

Farmers Prone to Drought Risk: Why Some Farmers Undertake Farm-Level Risk-Reduction Measures While Others Not?

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Abstract This research investigates farmers' cognitive perceptions of risk and the behavioral intentions to undertake farm-level risk-reduction measures. It has been observed that people who are susceptible to natural hazards often fail to act, or do very little, to protect their assets or lives. To answer the question of why some people show adaptive behavior while others do not, a socio-psychological model of precautionary adaptation based on protection motivation theory and trans-theoretical stage model has been applied for the first time to areas of drought risk in the developing countries cultural context. The applicability of the integrated model is explored by means of a representative sample survey of smallholder farmers in northern Ethiopia. The result of the study showed that there is a statistically significant association between farmer's behavioral intention to undertake farm-level risk-reduction measures and the main important protection motivation model variables. High perceived vulnerability, severity of consequences, self-efficacy, and response efficacy lead to higher levels of behavioral intentions to undertake farm-level risk-reduction measures. For farmers in the action stage, self-efficacy and response efficacy were the main motivators of behavioral intention. For farmers in the contemplative stage, self-efficacy and cost appear to be the main motivators for them to act upon risk reduction, while

perceived severity of consequences and cost of response actions were found to be important for farmers in the pre-contemplative stage.

Keywords Drought · Risk perception · Protection motivation theory · Transtheoretical model · Adaptation

Introduction

As in other sub-Saharan Africa countries, rain-fed agriculture is the dominant source of food production, employment, and income for the majority of the rural poor in Ethiopia. The agriculture sector contributes about 40 % of the gross domestic product and provides 85 % of employment for about 90 % of rural peoples' income (Diao 2010). The nature of Ethiopia's rain-fed agriculture is often unpredictable. As a result, food production is very vulnerable to the influence of adverse weather conditions such as drought. Von Braun (1991) reported that in Ethiopia, a 10 % decrease in rainfall below the long-term average results in a 4.4 % decrease in national crop production. Davies et al. (2009) claimed that the high dependence on subsistence agriculture means the impact of stresses and shocks (such as droughts) are felt keenly by rural poor people who directly depend on food system outcomes for their livelihoods. Tesfaye et al. (2011) and Mohammed and Inoue (2013) similarly reported rural farmers' local level dependency on agriculture and other natural resources.

Ethiopia's heavy reliance on rain-fed agriculture and existence of recurrent drought have been the main causes of food shortages and household food insecurity. Drought is the single most important climate-related natural hazard impacting on the country. In the past 15 years, the country has been hit by climate-change-induced disasters about 15

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times (FAO 2010). Drought impacts are usually first apparent in agriculture. According to the World Bank (2005), droughts can lower household farm production by up to 90 % of a normal year's output. Dercon and Hoddinott (2003) also reported that drought shocks have had a persistent negative effect on economic growth in Ethiopia. Both the spatial coverage and frequency of droughts have increased in the past decades causing significant economic losses and adverse social consequences (Demeke et al. 2011; Lautze et al. 2003).

The northern highlands of Ethiopia are known to be a recurrent victim of drought and famine. Drought is frequent due to large inter-annual variability, abnormally low and untimely rainfall (Gissila et al. 2004). Even if the rains commence at the right time for farmers, this cannot guarantee a drought-free season (Gebrehiwot et al. 2011). Change in climate is generally recognized as one of the most important challenges facing society today. Recent studies reveal that Africa's agriculture, upon which majority of the rural poor rely as main livelihood support, is one of the sectors that are negatively affected by changes in climate (IPCC 2007; McCarthy et al. 2001; Onyeneke and Madukwe 2010; Pearce et al. 1996). In Ethiopia, the recurrent cycles of changes in climate and drought make agriculture more risky and problematic. As a result, the rural poor are forced to depend on food aid and social welfare.

In order to reduce the negative consequences of expected changes in climate, farm-level adaptation is recognized as one policy option to reduce the negative impacts of climate change in this sector (Adger et al. 2003; Kurukulasuriya and Mendelsohn 2006). The IPCC (2001) refers to adaptation as "changes in processes and practices to moderate potential damages or to benefit from opportunities associated with the changes in climate." Similarly, DFID (2006) defines adaptation as "an adjustment in response to perceptions of vulnerability with intent to reduce the risks posed by climate change to the farming operation, livelihoods, and people's lives."

Accordingly, adoption of technological innovations in agricultural has become a key focus of the scientific and policy-making communities. Farmers' adaptation to climate change and variability has attracted researchers across different disciplines. As a result, a considerable volume of research work has been devoted to the adaptive behavior of farmers and its determining factors (Below et al. 2012; Bryan et al. 2009; Deressa et al. 2009; Gebrehiwot and van der Veen 2013b; Hassan and Nhemachena 2008). So far, the studies on farmers' perception of climate variability and barriers to adaptation have been almost exclusively restricted to socio-economic factors and resource constraints. However, the cognitive and psychological barriers to adaptation so far have been largely neglected, especially in the developing countries cultural context.

Adoption of technological innovations has been a major area of focus in Ethiopia. However, different drought-prone farmers show differences in their level of adaptation measures in agriculture from almost none to extensive. It has been observed that people who are susceptible to natural hazards often fail to act, or do very little, to minimize their risk of death, injury, or property damage (Kunreuther 1978; Peek and Mileti 2002) as cited in Grothmann and Reusswg (2006). Different factors could cause people to carry out risk-reduction measures against potential risks. Personal experience with risk, lack of reliance upon protection measures or perceived ability to carry out these measures, or costs of response actions are seen as the main important factors. To answer the question 'why some people show adaptive behavior while others do not?', a socio-psychological model of precautionary adaptation based on protection motivation theory (PMT) and trans-theoretical stage model (TTM) has been applied (Rogers 1983).

