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RESEARCH ARTICLE



Women and climate change adaptation behaviour: What's the problem and solution?

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ABSTRACT

Rural women's contribution to reacting to climate change is highly significant but has been largely marginalized due to gender roles. This gender discrimination makes them more vulnerable to a variety of threats. Therefore, the purpose of this study was to examine the behaviour of female rice farmers in Mazandaran Province, in northern Iran, toward climate change adaptation using protection motivation theory (PMT). 173 female heads of households' rice farmers in Mazandaran Province were selected through stratified random sampling. According to the findings, the perceived vulnerability ($\beta = 0.19$), perceived severity ($\beta = 0.33$), self-efficacy ($\beta = 0.4$), and response effectiveness ($\beta = 0.35$) of female rice farmers have a positive and noticeable effect on responding behaviour to climate change. However, the response costs ($\beta = -0.61$) have a negative but noticeable effect on their adaptation behaviour toward changing climate. Research findings also show that climate change severely damages the physical capital of women paddy farmers. The damage caused by these climate crises has a greater impact on the production capacity, product quality, production costs and food security of female heads of households. The findings of this study will help define patterns determining the adaptation of women to climate change, and public and private sector's strategic planning and action.

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Female paddy farmer; climate adaptation; protection motivation theory (PMT); agriculture; vulnerability; gender inequality

1. Introduction

According to the recent Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6), global surface temperature will continue to increase and global warming levels of 1.5°C and 2°C will be exceeded unless the increase in adaptation and mitigation in the coming decades occurs more rapidly (IPCC, 2022). These changes can affect social-biological aspects (Thakali et al., 2016) such as gender-specific aspects (Jost et al., 2016), causing numerous problems such as poverty (Issahaku et al., 2020) and gender inequality (Ylipaa et al., 2019). Consequently, the advent of climate change (CC) and its impact on rural livelihoods, and in particular on food security (Ampaire et al., 2020), call for acceleration in efforts to increase gender adaptation.

Vincent et al. (2010), in the UNDP report Gender, CC and community-based adaptation, listed a number of direct and indirect effects of CC and their impact on women. Besides that, IPCC (2022) pointed out that adaptation measures most commonly found include farming-related changes (e.g. resilient or drought tolerant crop varieties, irrigation techniques, crop storage, and livestock insurance schemes), infrastructure development, Indigenous knowledge, community-based capacity building, and ecosystem-based adaptation (high confidence). A similar report states that most common limits to adaptation are frequently related to governance, economics, and social/cultural constraints, and can be overcome

principle through targeted efforts to address social conditions that impede adaptation planning and action.

Carr and Thompson (2014) state the existence of a broad, pervasive (if not universal), and enduring lack of women's inclusion in agricultural decision-making in households at scales and settings from the household to agricultural development programmes and projects. A similar author pointed out the nexus of gender and CC adaptation in agrarian settings and some promising adaptation strategies that are unique to women. As stated by Nizami and Ali (2017), women mostly volunteer for activities related to CC adaptation which are known as a value in society. They have important knowledge and skills to perform adaptation processes that originate from their social roles (Carvajal Escobar et al., 2008). Women's attitudes toward gender issues stemming from their social roles (whether at home, at work, or in society) are factors that influence their motivation to commit to CC adaptation behaviour. If they feel that the issue of gender equality is not a concern, it is unlikely that they do not intend to commit to it. This is because women's adaptive behaviour is influenced by various elements such as environment, experience, political affiliation, social norms and values and traditions (Eastin, 2018). Masson et al. (2019) stated that improved knowledge about gender equality and CC can affect the degree of importance accorded to the subject and can increase voluntary behaviours among rural women. Rural women are more willing to

engage in gender-responsive climate action when they understand how and why CC affects men, women, girls, and boys in different ways. Otherwise, a lack of understanding can lead to inappropriate behaviour that reinforces gender inequalities in climate action or even creates new sources of gender inequalities (Jordan, 2019). However, it is very clear that improved knowledge in and of itself is rarely sufficient to motivate rural women and change behaviour patterns. Because weak political leadership regarding equality, paired with a lack of information about gender, has resulted in a limited understanding of the concept of gender and of its relevance in policies relating to CC adaptation (NAP, 2022).

Empirical evidence from a review of global research, as well as a number of studies carried out in Iran, indicates that Iranian women, compared with Iranian men, are more interested in the environment, such as recycling, protecting natural resources, energy, and water and adaptation to CC (Gupta, 2015; Salehi, 2012).

As mentioned by Khatri-Chhetri et al. (2020) and FAO (2011), the gender gap in agriculture is a pattern, documented worldwide, in which women have less access to productive resources, financial capital and to advisory services compared to men. These issues have also affected the lives of rural women, and their impacts are increasing in Iran (Riahi & Toulabi Nejad, 2019). As highlighted in the latest IPCC Special Report (2022), the climate emergency requires major changes, not just in the financial, also in the institutional and legal spheres. Behavioural changes – at the individual, collective, and organizational levels – along with changes to overall way of life are also necessary. Therefore, changing women farmers' behaviour or attitude can improve their adaptive capacity towards CC, and it can also reduce the adverse consequences of CC.

According to the recent report by NAP (2022), to change behaviours, it is important to combine a variety of mechanisms – not only the traditional mechanisms related to information (for example, by means of education), to rules and regulations (for example, through quotas), and to material incentives – but also to appeal to the emotions or to social influences and to change the context in which the choices are made. Several studies (e.g. Ghanian et al., 2020; Quiroga et al., 2020; Zhang et al., 2020) have somewhat described mechanisms of farmers' decision-making on adaptation actions (Wiréhn et al., 2020); physiological barriers to the adaptation of farmers to these changes, however, are often ignored, particularly in developing countries (Gebrehiwot & Veen, 2015). For example, Grothmann and Reusswig (2006) used PMT to investigate the families' flood adaptive behaviours in Germany and mentioned that this model, unlike economic and social variables, is a suitable model to identify adaptation behaviours. If more men are searching for work openings away from home, women are expected to develop new capacity to cope with new problems, including CC threats (Banerjee et al., 2019). Past studies have focused more on women looking at vulnerability (Bunce et al., 2016; Owusu et al., 2019), social justice (Alvarez & Lovera, 2016), migration (Baada et al., 2019; Meeks, 2018), and CC policies (Deshar & Koirala, 2020; Mcleod et al., 2018), and their adaptive behaviour toward these changes using behavioural models such as PMT has received less attention in one country. In Iran, which has

experienced many climate crises in recent years, no study has been conducted in this regard. Therefore, considering that the PMT can provide more appropriate solutions for the adaptive behaviours of women via risk appraisal during CC and risk management, will be one of the effective models in understanding the factors affecting CC adaptation behaviour. The aim of this study is to examine the female rice farmers' adaptation behaviour in the face of CC based on the PMT in the north of Iran, by addressing the following questions:

- (1) Does the severity of understanding the problems of rice farmers affect their adaptation behaviour toward changing climate?
- (2) Does the perceived vulnerability of women rice farmers affect their adaptation behaviour to CC?
- (3) Do the costs of female rice farmers' response affect female rice farmers' behaviour toward adjusting to CC?
- (4) Does the effectiveness of female rice farmers' responses affect their adaptation behaviour toward CC?
- (5) Do aspects of rice farmers' self-efficacy affect their adaptation behaviour toward CC?

2. Theoretical framework

Iran is known as one of the driest countries in the world since more than 85% of its land is located in the geographical dry belt and desert strip (25–40 degrees' north latitude) and is among the low rainfall regions of the world (Madani, 2014). Iran is facing two major crises, i.e. shortages of water and electricity in the twenty-first century (Rahimi et al., 2020). In recent years, it has experienced various climatic events such as drought and flood, which have led to damage to agricultural products, food shortage, economic damage, and an increase in rural households' vulnerability (Keshavarz & Karami, 2016). In spring 2019, three successive heavy rainfalls led to the overflow of 140 rivers in Iran. Because of these overflows, 78 people were killed, more than 2000 villages of Iran (in 26 out of 31 provinces of Iran) were affected by the flood, about 2.5 million people were directly injured, and about 16.6 million people were indirectly injured (Zare, 2019). One of the most affected watersheds is the Caspian Sea, located in the northern strip of Iran in the provinces of Gilan, Golestan, and Mazandaran. Due to its special climatic location, climatic diversity, suitable distribution, and vast fields in plain areas, the Caspian Sea is among the rich agricultural regions of Iran, which more than 600 thousand (ha) of its lands are under cultivation of agricultural and horticultural crops (Agricultural Jihad Organization of Mazandaran Province, 2018), and by possessing about 75% of paddy fields of Iran, it plays a very important role in the production of more than 37% of the rice eaten by the nation (Agricultural Jihad Organization of Mazandaran Province, 2018). Evaluating meteorological parameters of Mazandaran Province shows a decrease in rainfall in certain seasons; a change in the type of precipitation; an increase in temperature in various seasons (Jahanbakhsh et al., 2010); and an increase in serious and prolonged droughts, precipitation, winds, cold, and frost (Meteorological Organization of Iran, 2018). According to the statistics of Mazandaran

Governor's Office in 2022, about 29% of the rural population of Mazandaran Province are women, about 8% of whom are heads of households and are in the age range of 18–65 years. In fact, CC has made it more difficult for women, particularly rural women heads of families in Mazandaran province, who are responsible for fetching water, gathering firewood, handling agricultural activities, caring for small animals along with housekeeping responsibilities. They are extremely sensitive and vulnerable to CC. This is because the economy and livelihood of women and girls living in rural areas of Mazandaran are highly dependent on land, agriculture and animal husbandry, which with the occurrence of CC, these sources of income will suffer, albeit slightly (Ahmadpour et al., 2019). As a result, they will face serious harm to their livelihood, including economic dependence on men, immigration, social and psychological harms due to their emotionality, caring role, and motherly self-sacrifice (Goli et al., 2020). Along with other agricultural activities, due to the importance of rice cultivation in Mazandaran, women have a role, position and special importance from planting to harvesting this important crop. For example, they are responsible for preparing seeds for seedling production, preparing seedling nurseries, transplanting in the traditional way, weeding, harvesting, collecting the straw remained from rice cultivation, drying, storing, and supplying rice to local markets. Therefore, CC, that by changing the rice plant physiology will reduce its growth period, is important in this province. This shows the need for climate-adaptive behaviour among female rice farmers (Goli et al., 2020).

