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Investigating the conceptual model of the formation of psychological resilience in farmers affected by droughts in Iran using structural equation modeling

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Abstract

Introduction Drought has had a significant impact on farmers, resulting in a substantial increase in mental health disorders among them. This study aimed to test the model of forming psychological resilience among farmers in drought-affected regions in Iran using a valid and reliable tool designed during the research.

Method A quantitative cross-sectional study was conducted in 2024 in two stages. Firstly, the tool for measuring the model components was designed. Its psychometric properties were evaluated using the content and face validity as well as Cronbach's alpha and test-retest methods. Secondly, the model was tested using structural equation modeling (SEM). The sample size was estimated as 400 farmers being selected by the cluster–random sampling method. Descriptive statistics were performed using SPSS version 22.0 and SEM was conducted using Mplus version 7.

Results Out of 400 distributed questionnaires, 387 were returned to the researchers. The psychometric results showed acceptable validity and reliability (CVI = 0.86, CVR = 0.92, and Cronbach's alpha = 0.88). The SEM results indicated that the initial model needed modifications to improve fit indices (χ^2/df = 2.30, CFI = 0.67, TLI = 0.77, RMSEA = 0.042, SRMR = 0.031). The valid model for psychological resilience was achieved after conducting the modifications (χ^2/df = 2.90, CFI = 0.98, TLI = 0.97, RMSEA = 0.031, SRMR = 0.021).

Conclusion This study showed that the model is appropriate for the context of Iran. Utilizing the model and its components, targeted interventions can be implemented to improve the psychological resilience of farmers both in practice and in the field. Furthermore, the tool designed in this study allows for the analysis of the model's applicability in other provinces affected by drought in Iran. Based on the findings, informed decisions and interventions can be effectively formulated.

Keywords Psychological resilience, Mental health, Farmers, Droughts, Structural equation modeling

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Introduction

Drought is a prolonged period of abnormally low precipitation, resulting in a shortage of water for various human and environmental needs [1]. The consequences of drought can be severe, including reduced agricultural productivity, water scarcity, ecosystem degradation, and economic hardship [2]. Farmers are among the populations mostly impacted by drought and their livelihoods are directly dependent on the availability of water and the productivity of the land [3].

While the physical and financial impacts of drought on farmers are well-documented [4], its psychological consequences remain underexplored. Drought can intensify stress, anxiety, depression, and suicidal ideation as farmers face the loss of crops, livestock, and income.

This psychological burden is particularly underreported in some regions. International studies from countries such as Australia, the United States, France, the UK, and India consistently link prolonged drought with increased psychological distress among farmers [5–10]. For example, an Australian survey highlighted a direct correlation between agricultural losses and mental health issues [5], while Indian studies reported elevated depression and suicide rates in drought-affected regions [11]. These findings highlight the need for targeted mental health interventions in drought-affected agricultural regions.

Many countries are facing climatic disasters, such as droughts, as one of the most important ones [12]. The countries in the Middle East, including Iran, have frequently encountered droughts profoundly impacted by the consequences of this phenomenon [13]. Iran, located in arid and semi-arid regions, is expected to face severe to extremely severe drought conditions by 2039 [14]. In Iran, where small-scale agriculture underpins the economy, over 90% of regions face some form of drought [15, 16], with significant psychological effects on farming communities. These drought-related stressors have led to reduced life satisfaction and quality of life, as well as low psychological resilience among Iranian farmers [17–23], emphasizing the need for a tailored psychological resilience framework [24, 25].

Psychological resilience—the ability to maintain mental well-being despite adversity—is critical in mitigating drought-induced stress [26–28]. However, existing models fail to address the unique challenges faced by drought-affected farmers, highlighting the need for a context-specific framework [29–32].

Models extracted from qualitative studies often provide rich and deep insights into relationships and phenomena. However, they usually lack quantitative measures and generalizability. Conceptual models should be tested to evaluate hypotheses derived from qualitative and validating findings or to modify the theoretical framework. The test of the designed model helps to evaluate the efficiency and practicability of the model obtained from the qualitative stage. It is possible to use actual data to identify the strengths and weaknesses of the model. This can help to develop a practical model to enhance the psychological resilience of farmers affected by drought.

Therefore, in this study, we used a conceptual model derived as one part of the first author's PhD dissertation. This model showed the process of forming psychological resilience among farmers living in drought-affected regions in Iran [33]. Accordingly, the current study aimed to test the model of forming psychological resilience among farmers in drought-affected regions in Iran using a valid and reliable tool designed during the research.

Policymakers and decision-makers can use the model of psychological resilience among farmers in drought-affected regions to implement community-oriented planning. These strategies aim to improve the psychological resilience of farmers. Additionally, they can help prevent mental disorders caused by the unfortunate consequences of drought in this group. Also, targeted interventions and support systems can be designed based on the extracted paradigm framework and appropriate to the available resources.

Methods

Study design

This research is a quantitative cross-sectional study. The following steps were taken to test the model. A research tool was developed based on the components of the conceptual model for data collection. Using the developed tool, data were collected from the community of farmers to ensure relevant and contextual insights. Then, the structural equation modeling (SEM) method was employed to measure the fitness criteria for the model and extract the final model (Fig. 1). The study was conducted between February 2024 and September 2024.

Settings

Nearly all regions of Iran are affected by droughts (Fig. 2). Khorasan Razavi province is one of the areas that has endured significant droughts in recent years. Khorasan Razavi province, situated in northeastern Iran, is experiencing severe drought conditions affecting nearly all areas (Fig. 3) [34]. The province features diverse agricultural landscapes, encompassing various climates such as hot, dry, temperate, and mountainous regions, along with both irrigated and rainfed farming practices [35]. It comprises 34 cities and 179 villages [36]. Selected villages were identified from Sarakhs, Neyshabur, Bardaskan, Fariman, and Khaf districts by the mean of cluster random sampling.