The main objective of this research is to investigate farmer's cognitive perception of risk and the behavioral intention to undertake farm-level risk-reduction measures against drought and identify those triggers that should be used to effectively communicate drought risk. We build up our research on the works of Martin et al. (2007) and Bočkarjova et al. (2008, 2009). But we have extended the model by including some selected socio-economic factors and resource endowments that are believed to have influence on adaptation in agriculture. To the best of our knowledge, these conceptual ideas have not been applied to the area of drought risk. Moreover, studies applying PMT to natural hazards in the context of developing countries are non-existent. Most of the studies are limited to the European and United States cultural setting (Grothmann and Reusswg 2006). Thus, testing the applicability of the integrated PMT-TTM model to drought risk in the Ethiopian cultural setting is one of the innovations of our research.

Theory of Risk Perception

Risk perception is a topic of substantial interest, both to academics and to policy makers. According to Slovic (2000), risk perception is considered as the intuitive judgment of individuals and groups of risks in the context of limited and uncertain information. It is the subjective assessment of the likelihood of a specified type of threat happening and how worried people are with the consequences. Knowledge about risk perception of natural hazards may provide vital information about individual decisions to take protective actions and public support for governments' risk reduction (Botzen et al. 2009). Hence, evaluations of the likelihood, as well as the consequences of a negative outcome, are important to perceive risk.

Currently, two main theories dominate the field of risk perception. One is the psychometric paradigm, while the other originates from cultural theory. Under the psychometric paradigm (Slovic 1987), people tend to make quantitative judgments about the current and desired level of riskiness. One of the main assumptions within the psychometric approach is that risk is inherently subjective. On the other hand, cultural theory is fundamentally a social theory concerned, first, with relationships among human beings and, secondly, with societal relationships with nature (Legesse and Lars Drake 2005). Based on this literature, risk perceptions influence risk acceptance and attitude and this, in turn, influences the formation of individual decision making associated with risk. Hence, in a more refined theoretical framework for the analysis of risk perception, risk communication and change in behavior or intention, as a result of risk communication, are vital. Moreover, understanding the main factors that trigger individuals to protect themselves when faced with the risks can aid policy makers in their decision making.

The Integrated Theory of PMT and TTM Model

In the past two decades, the question of why individuals choose to mitigate or ignore risk has been a topic of much research in areas for natural- and human-caused risks. Accordingly, there is an established body of literature devoted to health behavior models, such as the above-mentioned PMT and the TTM in decision stage theories.

PMT is among the four key theories within the domain of psychological research on health behavior reviewed by Weinstein (1993). PMT was originally developed to explain the effects of fear appeals on health attitudes and behaviors (Rogers 1975). A review of literature on PMT by Rogers and Prentice-Dunn (1997) indicated that it had been applied to a number of threats, the majority being health-related threats. Beyond health-related issues, it has been applied to natural hazards (e.g., flooding, wildfire, earthquake preparedness). Martin et al. (2007), Bočkarjova et al. (2009), Grothmann and Patt (2005), Kuruppu and Liverman (2011), Bubeck et al. (2013), and Mankad et al. (2013) are among the few researchers who applied PMT in the context of natural hazards. PMT has been applied to predict and understand protective behavior. Thus, this theory involves a threat for which there is an effective recommended response that can be carried out by the individual. PMT provides an important social cognitive account of protective behavior (Rogers 1983). Moreover, PMT provides a much more elaborate framework for understanding human behavior, overcoming many of the theoretical problems that lead to low correlations between perceptual variables and behavior (Grothmann and Reusswg 2006).

PMT consists of two underlying cognitive mediating processes that cause individuals to adopt protective behaviors when faced with a hazard (Rogers 1983; Rogers and Prentice-Dunn 1997). These are the threat-appraisal process and the coping-appraisal process. Protection motivation is a key mediator of the relationship between behavior and threat and coping appraisal (Milne et al. 2000). Assessments of threat and coping factors combine to form the intervening variable protection motivation. The two cognitive mediating processes are sequential. Individuals must first believe that a threat applies to them (threat appraisal) before considering preventive behaviors (coping appraisal) (Neuwirth et al. 2000). Threat appraisal evaluates the perceived probability of harm occurring and the perceived severity of this harm (Arthur and Quester 2004). The threat-appraisal process comes first, since individuals must first perceive a threat before there can be an evaluation of the adaptive options. Thus, it is important to note there is a risk and this risk is admitted to pose a threat to the individual in question.

The PMT variables that capture the threat-appraisal process comprise the perception of a threat (perceived severity of hazard and vulnerability to hazard) and the maladaptive response rewards (extrinsic and intrinsic rewards). Perceived vulnerability assesses how personally susceptible an individual feels to the threat. Perceived severity is the individual's personal appraisal of how harmful the consequences of the threat would be to his or her own life or assets (Grothmann and Patt 2005). According to Milne et al. (2000), the higher the perceived threat, the more probable the individual is to be motivated to protect himself or herself, that is, the more likely a behavioral intention to adopt a protective behavior will be formed. In contrast, adoption of a self-protective behavior tends to decrease by extrinsic and intrinsic rewards (Neuwirth et al. 2000).

The second process of coping appraisal, on the other hand, evaluates the perceived ability to undertake the coping behavior, as well as the perceived effectiveness of the coping responses to prevent the threatened hazard (Arthur and Quester 2004; Maddux and Rogers 1983). Coping appraisal comes after the risk perception process. It only starts if a specific threshold of threat appraisal is exceeded (Schwarzer 1992).

Response efficacy and self-efficacy are the main important efficacy variables comprising the coping-appraisal process. The perceived cost of protective action is an additional factor within the coping appraisal. According to Floyd et al. (2000), response efficacy is the belief that the adaptive response will work, that is the belief that the alternative protective measures are effective in reducing a certain risk.

Self-efficacy is the perceived ability of an individual to undertake the recommended coping or adaptive responses. In other words, self-efficacy indicates whether an individual feels able to actually implement a certain risk-reduction measure. Perceived response costs of actions are any costs (such as monetary, time, or effort) associated with undertaking the adaptive coping response. Thus, perceived response costs concern beliefs about how costly performing the recommended coping response will be to the individual. Different studies confirmed that people's adoption of risk adjustments is related to the perceived cost of adjustments (Fothergill and Peek 2004; Lindell and Perry 2000; Peacock et al. 2005). The cognitive perceptions (vulnerability, risk severity, and efficacy) can enhance the persuasive effects of a risk communication strategy that elicits protection motivation (Martin et al. 2007). High perceptions in risk vulnerability, severity, response efficacy, and self-efficacy will increase the likelihood of undertaking adaptive responses, while perceived response costs of self-protective actions will decrease the likelihood of undertaking the adaptive response (Mulilis and Lippa 1990; Rustemli and Karanci 1999).

