Research Paper: Analysis of Strategies to Improve the Resilience of Rural Households in Dezful County in Dealing with Drought

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ABSTRACT

Purpose: The main objective of this research was to identify strategies for improving rural households' resilience in dealing with drought.

Methods: The statistical population studied comprised all rural-farmer households in Dezful County, located in Khuzestan province. A sample size of 350 people was selected for the study using a stratified sampling method with proportional allocation. The main research tool was a questionnaire whose validity was confirmed by a panel of experts, and whose reliability was confirmed through Cronbach's alpha coefficient and composite reliability. Data analysis was conducted in two sections, descriptive and inferential statistics, using SPSS and LISREL software.

Results: The results of prioritizing strategies to improve the resilience of rural households from the perspective of the people studied showed that the most important strategies included "development of early warning and meteorological programs" and "combined use of indigenous and modern knowledge during drought". Additionally, the exploratory factor analysis classified the solutions to improve the resilience of the respondents into five categories: economic and supportive factors, social, diversification of livelihood, appropriate cultivation pattern, and industrialization of the rural area. Also, the solutions identified in this section were confirmed by structural equation modeling.

Conclusion: In general, the findings of this research can provide valuable insights for policymakers to help stabilize the livelihood of rural households under drought conditions.

1. Introduction

Across the globe, disasters and emergencies present significant health, social, and economic challenges to regional development (UNDRR, Special Report on Drought, 2021; Savari & Khaleghi, 2025; Savari et al., 2025a). The frequency of natural and climate-related disasters has increased in recent decades (UNISDR, 2009). Climate change is

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evident in the sustained rise in global temperatures, with an increase of 1.1°C between 2011 and 2020 compared to the average from 1850 to 1900 (Berhanu et al., 2024). The interplay between rising temperatures and shifting precipitation patterns has intensified extreme weather events, including heatwaves, heavy rainfall, droughts, and wildfires, resulting in widespread damage to ecosystems, human settlements, and infrastructure (Cooley et al., 2023; Bayranvand et al., 2025; Amghani et al., 2025; Shokati Amghani et al., 2023; Savari et al., 2024a; Savari & Khaleghi, 2024). Among natural hazards, drought is the most significant climate-related disaster (Quandt, 2021) and simultaneously the most complex (Quandt & Kimathi, 2017), given the vast number of people it affects globally. The complexity of drought stems from its uneven distribution across different regions; each area or individual experiences drought to varying degrees, shaping diverse perceptions of its severity and impacts (Quandt, 2019; Savari et al., 2025b).

Agriculture is a fundamental sector of the global economy, contributing approximately 4% to global GDP and up to 25% in certain developing nations (World Bank and Agriculture and Food, 2022). As the primary land use supporting human sustenance, sustainable agricultural development is essential for ensuring food security (Zhang et al., 2018; Zhang et al., 2020; Savari et al., 2024b; Savari et al., 2025c). However, climate change exacerbates challenges such as declining agricultural productivity, livestock losses, food insecurity, and water scarcity (Ackerl et al., 2023). Agricultural development plays a crucial role in increasing income, reducing poverty, and strengthening food security for the approximately 80% of the world's poor, who primarily reside in rural communities and rely on agriculture for their livelihoods (Baffour-Ata et al., 2023). However, agricultural production in many regions is increasingly impacted by climate-related disasters (FAO, 2015). As the frequency and severity of extreme climate events continue to rise globally, their adverse effects on agricultural systems pose significant challenges (Farhadi & Ghanbari, 2024).

Farmers in developing countries continue to rely on rainfed farming systems, making them highly vulnerable to climate change, including shifts in temperature and rainfall, which significantly influence their decision-making processes (Ahiamadia et al., 2024; Bathaiy et al., 2021). These climatic variations pose serious risks to food security and the economic stability of smallholder farming households (Wossen et al., 2014). Over the past 40 years, increasing climate variability has heightened uncertainty in agricultural production systems, exposing impoverished farmers to greater production risks (Issahaku & Abdulai, 2020). Farmers in developing countries live in vulnerable conditions and face various shocks, including health crises and weather-related disasters (Béné et al., 2023; Macours et al., 2022; Mishra & Chang, 2012; Smith & Frankenberger, 2018; Savari et al., 2024c). These unforeseen events have significant repercussions on their livelihoods and overall well-being (D'Errico et al., 2018; Gloede et al., 2015; Nguyen et al., 2023). Strengthening resilience is essential to mitigate the impacts of these adverse shocks (Barrett et al., 2021; Upton et al., 2022; Savari et al., 2025d). Agricultural resilience has become a key concern for farmers in developing nations, drawing increasing attention from researchers and policymakers (Do & Nguyen, 2024). Therefore, implementing adaptive and resilient strategies to address climate change is crucial for those reliant on agriculture and farming production (Haile et al., 2020; Rouzaneh & Savari, 2024; Savari et al., 2024d).