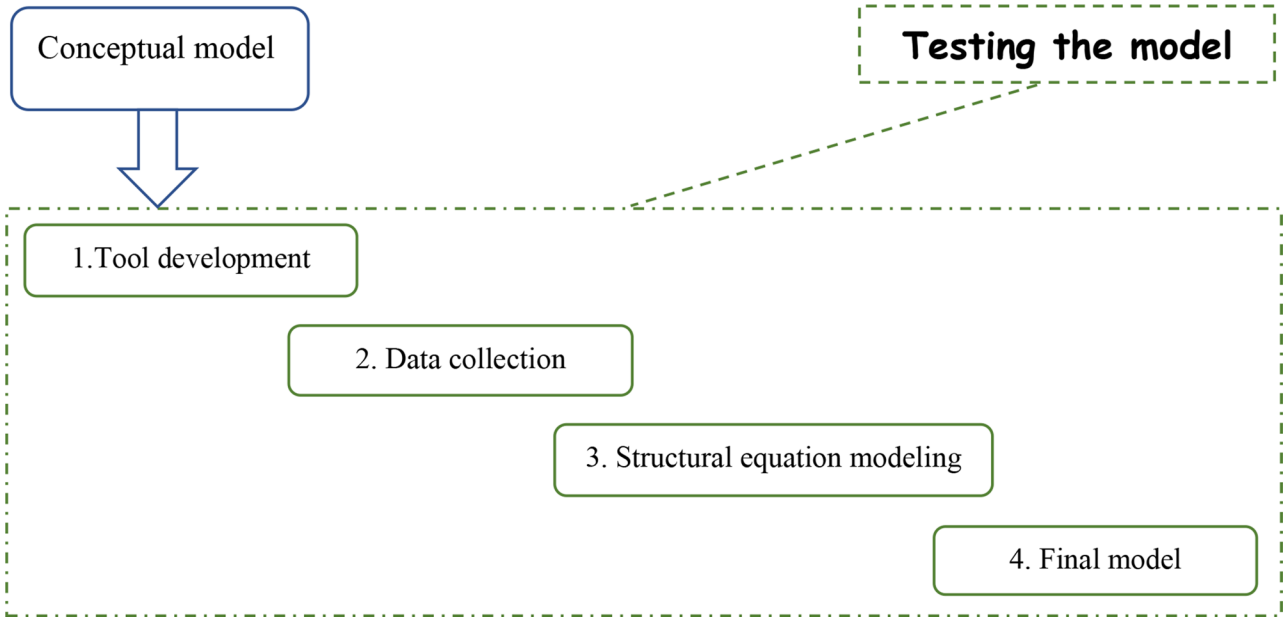

Fig. 1 Study steps

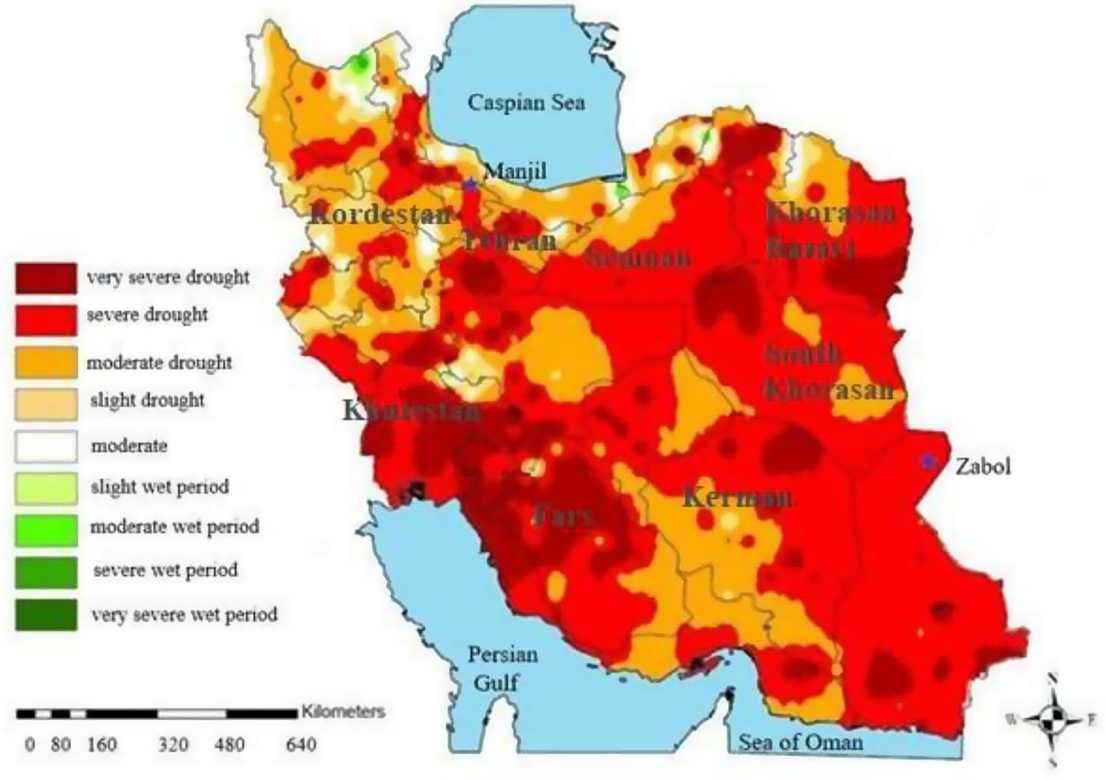

Fig. 2 Drought atlas of Iran based on SPEI in 10 years, 2018 [37]

Conceptual model

We developed a conceptual model for forming psychological resilience among farmers in drought-affected regions in Iran. This model was created through a qualitative study using the grounded theory approach, which is a systematic methodology for generating theories from qualitative data [39]. Grounded theory involves iterative data collection and analysis, allowing researchers to identify key themes and develop a theoretical framework based on participants' lived experiences [40]. In