The outcome of these two cognitive mediating processes would lead to either adaptation or mal-adaptation. If the individual chooses a protective response, he or she first forms an intention or decision to take preventive action. This is labeled as protection motivation (Grothmann and Reusswg 2006). Generally, protection motivation is synonymous with the intention to perform behavior. PMT hypothesizes that the motivation to protect oneself from a threat or hazard is a positive linear function of the cognitive beliefs where individuals perceive that the threat is severe; the individual is vulnerable to the threat; the recommended coping measure is effective in averting the threat or hazard; and the individual is able to undertake the recommended coping measures. In contrast, PMT is a negative linear function of the belief that the perceived costs of the recommended coping responses would be high (Milne et al. 2000; Neuwirth et al. 2000; Plotnikoff and Higginbotham 2002).

The trans-theoretical model (TTM) has been used in a parallel stream of research in decision stage theories to examine health behavior change based on the assumption that a set of variables will influence different people in different ways (Horwath 1999). Prochaska and Velicer (1997), set up a TTM model as a stage-based theory of behavior change. According to Norcross et al. (2011), this behavioral change is conceptualized as a process that unfolds over time and involves progression through six stages of what is called 'successful self-change' or the degree of readiness to act upon threat or hazard. Thus, a decision stage represents a state in a behavior change process that is qualitatively psychologically distinct from

another state (Aveyard et al. 2009). Stage theories specify an ordered set of categories into which people are classified (Martin et al. 2007). Based on this categorization, one can identify the factors that can explain how to effectively communicate with each sub-group (Weinstein et al. 1998). The stages are pre-contemplation, contemplation, preparation, action, maintenance, and termination. Prochaska et al. (1994) described that people are assigned to one of these six stages based on their behavior and intentions to undertake risk-mitigating actions. However, only the three decision stages (pre-contemplation, contemplation, and action) are frequently used in empirical studies (Block and Keller 1998; Bočkarjova et al. 2009; Martin et al. 2007). According to Block and Keller (1998), individuals in the pre-contemplation stage are not thinking about or intending to change behavior in the foreseeable future; an individual enters the contemplation stage when he/she acknowledges a problem exists and then thinks to change a particular behavior; and the action stage is a stage where individuals start modifying their behavior in order to overcome the threat.

Martin et al. (2007) argued that the two streams of research do not separately provide the condition under which one can determine what will motivate an individual (a farmer in our case) to move from one decision stage to the other. Individuals at different decision stages (TTM) are differentially influenced by the PMT variables of vulnerability, risk severity, and perceived costs of responses actions. For instance, in our case, individual farmer's perceived level of drought risk severity influences his/her degree of readiness or willingness to move through the stages of pre-contemplation, contemplation, and action stages in order to mitigate drought risk. Hence, integrating the PMT-TTM model can provide a more complete picture of the cognitive and motivational process that individuals go through in the different decision stages to mitigate risks (Martin et al. 2007). The integrated PMT-TTM model provides us the advantage to clearly identify stage-specific determinants of motivation for protective behavior (Bočkarjova et al. 2009). Furthermore, the integrated model describes what risk variables are most effective at motivating individuals in the various decision stages. Thus, this methodology not only provides explanation for individual engagement into protective behaviors, but also lends itself to extract implications for influencing individuals in performing desirable protective behaviors (Bočkarjova et al. 2009). A review of literature on health behavior showed that factors, such as perceived self-efficacy, response efficacy or risk severity, or perceived vulnerability, are the main predictors that can produce a transition between the decision stages (Block and Keller 1998; Duan et al. 2011; Lindell and Prater 2002; Martin et al. 2007).

Research on risk behavior has indicated that the perception of vulnerability among the pre-contemplatives proves effective to make them move to the contemplative stage, while strengthening the perception of severity of threat would motivate contemplatives to turn to action (Bočkarjova et al. 2009; Martin et al. 2007). Individuals at more active stages are stimulated by the variables influencing coping appraisal. Improved response efficacy and the perception of self-efficacy would help those who are already found in the action stage remain engaging in protective behaviors. Thus, the integrated PMT-TTM approach to influencing personal behavior also should prove suitable for our study in the Ethiopian highlands cultural context where we expect varying motivations to exist. In summary, we aim to test the following hypotheses: self-efficacy and response efficacy are the main predictors of behavioral intention for farmers in the action stage; farmers in the contemplation stage would be predicted by perceived risk severity and vulnerability; increasing perceived vulnerability is a key predictor for farmers in the pre-contemplation; and high level of subjective knowledge about drought hazard would lead to higher motivation to carry out farm-level risk-reduction measures.

Method

We focused on smallholder farmers located in the northern highlands of Ethiopia, the most severely affected region in the well-known famines of 1971–1974 and 1983–1984. Accordingly, the data for this study are derived from a household survey conducted in three villages of *Hintalo wajirat* District in the southern part of Tigray Region. The *Hintalo Wajirat* District has latitude between 12°54'00" and 12°22'00" North and longitude between 39°17'30" and 39°46'00" East. It covers a total land area of 1,933 square km. The altitude ranges from 1,400 to 2,700 m above sea level. Agro-ecologically the district is characterized as an arid zone comprising three agro-ecological zones: *Kolla* (<1,500 masl), *Weina-Degua* (1,500–2,300 masl), and *Degua* (>2,300), which constitute 13.75, 63.75, and 22.5% of the total area coverage, respectively. Agriculture is the dominant source of livelihood for the majority of smallholder farmers.