Resilience is a relatively new concept in disaster risk management, defined as the ability of a system to recover from disruptions and restore normal functioning (Karamouz et al., 2016; Memarbashi et al., 2023; Savari et al., 2023). In the context of climate change, resilience refers to the capacity to minimize vulnerability to climate-related shocks, such as floods and droughts (Grasham et al., 2021). Efforts to enhance climate resilience currently involve social, economic, technological, and political strategies implemented at all levels of society (Portner et al., 2022). A region's ability to withstand, survive, and recover from drought risk is closely linked to the resilience of its ecosystems and communities (Wassie et al., 2023). Studying resilience is an effective approach to assessing a region's preparedness for drought. This concept provides a practical framework for reducing the vulnerability of drought-prone communities through resilience-building strategies (Zhou et al., 2010). Unlike vulnerability, which focuses on responses during and after a hazard, resilience emphasizes minimizing the adverse effects of a hazard by proactively strengthening adaptive capacity (Asmamaw et al., 2019). In this context, examining livelihood resilience to drought offers valuable insights into the readiness of agricultural activities, including farming systems, to withstand its impacts (Karamouz et al., 2016). A comprehensive analysis of livelihood resilience in the face of drought helps to assess individual risk and vulnerability (Ado et al., 2022; Savari et al., 2024e). Accordingly, various studies have explored the factors influencing resilience, which are discussed below.

2. Literature Review

Rajab-Kalantarzadeh, M., & Savari, M. (2025). Analysis of Strategies to Improve the Resilience of Rural Households in Dezful County in Dealing with Drought. JSRD, 9(1), 137-148.

A study examining the factors influencing the resilience of smallholder farmers' livelihoods in Ethiopia found that 57% of respondents were classified as non-resilient. The research highlighted that greater access to agricultural inputs, education, and institutional support had the most significant impact on individuals' ability to cope with drought (Wassie et al., 2023). A study examining the factors influencing the resilience of rural households in Kerman Province found that individuals exhibit relatively low levels of resilience. The research identified economic, social, physical, human, and natural factors as key contributors to strengthening resilience (Savari et al., 2023b).

A study examining adaptation strategies of small-scale farmers in West Azerbaijan Province found that, in arid and semi-arid regions such as Iran, drought is the most severe climatic threat. According to experts, the most important adaptation strategies are economic, extension-technical, agricultural, infrastructural, and socio-cultural, in that order. However, farmers prioritize these strategies differently, ranking them as economic, extension-technical, socio-cultural, agricultural, and infrastructural (Savari & Shokati Amghani, 2019).

A study on resilience factors identified social networks and social capital as critical elements in supporting drought-affected communities (Ruttet et al., 2015). Another study, "Measuring Livelihood Resilience: A Household Livelihood Resilience Approach," introduced effective methods for assessing household resilience, utilizing capital assets as key indicators. The findings suggest that the household livelihood resilience approach can help organizations design targeted interventions to strengthen resilience among society's most vulnerable groups (Quandt, 2018).

A study titled "The Impact of Natural Disasters on the Livelihood Resilience of Rural Residents in Sichuan, China," Found That livelihood resilience among rural residents is positively correlated with livelihood quality, livelihood promotion, and livelihood security. Additionally, the study revealed a negative correlation between livelihood resilience and the level of natural disaster stress, indicating that higher disaster stress weakens resilience (Fang et al., 2018). A study titled Livelihood Resilience of Icelandic Riverside Residents to Natural Disasters: Empirical Evidence from Bangladesh examined the livelihood resilience of daily wage earners. The findings revealed that the studied households exhibit low resilience to environmental hazards. Key factors constraining livelihood resilience in this region include limited access to food, income, and health services, as well as deficiencies in agricultural and non-agricultural assets and technology adoption. Improving these aspects is essential for ensuring the survival and well-being of residents (Sarker et al., 2020).