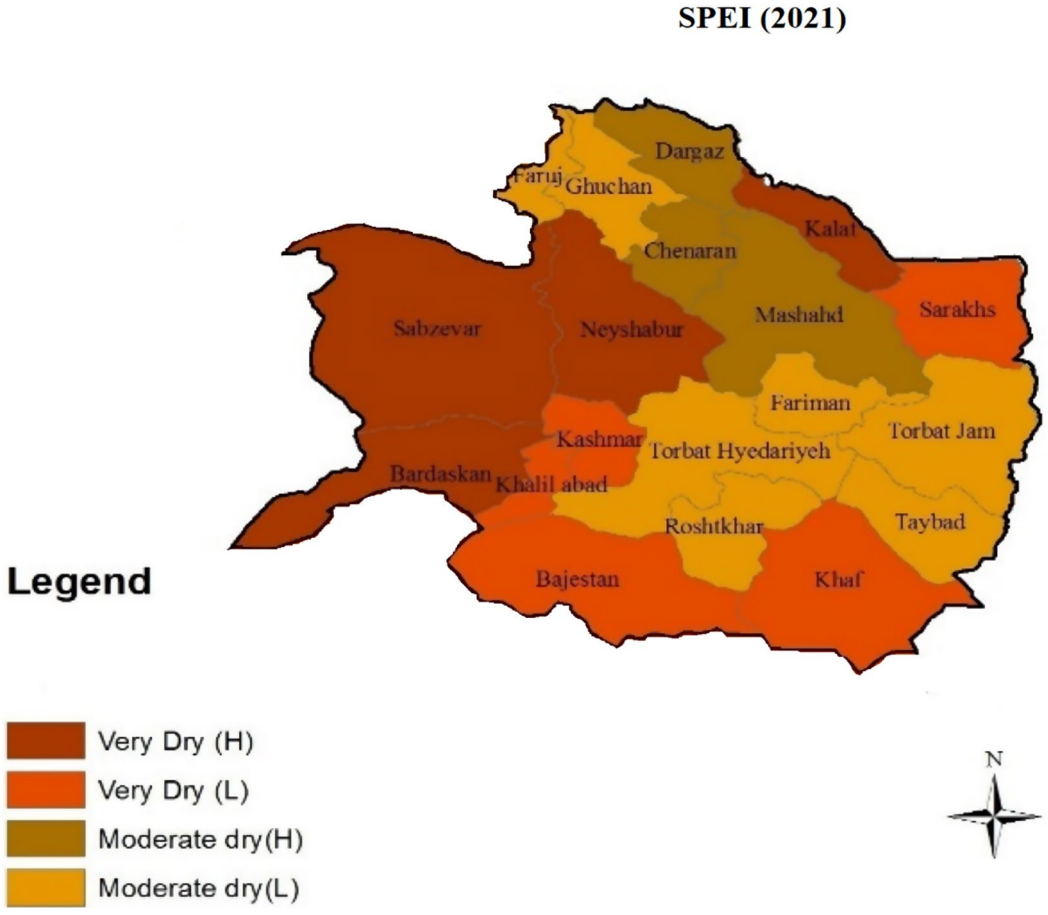

Fig. 3 Map of drought severity using SPEI in different regions of Khorasan Razavi province in 2021 [38]

our study, data were collected through in-depth interviews with farmers, analyzed using open, axial, and selective coding to construct the resilience model [41]. This approach ensures that the model is grounded in empirical evidence, reflecting the psychological adaptation strategies of farmers facing drought conditions.

This paradigm model uses the Corbin and Strauss (2015) approach and consists of three components conditions, actions-interactions and consequences, and a main phenomenon. This study showed that the main phenomenon is adaptation to the impacts of drought. The factors related to the condition component include psychological factors, personal characteristics, perception and knowledge, and agricultural infrastructural factors. The actions-interactions component includes drought coping strategies as action and economic, health, cultural and social factors, and government policies were obtained as part of the reactions. Also, the consequences component with classes, including the formation of psychological resilience and reduction of mental disorders, were discovered (Fig. 4) [33].

The tool

The initial tool was designed based on the components of the conceptual model. Each of the 12 factors in the model was considered a distinct construct, and for each construct, a set of items was developed to represent its corresponding subcategories. Consequently, during the initial phase of tool development, a pool of 104 items was created to ensure comprehensive representation of the model's dimensions and components. This preliminary tool underwent extensive review during individual and group meetings, focusing on the clarity of writing, organization of components, and specificity. Ultimately, after eliminating items that conveyed repetitive concepts, the refined tool emerged with 67 items.

Psychometric properties of the tool

Following the creation of a provisional version of the tool, the process for assessing its psychometric properties was carried out as described below:

Content validity

The provisional tool was distributed to 10 professionals, including specialists in drought management, agriculture,

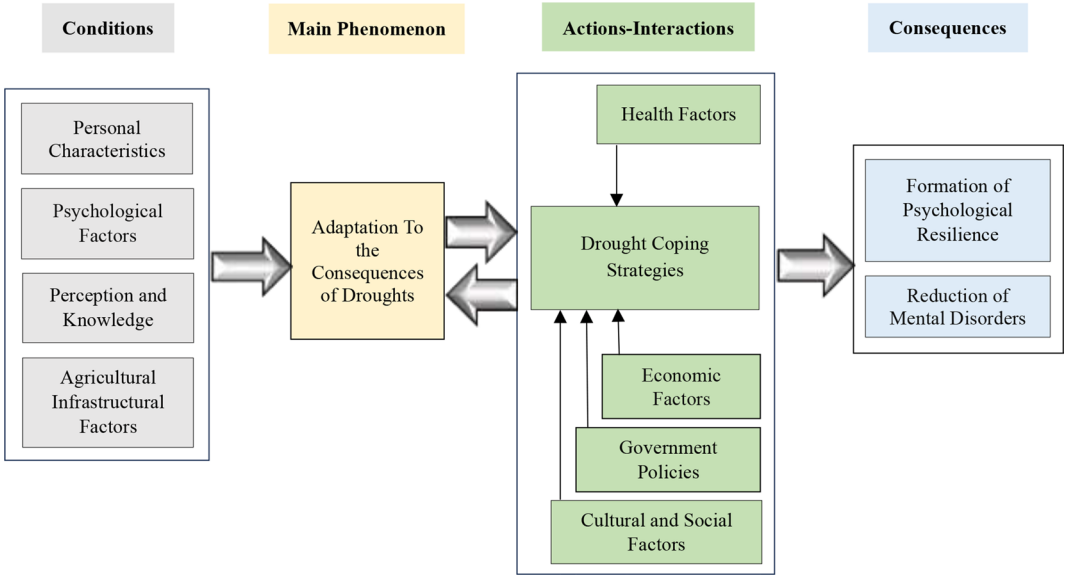

Fig. 4 Conceptual model of forming the psychological resilience among farmers living in drought-affected regions in Iran

health in disasters and emergencies, health policy, and psychology. They were requested to review the grammar, wording, and item placement for each component. If any discrepancies were identified, they were asked to suggest improvements. Additionally, a survey was conducted with 15 farmers to clarify any ambiguities and enhance the clarity of the items. Feedback from both the professionals and healthcare workers was gathered and discussed among the research team, leading to necessary modifications. Some items were further clarified with additional descriptions. To evaluate the validity of the revised tool, we used the content validity index (CVI), content validity ratio (CVR), and impact score (IS). Two separate documents were sent to 20 university professors and subject matter experts. The first document focused on CVI evaluation, where experts assessed each item based on relevance, clarity, and simplicity [42]. According to Polit et al.'s guidelines, items with CVIs above 0.79 were deemed acceptable, those between 0.7 and 0.79 required revision, and items below 0.7 were considered unacceptable and removed. A valid assessment tool was expected to achieve a minimum average CVI of 0.80 [42]. The second document assessed the necessity of each item to calculate CVR [43]. Based on the Lawshe table, which provides thresholds according to the number of experts, items with a CVR greater than 0.49 (for 20 experts) were considered significant ($p < 0.05$), while those with lower CVR values were removed [43].