Compared to most other parts of the Tigray Region, the district has been most severely affected by recurrent drought events and is among the most drought-prone and chronically food insecure districts identified by the regional government. Most smallholder farmers here face sizeable food deficits every year and are vulnerable to recurrent drought shocks. The southern parts of Tigray receive much less rainfall than other parts of the region (Gebrehiwot et al. 2011). Recent studies further reveal that the southern parts of Tigray, including *Hintalo Wajirat*, show a short-

and long-range tendency for drought risk and are most likely to suffer from drought (Gebrehiwot et al. 2011; Tonini et al. 2012). Accordingly, crop failure due to recurrent cycles of drought is common, and farmers in the district remain vulnerable to the vagaries of weather. Furthermore, Gebrehiwot and van der Veen (2013a) studied the climate vulnerability situation of districts in Tigray region using important socio-economic and bio-physical indicators and labeled the study district, *Hintalo Wajirat*, as the most vulnerable. Hence, the district was selected purposefully as it suits to the focus of the study.

The research design was based on multi-stage sampling techniques to draw the samples. In the first stage, three villages were randomly selected from the sample of *woreda*. In the second stage, random sampling techniques were used to draw the sample of smallholder farmers. A sample frame acquired from the village administration was used to sample the required number of farmers from each village. Accordingly, a total of 240 smallholder farmers were randomly selected from the three villages.

To generate the required data, a structured questionnaire was adapted from Bočkarjova et al. (2009) to suit to drought risk and administered with smallholder farmer's being the unit of analysis. The survey captured information about farmers' drought risk perceptions (perceived vulnerability and severity); self-efficacy; reliance on adaptation measures; costs of self-protective behavior; subjective knowledge; trust in government; and intention for adaptation measures. Respondents were asked to rate their opinion answers on a seven-point Likert scale for the majority of the questions (Table 1). Furthermore, the questionnaire captured sample respondents' socio-economic variables including age; gender; education; farm size; and, asset ownership, particular livestock ownership. Two field assistants who served in similar socio-economic surveys were recruited and trained to work with the questionnaire. The questionnaire was tested prior to the actual fieldwork commencing, and the actual household survey was conducted in the three villages during August to September in 2013.

Measures

Risk perception, self-efficacy, response efficacy, and trust measures are used in this study as independent measures. According to Martin et al. (2007), perceived vulnerability and risk severity are considered as the main important risk perception measures in the PMT literature.

Renn (1992) handles the term risk as "the likelihood that an adverse effects may occur as a result of natural events or human activities." Risk vulnerability is defined as "the probability of harmful consequences or expected loss to property and life if there is no change in behavior" (Canali and Slaviero 2010; Martin et al. 2007). Howden et al.

(2007) claimed that perceived vulnerability and concern about climate-related hazards (such as drought) that impact on agricultural livelihood are hypothesized to be a critical arbiter of farmer support for adaptive and mitigation action. In this study, six items measuring constructs of concern about perceived risk vulnerability are used. Accordingly, farmers were asked to indicate “how vulnerable do you feel when you think that you and your family will suffer (loss of productive asset and lives) as a result of severe drought risk” on a seven-point Likert scale anchored (1 = not vulnerable to 7 = very vulnerable). These six measures were combined into a composite measure of risk vulnerability with a Cronbach’s alpha reliability coefficient (α) of 0.68, indicating an acceptable level of internal consistency. In general, this varies by discipline. Nunnally (1967) recommended 0.50 to 0.60 for the early stages of research, 0.80 for basic research tools, and 0.90 as the minimal tolerable estimate of α coefficient. Nunnally further stated that what a satisfactory level of reliability is depends on how a measure is being used. Recent studies on applications of PMT on adaptation behavior, such as Mankad et al. (2013) and Martin et al. (2007) used Cronbach α of 0.6 as an acceptable level of internal consistency coefficient. By the same analogy, the coefficient $\alpha = .68$ is considered as a modest reliability as the concept is new to respondents in the research context.

Risk severity is defined as “the amount of hardship that would occur if one experienced the risk”. Smallholder farmers were asked to indicate their perceived personal risk severity and this was measured using 7-point Likert scales by asking “how serious do you feel the consequences of severe drought are to you and your family” anchored by 1 = not at all serious/no damage at all to 7 = very serious/disastrous ($\alpha = 0.811$).

Floyd et al. (2000) defined self-efficacy as “the perceived ability of the person to actually carry out or not carry out the adaptive response”. Thus, self-efficacy is the main component of the PMT model and is believed to be an important influencing variable in motivational, cognitive and affective processes (Bandura 1992; Snipes et al. 1999). The measures of self-efficacy were developed based on measuring how confident respondents felt about their ability to protect their productive assets and themselves from drought risk. Respondents were asked “how confident do you feel in general about your ability to protect yourself and your productive assets from severe drought risk” as well as “how confident do you feel you can perform the following risk reduction behaviors” anchored by 1 = not confident to 7 = very confident. These 16 measures were combined into a composite measure of self-efficacy with a reliability scale of $\alpha = 0.936$. Similarly, response efficacy concerns beliefs about whether a proposed coping response will be perceived to be effective in reducing threat to the

individual (Milne et al. 2000). It is generally believed that the stronger the individuals’ belief that a coping response prevents a risk, the stronger the intention to adopt the risk-reduction measures (Arthur and Quester 2004). Respondents were asked to rate the effectiveness of drought risk-reduction measures by asking “how effective are the following precautions at helping to reduce and possibly prevent the consequences of drought impacting your crop harvest, livestock, and your life.” Consequently, 13 drought risk-reduction measures were presented and each item was anchored by 1 = not at all effective and 7 = very effective. These 13 measures were combined into a composite measure of response efficacy. The reliabilities of the response efficacy scales were $\alpha = 0.94$, indicating a highly acceptable level of internal consistency.

