perception of CC.

Attitude toward adaptation

For a long time, attitudes considered as important determinants of behavior (Bagozzi, 1981, Cited in Gorton et al., 2008). Results of socio-psychology researches revealed the importance of attitude in environmentally oriented behavior (Liu et al., 2010; Shojaei-Miandoragh et al., 2019; Valizadeh et al., 2018). Positive or negative attributes relative to an object or behavior automatically shape an attitude towards the object or behavior. Different attitudes lead to different behavior (Beedell & Rehman, 2000). Attitudes are useful in understanding why people make decisions and behave the way they do (Winter et al., 2005).

In the case of cognitive variables, Zarafshani et al. (2007) indicated that attitudes toward drought management and the perceptions of the severity of drought were important factors in coping with the situation that caused by the drought.

Perception toward adaptation obstacles

Obstacles reduce farmers' adaptation capacity and they are constraints to adaptation (O'Brien, 2009). Kolikow et al., (2012) divided adaptation obstacles in two categories: limits (absolute obstacles), that cannot be overcome, and barriers (mutable obstacles) that can be overcome. O'Brien (2009) argued in addition to technological, financial and institutional barriers, social and individual characteristics might act as barriers to adaptation. These characteristics can be objective and observable like behavior or subjective like values. If farmers think these obstacles are so much and they cannot overcome them, their adaptation activities will be less.

Social norm regarding adaptation activities

Public attitudes toward agriculture are important factors in farmers' decision-making process (Van Tassel & Keller, 1991). Adaptation to CC is a heterogeneous process, and it is shown that farmers' adaptive capacity is affected by not only economic and technological development, but also social norms,

values, rules and cultural barriers have influenced it (Nielsen & Reenberg, 2010). Farmers' social capital and resources could persuade adaptation to CC (Adger et al., 2003). Adger et al., (2009) argued limits to adaptation to CC are endogenous to society and emerge from inside of society. Anthropologists believe disruption of social cohesion reduces people's adaptive capacity and makes them less resilient to environmental stress (Grothmann & Patt, 2005).

Personal norms (subjective norms and moral norms)

Ajzen's Theory of Planned Behavior is a famous model in studying attitude-behavior relationship (Chiou, 1998; Gorton et al., 2008). According to this model, subjective norm along with attitudes and perceived behavioral control are three factors that influence intentions to perform specific behaviors. Subjective norms are a person's beliefs about social expectation from him/her to perform or not perform the specific behavior (Ajzen & Fishbein, 1980 cited in Gorton et al., 2008).

Contrary to the rational decision making theories (Reasoned Action Theory (RAT) (Ajzen & Fishbein, 1980) and Planned Behavior Theory (PBT) (Ajzen, 1991), Moral decision making approach (Norm Activation Theory (NAT) (Schwartz, 1970) and Value-Belief-Norms (VBN) Theory (Stern, 2000)) focused on moral variables such as moral norms (responsibility, justice) value (egoistic, altruistic and biospheric) orientations, moral obligation to next generations etc. Several researchers investigated the effect of subjective norms and moral norms on farmers' behaviors (Salehi et al., 2018; Valizadeh et al., 2018).

Results of other farmers' adaptations

Sambodo (2007) mentioned farmers' neighbors and their village colleagues as factors that could influence their decision-making processes. Research results of Keys & Chowdhury (2006) about factors encourage farmers to cultivate new crop showed com-

munity and neighbor engagement in this practice was the most important determinant. Observability and relative advantage of innovation are attributes that have significant role in adoption rate of innovation (Rogers, 1983 cited in [Leeuwis & Van Den Ban, 2004](#)). Neighbors can reveal these characteristics of adaptation activities for other farmers and influence on their adaptation.

Knowledge and information about climate change adaptation

Access to weather information plays a critical role in shaping farmers' perceptions of climate variability and change ([Mubaya et al., 2012](#)). People's right or wrong knowledge and information about their world shape their beliefs and these beliefs influence their behavior ([Beedell & Rehman, 2000](#)). [Stakhiv & Stewart \(2010\)](#) and [Raeisi et al. \(2018\)](#) argued the communication of information as a key success factor in water management decisions; moreover, information and knowledge for local adaptation must be considered as a public good and accessible to all people. Better access to information is a prerequisite for successful adaptation ([Stakhiv & Stewart, 2010](#); [Frank et al., 2011](#)).

According to [Bryan et al. \(2013\)](#) Farmers' perceptions of climate change are influenced by their observation and access to information. Therefore, Extension services can increase resilience to climate change.

Farmers' risk perception

One of the most important factors that affect farmers' decisions especially in facing the CC is their risk perception. [Grothmann & Patt \(2005\)](#) defined the relative risk perception as "the perceived probability of being exposed to CC impacts and appraisal of how harmful these impacts would be to things an actor values". There is a substantial amount of uncertainties in risks posed by CC and its consequences ([Barak, 2006](#)). This risk is more serious for smallholder farmers because these farmers usually have limited resources and manage multiple and complex

production systems ([Ayele, 2008](#)). Anthropologists that study peasant decision-making argued that farmers are generally more concerned with minimizing risks instead of maximizing profits ([Ludewigs, 2006](#)). Understanding the relationship between risk perceptions and behavioral decision-making is crucial when studying farmers' adaptation to climate change ([Barak, 2006](#)).