Face validity

After evaluating the content validity and removing items that did not meet the criteria, the IS was assessed. 20 farmers were asked to value the importance of the remaining items. Those with an IS lower than 1.5 were removed [44].

It is important to note that since the tool was developed based on the dimensions and components obtained from the qualitative phase, the assessment of construct validity was unnecessary at this stage and therefore excluded.

Reliability

The tool's reliability was evaluated using Cronbach's alpha for internal consistency and test-retest reliability. Cronbach's alpha was calculated using responses from the provisional tool, administered to 30 farmers. An alpha value above 0.7 indicates that the tool items are reliable and trustworthy [45]. For test-retest reliability, the same group of farmers completed the tool twice, with a two-week interval between administrations. The data were analyzed using intra-class correlation (ICC) test. A high correlation indicates good reliability over time (≥ 0.7) [46].

Testing the model

Sampling and data collection

The sample size was determined based on the widely accepted rule of thumb in SEM that recommends 10 respondents per observed variable or item [47, 48]. Given that the final tool consisted of 38 items, a minimum sample size of 380 was required to ensure model stability and statistical power. We therefore recruited 400 participants to ensure adequacy and account for potential non-responses or exclusions. Sampling utilized a cluster-random method. Initially, five districts were randomly selected out of 34 in Khorasan Razavi province using data from the Iran Statistics Center. Afterwards,

Table 1 Reliability coefficients for the tool dimensions

Dimension	Item	ICC	Cronbach's alpha
Personal characteristics			0.855
	Pc1	0.931	
	Pc2	0.977	
	Pc3	0.964	
	Pc4	0.891	
Psychological factors			0.931
	Pf1	0.901	
	Pf2	1.000	
	Pf3	0.942	
	Pf4	0.985	
Perception and Knowledge			0.916
	PK1	0.887	
	PK2	1.000	
Agricultural infrastructure factors			0.870
	Aif1	0.896	
	Aif2	0.951	
	Aif3	0.931	
	Aif4	0.942	
Adaptation to the consequences of drought			0.859
	Acd1	0.892	
	Acd2	1.000	
	Acd3	0.935	
Health factors			0.821
	Hf1	0.964	
	Hf2	0.964	
	Hf3	0.977	
Drought coping strategies			0.890
	Dcs1	0.931	
	Dcs2	0.963	
	Dcs3	1.000	
	Dcs4	0.898	
Economic factors			0.933
	Ef1	0.923	
	Ef2	0.978	
	Ef3	0.942	
Government policies			0.916
	Gp1	0.985	
	Gp2	0.988	
Cultural and Social factors			0.833
	Scf1	0.964	
	Scf2	0.964	
	Scf3	0.887	
Formation of psychological resilience			0.867
	Fpr1	0.892	
	Fpr2	1.000	
	Fpr3	0.931	
Reducing of mental disorders			0.966
	Rmd1	0.977	
	Rmd2	0.964	
	Rmd3	0.931	

*P-value: Not applicable (N/A)

five drought-affected villages and sixteen farmers from each village were randomly chosen in each district. In this study, drought-affected villages were identified by referencing sources that have analyzed the drought conditions in Iran [16, 49, 50] and by utilizing reports from reputable national organizations, including the Statistical Center, the National Drought Monitoring Center, and the National Center for Weather and Climate Change. The criteria for these farmers included being actively engaged in agriculture and having a minimum of three years of agricultural experience. The designed questionnaire was distributed and filled out by the farmers. Interviewers assisted illiterate farmers in completing the tools.

Data analyses

Demographic characteristics of the participants were presented as numbers and percentages. Subsequently, structural equation modeling (SEM) was conducted to evaluate the developed model. Five goodness-of-fit indices were used to evaluate how well the conceptual model matched the data: The chi-square to degrees of freedom ratio (χ^2/df), Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). χ^2/df is considered reasonable when close to 1, and values up to 3 are acceptable. The CFI values nearing 1 indicate a good fit, with those above 0.90 deemed acceptable. Similarly, the TLI also suggests a good fit for values over 0.90. The RMSEA indicates a good fit with values below 0.08. Lastly, the SRMR should be below 0.08 for a good fit. These indicators help assess how well the models represent the data and inform necessary adjustments. SPSS version 22.0 and Mplus version 7 were employed for statistical analyses.

Results

The tool

Face and content validity

According to the results from the CVI and CVR, 19 of the original 67 items were deemed unsuitable, leading to a reduction in the total to 48 items. The average CVI and CVR for the remaining 48 items were found to be 0.86 and 0.92, respectively, which suggests that the content validity was acceptable from the experts' perspectives. Additionally, it was noted that the IS for 10 items fell below the minimum acceptable threshold of 1.5, resulting in the retention of 38 items.

Reliability

Reliability coefficients (Cronbach's alpha) of the tool Dimensions are reported in Table 1. The results showed that the highest and lowest reliability coefficients were related to the effectiveness of reducing mental disorders, economic factors, and psychological factors,

Table 2 Demographic characteristics of the participants

#	Variable	Variable description	*N*	%
1	Age groups (year)	18–25	63	16.27
		25–40	107	27.64
		55 – 40	146	37.72
		55–75	71	18.34
2	Agricultural experience (year)			
		10 – 3	84	21.70
		10–20	91	23.51
		20–30	119	30.74
		More than 30 years	93	24.03
3	Gender			
		Mail	344	88.88
		Female	43	11.11
4	Marital status			
		Single	72	18.60
		Married	315	81.39
5	Educational level			
		Illiterate	71	18.34
		Middle school degree	142	36.69
		Diploma	102	26.35
		Bachelor	57	14.72
		Master	13	3.35
		PhD	2	0.51
7	Average monthly income (Rial)			
		Less than 100 million	146	37.72
		100–200 million	115	29.71
		200–300 million	89	22.99
		More than 300 million	37	9.56

Table 3 Mean and standard deviation of tool dimensions for the formation of farmers' psychological resilience

#	Dimension	Raw score range	Earned score range	Standard deviation ± mean
1	Personal characteristics	4–20	8–18	14.5 ± 3.2
2	Psychological factors	4–20	12–17	15.0 ± 2.9
3	Perception and Knowledge	2–10	5–9	7.0 ± 1.5
4	Agricultural infrastructure factors	4–20	8–16	13.5 ± 3.0
5	Adaptation to the consequences of drought	3–15	7–13	9.5 ± 2.5
6	Health factors	3–15	7–13	10.0 ± 2.3
7	Drought coping strategies	4–20	15–20	14.0 ± 3.1
8	Economic factors	3–15	7–13	10.5 ± 2.4
9	Government policies	2–10	3–8	6.0 ± 1.7
10	Cultural and Social factors	3–15	7–13	11.0 ± 2.6
11	Formation of psychological resilience	3–15	7–14	10.5 ± 2.2
12	Reducing of mental disorders	3–15	8–15	10.0 ± 2.1
	Total score	38–190	94–169	117.0 ± 22.0

respectively. The Cronbach's alpha for the total scale was 0.88. The ICC value for Test-Retest reliability was 0.927. The final tool included 12 domains and 38 items as follows (see Additional File 1): personal characteristics (4 items), psychological factors (4 items), perception and knowledge (2 items), agricultural infrastructural factors (4 items), adaptation to the consequences of droughts (3 items), health factors (3 items), drought coping strategies (4 items), economic factors (3 items), government policies (2 items), cultural and social factors (3 items), formation of psychological resilience (3 items), reduction of mental disorders (3 items).