2.1. Women's decision-making in response to climate shocks

Mehar et al. (2016) defined decision-making related to CC as the ability or potential of a system to respond successfully to climate variability and change and includes adjustments in both behaviours and in resources and technologies. However, decision-making can be highly heterogeneous within a society or locality, and for human populations, it is differentiated by age, class, gender, health, and social status (Petheram et al., 2015). Ayeb-Karlsson (2018) argued, individuals often choose a combination of strategies to deal with the effects of climate shocks. Whether these strategies are chosen by women or men, or both is often related to the socio-economic context of the decision-maker.

The choice of coping strategies among women depends on a set of these factors: (a) women's ability and family circumstances (i.e. farm size, family size, social class, education, age, marital status, culture and family traditions); (b) awareness of each family member about CC, as well as coping or adaptation strategies learned through training or external resources; and (c) shock intensity: The extent to which the shock affects the performance or security of the entire family and their assets (Mehar et al., 2016).

Another important aspect is who decides on the appropriate coping strategy. According to Partey et al. (2020), in the event of a climate crisis, decisions made by male and female family members may differ due to differences in roles associated with different activities. Also, this factor depends on the

individual's understanding of the risks and options available with respect to a subset of knowledge, access and control over resources (Van Aelst & Holvoet, 2018). In addition, in cases of major shocks that affect almost all aspects of life, sometimes all family members (responsible and empowered) jointly discuss the relevant coping strategy and take collective action. However, in most cases, it is the largest and most important family member in Iran's rural communities, often men (spouse, father, brother or son), who control family resources such as land and house, and are usually the final decision maker (Goli et al., 2020; Mehar et al., 2016).

Women's vulnerability to CC can be identified in terms of two dimensions: first, the risks, shocks, and stresses to which people are subjected; and second, capacity and associated means to withstand, or adjust, to damaging losses (Hossain & Ashiq Ur Rahman, 2018). But what ultimately matters in choosing adaptation strategies is the size of the shock (short-term or long-term) that women farmers face. Rural women usually work as unskilled labour and lack different livelihood capitals; and CC is an increasingly important influence exacerbating an already vulnerable livelihood context (Yadav & Lal, 2018). Therefore, adaptation strategies for rural women are delivering short-term survival strategies disregarding the notion of wellbeing in the medium to long-term perspectives. However, short-term approaches could help to reduce vulnerability. As rural women are significantly more resource-constrained (in comparison with men), it is reasonable to assert that targeted asset transfers could be short-term adaptation strategies in a changing climate (Partey et al., 2020). Targeted asset transfers approaches consider the accumulation of physical, financial, human, and social capital in order to build the adaptive capacity of rural women. This adaptive capacity of the rural women can facilitate adjustments in assets, livelihoods, behaviours, and technologies in order to reduce future climate vulnerability (Hossain & Ashiq Ur Rahman, 2018). Therefore, due to gender gaps, rural women often choose medium and short-term strategies.

2.2. Literature review

In this study, to achieve the research variables, the literature review in four continents of Asia, Africa, America, and Europe has been studied. The keywords 'Behavioral theory', 'Climate change', 'Adaptation behavior', 'Asia', 'Africa', 'Europe' and 'America' in the Google Scholar searching browser (between 2000 and 2020) have been searched. The results show that in Asia 185, in Africa 168, in Europe 206 and in the United States 191 types of research have been done on adaptation behaviour to CC by behavioural theories. Then the keyword 'women' was added to these keywords. The results showed that only 11 studies in Asia, 8 studies in Europe, 14 studies in Africa and 9 studies in the United States examined the adaptive behaviour of women farmers in the face of CC. In this study, while reviewing the intercontinental literature, a general analysis of these studies is presented in the form of a table (Table 1).

2.3. Protection motivation theory (PMT)

In 1975 and 1983, the PMT was first proposed by Rogers, which offers a combination of psychological structures to

Table 1. The results of the literature review in Asia, Africa, US and Europe.

Continent name	Researcher's names	Findings
Asia	Lioubimtseva and Henebry (2009) Le Dang et al. (2014) Arunrat et al. (2017) Goli et al. (2020)	The Asia region is more vulnerable to CC risks than other regions of the world, because of its dependence on the natural resources and agriculture sectors, densely populated coastal areas, weak institutions, and poverty among a considerable proportion of the population. Therefore, adaptation – making adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects that moderate negative or exploit beneficial opportunities – becomes a key strategy for sustainable economic growth. Failure to adapt could stall development, particularly in the countries that depend on natural resources. Adaptive capacity entails the ability to adapt, conduct a sum of actions to change behaviours, shift priorities, produce necessary goods and services, and to plan and respond in ways that reduce harmful CC impacts or transform them into no-regret economic opportunities.
Africa	Bryan et al. (2009) Shackleton et al. (2015) Somda et al. (2017)	The temperatures in Africa are rising therefore, it is time to mainstream, scale-up and accelerate support for CC adaptation across the continent. Recent studies indicate it is likely that the true costs of adaptation will be substantially higher than originally projected and will require creative financial mechanisms and substantial engagement with the private sector to meet. While initial CC adaptation initiatives show good potential for economic viability, livelihood enhancement and vulnerability reduction, long-term sustainability will depend on the prevailing levels of poverty, the wider context of policies and regulations, access to markets and financial services, as well as government capacity to provide continuous technical support to communities. This indicates that baseline development is still required to reach targets for poverty reduction and climate behaviours in Africa.
United State (US)	Walthall et al. (2013) McCarl (2015) Timberlake and Schultz (2017) Gisbert-Queral et al. (2021)	CC poses unprecedented challenges to US agriculture because of the sensitivity of agricultural productivity and costs to changing climate conditions. Adaptive action offers the potential to manage the effects of CC by altering patterns of agricultural activity to capitalize on emerging opportunities while minimizing the costs associated with negative effects. The aggregate effects of CC will ultimately depend on a complex web of adaptive responses to local climate stressors. These adaptive responses may range from farmers adjusting planting patterns and soil management practices in response to more variable weather patterns, to seed producers investing in the development of drought-tolerant varieties, to increased demand for Federal risk management programmes, to adjustments in international trade as nations respond to food security concerns. Potential adaptive behaviour can occur at multiple levels in a highly diverse international agricultural system including production, consumption, education, research, services, and governance. Understanding the complexity of such interactions is critical for developing effective adaptive strategies.
Europe	Leclère et al. (2013) van de Ven et al. (2018) Sordo-Ward et al. (2019) Agovino et al. (2019)	CC has already negatively affected the agriculture sector in Europe, and this will continue in the future. The EU strategy on adaptation to CC and the common agricultural policy have enabled adaptation actions in the agriculture sector. The EU Member States have defined the agriculture sector as a priority in their national adaptation strategies or national adaptation plans. Measures at national or regional levels include awareness raising, practical measures to decrease the impacts and risks of extreme weather events, or risk-sharing strategies, and developing and implementing infrastructure for irrigation and flood protection. There are opportunities for implementing a wide variety of existing measures at farm level that aim to improve the management of soils and water, which can provide benefits for adaptation, mitigation, the environment and the economy. However, adaptation at the farm level, in many cases, does not take place because of a lack of, among other things, resources for investment, policy initiatives to adapt, institutional capacity and access to adaptation knowledge.

explain persons' function in a health care environment (Scarpa & Thiene, 2011). In fact, it is a general decision-making model in facing different threats (Dang et al., 2014), a valuable tool for defining environmental decision-making (Karrer, 2012), and a significant social-physiological paradigm (Haer et al., 2016). While the original model was intended for health protection patterns (health care) study (Rogers, 1975, 1983), it is now used in other areas, such as technical, environmental, and natural hazards (Bubeck et al., 2013) and human adaptation to CC (Bubeck et al., 2013) (Truelove et al., 2015). According to Keshavarz and Karami (2016), the main assumption in this model is that people adopt their new behaviours by considering their interests and cost effectiveness when making decisions. In this model, individuals will improve their defense habits by identifying barriers to acceptance, and while choosing adaptation behaviours, they will try to balance the risks and benefits of adaptation (Bockarjova & Steg, 2014). PMT's principal theory is that while facing hazards, people use two major cognitive processes, along with adaptation actions (Keshavarz & Karami, 2016), i.e. coping appraisal and threat appraisal (Tapsuwan & Rongrongmuang, 2015).