Additional measures, such as perceived costs of response actions, subjective knowledge, and intrinsic rewards, were included in the study as important variables that motivate people to carry out risk-reduction measures against drought. According to Prokopy et al. (2008), agricultural conservation practice adoption has positive

Table 1 Description of key explanatory variables

No.	Variables	Description	Coding
1	Perceived vulnerability	Respondents’ perception of how vulnerable do they feel to drought risks	7-point Likert scale
2	Perceived severity	Respondents’ perception of severe drought consequences	7-point Likert scale
3	Perceived self-efficacy	Respondents’ perception of own ability to actually implement specific risk-reduction measures	7-point Likert scale
4	Perceived response efficacy	Respondents’ perception on the effectiveness of a specific precaution	7-point Likert scale
5	Intrinsic reward		
6	Subjective knowledge	Respondents’ perception of how well informed do they consider themselves about drought risks	7-point Likert scale
7	Age	Age of the household head in years	In years
8	Household size	Size of the household in numbers	
9	Education	Number of years of schooling	
10	Farm size	Field area in local units of measurement	
11	Livestock ownership	Measured in terms of Tropical Livestock Units (TLU)	TLU

TLU is an index number that aggregates the different types of livestock a household owned to a single number. It is calculated using the following weighing index factors from ILRI (1990): Ox = 1.10, cow = 0.8, sheep and goats = 0.09, donkey = 0.36, horse and mule = 0.8

associations between awareness of environmental problems, attitudes toward potential measures, and the willingness to adopt those measures. Thus, when situations are perceived as problems, then attitudes regarding potential precaution measures are more predictive of behavioral change (McCown 2005). Accordingly, the sampled farmers were asked to indicate their personal perception on subjective knowledge (4 measures), intrinsic rewards (3 measures), and cost (3 measures) on a seven-point scale. The reliabilities of these measures were $\alpha = 0.70$, 0.86, and 0.74 for perceived costs of response actions, subjective knowledge, and intrinsic reward, respectively.

The dependent measure is farmer's behavioral intention to adopt farm-level risk-reduction measures. According to Dercon (2002), farmers in the highlands of Ethiopia have a variety of strategies both to prepare for drought shocks (risk management strategies) and to respond to recurrent environmental calamities (risk coping strategies). Risk management refers to the process that involves confronting risks and coping with their effects (ex post risk management). Patt and Schroter (2008) defined risk management as the process of taking protective actions to improve expected welfare by reducing the likelihood or severity of future risks. These strategies can also be categorized into household and social risk management strategies. According to Siegel and Alwang (1999), household risk management refers to the set of mechanisms used by households to deal with expected or actual losses associated with uncertain events and outcomes, while social risk management strategies comprise policies and programs that help poor households manage risks.

Household risk management strategies include asset accumulation; diversifying income sources; partaking in risk-sharing networks; and adoption of low-risk activities (Gray and Muller 2012). Rural poor farmers in the highlands of Ethiopia prepare for drought by accumulating livestock, planting drought-tolerant crops and partaking in traditional risk-sharing networks, such as 'Equb' (Dercon et al. 2008; Little et al. 2006), and accessing publicly available food aid and food-for-work programs (Caeyers and Dercon 2008; Ezra 2001) as cited in Gray and Muller (2012). Irrigation, water harvesting schemes, conserving and managing natural resources, participating in voluntary resettlement programs, and accessing productive safety net programs are the main public-level risk-mitigation strategies in Ethiopia (Deressa et al. 2011). In this paper, 13 questionnaire items for reducing or mitigating drought risk in agriculture were included in the study. According to Martin et al. (2007), the primary measure of adaptive coping was the intentions of smallholder farmers to change from not undertaking any risk-reduction behaviors to undertaking a set of behaviors. Thus, the dependent measure is the number of risk-reduction measures that

smallholder farmers have undertaken or intend to undertake to protect his/her productive asset and lives from severe drought risk.

Adaptation against drought risk was measured by asking smallholder farmers to report whether they had carried out farm-level soil conservation structures; use fertilizer and improved seeds; use drought-tolerant crop varieties; change the cropping and planting dates; apply self-insurance through saving; adopt early maturing crop varieties; diversify income sources (livelihood diversification); use irrigation; adopt different water harvesting schemes; use drought resistant livestock varieties; build productive assets; and/or partake in resettlement programs. These were measured using a 5-point Likert scales (5 = already done, 4 = will do next month, 3 = will do in 3–6 months, 2 = will do within the next year, and 1 = probably will not do). The 13 risk-reduction behaviors were combined into a composite behavioral intention measure with a reliability of $\alpha = 0.654$.

For other demographic variables, respondent age was measured in years and gender was measured as a dichotomy (Male = 1, Female = 2). With regard to sex differences, researchers argue that traditional divisions of labor account for higher levels of environmental concern among women (Kellstedt et al. 2008). Farm size was measured as less than or equal to 0.25 ha (=1), 0.26–0.50 ha (=2), 0.56–0.75 ha (=3), 0.76–1 ha (=4), and above 1 ha (=5). Education was measured by the number of schooling years. Studies indicate that perceived asset ownership is a factor that appears to play a large role in judging the seriousness of outcomes (Patt and Schroter 2008). Little et al. (2006) similarly reported that asset endowments (social and economic) largely determine a household's or individual's future capacity to earn income and withstand shocks. Accordingly, livestock ownership, which is the main productive asset in rural Ethiopia, is considered in the study.

Decision Stages

In this study, three stages of the PMT-TTM model are considered, which are similar to Martin et al. (2007) and Bočkarjova et al. (2009). The sampled smallholder farmers were categorized into the stages based on the actual number of adaptation strategies that were adopted to reduce the consequences of drought risk. Based on Martin et al. (2007), a frequency distribution was run on categories for the composite actual behavior measure. The resulting trimodal distribution was used to categorize respondents into 'pre-contemplatives,' 'contemplatives,' and 'action' smallholder farmers. As a result, 66 farmers were categorized as pre-contemplative; 78 as contemplative; and 96 as action. A farmer was categorized as being in the "Action" stage, if he or she had already adopted eight or more

adaptation measures. A person was categorized as ‘Pre-contemplative,’ if he or she had five or more behaviors that they answered as “will not do.” All those who did not fall into the ‘Action’ or the ‘Pre-contemplative’ categories were classified as ‘Contemplatives’.