Test of model

Descriptive characteristics

Out of 400 distributed questionnaires, a number of 387 ones was returned to the researchers. The majority of participants were male, comprising 89% of the sample, with an average age of 47.21 (± 26.32) years. Additional demographic details are provided in Table 2.

Analysis of tool's scores

Table 3 presents the total score, with a mean of 117.0 and a standard deviation of 22.0, reflecting the overall state of the model for farmers' psychological resilience to drought. The results highlight the importance of considering the various factors that influence farmers' psychological resilience.

To assess the dimensions of the model for the development of farmers' psychological resilience, we analyze the mean and standard deviation of each dimension's scores. These values provide insight into the overall state of farmers' psychological resilience against drought.

Personal characteristics, with a mean of 14.5 and a standard deviation of 3.2, highlight the significant role of individual traits in building resilience. The relatively high score suggests that farmers generally possess positive personal attributes that help them cope with challenges, including drought. Similarly, psychological factors show a high mean of 15.0 and a standard deviation of 2.9, indicating their crucial contribution to strengthening psychological resilience. Knowledge and awareness, a key dimension with a mean of 7.0 and a standard deviation of 1.5, emphasize the necessity of enhancing education and awareness programs to improve farmers' resilience to drought. Agricultural infrastructure factors, with a mean of 13.5 and a standard deviation of 3.0, underline the importance of improving infrastructure in the agricultural sector. This finding suggests that investments in agricultural infrastructure can play a vital role in strengthening farmers' resilience.

Adaptation to drought consequences, with a mean of 9.5 and a standard deviation of 2.5, underscores the need to reinforce adaptation strategies for drought. Regarding health factors, a mean of 10.0 and a standard deviation of 2.3 highlights the importance of farmers' health and well-being in fostering resilience. Drought coping strategies, with a mean of 14.0 and a standard deviation of

Table 4 Fit indices obtained using Mplus software for SEM

#	Indicators	Fit amount of the first model	Fit amount of final model	Acceptable fit
1	χ^2/df	2.30	2.90	$1 \le \chi^2/df \le 3$
2	CFI	0.67	0.98	≥ 0.9
3	TLI	0.77	0.97	≥ 0.9
4	RMSEA	0.042	0.031	≤ 0.08
5	SRMR	0.031	0.021	≤ 0.08

*Significance level = 0.05

**P-value: '< 0.01` for all path coefficients

3.1, indicate the presence of effective strategies in managing drought, positioning them as a key factor in farmers' resilience. Economic factors, with a mean of 10.5 and a standard deviation of 2.4, reflect the need to improve farmers' financial stability, while government policies, with a mean of 6.0 and a standard deviation of 1.7, demonstrate the government's influence on resilience-building efforts. Cultural and social factors, scoring a mean of 11.0 with a standard deviation of 2.6, further reinforce the role of community and social support in shaping psychological resilience.

Psychological resilience against the consequences of drought, with a mean of 10.5 and a standard deviation of 2.2, highlights its significance as a model outcome. Finally, reduction in mental disorders, with a mean of 10.0 and a standard deviation of 2.1, suggests that minimizing mental health issues can be an essential outcome of strengthening farmers' psychological resilience.

Model fitting

Normal distribution of data was confirmed using the Kolmogorov-Smirnov test before data analysis. The initial model fit yielded a χ^2/df ratio of 2.30, which falls within the acceptable range ($1 \le \chi^2/df \le 3$), indicating a reasonable fit of the model to the observed data. The CFI was 0.67, and the TLI was 0.77, both below the recommended threshold of 0.9, indicating that the model requires modifications for improved fit.

The initial model exhibited suboptimal fit, particularly in the CFI (0.67) and TLI (0.77), both of which fell below the commonly accepted threshold of 0.90, indicating a poor fit to the data (Table 4). These issues likely stemmed from low initial factor loadings (ranging from 0.42 to 0.59), suggesting that several observed items were weak indicators of their corresponding latent constructs [51, 52]. Modification indices provided by Mplus were reviewed, leading to the removal or reassignment of weak-loading items and the inclusion of theoretically justified covariances between related error terms. These steps enhanced model parsimony and improved the overall fit. After revision, the factor loadings improved substantially (0.71–0.99), and all fit indices met acceptable standards (Table 5).

Table 5 Comparative factor loadings before and after model modification

Construct	Example Item	Initial Loading	Final Loading
Personal Characteristics	PC2	0.55	0.91
Psychological Factors	PF3	0.48	0.94
Perception and Knowledge	PK1	0.44	0.87
Agricultural Infrastructure	AIF2	0.59	0.93
Adaptation to Consequences	ACD3	0.51	0.89
Health Factors	HF1	0.47	0.92
Drought Coping Strategies	DCS1	0.45	0.95
Economic Factors	EF2	0.50	0.98
Government Policies	GP1	0.42	0.88
Cultural and Social Factors	CSF2	0.49	0.93
Formation of Psychological Resilience	FPR3	0.56	0.94
Reduction of Mental Disorders	RMD1	0.53	0.90

Final model

Figure 5 shows that the path coefficients (or regression coefficients) between the variables range from 0.71 to 0.94, which are typically regarded as large effects. Strong path coefficients contributed to our well-fitting model, suggesting that the relationships among the variables were meaningful and potentially predictive. The p-values for all path coefficients were below 0.05, confirming statistical significance, and the 95% confidence intervals did not include zero, further supporting the robustness of these relationships.

The modified model identified a complex interplay among the main phenomenon (adaptation to the consequences of drought) and other model factors. For example, personal characteristics (PC) significantly impacted this adaptation process, with a strong path coefficient of 0.73 ($p < 0.01$, 95% CI: 0.69–0.77), indicating that experienced and educated farmers were better equipped to navigate the challenges posed by drought conditions. Similarly, psychological factors (PF) played a crucial role; a path coefficient of 0.75 ($p < 0.01$, 95% CI: 0.71–0.79) suggested that self-efficacy, job satisfaction, creativity and innovation, and sense of place enhanced a farmer's ability to adapt effectively, underscoring the importance of psychological resilience in coping with environmental stressors.