Threat appraisal measures factors that raise or decrease the risk of incompatible responses (i.e. benefits) or decrease the risk of incompatible responses (i.e. benefits) (perceived vulnerability and perceived severity) (Tapsuwan & Rongrongmuang, 2015). Perceived vulnerability reflects the vulnerability of a

person to an existing threat (Keshavarz & Karami, 2016). Perceived severity refers to the strength of the emotions of an individual regarding the extent of difficulties or concerns in negative situations (Cismaru et al., 2011). Coping appraisal includes response effectiveness, response costs, and self-efficacy and evaluates factors responsible for the possible improvement (i.e. self-efficacy and efficacy of reactions) or a decrease (i.e. cost) in adaptive reactions (Mc Donald, 2014; Tapsuwan & Rongrongmuang, 2015). Self-efficacy is one of the main concepts of field study in health care (Ung et al., 2015) and applies to the confidence of an individual in his/her capacity to embrace prescribed habits, take necessary actions, and receive the desired result (Truelove et al., 2015). Response efficacy refers to the confidence of an individual in the effectiveness of prescribed risk mitigation or elimination activities (Kuruppu & Liverman, 2011), or in other words, the successful expectation of risk reduction actions (Truelove et al., 2015). Finally, response costs, such as cash costs, time, and effort, represent all of the perceived costs associated with prevention steps (Bubeck et al., 2013). The study hypotheses are, therefore, described as follows:

H₁: Perceived severity of female paddy farmers' perception of problems has a considerable positive effect on their protection motivation behavior toward CC.

H₂: Female rice farmers' perceived vulnerability has a considerable positive effect on their protection motivation behavior toward CC.

H₃: Response costs of female paddy farmers have a considerable positive effect on their protection motivation behavior toward CC.

H₄: Response efficacy of female paddy farmers has a considerable positive effect on their protection motivation behavior toward CC.

H₅: Self-efficacy aspects of female paddy farmers have a considerable positive effect on their protection motivation behavior toward CC.

Finally, [Figure 1](#) explains the theoretical model of the defensive motivation for the adaptation actions of female rice farmers against CC in the Mazandaran Province, taking into account the important role of women in the behaviour of adaptation.

3. Research methodology

3.1. Study area

Province of Mazandaran with an area of 24,091 square kilometres and a population of about 2,602,008 people is one of the main provinces on the Caspian Sea's southern coast, in the north of Iran (Statistical Center of Iran Website, 2018). It sits on the southern coast of the largest lake in the world ([Figure 2](#)), and its adjacency to four coastal countries of this sea, i.e. Turkmenistan, Kazakhstan, Russia, and the Republic of Azerbaijan, on the one hand, and its location in the north of Tehran metropolis (the capital of Iran) on the other, have caused it to enjoy a geographical place of strategic significance (Mazandaran Cultural Heritage Organization, 2018). The climate condition in Mazandaran Province can be divided into two types of temperate Caspian climate and mountainous climate. The mountainous climate itself is divided into two types of temperate mountainous climate and cold mountainous climate. According to Hansen classification, Mazandaran Province is located in the warm temperate circle, and according to De marten classification, Mazandaran's western regions are very wet and located in tropical central areas, Mediterranean eastern areas, and semi-humid mountain areas (Iran Metrological Organization, 2018). The average annual temperature of this province is 17.6°C, and in the last ten years (2009–2019), the total annual rainfall in this province has been around 700 mm (Iran Metrological Organization, 2018). This province is ranked seventh in Iran's GDP (Iran's Ministry of Economic Affairs and Finance, 2017). About 78% of the population of this province is committed to agriculture, and the most important agricultural and horticultural products of this province are rice and citrus. Around 220 thousand (ha) of agricultural lands of this province are used for rice cultivation. Therefore, the province of Mazandaran is ranked first in rice cultivation in Iran (Agricultural Jihad Organization of Mazandaran Province, 2018).

3.2. Research and sampling method

This study is a quantitative study. In this study, stratified sampling with proportional assignment has been used for the determination of the sample size. The studied statistical population was randomly selected from all female paddy farmers who have cultivated rice in Mazandaran Province in the

2017–2018 year of the harvest; however, destruction was caused by CC (drought, flood, storm, etc.) (Agricultural Jihad Organization of Mazandaran Province, 2018). By determining the size of the study sample using the data on the number of female rice farmers in the rice-growing regions of the cities of Mazandaran Province and the percentage of damage caused by CC to paddy fields of Mazandaran Province during three consecutive crop years (2014–2015, 2015–2016, and 2016–2017), another index called the ratio of damage percentage to the area under cultivation was calculated. Finally, the cumulative percentage of harm was calculated applying this index to the rice fields of the province of Mazandaran during these three crop years, and using Cochran's formula, the sample size of female paddy farmers was estimated in each of the province's towns. At last, the final sample was identified and 173 female rice farmers were investigated in 21 towns in Mazandaran Province.

3.3. Instrument for survey

A quantitative questionnaire was developed as the key study instrument and the data to address the analysis issue and the test priorities were established using this questionnaire, which was designed as a tutorial for this study. To assess the relevance of the questionnaire, opinions and recommendations of 15 supervisors, advisors, researchers, and experts of the Agricultural Jihad Organization of Mazandaran Province were used. After the essential corrections, the ability and capability of the set questions in measuring the desired contents and features were confirmed. In a pilot test, to determine the validity of the prepared questionnaire, 30 copies of it were completed by female rice farmers in Sari County (in the villages that have not been investigated in the final assessment). Using Spsswin19 tools and Cronbach's alpha and sequential theta approaches, completed questionnaires were tested. According to the results, for the questionnaire, the Cronbach alpha was 0.840 (threat appraisal = 0.724; coping appraisal = 0.813; adaptation behaviour = 0.917) and sequential theta coefficients were 0.914 (threat appraisal = 0.860; coping appraisal = 0.946; adaptation behaviour = 0.941).

In order to validate the study hypothesis, dynamic equation simulation (SEM) using Linear Structural Relationships (LISREL) software is used. SEM is a procedure to estimate a series of dependence relationships among a set of concepts or constructs represented by multiple measured variables and incorporated into an integrated model (Malhotra et al., 2014). SEM is used mostly as a tool that is confirmatory, not exploratory. LISREL was recognized in this analysis as one of the best solutions to estimate structural equation models for covariance matrices (Levêque & Burns, 2017).

4. Results and discussion

4.1. Analysis of personal characteristics

The results of personal characteristics show that 80.3% of the studied women, with the highest frequency, were aware of CC, but 19.7% of them did not have a clear perception of CC. In addition, among the female rice farmers studied in

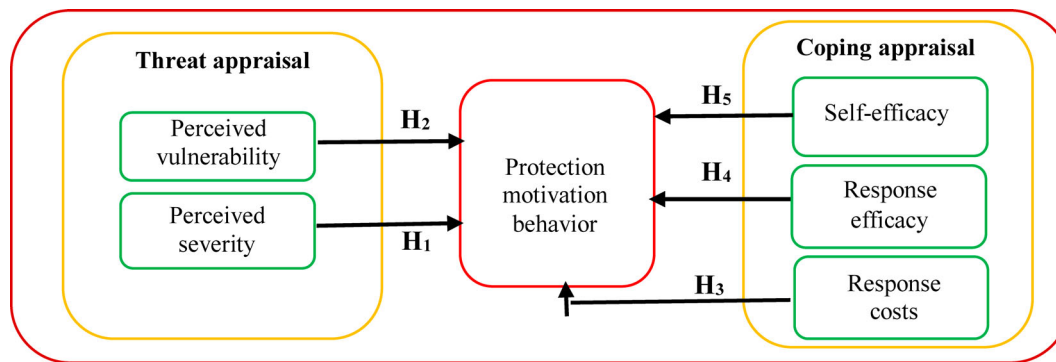


Figure 1. The theoretical model of female rice farmers' adaptation behaviour toward climate change (Bockarjova & Steg, 2014).

this research, the youngest was 20 and the oldest was 68 years old. The marital status of the studied women showed that 75% of them were married with the highest frequency ($F = 130$). In terms of education level, most of them with a frequency of $F = 60$ had elementary education, and their highest experience in rice farming was 41 years. In terms of ownership type, most of the studied people ($F = 120$) were owners of their lands. The lowest area under rice cultivation by the studied women was 0.5 (ha), and the highest area under cultivation was 10 (ha). The lowest annual yield of their rice crop was 1 ton/ha, the highest was 4 ton/ha, and the average annual yield was 2.8 ton/ha. In general, the findings show that in the selection of different types of adaptation strategies, a combination of individual factors are decisive. There are different sets of explanatory variables that significantly influence women's adaptation strategies such as the age of the household head, experience in farming, perception of climate-related threats, education levels, access to credit, marital status and land size.