Results

Descriptive Results

Profile of the Sample Smallholder Farmers

Table 2 below shows the socio-economic characteristics of the smallholder farmers. The average age of the sample farmers is 41.76 year. Similarly, the average family size is found to be 5.40 persons with no major significant difference across the three study villages. Regarding the level of education, about 56.3 % of the sample farmers had no

education. 31.3 % of the farmers surveyed had 1–6 years of schooling, while 12.4 % of the farmers had above 6 years of schooling. Data on farm size indicate that the average land holding for sample farmers is 0.56 ha. About 26.3 % of the surveyed farmers have farm size of 0.25 ha, while only 8.3 % have above one hectare. A majority of the farmers (47.1 %) have farm sizes that range between 0.25 and 0.75 ha. The data indicate that the average size of livestock holding for the surveyed smallholder farmers was found to be 2.74 Tropical Livestock Unit (TLU). Out of the total surveyed farmers, 30.4 % did not have any oxen, 23.8 % had only one ox, 38.3 % had two oxen, and 7.6 % had three and above.

Table 3 presents the summary statistics of the PMT variables across the three decision stages. As illustrated in Table 3, the majority of the independent and dependent measures used in PMT-TTM model have significant statistical difference between the three decision stages, while intrinsic reward is not different statistically.

Table 2 Sample households selected characteristics

Variables	Village							
	Feker Alem		Ara Alemsegeda		May-Nebri		Total	
	Freq	%	Freq	%	Freq	%	Freq	%
Age								
20–30	12	14.1	24	34.3	8	9.4	44	18.3
31–40	41	48.2	23	32.9	23	27.1	87	36.3
41–50	19	22.4	17	24.3	25	29.4	61	25.4
51–60	8	9.4	5	7.1	19	22.4	32	13.3
Above 60	5	5.9	1	1.4	10	11.8	16	6.7
Household size								
3 and less	15	17.6	20	28.6	13	15.3	48	20.0
4–6	47	55.3	29	41.4	43	50.6	119	49.6
7–9	22	25.9	20	28.6	25	29.4	67	27.9
10 and above	1	1.2	1	1.4	4	4.7	6	2.5
Gender								
Male	51	60	46	65.7	64	75.3	161	67.1
Female	34	40	24	34.3	21	24.7	79	32.9
Education								
Can’t read & write	52	38.5	43	31.9	40	29.6	135	56.3
1–6 years of schooling	27	36	21	28	27	36	75	31.3
7–8 years of schooling	6	40	3	20	6	40	15	6.2
9–10 years of schooling	0	0	3	25	9	75	12	5
Above 10 years of schooling	0	0	0	0	3	100	3	1.2
Farm size								
≤0.25 ha	23	27.1	19	27.1	21	24.7	63	26.3
0.26–0.5 ha	28	32.9	23	32.9	26	30.6	77	32.1
0.51–0.75 ha	13	15.3	12	17.1	11	12.9	36	15.0
0.76–1 ha	15	17.6	10	14.3	19	22.4	44	18.3
Above 1 ha	6	7.1	6	8.6	8	9.4	20	8.3

Table 3 Descriptive statistics of dependent and independent variables

Measures	Pre-contemplative stage		Contemplative stage		Action stage		Total sample	
	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
Behavioral intention	3.21	0.242	2.87	0.174	2.32*	0.296	2.74	0.447
Vulnerability	4.28*	0.433	4.53	0.450	4.83	0.347	4.58	0.464
Drought risk severity	3.43*	0.559	3.79	0.427	4.26	0.282	3.88	0.541
Self-efficacy	4.11*	0.515	4.44	0.726	5.21	0.619	4.66	0.783
Response efficacy	4.19*	0.342	4.91	0.527	5.43	0.495	4.92	0.684
Subjective knowledge	4.54*	0.549	4.83	0.551	5.35	0.494	4.96	0.625
Cost	5.12*	0.638	4.96	0.679	4.72	0.668	4.91	0.681
Intrinsic reward	5.42	0.467	5.45	0.486	5.78	0.463	5.57	0.499
Total observation	66		78		96		240	

* Statistically different at probability levels of 1 %

A Spearman correlation analysis was run to investigate the associations between variables included in the PMT model and the composite behavior intention to undertake risk-reduction measures. The result showed that all the associations are in the hypothesized directions. Consistent with PMT, perceived vulnerability and severity, self-efficacy, and response efficacy correlated positively with behavioral intention to undertake farm-level adaptation measures. Perceived costs of response actions correlate negatively with protective response. Other variables, such as farm size and asset ownership, correlate with the intention to undertake risk-reduction measures. Moreover, problems of high multicollinearity were not observed between the variables. Only both self-efficacy and response efficacy measures were found to be relatively high correlated ($r = 0.56$) with subjective knowledge which is expected.

Regression Results

Guisan et al. (2002) reported that an important statistical development of the last 30 years has been the advance in regression analysis provided by generalized linear models (GLMs). GLMs have been extensively applied in social science research since their development due to their ability to deal with the multitude of distributions that define the data. Thus, it is believed that GLMs are more flexible for analyzing behavioral relationships. Accordingly, a set of generalized linear regression models was used in this study in order to establish the relationship between the dependent variables of composite behavioral intention and the explanatory variables. Two different model specifications were used in order to check the relationship and the consistency of the independent measures across the decision stages.

Model specification 1 was estimated by only including the main important threat and coping appraisal variables of the PMT model. In the case of model specification 2, we

included additional variables, such as subjective knowledge and intrinsic reward, which are believed to have influence on behavioral intentions. Some selected socio-economic characteristics of the sample respondents, which theoretically are believed to have influence on farm-level adaptation measures, are also included in the model.

Table 4 presents the results of regression analyses for model specification 1 which is used to assess the explanatory power of the PMT variables of farmers' farm-level risk-reduction measures. The model yields statistically significant association between farmer's composite behavioral intention and the main important PMT model variables in the whole sample. All the variables also have the anticipated sign. Consistent with the PMT, it is observed that high perceived vulnerability, severity of consequences, self-efficacy, and response efficacy will lead to higher levels of behavior intentions to carry out farm-level risk-reduction measures.