Farmers' perceptions and knowledge (PK) about drought impacts further contributed to their adaptation efforts, as indicated by a path coefficient of 0.71 ($p < 0.01$, 95% CI: 0.67–0.75). Those who were well-informed were more prepared to implement effective strategies. The availability and quality of agricultural infrastructure factors (AIF) also played a vital role, with a path coefficient

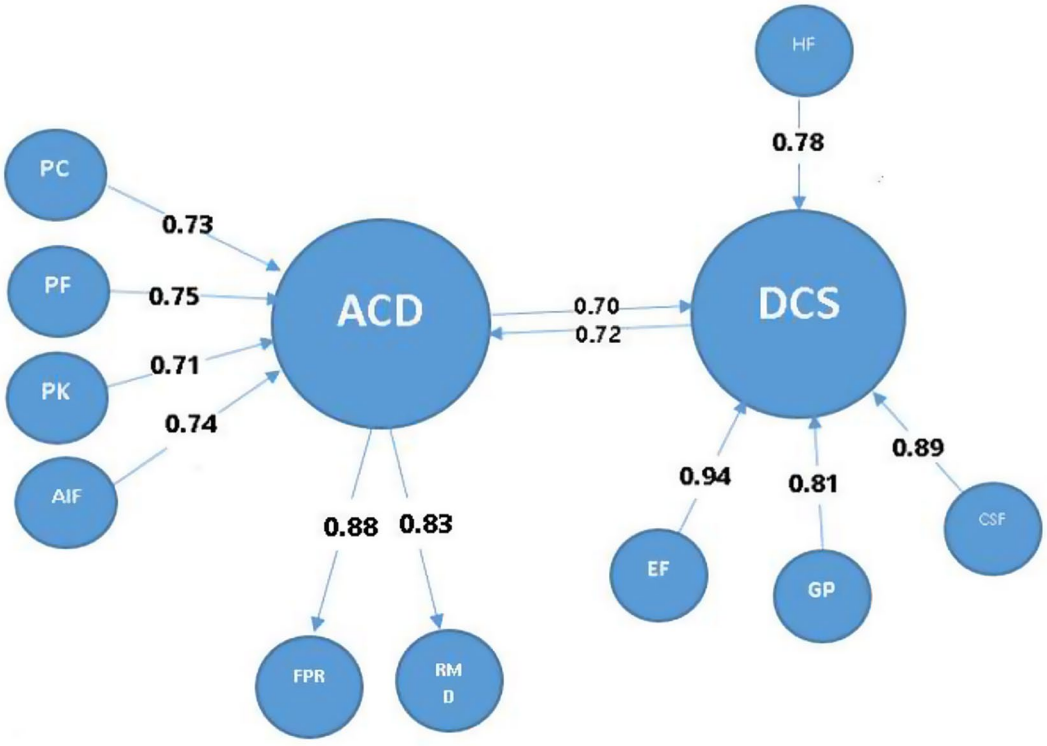

Fig. 5 Model diagram obtained. P-values for all paths: < 0.01. PC: Personal Characteristics. PF: Psychological Factors. PK: Perceptions and Knowledge. AIF: Agricultural Infrastructure Factors. ACD: Adaptation to the Consequences of Droughts. DCS: Drought Coping Strategies. HF: Health Factors. EF: Economic Factors. GP: Government Policies. CSF: Cultural and Social Factors. FPR: Formation of Psychological Resilience. RMD: Reduction of Mental Disorders

of 0.74 ($p < 0.01$, 95% CI: 0.70–0.78), highlighting that adequate resources enabled farmers to mitigate the adverse effects of drought effectively.

Additionally, there was a reciprocal relationship between adaptation to the consequences of droughts (ACD) and drought coping strategies (DCS), with path coefficients of 0.70 ($p < 0.01$, 95% CI: 0.66–0.74) and 0.72 ($p < 0.01$, 95% CI: 0.68–0.76), respectively. This suggested that effective coping strategies not only facilitated adaptation but that successful adaptation could inform and enhance future coping mechanisms. Health factors (HF) were critical as well; A path coefficient of 0.78 ($p < 0.01$, 95% CI: 0.74–0.82), indicating that healthier farmers were more likely to engage in adaptive strategies, thereby improving overall resilience. Economic factors (EF) exhibited the strongest influence on coping strategies, with a path coefficient of 0.94 ($p < 0.01$, 95% CI: 0.90–0.98), emphasizing that financial stability was essential for implementing effective measures.

Government policies (GP) significantly shaped these coping strategies (path coefficient: 0.81, $p < 0.01$, 95% CI: 0.77–0.85), facilitating access to necessary resources. Cultural and social factors (CSF) also played a strong role, with a path coefficient of 0.89 ($p < 0.01$, 95% CI: 0.85–0.93), highlighting the importance of community support in fostering effective adaptation. Ultimately, adaptation contributed to the formation of psychological resilience (FPR) (path coefficient: 0.88, $p < 0.01$, 95% CI: 0.84–0.92) and helped reduction of mental disorders (RMD) (path coefficient: 0.83, $p < 0.01$, 95% CI: 0.79–0.87), promoting better mental health outcomes. Together, these findings illustrated the intricate relationships among various factors that influenced farmers' adaptation and coping strategies, forming their psychological resilience.

In this model, the Consequences component represents the outcomes resulting from farmers' adaptation to drought. These consequences include both positive effects, such as increased psychological resilience, improved coping mechanisms, and enhanced innovation in agricultural practices, as well as negative effects, such as mental health challenges for those unable to adapt effectively.