A study on farmers' perceptions of drought in Afghanistan, focusing on both rainfed and irrigated farming systems, found that farmers' assessments of drought severity closely aligned with climatic data. However, farmers in rainfed areas perceived drought frequency and severity to be significantly higher than those in irrigated regions. Additionally, crop productivity was lower in both farming systems, though the agricultural strategies employed varied considerably between rainfed and irrigated areas, reflecting distinct adaptation approaches (Aliyar et al., 2022).

3. Methodology

3.1. Study Area

This research was conducted during the years 1402–1403 in Dezful, a city in northern Khuzestan Province. The Dez River, the region's most significant water source, originates in the Zagros Mountains in Lorestan province. Dezful is recognized as one of Iran's key agricultural hubs, benefiting from fertile soil and an ample water supply, which create ideal conditions for cultivating citrus fruits, vegetables, flowers, and other plants. The city has a long-standing agricultural tradition, further strengthened by the establishment of the Safiabad Agricultural Research Center, which has played a pivotal role in agricultural advancements for over five decades.

3.2. Research Methodology

This research was conducted using a descriptive-analytical approach and survey technique. For practical application, field data collection methods were employed, and statistical analysis was performed using both descriptive and inferential methods. Given its time frame, this study was cross-sectional, with data gathered at a single point in time. The statistical population included all rural farming households in Dezful County. The sample size was determined using the Krejcie and Morgan table, and a multi-stage cluster sampling method was applied. A total of 350 samples were selected through a multi-stage stratified sampling method with proportional allocation. First, the population of rural households in different areas of the city was identified, and the sample size was then determined based on the population distribution in each region. Data collection was conducted using researcher-developed questionnaires, designed concerning the theoretical literature of the study.

The primary research instrument was a questionnaire structured into two main sections. The first section collected demographic data, including age, education level, income, work experience, and participation in relevant training programs. The second section comprised 21 items designed to assess farmers' resilience strategies in drought conditions. The validity of the research variables was assessed by an expert panel consisting of professors specializing in agricultural extension and development. Additionally, the average variance extracted (AVE) index was calculated to further evaluate validity. To determine the reliability of the questionnaire, Cronbach's alpha coefficient and composite reliability were estimated. The Cronbach's alpha value for the solutions section was calculated at 0.82, composite reliability was found to be 0.87, and construct validity was 0.608. Given that the alpha value exceeded 0.7, composite reliability surpassed 0.6, and construct validity was above 0.5, the research instrument demonstrated appropriate validity and reliability.

In this study, SPSS Win 27 and LISREL 8.8 software were utilized for data analysis, incorporating both descriptive and inferential statistical methods. In the descriptive analysis, measures such as mean, standard deviation, and coefficient of variation were applied. The inferential analysis involved exploratory and confirmatory factor analysis tests to assess underlying patterns in the data. Factor analysis is used to identify underlying variables in a phenomenon or to assess the reliability of items measuring specific factors. The initial data for factor analysis consisted of a correlation matrix among variables. This method does not involve dependent variables, as its objective is not to examine relationships between latent variables. Instead, it focuses on determining the connection between latent and manifest variables (Harrington, 2009). When the goal is to classify a set of items into a limited number of factors, exploratory factor analysis is employed (Hoyle, 2012). Confirmatory factor analysis is a method used to assess the appropriateness of items selected for measuring a construct. Specifically, it evaluates whether the questionnaire items designated for each factor effectively measure the intended variable (Khoshmaram et al., 2020). In first-order confirmatory factor analysis, the relationship between latent variables (factors) and observable variables (items) is examined. This type of measurement model serves to ensure the accurate representation of latent variables. First-order confirmatory factor analysis can assess the relationship between a single factor and multiple items or multiple factors and their respective items (Hoyle, 2012).