In model specification 2, additional variables, such as subjective knowledge, intrinsic reward, and some selected socio-economic variables, such as age, educational status, farm size, and livestock ownership, were included in the regression analysis. Livestock ownership was measured in TLU. As Table 5 clearly depicts, all the PMT variables included in model 1 still maintain their significance in the whole sample. From the new variables included, subjective knowledge is found to be significant indicating that higher subjective knowledge of farmers on drought and its consequences will lead to higher intentions to carry out adaptation measures (Table 5).

Discussion

This study investigated farmer's cognitive perception of risk and the behavioral intention to undertake farm-level risk-reduction measures against drought risk. Moreover, the study examined the main triggering variables that

Table 4 Model 1

Model Variables	Whole sample		Pre-contemplation		Contemplation		Action	
	β	Std. error	β	Std. error	β	Std. error	β	Std. error
Vulnerability	0.127**	0.045	0.007	0.070	-0.062	0.084	0.096*	0.036
Severity	0.163**	0.041	-0.071*	0.053	0.084	0.107	-0.014	0.037
Self-efficacy	0.145**	0.035	0.067	0.059	0.103*	0.056	0.083*	0.032
Response efficacy	0.209**	0.042	-0.017	0.086	0.037	0.068	0.036	0.044
Cost	-0.096**	0.028	-0.061	0.046	-0.076*	0.044	-0.049	0.024
Constant	5.190**	0.275	2.894**	0.616	2.755**	0.623	3.554**	0.290
LR	205.6** (5)		0.11		17.23** (5)		35.16** (5)	

* and ** significant at probability levels of 5 and 1 %, respectively

Table 5 Model 2

Model	Whole sample		Pre-contemplation		Contemplation		Action	
	β	Std. error	β	Std. error	β	Std. error	β	Std. error
Vulnerability	0.134**	0.043	-0.007	0.069	0.010	0.079	0.086*	0.037
Severity	0.121**	0.040	-0.095*	0.050	0.110	0.104	0.005	0.039
Self-efficacy	0.104**	0.037	0.040	0.060	0.044	0.056	0.087*	0.036
Response efficacy	0.184**	0.041	0.012	0.082	-0.001	0.071	0.049	0.045
Cost	-0.099**	0.027	-0.078*	0.044	-0.098*	0.041	-0.060*	0.025
Intrinsic reward	0.053	0.042	0.099	0.066	0.165*	0.067	-0.074*	0.037
Subjective knowledge	0.080*	0.042	0.074	0.063	0.063	0.071	0.025	0.042
Age	-0.008**	0.002	-0.006*	0.003	-0.009**	0.003	-0.002	0.002
Educational status	0.005	0.006	-0.008	0.009	-0.006	0.008	-0.004	0.005
Farm size	0.046**	0.016	0.034	0.025	0.054*	0.024	0.005	0.014
Livestock holding (TLU)	0.001	-0.900	-0.013	0.017	-0.004	0.012	-0.008	0.008
Constant	5.190**	0.322	3.331**	0.671	3.613**	0.649	3.216**	0.319
LR	236.0** (11)				36.17** (11)		42.44** (11)	

* and ** significant at probability levels of 5 and 1 %, respectively

motivate farmers to move through the stages of pre-contemplation, contemplation, and action stages in order to mitigate drought risk. The research is based on the works of Martin et al. (2007) and Bočkarjova et al. (2009). We extended the model by including some selected socio-economic factors and resource endowments that were believed to have influence on adaptation in agriculture.

We found varying motivators in the different models to carry out farm-level adaptation measures in agriculture. Results showed that perceived vulnerability and severity, self-efficacy, and response efficacy positively correlated with behavioral intention to undertake farm-level adaptation measures. This is consistent with PMT. This indicates that farmers' risk appraisal and coping appraisal contribute to their drought adaptation motivation.

The regression result further indicated statistically significant association between farmer's composite behavioral intention and the main important PMT model variables.

Also consistent with the PMT is the observation that high perceived vulnerability, severity of consequences, self-efficacy, and response efficacy would lead to higher levels of behavior intentions to carry out farm-level risk-reduction measures. Similarly, Blennow and Persson (2009) found a significant and positive association between the farmers who adapted their risk-reduction measures against drought and their strength of belief in climate change.

Moreover, we observed that high perceived cost of response actions would decrease farmer's intention to carry out farm-level risk-reduction measures. This result indicates that farmers would be more likely to take up more adaptation behaviors, if the perceived costs, time, and effort of implementing the response actions are minimal. In Greece, in a study on flood protection, Koerth et al. (2013) similarly reported that perceived costs of response actions were negatively associated with the number of flood protection measures implemented. Looking at the triggering

variables that influence behavioral intention at the three levels of decision stages, increasing farmers' perceived severity of consequences is a key motivator of behavioral intention for farmers in the pre-contemplative stage. Accordingly, high perceptions of severe drought damages have a robust effect in the implementation of farm-level adaptation measures. This is in line with the finding of Milne et al. (2000) that the higher the perceived threat, the more likely the individual is to be motivated to undertake a behavioral intention to adopt a protective behavior. Increased self-efficacy is also main predictor of behavioral intention for farmers at the contemplative stage. In addition to self-efficacy, the perceived costs of response action were found to be significant indicating perceived cost as the main predictor of intention behavior for farmers in the contemplative stage. Floyd et al (2000) reported that self-efficacy will increase the likelihood of undertaking adaptation measures, whereas perceived response costs will decrease the likelihood of undertaking the adaptive response. For farmers in the action stage, strong beliefs in perceived vulnerability and self-efficacy were found to increase farmer's behavioral intention to carry out farm-level risk-reduction measures. In line with our finding, Grothmann and Patt (2005) claim that perceived adaptive capacity and perceived probability of an adverse event explain more of the variation between those taking action and not taking action to adapt to climate change. Social cognitive theories have provided strong evidence that forming intentions to act are facilitated by the expected outcomes of a new behavior and the confidence in one's ability to perform it, i.e., self-efficacy (Armitage and Conner 2000; Weinstein 1993).