The distinction between the modified model (Fig. 6) and the model derived from the qualitative phase (Fig. 4) lies in the relationship between the consequences component and the actions-interactions component. The quantitative phase of the study revealed that the relationship between these two components of our three-component model differs. The actual data indicated that the consequences component is primarily linked to the main phenomenon, rather than the actions-interactions component. Consequently, the relationship between the

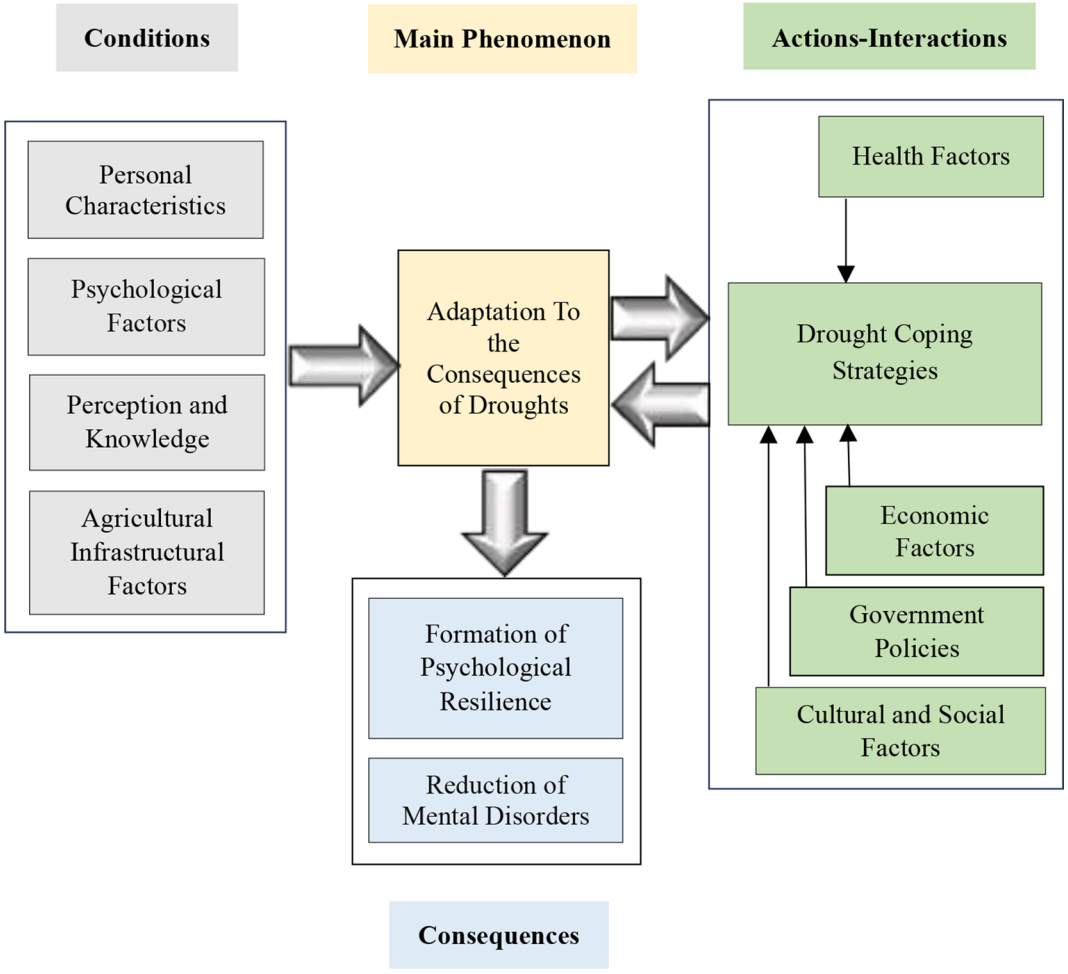

Fig. 6 The final model of forming the psychological resilience among farmers living in drought-affected regions in Iran

consequences component and the actions-interactions component was removed, and a relationship between the consequences component and the main phenomenon was established. Additionally, Table 4 compares the fit indices of the initial and final models, demonstrating that the final model has significantly improved.

The final model indicated that the conditions component had a direct effect on the main phenomenon. The main phenomenon had a two-way relationship with the actions-interactions component, and finally, the consequences component was derived from the main phenomenon (Fig. 6). Moreover, the findings revealed that psychological resilience entails accepting the persistent reality of drought for farmers, despite the difficulties they face in agriculture. Rather than resisting change or clinging to past methods, farmers who embrace adaptive strategies can find ways to thrive in new conditions, mitigating the adverse effects of drought and fostering long-term resilience.

Discussion

To our best knowledge for the first time, a context-based model for the formation of psychological resilience among farmers living in drought-affected regions was tested. In this way, the researcher developed a standardized tool for the comprehensive assessment of the model's components. The findings from this quantitative study revealed that the new assessment tool demonstrated strong psychometric properties. Additionally, the results of the SEM indicated that, with minor modifications, the final model demonstrated good fit indices and was considered valid.

The tool

This study developed a valid and reliable tool to assess the components of the psychological resilience model specifically for the farmers' population, addressing limitations in existing resilience measurement tools. While tools like the Connor-Davidson Resilience Scale (CD-RISC) [53] and the Adult Resilience Tool [54] evaluate various psychological factors, they are not tailored to

the unique challenges faced by drought-affected farmers, such as economic conditions and governmental policies. Additionally, a 14-item resilience questionnaire, while useful, overlooks critical environmental and individual factors [55].

SEM

Based on the final model tested in this research, the main components were psychological factors, personal characteristics, perception and knowledge, agricultural infrastructure factors, drought coping strategies, health, economic, Cultural and social factors, government policies, formation of psychological resilience, and the reduction of mental disorders. In the following, the final model is compared with the previous studies.

The results of our study indicate a satisfactory fit for the model of forming psychological resilience among farmers in drought-affected regions. This aligns with findings from the international collaboration of workforce resilience model, which clarifies the concept of psychological resilience and its role in alleviating workplace stress, such as burnout and compassion fatigue. The model suggests that psychological resilience mediates the relationships between factors like neuroticism, mindfulness, and self-efficacy, ultimately impacting psychological adjustment outcomes [56].

Moreover, our findings resonate with the cognitive model of psychological resilience, which emphasizes cognitive processes in responding to adversity. This model advocates for cognitive flexibility as essential for resilient responses, suggesting that adaptive cognitive strategies can enhance coping mechanisms during challenging times [57]. Our study complements this by demonstrating how perception and knowledge (a key cognitive domain) directly influence adaptation, which in turn contributes to psychological resilience in a high-risk population.

Additionally by our finding, the psychological immunity-psychological elasticity (PI-PE) model offers a dynamic perspective on resilience, focusing on personal and environmental factors that shape individual responses to stressors [58].

In another related study, the state-trait assessment of resilience scale (STARS) model was developed to provide a comprehensive measure of psychological resilience by integrating both state and trait factors. with the difference that STARS is deemed useful for tracking and predicting resilience in various demanding professional contexts, such as healthcare, policing, and military [59].

This study identified adaptation to the impacts of droughts as a key factor in developing psychological resilience among farmers. In the same way, research indicated a strong link between farmers' ability to adapt and their psychological resilience [60]. Similarly, a study showed adapting to drought not only enhances mental strength but also develops sustainability and psychological resilience [61]. Also, another research indicated that adaptation is essential for emotional well-being, especially in the face of prolonged stress and uncertainty [62]. In essence, adapting to drought consequences is vital for farmers, as it boosts motivation, aids in decision-making, enhances problem-solving skills and increases self-efficacy [63].