4. Findings

4.1. Investigation of the personal and professional characteristics of the rural households - farmers studied

The study of personal and professional characteristics among rural farming households revealed an average age of 52.10 years, with a standard deviation of 10.56 years, indicating that respondents ranged from 23 to 78 years old. The average agricultural work experience was 31 years, with a standard deviation of 0.13 years. The mean irrigated land area was 9 hectares, with a standard deviation of 13 hectares, while the average area of rain-fed crops was 2 hectares, with a standard deviation of 14 hectares. Additionally, household size averaged 5 members, with a standard deviation of 1.61. Regarding education levels, the majority, 88 individuals (25.14%)—had completed primary education. In terms of livelihood impact due to drought, 28.2% of respondents reported a very low impact, 28.1% reported a low impact, 14.39% reported a moderate impact, 85.34% reported a high impact, and 9% reported a very high impact.

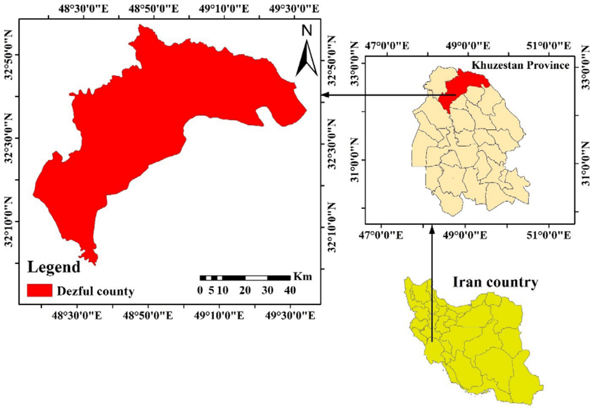

Figure 1. Study area

JSRD

4.2. Prioritizing solutions to increase the resilience of rural households - farmers in dealing with drought

To prioritize the solutions for enhancing the resilience of rural households in Dezful city against drought, the coefficient of variation (CV) was employed. The results showed that “Development of forecasting and meteorological programs” and “Combined use of indigenous and modern knowledge during drought” were the most critical solutions. Conversely, “Development of rural organizations and NGOs” and “Utilizing the capacity of handicrafts in the rural areas” were identified as the least important (Table 1).

In the next step, exploratory factor analysis was performed to consolidate the 21 factors into broader categories. The suitability of the data for factor analysis was evaluated using the Kaiser-Meyer-Olkin (KMO) test and Bartlett’s test. The KMO value was 0.869, and the Bartlett test yielded a statistically significant result ($\chi^2 = 1789.58$, $p < 0.01$), confirming that the dataset was appropriate for factor analysis. Five factors with eigenvalues greater than 1 were extracted. The first factor accounted for the highest variance, while the fifth contributed the least (Table 2).

Table 1. Prioritization of items for strategies to increase resilience

Items	Mean	SD	CV	Rank
- Development of forecasting and meteorological programs	3.94	0.91	0.230	1
- Combined use of indigenous and modern knowledge during drought	3.78	0.93	0.246	2
- Multi-crop system in agriculture	3.50	0.98	0.281	3
- Sustainable management of water resources using modern technology	3.15	0.91	0.288	4
- Job diversification in the rural area	3.48	1.01	0.290	5
- Guaranteed purchase of products	3.82	1.16	0.303	6
- Developing crop and livestock insurance in rural areas	3.32	1.01	0.304	7
- Greater access to credit and facilities for rural communities	3.68	1.13	0.307	8
- Reducing the livelihood dependence of rural communities on the agricultural sector	3.15	0.97	0.307	9
- Development of agricultural subsidies	3.70	1.16	0.313	10
- The existence of a spirit of cooperation and participation in the village environment	3.04	0.99	0.325	11
- Changing the cultivation pattern in the region	3.13	1.05	0.335	12
- Trying to improve farmers’ adaptation using adaptation strategies	2.79	0.94	0.336	13
- Postponement of loan repayments for affected farmers	2.94	1.01	0.343	14
- Visiting model farms and professional development	3.00	1.04	0.346	15
- Establishing a rural bank for affected farmers	3.46	1.21	0.349	16
- Creation and development of complementary processing industries in rural areas	3.00	1.06	0.353	17
- Existence of tourism-related activities	3.23	1.16	0.359	18
- Use of high social capital among villagers	2.80	1.01	0.360	19
- Utilizing the capacity of handicrafts in rural areas	3.09	1.13	0.365	20
- Development of rural organizations and NGOs	2.30	1.17	0.508	21

JSRD

Table 2. Extracted factors with their factor loadings

Factors	Eigen value	Variance	Cumulative variance
1	2.804	13.351	13.351
2	2.639	12.566	25.918
3	2.126	10.123	36.041
4	2.018	9.611	45.651
5	1.530	6.530	52.182

JSRD

Varimax factor rotation was applied to differentiate the extracted factors, and the factor loadings for each variable following rotation are presented in the table. After analyzing the variable items associated with each factor and their respective loadings, the identified factors were categorized into economic and support factors, social factors, livelihood diversification, appropriate cultivation patterns, and the industrialization of rural spaces (Table 3).