Based on the results of the face-to-face interview, age and experience are the most important personal characteristics that influence the choice of women's adaptation strategies. It is expected that experienced farmers will be more likely to adjust their activities to reduce the impacts of CC and increase the adaptation – relative to less experienced farmers. In fact,

compared to households with less agricultural expertise, households with greater farming experience are more likely to utilize adaptive measures. Farmers with more expertise, according to Debalke (2014), are better able to forecast and adapt their agricultural production accordingly. Although researchers have found no relationship between adaptation and age (e.g. Bekele & Drake, 2003), others like Anley et al. (2007) have found that age is significantly and negatively related to adaptation decisions. Atampugre et al. (2020) on the other hand found significant and positive association between age and adaptation decision-making. As a result of having encountered more climate crisis, older farmers are more likely to participate in using adaptive behaviour actions than younger farmers. In this study, older farmers adopted more than the younger ones and used more of medium- to long-term adaptation strategies, relative to their younger counterparts.

4.2. Testing the research hypotheses

According to the results of the Kolmogorov–Smirnov test (Table 2), the significance level of all variables is greater than 0.05; therefore, it can be said that the distribution of variables'

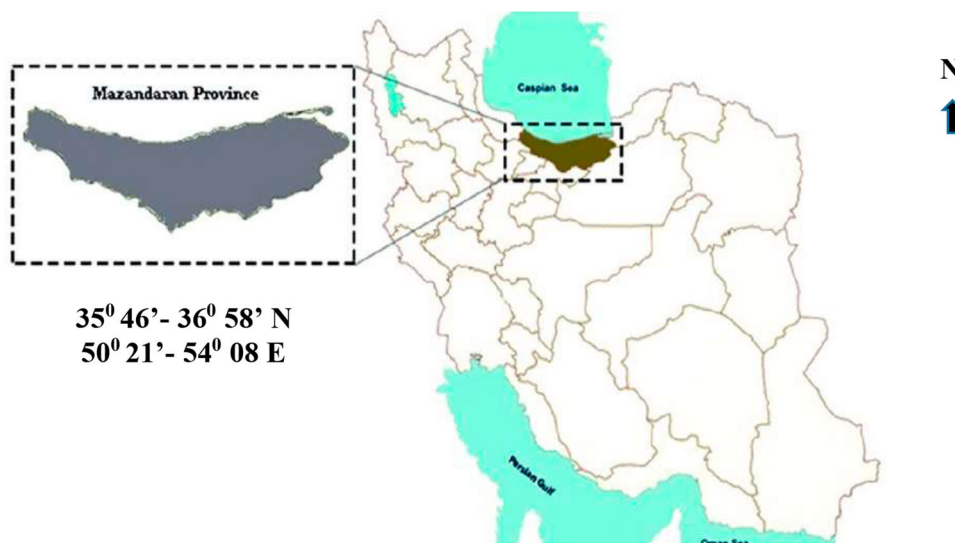


Figure 2. Geographical location of Mazandaran Province.

Table 2. Investigating the normality of the distribution of research variables using the Kolmogorov–Smirnov test.

Variable	z	Significance level
Perceived vulnerability	1.173	0.127
Perceived severity	1.529	0.059
Self-efficacy aspects	0.882	0.419
Response efficacy	1.167	0.131
Response costs	1.392	0.055
Adaptation behaviour	0.805	0.635

data is normal. As a result, the parametric tests are used to examine the research hypotheses.

Based on the results (Table 3), the perceived severity ($\beta = 0.33$) would have a positive influence on the occurrence of defensive incentive adaptation behaviour. Therefore, the research hypothesis is confirmed with 99% confidence at 0.001 significance level. Hence, it can be said that by increasing the intensity of female rice farmers' perception of CC effects, assuming that other variables are constant, their adaptation behaviour will improve. In other words, the more women evaluate the severity of perceived problems, the more they will accept adaptive behaviours. Alternatively, if these risks are perceived to be high risk, the participant would be more likely to develop coping behaviours to safeguard himself from the threats.

The results of studying the subsections of the intensity of problems perception (Figure 3) show that the harm that CC has caused strongly affects the physical assets of female rice farmers ($\beta = 0.75$) such as house, land, furniture, and agricultural machinery. Therefore, it can be said that by increasing the intensity of female rice farmers' perception of problems caused by the damage to their physical assets, their threat appraisal ability improves, and as a result of higher threat appraisal, they will show a higher motivation to develop better and more effective adaptation behaviours to protect themselves from CC. Similar effects are seen from a study of the literature, and most studies demonstrate the positive impact of the severity of perception problems on protection motivation behaviour (Bockarjova & Steg, 2014; Bubeck et al., 2013), although others point to its detrimental impact (Ifinedo, 2012; Keshavarz & Karami, 2016).

The results show that after the perceived vulnerability, female rice farmers' perception of vulnerability ($\beta = 0.19$) has the highest effect on women's CC adaptation behaviour. Therefore, the research hypothesis on the positive effect of vulnerability perception on protection motivation behaviour of female rice farmers is confirmed (Table 3). Female paddy farmers, in reality, who are in more danger and are more

worried will behave more adaptively. The reason for this can be mentioned as follows. Those who are persuaded that CC, in different ways, will have drastic consequences on their income, inflict severe economic harm to their income, and endanger their wellbeing, will definitely take the requisite actions, such as acceptable adaptation habits. The findings of this study are confirmed by Ayanlade et al. (2017). They have shown in their study that the perceptions of farmers about CC reflect meteorological research, but their perceptions are focused on local climate parameters. Smallholder farmers are especially vulnerable to CC, as most of them do not have adequate money to deal with this crisis. In addition, the results of studying the subsections of vulnerability perception show that the damage caused by CC has a greater effect on products ($\beta = 0.73$), production power, products quality, production costs, and food security (Figure 4). This is because, from the female rice farmers' point of view, the severity of harm and damage caused by CC to production power, products quality, production costs, and food security is more important as a threat to their lives. In fact, most women are present in paddy fields as labour force, and since most of them are not the large landowners, they are deeply concerned about the non-reimbursement of development costs related to the harm caused to the nature and quantity of their goods by CC. In addition, since they are primarily responsible for preparing and providing family members with food, they are worried about the food security of their families, particularly children and the elderly, in the turmoil caused by these changes. Therefore, it can be said that by an increase in the intensity of female rice farmers' perception of vulnerability, their threat appraisal ability improves, and as a result, higher threat appraisal leads to better and more effective adaptation behaviours by them. These findings are in line with the findings of studies by Coayla and Culqui (2020), and Richardson et al. (2018) and are confirmed by them.

In fact, the provision of information will increase the perceived severity and vulnerability of CC threats, leading to higher levels of personal perceived risk compared to individuals receiving no information. Several social and psychological barriers continue to act as obstacles to behavioural change with respect to adaptation. One of these barriers is the large gap between the scientific community and general public in terms of understanding, awareness and perceptions of risk about CC. This implies that although societies are aware and uneasy about CC, they may not fully understand the fundamental science, possible effects, or the responses needed in order to ameliorate its impacts. According to Osberghaus et al. (2010), knowledge about the specific causes and effects is vital to generate the motivation to engage in protective

Table 3. Linear impact of the results of testing variables used to assess general research hypotheses.

Reject/Approve at 0.05 level Women	Significance level (P-value) Women	T statistic (t-value) Women	Path coefficient (β) Women	Research hypotheses
Confirmed	0.001	3.41	0.19	Vulnerability perception → Adaptation behaviour
Confirmed	0.001	4.64	0.33	Perceived severity → Adaptation behaviour
Confirmed	0.001	5.59	0.40	Self-efficacy → Adaptation behaviour
Confirmed	0.001	4.83	0.35	Response efficacy → Adaptation behaviour
Confirmed	0.001	-8.36	-0.61	Response costs → Adaptation behaviour

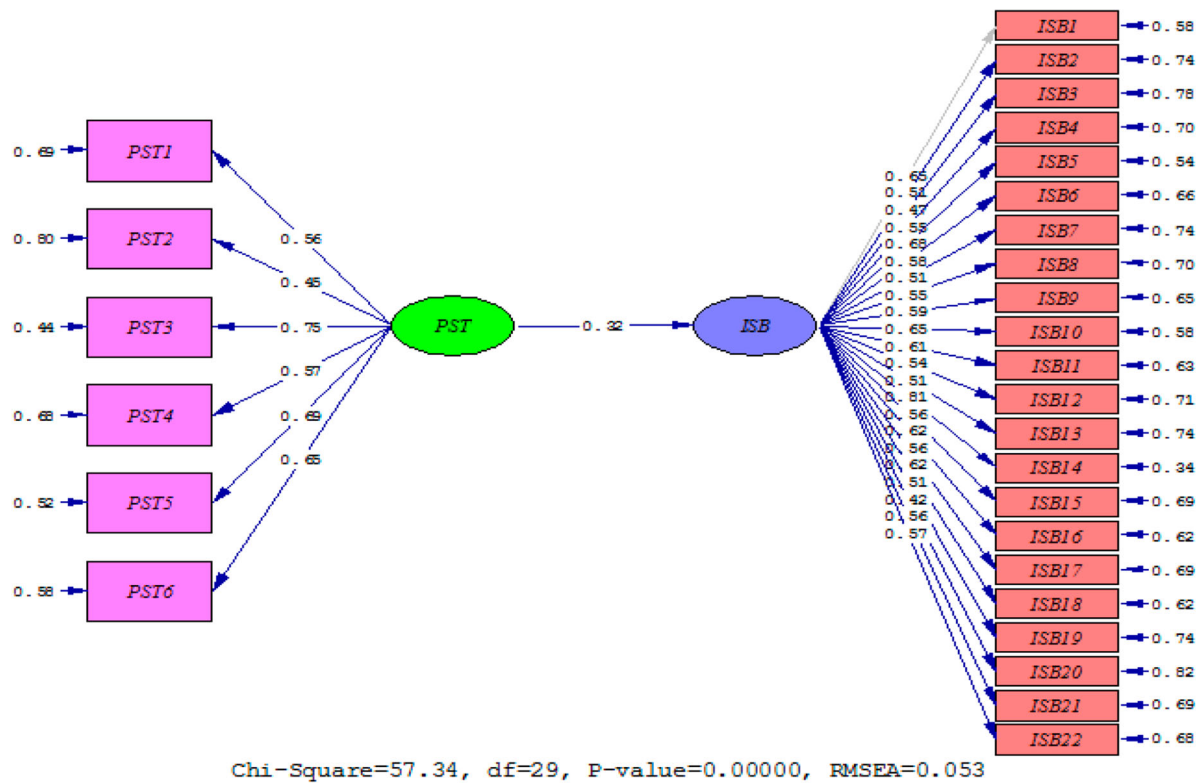


Figure 3. The model for the effect of the perceived severity on female paddy farmers' adaptation behaviour.