Psychological factors emerged as the most significant condition influencing psychological resilience, consistent with the PI-PE model, which identifies self-efficacy, optimism, and stress tolerance as key buffers against adversity [58]. Evidence suggests that self-efficacy is crucial for farmers' adaptation to drought [64]. In accordance with our findings, a study showed that other psychological traits, such as a passion for agriculture, hope, courage, and a strong belief system, also positively affect adaptability [60]. Similarly, studies showed that farmers and their families focus on optimism to mitigate the negative effects of drought [62] and, self-efficacy and community belonging play essential roles in both adaptation and psychological resilience [65].

Personal characteristics, including demographics like education and gender, were also critical for psychological resilience formation. Similar to our findings, previous studies have highlighted these factors influence farmers' psychological resilience in various contexts, including natural disasters and health challenges [66–69]. Overall, demographic traits significantly shape farmers' capacity to adapt to drought conditions.

Perception and knowledge were essential for enabling farmers to comprehend drought challenges, identify adaptation strategies, and make informed decisions. Similarly, research indicates that farmers' awareness directly impacts their responses to climate change and drought, emphasizing the importance of acquiring knowledge from past experiences [60, 70–72]. However, many farmers lack a comprehensive understanding of climate change, which can affect their psychological resilience.

Agricultural infrastructure was another key driver of adaptation, echoing findings from the Resilience Thinking Framework [73], where access to resources and institutional support systems is central to socio-ecological resilience. Similar to our findings, studies have shown that inadequate infrastructure and technology limit farmers' ability to cope with climate challenges [74, 75]. Furthermore, research showed that access to agricultural resources is critical for overcoming drought-related difficulties [76].

Coping strategies represented practical actions farmers can take in response to droughts. In accordance with our findings, researchers underscored the importance of these strategies in enhancing psychological resilience [62, 77], with methods such as mulching and innovative irrigation techniques showing promise [60]. It is also

stated in previous studies that developing diverse agricultural practices and seeking new resources can further strengthen farmers' resilience to climate risks [78, 79].

Health factors, encompassing both physical and mental well-being, were vital for effective adaptation to drought. Good health supports resilience against stressors and enhanced decision-making. Similarly, previous studies have linked mental resilience to improved well-being among farmers, suggesting that health conditions enable the effective implementation of coping strategies [80–82].

Economic, cultural and social, and governmental factors also influenced farmers' drought responses. Consistent with our findings, studies showed that access to financial resources, community support, and effective policies empower farmers to adopt various coping strategies. Conversely, poor economic conditions [28, 83–86] and ineffective policies can hinder resilience-building efforts [67, 81, 87–89]. Similarly, evidence showed that cultural and social factors significantly impact the strategies farmers employ, ultimately shaping their psychological resilience [62, 73, 90–92].

Finally, the study identified the formation of psychological resilience and the reduction of mental disorders as key outcomes of adaptation to the impacts of drought. Similar to our findings, other studies indicated that adaptation enhanced farmers' sense of control over their circumstances and mitigated the emotional stress associated with drought [93, 94]. Previous studies also showed that increased self-confidence and self-efficacy empowered farmers to navigate challenges, reducing anxiety and other mental health issues [95, 96].

In conclusion, while our findings shared similarities with previous models and existing studies of psychological resilience in agricultural communities, they also highlighted critical differences that underscore a multifaceted approach. The integration of psychological, personal, economic, and cultural elements in our model provided a valuable framework for understanding resilience among farmers in drought-affected regions, paving the way for targeted interventions and support mechanisms tailored to their unique challenges.

Strengths and limitations

One of the key strengths of this study was the application of Structural Equation Modeling (SEM), which enabled a comprehensive analysis of the complex relationships between variables, offering valuable insights into the factors influencing psychological resilience.

However, this study also has certain limitations. Due to financial and logistical constraints, data collection was limited to a single province in Iran, which may affect the generalizability of the findings to other regions with different socio-economic and environmental conditions. Additionally, the study relied on self-reported data, which may be subject to bias, as participants' perceptions and responses could be influenced by various personal and contextual factors.

Future studies could incorporate mixed-method approaches, combining qualitative interviews and objective resilience indicators to enhance data reliability. To further strengthen theoretical development research should explore the intersection of resilience, mental health, and sustainable development, particularly by integrating expressive art therapy psychoeducation or community-based interventions as potential resilience-enhancing strategies. Longitudinal studies are also recommended to examine how farmers' psychological resilience evolves over time in response to persistent drought conditions. Moreover, policy-driven interventions aimed at enhancing adaptive capacity, providing mental health support, and fostering sustainable agricultural practices should be explored to develop a holistic resilience framework.

Conclusion

This study demonstrated that the model is appropriate for the context of Iran. By utilizing the model and its components, targeted interventions can be developed to enhance the psychological resilience of farmers both in practice and policy. Specifically, interventions should focus on strengthening key factors such as personal characteristics, psychological factors, socioeconomic stability, and access to agricultural infrastructure. Additionally, tailored training programs on drought adaptation strategies, financial management, and governmental support could be implemented to mitigate the adverse effects of drought.

The tool designed in this study enables the analysis of the model's applicability in other drought-affected provinces in Iran. By applying this model in different regions, policymakers can formulate region-specific strategies to strengthen psychological resilience. For example, integrating resilience training into agricultural extension programs and developing financial aid packages tailored to vulnerable farmers could enhance their ability to cope with drought-related stressors.

The final model highlights the critical role of adaptation in building psychological resilience, emphasizing that interventions should focus on equipping farmers with adaptive. Policies should prioritize the development of drought-resistant agricultural techniques, access to credit and insurance programs, and community-based mental health services.

The study's findings can inform policymakers, climate change and drought management authorities, and occupational psychologists in designing targeted initiatives to improve the mental health and well-being of farmers during droughts. Future research should focus

on longitudinal studies to track changes in psychological resilience over time and evaluate the effectiveness of interventions such as mental health counseling, financial incentives, and education programs in fostering long-term resilience.

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Author contributions
All authors have read and approved the manuscript. AT, SS, YM, and AM are responsible for the overall conceptualization and oversight of the study, including study design, data interpretation, and manuscript write-up. AT is responsible for the first draft. All authors reviewed and provided feedback on the manuscript before submission.

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Data availability
The datasets used during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethical approval
The study received approval from the Ethics Committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran (ethical code: IR.SBMU.PHNS.REC.1402.034). Before participating, each individual was informed about the study's purpose and benefits. Participation was voluntary, requiring written consent, and participants could withdraw at any time. Additionally, they were assured that their personal information would remain confidential in any reports.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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