4.3. Assessing the fit of the confirmatory model for rural household resilience strategies

Confirmatory factor analysis (CFA) was conducted using LISREL 8.8 software to validate the factors identified in the exploratory phase. Multiple fit indices were employed to assess the model's adequacy. To evaluate the fitness of the measurement model for analyzing challenges in developing green businesses in the agricultural sector, the following indices were considered: chi-square per degree of freedom (X^2/df), comparative fit index (CFI), normed fit index (NFI), non-normed fit index (NNFI), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), incremental fit index (IFI), root mean square error of approximation (RMSEA), and root mean square residual (RMR). Table 4 presents the benchmark (desirable) values and the reported values of each of these indices for the measurement model assessing farmers' resilience strategies in response to drought.

Table 3. Factor analysis of Solutions to increase resilience

Solutions	Items	Factorial load
Economic and supportive	Development of agricultural subsidies	0.538
	Greater access to credit and facilities for rural communities	0.479
	Postponement of loan repayments for affected farmers	0.591
	Establishing a rural bank for affected farmers	0.526
	Developing crop and livestock insurance in rural areas	0.529
	Guaranteed purchase of products	0.614
Social	Development of rural organizations and NGOs	0.540
	Using high social capital among villagers	0.588
	The existence of a spirit of cooperation and participation in the village environment	0.463
	Combining indigenous and modern knowledge during drought	0.374
Diversification	Job diversification in rural areas	0.510
	Reducing the livelihood dependence of rural communities on the agricultural sector	0.540
	Existence of tourism-related activities	0.540
Suitable cultivation pattern	Multi-crop system in agriculture	0.462
	Changing cultivation patterns in the region	0.625
Industrialization of rural space	Sustainable management of water resources using modern technology	0.524
	Creating and developing complementary transformation industries in rural areas	0.478

JSRD

Table 4. Measurement model fit indices

Index	Criteria	Reported amount
X^2/df	Less than 3	2.73
RMR	Less than 0.05	0.033
GFI	More than 0.9	0.99
AGFI	More than 0.9	0.98
NFI	More than 0.9	0.98
NNFI	More than 0.9	0.99
IFI	More than 0.9	0.97
CFI	More than 0.9	0.98
RMSEA	Less than 0.08	0.043

JSRD

Based on the reported indices, the model demonstrated a good fit, indicating that the identified factors accurately represent rural households' resilience strategies. This indicates that the data derived from the exploratory factor analysis were correctly classified and can be reliably utilized in future research to measure the confirmatory model of resilience strategies in similar contexts.

Figure 2 shows the standard model of farmers' resilience strategies (factor loadings), confirming that each item is properly associated with its respective factor without redundancy.

Figure 3 presents the model with t-values, all exceeding 1.96, further validating the reliability of the factor-item relationships.

The confirmatory research model, in its standard mode (factor loading), demonstrated that the items identified during the exploratory factor analysis are accurately associated with their respective factors, with no evidence of overlap or redundancy within the model.

The confirmatory research model demonstrated that the t-value of all coefficients were significantly greater than 1.96, thereby verifying the accuracy of the selected items in measuring farmers' resilience strategies for coping with drought.

5. Discussion

This study aimed to investigate strategies for enhancing the resilience of rural farming households in Dezful County. The findings revealed that two key factors—(1) the development of forecasting and meteorological programs and (2) the combined use of indigenous and modern knowledge during drought—were the most effective strategies for strengthening resilience. These results align with previous studies by Vaughan et al. (2019) and Hansen et al. (2019). In agriculture, climate information services play a crucial role in managing climate change-related risks by supporting adaptation decisions and strengthening resilience (Vaughan et al., 2019). Over the past decades, many countries have acknowledged the significance of meteorological data and forecasting programs (Antwi-Agyei et al., 2021), leading to substantial investments in national meteorological services (Yegbemey & Egah, 2021). However, national meteorological services typically provide climate information at a broad, national scale, making it difficult for farmers to effectively utilize weather data (Hansen et al., 2019). To enhance resilience, it is advisable to integrate weather forecasts with technical-agronomic recommendations, ensuring more practical and accessible climate information for farmers.