strategies, as well as increasing the range of adaptive strategies an individual is likely to choose from. In other words, individuals are ill-equipped to deal with multiple-cause problems because they can generally not be solved with one clear

approach, often resulting in a sense of helplessness. The uncertain nature and onset of possible CC effects, as well as constant media debates between skeptics and supporters, may lead to confusion and naturally deter any decisive, rational action.

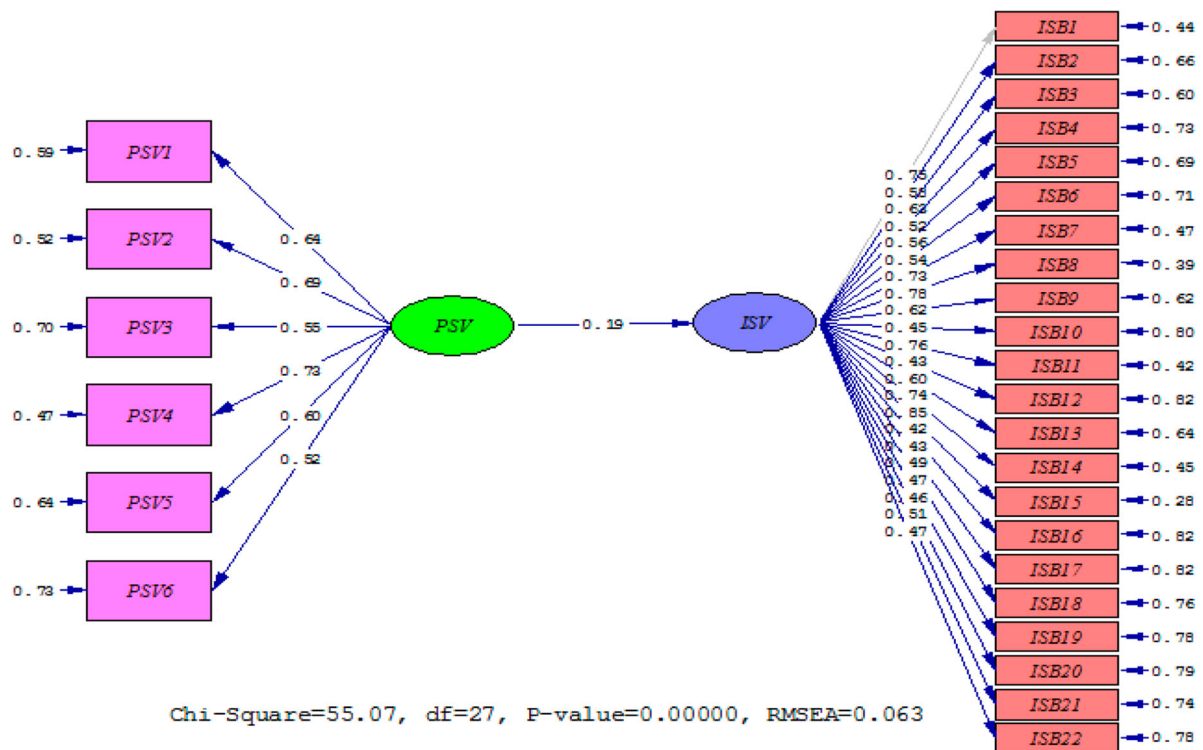


Figure 4. The model for the effect of vulnerability perception on female rice farmers' adaptation behaviour.

As a result, individuals tend to deny the threat or use heuristics such as unrealistic optimism which are likely to lead to under- or misestimating of threats in situations where uncertainty is high. Thus, lack of understanding about the true causes and mechanisms of CC may distort perceptions of risk among the public and hinder the implementation of any adaptive measures. The uncertainty related to CC and the imperfect information available to the public are evidently limiting factors when it comes to engaging in efficient adaptive behaviour. Information is required for women heads of households to make rational decisions and hence to operate in support of adaptation. As mentioned by van Valkengoed and Steg (2019), Smith and Mayer (2018) and Goli et al. (2020), information is vital to ensure that adaptation is carried out in an adequate and timely manner. Thus, the dissemination of research findings and the predictions about future CC impacts through information campaigns, including their temporal and spatial onset, is a key tool to increase the awareness of women.

According to the study findings (Table 3), female rice farmers' response costs ($\beta = -0.61$) have the greatest influence on their actions in responding to CC relative to the other two variables (self-efficacy and response effectiveness). Therefore, it can be said that response costs have an inverse but strong effect on adaptation behaviour. In other words, by decreasing the rice farmers' response costs, assuming that other variables are constant, their adaptation behaviour improves. In addition, the results show that (Figure 5) the most significant subsection of the response cost that has the biggest impact on reducing the cost of adapting is water consumption management ($\beta = 0.82$). Therefore, from the women's point of view, spending money, time, energy, and effort on equipping irrigation systems to manage water consumption, as a fundamental solution to resist the changing climate, is going to be cost-effective and supportive. Perceived costs, such as financial costs, time, and more effort, will also lead to better coping appraisal and as a result, better protective actions and more adaptation by the female rice farmers. As shown by Gawith et al. (2020), the costs of adapting to CC are of particular importance and should not be overlooked. Economic constraints reduce farmers' adaptation. They also consider the costs of injury to use adaptation strategies and select adaptation options accordingly. Strategies such as irrigation and conservation technologies were perceived as costly for female farmers in terms of finance, labour and time. Response costs such as financial, time, effort, and emotional costs represent all the perceived costs connected to protective actions. Under an underdeveloped financial system and uncertainty in the production, pattern female farmers are less likely to invest on such technologies. Wealth and human capital are important predictors of adaptation behaviour among female farmers. Consequently, costly strategies are less accepted and implemented by female farmers who have less access to credit and financial resources. In fact, female farmers' subjective understanding of changes in the climate positively influences their protection motivation, while the high cost of adaptation measures negatively affects their protection motivation (Ali & Erenstein, 2017; Bagagnan et al., 2019; Keshavarz & Karami, 2016).

As Table 3 indicates, the efficacy of the response of female rice farmers ($\beta = 0.35$) has a considerable positive effect on their

adaptation behaviour to climate threats. However, the research hypothesis is verified. Furthermore, the findings of the analysis of subsections of efficacy indicate that water consumption management ($\beta = 0.81$) has the highest effect on response to protective actions (Figure 6). In other words, water consumption management in paddy fields by female rice farmers will be effective in reducing danger and improving coping appraisal to increase protective and adaptation behaviours. These findings are in line with the findings of studies by Arouna and Akpa (2019), and Kolytha and Malamataris (2020).

As the results of Table 3 show, female rice farmers' self-efficacy elements ($\beta = 0.4$) have a major positive impact on their actions in responding to CC, which confirms the research hypothesis. In other words, by increasing rice farmers' self-efficacy, assuming that other variables are constant, their adaptation behaviour improves. As shown by the results, adjusting women's cultivation techniques ($\beta = 0.81$) has a greater effect on their self-efficacy. This means women would be more capable of adjusting cultivation techniques, such as irrigation scheduling, fertilization, and using chemicals (insecticides and herbicides), as a coping and adaptation action, which will lead to more desirable results (Figure 7). These results are consistent with studies conducted by Bockarjova and Steg (2014) and Keshavarz and Karami (2016). Their study shows that self-efficacy beliefs serve as a strong, optimistic indicator of the purpose of adaptation.

Therefore, in climate decision-making, it is necessary to differentiate adaptation behaviours aimed at reducing global risks, and those associated with personal adaptation action to protect livelihoods against future climate-related threats. In fact, it is perceived risk, vulnerability, the severity of adverse consequences, and the potential to minimize those risks through the individual's self-efficacy and response efficacy. This is because, female farmers are more likely to engage in behaviours that minimize risks under the conditions of perceived higher susceptibility and severity, as well as high response efficacy and perceived self-efficacy. However, in the case of CC, maybe female farmers underestimate risks. This is due to two factors. Firstly, they (may) lack personal experience of climate hazards against which to imagine and interpret future CC-related hazards. Secondly, there are cognitive challenges associated with engaging with low probability-high consequence events. This means that CC can potentially remain 'invisible' or psychologically distant.