The finding further indicated that subjective knowledge is found to be significant indicating that the higher the subjective knowledge of farmers on drought and its consequences would lead to higher intentions to carry out adaptation measures. This is consistent with the theory that subjective knowledge about risk perception of natural hazards provides important information about individuals decision to take self-protection measures (Botzen et al. 2009). Bočkarjova et al. (2009) similarly found subjective knowledge to be highly significant in predicting intention to undertake flood risk-reduction actions. The sign remained consistent in the three decision stages signaling that self-reported knowledge about drought risk has a positive influence on individual motivation, which is consistent with the findings of Bočkarjova et al. (2009) and Martin et al. (2007).

When we extended the model by including selected socio-economic factors and wealth indicators that are believed to have influence on adaptation in agriculture, the

result indicates that perceived severity of drought consequences was still an important trigger for farmers in the pre-contemplative stage. Moreover, the perceived cost of response actions and farmer's age were important predictors for farmers in this stage. Higher farmer's age would lead to lower behavioral intentions to undertake adaptation measures in agriculture. For the contemplatives, age and farm size were important and determine the readiness to undertake risk-reduction measures. For farmers in the action stage, perceived vulnerability and self-efficacy were still important triggers to undertake risk-reduction measures. In addition to perceived vulnerability and self-efficacy, intrinsic reward and perceived costs of response actions were important ones to motivate behavioral intention at this stage. Consistent with our findings, several studies, such as Snipes et al. (1999), Maddux and Rogers (1983), and Rippetoe and Rogers (1987), have concluded that maximizing one's ability to cope produces more adaptive coping.

Furthermore, the result indicated that perceptual factors were better than the socio-economic variables at predicting farm-level drought adaptation. Farmer's age and size of land holding were found to be significant to influence behavioral intention to undertake farm-level agricultural adaptation measures. Surprisingly, age has a negative sign indicating the higher the age of a farmer, the lower the behavioral intention to undertake risk-reduction measures. This is in contrast with the available literature. Age is basically assumed to represent a farmer's experience in farming. Different studies reported that experienced farmers have a higher probability of perceiving changes in climate as they have been exposed to climatic conditions over a longer period of time (Ishaya and Abaje 2008; Maddison 2006). Hence, it is believed that the higher the age of a farmer, the higher the intention to undertake risk-reduction measures. This is in contrast with our findings. The sign for farm size is found to be positive, implying that farmers with larger farm land size have higher behavioral intention to carry out farm-level risk-reduction measures. Education and livestock ownership also directly influence farmer's behavior to undertake adaptation measures though not significant. This result indicates that the socio-economic and wealth characteristics of the farmers rarely make a significant contribution to explaining farm-level adaptation behavior.

However, like all studies, the current study is not without limitations. One of its limitations is that there may be grounds for questioning whether it is possible to elicit farmer's real perception of drought risk from answers to standardized questions. This limitation should be kept in mind when evaluating the conclusions of our study.

Conclusions

In general, as it is mentioned in the preceding discussion, the authors had two objectives in conducting this empirical study. First, we aimed to test the hypothesis: self-efficacy and response efficacy were the main predictors of behavioral intention for farmers in the action stage; farmers in the contemplation stage would be predicted by perceived risk severity and vulnerability; increasing perceived vulnerability is a key predictor for farmers in the pre-contemplation; and high level of subjective knowledge about drought hazard would lead to higher motivation to carry out farm-level risk-reduction measures. Second, the authors wanted to test the applicability of the integrated PMT-TTM model in assessing drought risk vulnerability in the Ethiopian cultural context.

As to the first aim, the study findings indicated that the PMT variables play a significant role at predicting farmer's motivation and their behavioral intention to undertake farm-level adaptation against drought risk. The study showed the significance of perceived vulnerability, severity of consequences, self-efficacy, and response efficacy to influence farmer's behavior intentions to carry out farm-level risk-reduction measures. Consistent with the PMT, high perceived vulnerability, severity of consequences, self-efficacy, and response efficacy were found to lead to higher levels of behavior intentions. Moreover, the result showed a statistically significant association between farmer's composite behavioral intention to undertake farm-level risk-reduction measures and the main important PMT model variables.

We found varying motivators in the different models to carry out farm-level adaptation measures in agriculture. For farmers in the action stage, self-efficacy and response efficacy were the main predictors of behavioral intention, indicating drought-coping appraisal as an important variable to understand drought mitigation behavior and drought risk communication. Perceived costs of response actions and intrinsic reward also influence the readiness of farmers to carry out farm-level adaptation measures. For farmers in the contemplative stage, self-efficacy, cost, and intrinsic reward appear to be the main motivators to act upon risk reduction, while perceived severity of consequences and cost of response actions are important for farmers in the pre-contemplative stage. In general, farmer's threat and coping appraisal significantly influence their behavioral intention to undertake risk-reduction measures. Subsequently, it can be concluded that public drought risk management strategies aiming at stimulating farmers' adaptive capacity should raise awareness on the consequences of drought risk, as well as to provide information and training addressing the effectiveness of available farm-level adaptation measures.

Secondly, the empirical study provided clear evidence that the integrated PMT-TTM approach can be used as a basic framework for explaining adaptation behavior of farmers and drought risk preparedness in the developing countries context in general, and in the Ethiopian cultural setting in particular. Besides, the study provides insight on the important role of socio-psychological factors on farmer's adaptation process. Accordingly, the study provides vital information for drought risk management policies, as it indicates whether risk communications should focus on the effectiveness of drought risk-reduction measures (response efficacy); whether they should give emphasis on providing practical guidelines on how to deploy such measures (self-efficacy); or whether the cost of protective measures should be addressed when stimulating drought mitigation behavior (response cost).

Generally, this study provides an important policy implication for decision makers. Differences in farmers adaptation behavior against drought risk are influenced not only by socio-economic variables, but also by their cognitive perception of risk. This finding supports to the validity of the PMT. Subsequently, it can be concluded that public drought risk management strategies aimed at stimulating farmers' adaptive capacity should raise awareness on the consequences of drought risk, as well as to provide information and training addressing the effectiveness of available farm-level adaptation measures.

Thus, using appropriate techniques would be vital in modifying and changing farmer's psychological and perceptual factors. We believe that this study contributes to the scant literature on the cognitive and psychological barriers to adaptation against drought risk in the context of developing countries.

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