Additionally, the results of the exploratory factor analysis categorized resilience-enhancing strategies into five key areas: economic and support factors, social factors, livelihood diversification, appropriate cropping pattern programs, and rural space industrialization. Together, these factors accounted for 52.182% of the total variance. The findings of this section align with previous studies by Sarker et al. (2020), Savari and Amghani (2022), and Savari et al. (2023b). The following section provides a detailed analysis of each strategy.

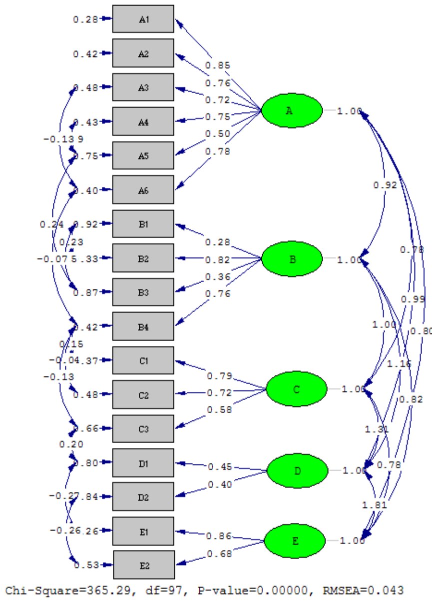

Figure 2. Model of farmers' resilience strategies in dealing with drought in the standard mode JSRD

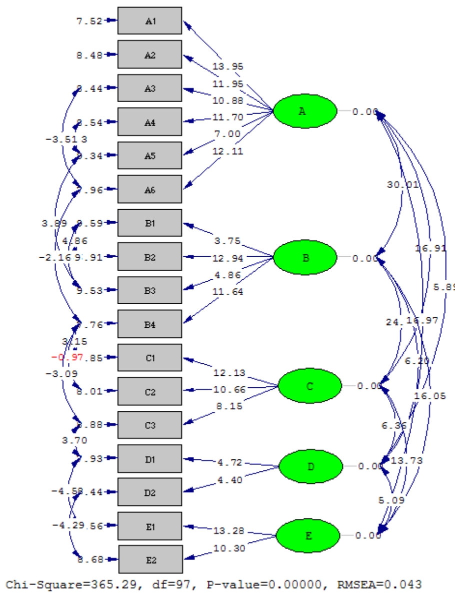

Figure 3. Model of farmers' resilience strategies in dealing with drought with t-value JSRD

Economic-supportive solutions:

Identified as the most significant resilience strategy, this factor was highlighted in the previous studies (Savari et al., 2023b; Wassie et al., 2023). It encompasses various economic and financial measures, including the development of agricultural subsidies, increased access to credit and financial resources for rural communities, postponement of loan due dates for affected farmers, establishment of rural banks, expansion of crop and livestock insurance in rural areas, and the guaranteed purchase of agricultural products. Analyzing these findings reveals that repeated droughts have significantly weakened the economic performance and financial stability of rural households, drastically reducing their savings and economic reserves (Quandt, 2021). Moreover, in developing countries such as Iran, the small scale of agricultural operations often results in limited economic power (Savari & Amghani, 2022). Consequently, vulnerability in these regions has increased sharply. Enhancing farmers' resilience to climate change necessitates effective access to and utilization of economic-supportive solutions (Wamalwa et al., 2016; Mase & Prokopy, 2014). The establishment of rural banks and the implementation of targeted support policies are strongly recommended to bolster rural economies.

Social solutions: Social strategies were the second most significant category, as highlighted in previous research (Ruttet et al., 2015; Quandt, 2019, 2021; Barnes et al., 2017, 2020; Savari & Noshad, 2022; Savari et al., 2015). This factor encompasses various approaches, including the development of rural organizations and NGOs, leveraging high social capital among villagers, fostering a spirit of cooperation and participation within rural communities, and integrating indigenous and modern knowledge during drought conditions. Two key variables—membership in social and non-governmental groups and the level of cooperation within them—underscore the importance of grassroots organizations in strengthening resilience. These organizations serve as knowledge hubs, preparing farmers for change (Cundill et al., 2015) while facilitating knowledge exchange through networks to enhance agricultural learning capacity (Dolinska & d'Aquino, 2016). Such interactions can significantly contribute to resilience (Barnes et al., 2017, 2020).