4.3. Adaptation behaviour

Since agriculture itself is recognized as one of the factors involved in CC, on the one hand, and is significantly affected by CC and its consequences, on the other hand, the most critical behaviours for CC adaptation have been analyzed in this research from the point of view of female rice farmers. The results show that (Figures 8 and 9) the most important adaptation behaviours from the viewpoint of female rice farmers are protective agriculture ($\beta = 0.85$), using crop rotation ($\beta = 0.77$), and using guaranteed crop insurance ($\beta = 0.76$). In fact, from the female rice farmers' point of view, using methods such as crop rotation, preserving plant residues on the soil surface for soil regeneration and fertility, paddy

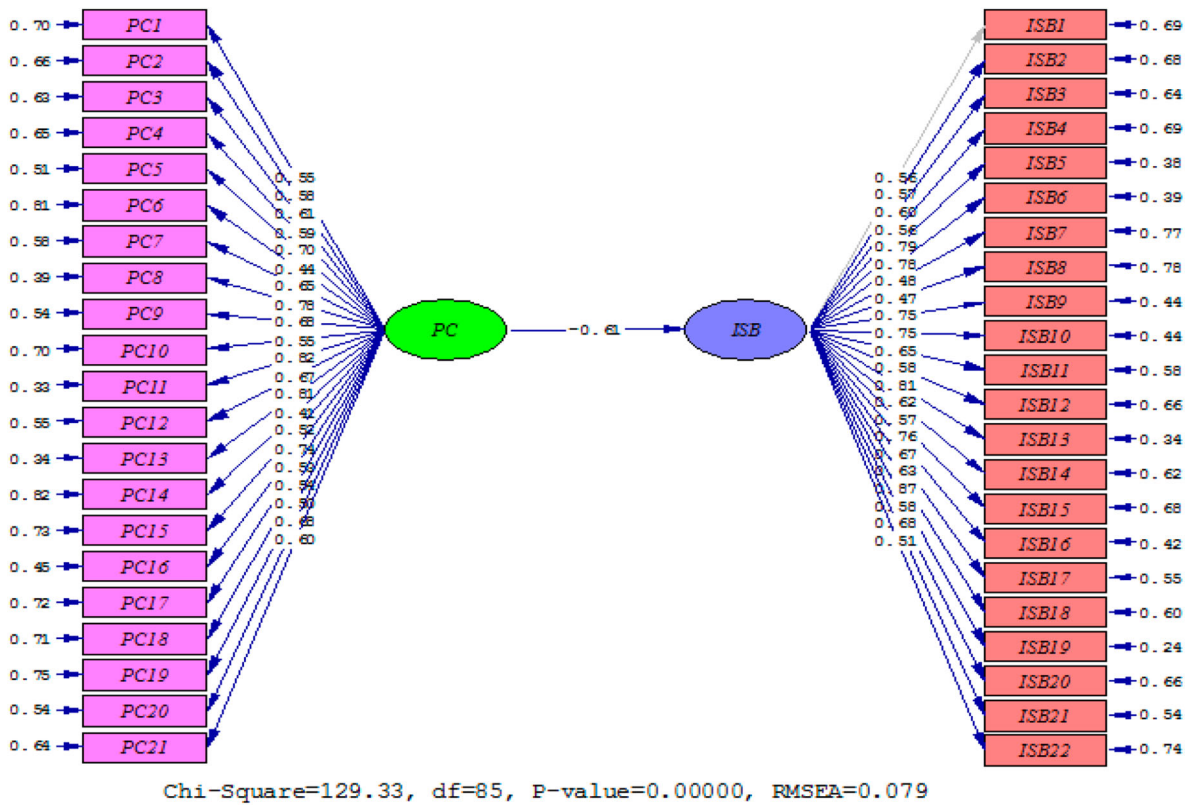


Figure 5. The model for the effect of response costs on female rice farmers' adaptation behaviour.

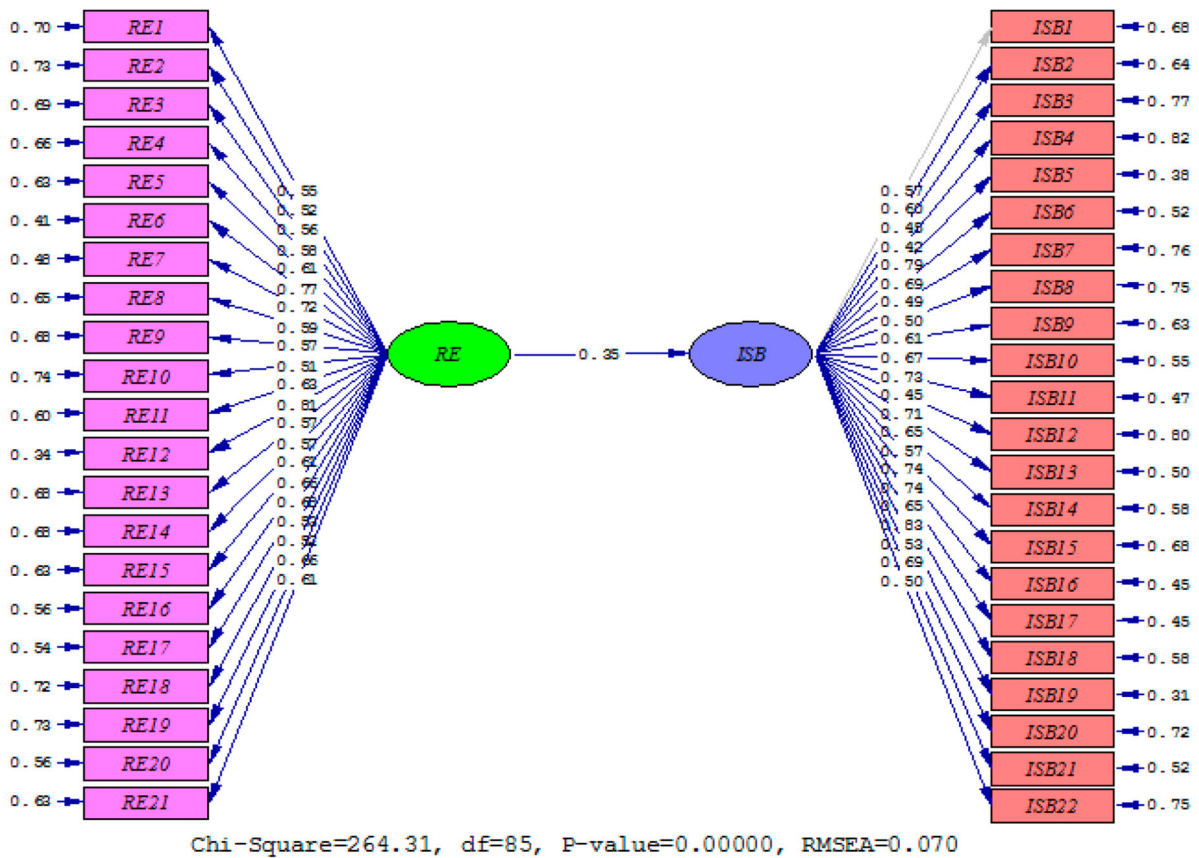


Figure 6. The model for the effect of response efficacy on female rice farmers' adaptation behaviour.