Farmers' motivation to adaptation

Empirical researches, up to now, mostly have neglected the importance of psychological determinants of adaptation such as motivation ([Grothmann & Patt, 2005](#)). Incorporating insights from motivation theory can improve theorization of adaptation activities. Motivation theories help to explain the underlying cognitive and psychological processes that drive actions ([Frank et al., 2011](#)). There are many motivation theories that can be useful in studying farmers' adaptation to CC. Such as Maslow's need hierarchy theory and Herzberg's two-factor theory.

Future perception of agriculture

Many of the rural poor don't expect good future for themselves in agriculture sector and agriculture is increasingly considered as a last resort activity that people do if everything else fails ([Leeuwis & Van Den Ban, 2004](#)). Surely, with these perspectives, farmers' efforts for improving their situation in agriculture sector (like adaptation activities) will be less. [Gandure et al. \(2013\)](#) argued the lack of interest in farming among the youth is one of the factors that discouraged the need for adaptation to CC. Farmers' future behavior is more based on their expectations rather than a precise assessment of the future of the agriculture sector ([Gorton et al., 2008](#)). By combining the socio-economic change and CC it is possible to evaluate the damage of future societies from CC ([Berkhout et al., 2002](#)).

This review of researches about farmers' decision-making show that there are many factors that influence farmers' decision making especially decisions related to CC adapta-

tion that has high level of uncertainty. To clear the relationship between these factors (concepts), a conceptual model of farmers' adaptation decision making will be present.

Farmers' decision-making model for adaptation to climate change

Decision-making is not only choosing among known alternatives, but a systematic process of sequenced steps that should be adaptable to the environment in which it is used (Roussel, 2011). Many researchers (Aegli et al., 2011; Ayele, 2008; Benowitz, 2011; Groves, 2005; Wang, 2011) have studied the decision making process. Regarding these studies, decision-making is unavoidable issue in every person's life; decisions can be different in regards of time spending on it or its importance in life. Everyone has some main purposes and values in life that affect the amount of consideration to different aspects of life.

Farmers' decision-making is a complex process, influenced by a large number of factors including exogenous factors, e.g. social, political, economic and biophysical, as well as endogenous factors, e.g. goals, values and characteristics of the farmers and their family (Reid, 2003). In the decision making process, there is an objective environment (like socioeconomic status) that affect people's mental processes (like believes and attitudes) and following these mental processes will cause individual behavior (like adaptation) (Sam-bodo, 2007). Among three main decision making theories, the *Descriptive theory* (also known as behavioral theory) is looking for how decision makers actually make decisions in real life and consider human real traits. It is suitable for studying individual behavior, moreover, the Theory of Planned Behavior is one of the famous models to predict human behavior and intention to behavior. With extending this model and review of literature about farmers' decision making especially in facing the CC, a conceptual framework is presented for studying farmers' adaptation to CC.

According to the conceptual framework there is an objective environment (such as farmers' (household) circumstances, economic factors, and information that is available to farmers) affecting mental processes for decision-making. Everyone has some incentives in life influencing the amount of consideration to different events and aspects of life such as perception to CC and risk perception of CC. In addition, these perceptions affected by farmers' characteristics, social & personal norms about adaptation and available information to farmers. These perceptions besides observation of other farmers' activities in facing the CC influence farmers' attitude toward different adaptation activities. Attitudes along with social & personal norms, perception about obstacles, farmers' characteristics and their knowledge and information about CC will affect farmers' decisions, which mitigate adverse impacts of CC or take advantage of its opportunities.

CONCLUSION

Despite growing literature on the climate change impacts on agricultural sector, there are still few researches that focus on social-cultural impacts of climate change. The majority of the studies analyzing the climate change impacts on crop yields, most studies assess the impacts of climate change on water resources, and the economic impacts of climate change on rural communities are dominant points of researchers and policy makers.

While assessing the impacts of climate change on environment is imperative, conducting research on the adaptive responses to climate change is also important. There are few empirical studies about farmers' adaptations to climate change, and one of the affecting factors is the lack of comprehensive model to assess farmers' perception and behaviors under climate change condition. To fill the knowledge gap it is necessary to understand the processes of farmers' decision-making and adaptation to climate change, and to develop an appropriate model based

on decision-making theories to apply in field studies. In this regard, the present study first reviewed dominant decision-making theories (Normative, descriptive and prescriptive), then based on a triangulation vision strived to formulate a decision making model for better understanding of farmers' response under environmental disasters. Farmers' decision-making model that presented in this paper could be a useful tool for policy makers as well as researchers who were interested in studying farmers' behavior in climate change situation.

There are several ways for governments and organizations to assist farmers to adapt to CC such as enhanced communication of climate-related information or the development of insurance networks (Grothmann & Patt, 2005), but indubitably the first action of these organizations should be the correct understanding of farmers' situations, perceptions and other factors that affect their decision making. This proper understanding is prerequisite for suitable policy making and protective programs aimed at helping farmers and conducting their behaviors into the appropriate direction.

Consideration to cultural and social factors along with economic and environmental factors in the study of farmers' adaptation to climate change should be taken into account, moreover with a holistic perspective as far as possible, problems from the farmer's view point should be analyzed.

In addition, the effects of climate change on poor families and small-scale farmers' decision making with minimal adaptive capacity needs to be recognized. These farmers are very vulnerable and have not high ability to respond to climate change effectively. Therefore, there is a need to understand their decision-making process so that how can it decrease pressures on poor and marginal famers.

Another point that could be considered by researchers is that most studies on climate change has been restricted to a specific region. It can be useful to make comparative

studies that compare the effects of climate change on different regions and farmers' adaptation to these challenges.

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