Livelihood diversification:

Diversifying employment opportunities beyond agriculture emerged as a crucial strategy for strengthening resilience. Promoting tourism-related activities and other non-agricultural sectors can reduce dependence on vulnerable agricultural incomes (Milne, 2006; Savari & Amghani, 2022). Income diversification becomes viable when regions are steered toward alternative activities based on local resources, fostering new employment opportunities for the workforce (Milne, 2006). Economic diversification is particularly critical in areas with monoculture-based economies, as it strengthens rural economic foundations and mitigates rural migration—especially during drought (Savari & Amghani, 2022). Sustainability is best achieved when systems remain diverse and maintain functional stability (Ghasemi & Javan, 2013). Livelihood diversity also serves as a year-round income-generation strategy, particularly for individuals who lack access to alternative risk mitigation mechanisms such as savings and insurance (Lanjouw & Lanjouw, 2001). It is a fundamental pillar of economic security and livelihood sustainability in rural areas, especially in conditions of water scarcity and drought. On one hand, increasing efficiency optimizes the use of both potential and actual capacities in economic activities. On the other hand, the diversification of rural economies is essential to sustaining employment, livelihoods, and income sources (Vaughan et al., 2019). Researchers further emphasize that agricultural activities alone may not provide a sufficient income for rural households under drought conditions. Consequently, transitioning to non-agricultural income sources is an effective measure for reducing rural poverty and promoting sustainable livelihoods.

Appropriate cropping pattern:

The fourth key strategy for enhancing farmers' resilience is implementing agricultural activities that align with a region-specific cropping pattern. This approach includes adopting a multi-cropping system and modifying existing cropping patterns to better suit local environmental conditions. The findings of this section align with previous research (Fang et al., 2018; Sarker et al., 2020). Many current cropping patterns in the region rely on water-intensive crops, making agricultural activities highly vulnerable to drought and water shortages. To enhance farmers' resilience during such conditions, it is essential to promote drought-resistant crops and optimize cropping patterns to ensure greater sustainability in the agricultural sector.

Industrialization of rural space:

The final key strategy for enhancing farmers' resilience is the improvement of rural industrial infrastructure. This factor includes the sustainable management of water resources through modern technology and the establishment and expansion of complementary agro-processing industries in rural areas. Water scarcity remains a significant barrier to agricultural, economic, and social development, particularly in developing countries situated in arid and semi-arid regions (Savari & Moradi, 2022). Globally, the depletion of freshwater resources has become a pressing crisis, posing serious threats to sustainable development, environmental health, and human well-being (Berhanu et al., 2024). One of the most effective approaches to mitigating this challenge is the adoption of modern irrigation technologies, ensuring the optimal and efficient utilization of available water resources. To strengthen farmers' resilience, proactive measures should be taken to promote and integrate advanced water management technologies within agricultural practices. Additionally, the lack of adequate processing and finishing industries in many rural communities forces farmers to sell raw agricultural products, limiting their income potential. Drought-induced instability in agricultural yields has further weakened rural economies, contributing to increased migration rates. Expanding agro-processing industries within rural areas can address these challenges by reducing income losses, adding value to raw products, and fostering economic stability. Strengthening these industrial capacities will ultimately enhance farmers' resilience and support sustainable rural development.

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Conflict of Interest

The authors declared no conflicts of interest.

References

Ackerl, T., Weldemariam, L. F., Nyasimi, M., & Ayanlade, A. (2023). Climate change risk, resilience, and adaptation among rural farmers in East Africa: A literature review. Regional Sustainability, 4(2), 185-193.

Ado, A. M., Savadogo, P., & Abdoul-Azize, H. T. (2022). Livelihood strategies and household resilience to food insecurity: Insight from a farming community in Aguie district of Niger. In Rethinking Food System Transformation (pp. 97-111). Springer, Cham.

Ahiamadia, D., Ramilan, T., & Tozer, P. R. (2024). Enhancing climate resilience in northern Ghana: A stochastic dominance analysis of risk-efficient climate-smart technologies for smallholder farmers. Environmental Development, 51, 101031.