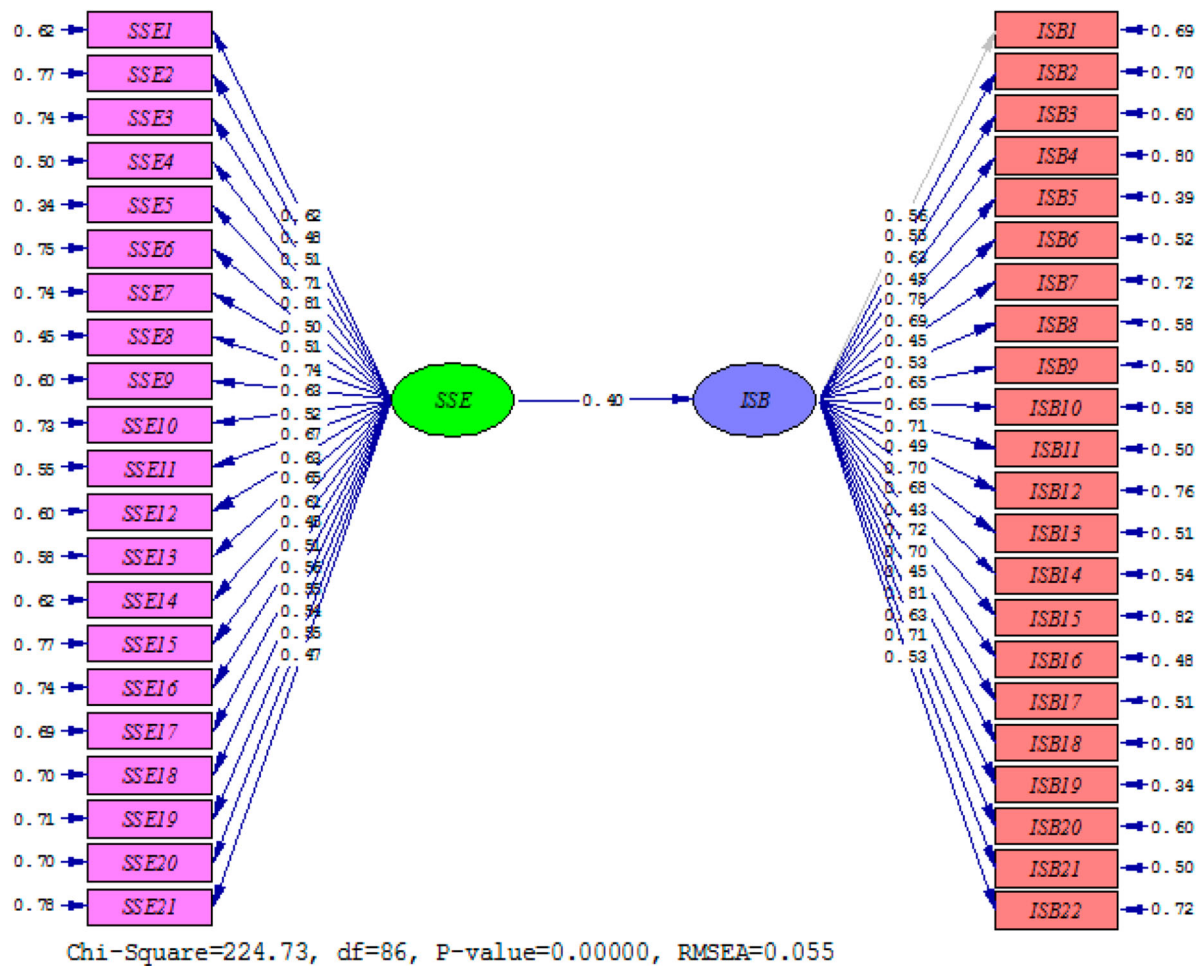


Figure 7. The model for the effect of self-efficacy aspects on adaptation behaviour.

fields levelling, using green fertilizers, proper use of agricultural machinery, as well as the government support for the optimal services of guaranteed index-based insurance (index based payout is paid as predefined damage for some index), can be very important and effective in adaptation to changing climate. This result is consistent with Dittrich et al.'s research results (2016). Furthermore, the findings of the study by Lawrence et al. (2014) show that the use of conservation agricultural methods as a strategy for CC adaptation plays an important role in meeting food security objectives. As shown by Teixeira et al. (2018), CC adaptation depends on the environmental and economic feasibility of future cropping systems. Therefore, the use of crop rotation approaches on agricultural land may also be one of the appropriate solutions for CC adaptation.

4.4. Determining the model fit quality

Table 4 shows the results of indices obtained from running the model. According to the fit indices presented in the table above, the calculated relative chi-square value is 2.200. A chi-square smaller than 3 is desirable. In addition, RMSEA (Root Mean Square Error of Approximation) must be less than 0.08, which is 0.027 in the proposed model. The values of goodness of fit indices, i.e. GFI, AGFI, CFI, and NFI, must be greater than 0.90, which in the studied model, are

0.96, 0.93, 0.94, and 0.92, respectively. Therefore, considering the fit indices, it can be said that the collected data support the conceptual model appropriately. In other words, it can be said that the research model has a good fit.

Finally, in Mazandaran Province, the field model of the adaptation behaviour of female rice farmers in the face of CC (Figure 10) can be presented as follows.

5. Conclusions and policy implications

The main purpose of this study was to investigate the behaviour of female rice farmers in relation to adaptation to CC. Therefore, the statistical population of this study was only female rice heads of households, so men were not studied. That is why the focus of research questions is on women. However, the results of the study (as mentioned in the Results, Discussion and Conclusion sections) show that the decision-making depends on the situation and sometimes requires joint or individual decisions (by women or men alone or jointly). This study contributes to the understanding that women's distinctive social roles and potentials for representation provide opportunities to promote effective solutions for sustainability, disaster risk reduction, and adaptation solutions. Perceived severity has a considerable positive effect on the behaviours of female rice farmers on adaptation,

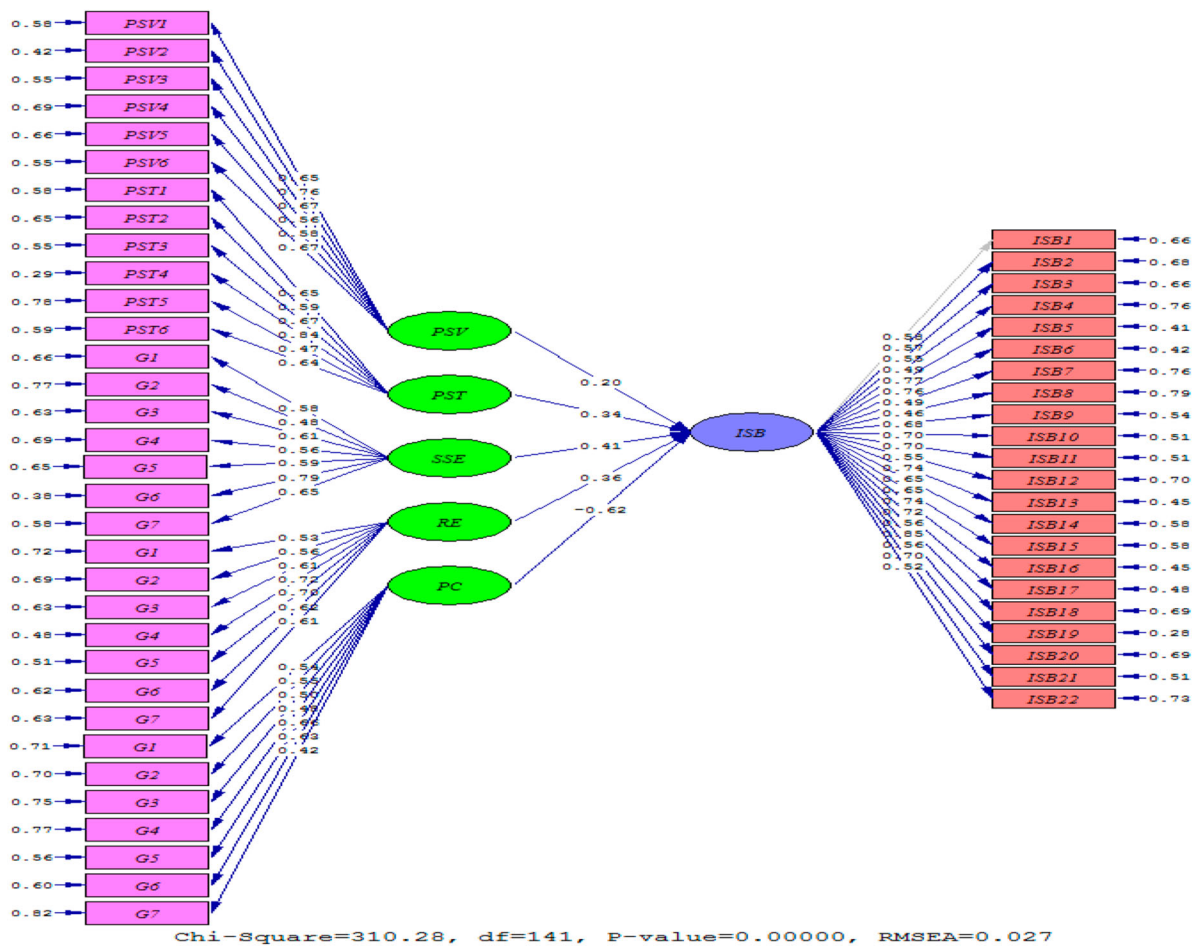


Figure 8. The model for factors affecting female rice farmers' adaptation behaviour (in standard mode).

according to the findings. In addition, the perceived vulnerability of female rice farmers has a positive influence on their production and behaviours in responding to CC. Considering the noticeable positive effect of response costs on adaptation behaviours, women find it useful to spend money to manage water consumption. The results confirm the considerable positive impact of response efficacy on the female rice farmers' adaptation behaviours. From their point of view, water consumption management is of high importance and is the most successful and advantageous approach to vulnerability mitigation and climate disaster management. The findings also suggest that self-efficacy has an important effect on female rice farmers' behaviour in terms of adaptation.

According to the findings of this study, it can be concluded that the adaptation behaviours of the female farmers cannot be possible with ad hoc measures such as a small cash grant; one must look for direct asset (e.g. land) transfers. At the heart of the asset transfer approach lies the belief that assets (and asset transfers) are central to increasing the adaptive capacity of female households to CC. Now is the time to build on this experience and significantly scale up the most successful asset approaches that have shown proven impact in allowing people to protect their assets, improve their livelihood and increase their adaptation to CC. These programmatic interventions typically involve asset transfers that provide female farmers with the capital needed to establish new income-generating

activities. When combined with training support, some protective and/or preventive measures and community mobilization, these interventions can transform the lives of extreme female farmers and lead them to greater adaptation to CC. The role of indigenous knowledge and its combination with new technologies should not be ignored in this regard. The key to the success of the national CC programme in rural areas would be correct targeting, comprehensive monitoring and evaluation, and active participation of all stakeholders including female farmers, local government and local elites. In addition, attention must be paid to establishing strong collective organizations of the female farmers to ensure that grassroots mobilization becomes a vehicle for breaking, rather than reinforcing, the existing social order and inequalities.

It would be worthwhile to acknowledge that there may be barriers to women adopting techniques that were not explored in this research (e.g. barriers in access to credit or loans, ties in women's social networks and livelihood capitals) that would need to be understood in order to positively increase self-efficacy.

According to the findings of this study and based on Iran's current CC plans and policies the following suggestions are offered:

- In reviewing macro-agricultural policy, special attention is needed to rural women to improve adaptation approaches.

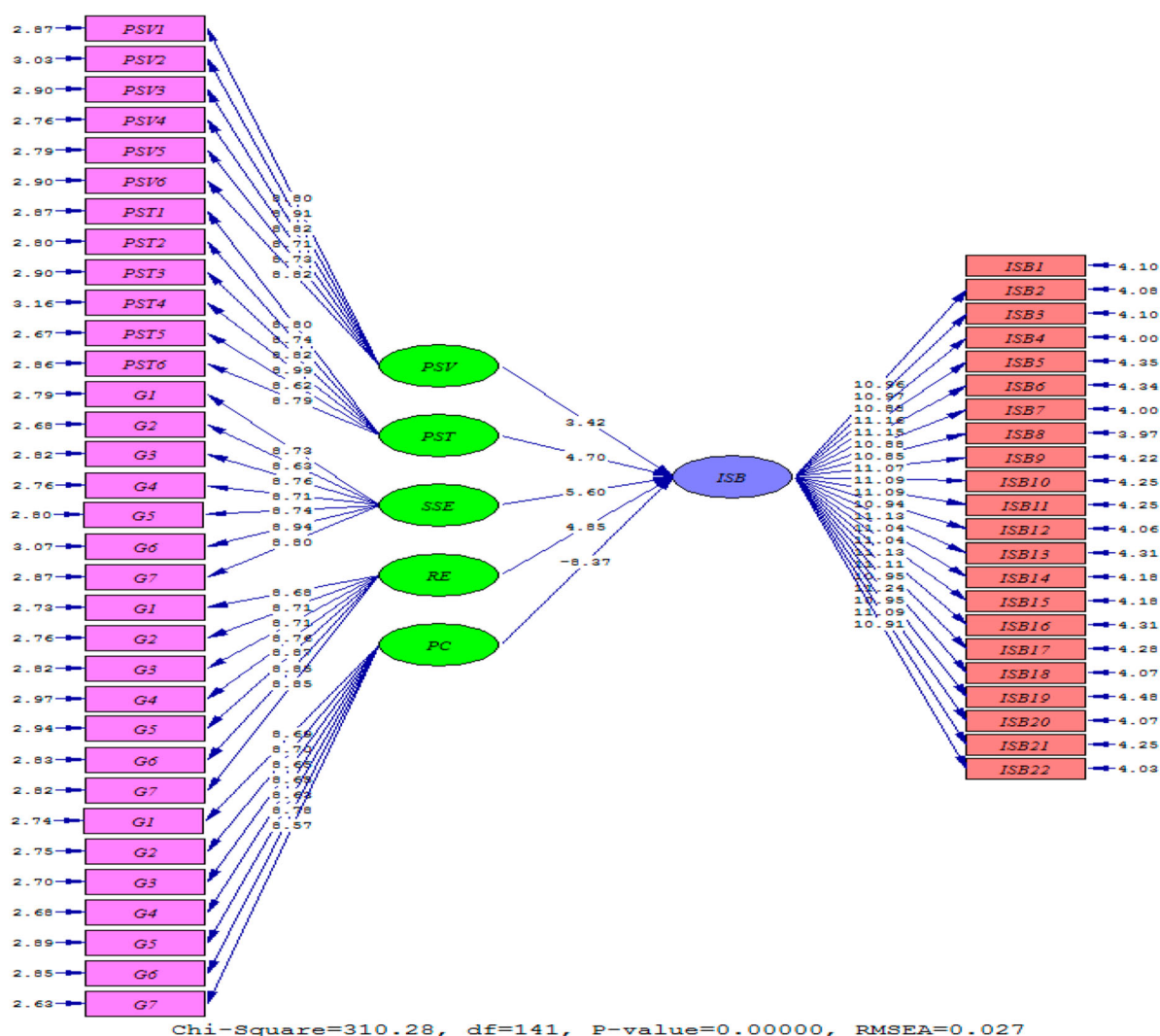


Figure 9. The model for factors affecting female rice farmers’ adaptation behaviour (in significance mode).

Table 4. Fit indices of the structural equations model.

Model Fit criteria	Acronyms	Value	Desired limit	Interpretation
Chi-square to degree of freedom ratio	χ^2/df	2.200	< 3	Desirable
Goodness of Fit Index	GFI	0.96	> 0.90	Desirable
Adjusted Goodness of Fit Index	AGFI	0.93	> 0.90	Desirable
Normalized Fit Index	NFI	0.94	> 0.90	Desirable
Comparative Fit Index	CFI	0.92	> 0.90	Desirable
Root Mean Square Error of Approximation	RMSEA	0.027	< 0.08	Desirable

This can be done by developing the technical capacities of rural women through education and their economic capacities through financial support, low-interest loans, and social capacities such as raising awareness and expanding rural women’s social networks.

- To improve the education of rural women more links between agricultural research and extension services are needed. Because the introduction of new, compatible and tolerant cultivars and new methods of management requires serious attention and multilateral cooperation between organizations.
- In this regard, it recommends the use of laboratory or live laboratory activities. These are multi-actor platforms where

women farmers could also learn from each other. A good example of this is in Estonia that farmers really like to learn from each other. They visit the ‘lighthouse’ farmers and try to learn from the best practices of other farmers. This can also be promoted among Iranian female farmers.

- To improve the education of rural women more links between agricultural research and extension services are needed. Because the introduction of new, compatible and tolerant cultivars and new methods of management requires serious attention and multilateral cooperation between organizations.
- To increase the motivation and support of rural women, the Agricultural Insurance Development Fund should have a

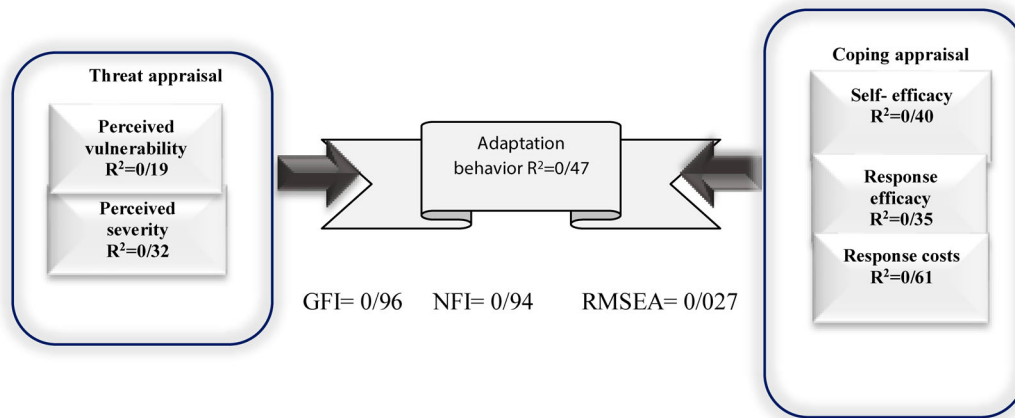


Figure 10. Field model of adaptation actions of female rice farmers against climate change in Mazandaran Province.

special focus on rural women as a marginalized group but an active element in the agricultural sector. Therefore, it is recommended that the government establish index-based insurance to ensure that women farmers will not be left without income in case of unfavourable weather and events.

- Relevant organizations should prepare integrated food-water, energy and climate programmes, especially for women, in order to maintain food security for family members. This is because women are responsible for the health and nutritional needs of the family.
- To strengthen women's human capital, it is necessary to formulate laws and regulations for proper and equitable access of rural women to health services and productive resources such as land, water and agricultural implements, along with training on coping methods, safety and increasing the production of healthy products.
- Planners and policy-makers need to pay attention to gender differences and move to reduce the existing differences and gaps. The process of issuing surface and groundwater harvesting permits for agricultural use needs to be reviewed. The fair issuance of these licenses should be far from any gender discrimination.
- The provision of financial and technical assistance by international organizations to reduce the adverse effects of CC should be considered in order to protect women as the most vulnerable, especially in developing countries. At last, it is recommended to design an official site by international organizations as a convenient place to document and share current and future events internationally.

The results of this study can be implemented as the first step of targeting large geographical regions for female farmers to adopt CC adaptation behaviours. The research also illustrates the important socio-economic disadvantages experienced by female farmers. In addition, the results of this study can help to identify behaviours determining women's adaptation to CC, as well as strategic planning and intervention by the public and private sectors.

One of the underlying drawbacks of a philosophical analysis, such as the analysis carried out in this article, is that only

the outcomes of this paper offer objective evidence for the proposed hypothesis. In addition, this methodology does not illuminate the underlying power dynamics of decision-making at the household level. This study includes an important unavoidable constraint that stems from discriminatory gender traditions, local culture, norms and practices at the level of rural communities in Iran, and as an important constraint can affect women's livelihood choices and hinder the implementation of recommendations. Therefore, in future studies, the study of these relationships and proposed systems will be interesting and significant. In addition to the variables studied in this research, some mediating variables like the tendency to behaviour, attitude, and motivation and the will for continuity and sustainability can be important to develop adaptation to CC action among female rice farmers. The mediation results of these factors are also proposed to be explored in future research.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

Raw data were generated at Tehran Science and Research Branch University. We confirm that, the data, models, or methodology used in the research are proprietary, and derived data supporting the findings of this study are available from the first author on request.

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