Aliyar, Q., Zulfiqar, F., Datta, A., Kuwornu, J. K., & Shrestha, S. (2022). Drought perception and field-level adaptation strategies of farming households in drought-prone areas of Afghanistan. International Journal of Disaster Risk Reduction, 72, 102862.

Amghani, M. S., Miladi, H., Savari, M., & Mojtahedi, M. (2025). Factors influencing the agricultural extension model sites in Iran. Scientific Reports, 15(1), 9590.

Antwi-Agyei, P., Dougill, A. J., & Abaidoo, R. C. (2021). Opportunities and barriers for using climate information for building resilient agricultural systems in the Sudan savannah agroecological zone of north-eastern Ghana. Climate Services, 22, 100226.

Asmamaw, M., Mereta, S. T., & Ambelu, A. (2019). Exploring households' resilience to climate change-induced shocks using Climate Resilience Index in Dinki watershed, central highlands of Ethiopia. PloS one, 14(7), e0219393.

B´en´e, C., Frankenberger, T.R., Nelson, S., Constas, M.A., Collins, G., Langworthy, M., Fox, K. (2023). Food system resilience measurement: principles, framework, and caveats. Food Secur. 1–22 https://doi.org/10.1007/s12571-023-01407-y.

Baffour-Ata, F., Atta-Aidoo, J., Said, R. O., Nkrumah, V., Atuyigi, S., & Analima, S. M. (2023). Building the resilience of smallholder farmers to climate variability: Using climate-smart agriculture in Bono East Region, Ghana. Heliyon, 9(11).

Barnes, M. L., Bodin, Ö., Guerrero, A. M., McAllister, R. R., Alexander, S. M., & Robins, G. (2017). The social structural foundations of adaptation and transformation in social–ecological systems. Ecology and Society, 22(4).

Barnes, M. L., Wang, P., Cinner, J. E., Graham, N. A., Guerrero, A. M., Jasny, L., ... & Zamborain-Mason, J. (2020). Social determinants of adaptive and transformative responses to climate change. Nature Climate Change, 10(9), 823-828.

Barrett, C. B., Ghezzi-Kopel, K., Hoddinott, J., Homami, N., Tennant, E., Upton, J., & Wu, T. (2021). A scoping review of the development resilience literature: Theory, methods and evidence. World Development, 146, 105612.

Bathaiy, S. S., Chizari, M., Sadighi, H., & Alambeigi, A. (2021). Social media and farmers' resilience to drought as an environmental disaster: A moderation effect. International Journal of Disaster Risk Reduction, 59, 102209.

Bayranvand, M. B., Rahimian, M., Savari, M., Molavi, H., & Movahed, R. G. (2025). Predictors of ranchers' Protection Behaviors in the Use of Pastures Through Protection Motivation Theory. Rangeland Ecology & Management, 98, 576-587.

Berhanu, A. A., Ayele, Z. B., & Dagnew, D. C. (2024). Impact of climate-smart agricultural practices on smallholder farmers' resilience in Ethiopia. Journal of Agriculture and Food Research, 16, 101147.

Cooley, S., Schoeman, D., Bopp, L., Boyd, P., Donner, S., Kiessling, W., ... & Simmons, C. T. (2023). Oceans and coastal ecosystems and their services.

Cundill, G., Leitch, A. M., Schultz, L., Armitage, D., & Peterson, G. (2015). Principle 5–encourage learning. Principles for building resilience. Sustaining ecosystem services in social-ecological systems, 174-200.

d'Errico, M., Romano, D., & Pietrelli, R. (2018). Household resilience to food insecurity: Evidence from Tanzania and Uganda. Food Security, 10(4), 1033-1054.

Do, M. H., & Nguyen, T. T. (2024). Impact of crop commercialization on smallholder farmers' resilience to shocks: Evidence from panel data for rural Southeast Asia. Food Policy, 128, 102709.

Dolinska, A., & d'Aquino, P. (2016). Farmers as agents in innovation systems. Empowering farmers for innovation through communities of practice. Agricultural systems, 142, 122-130.

Fang, Y. P., Zhu, F. B., Qiu, X. P., & Zhao, S. (2018). Effects of natural disasters on the livelihood resilience of rural residents in Sichuan. Habitat International, 76, 19-28.

FAO. (2015). The Impact of Natural Hazards and Disasters on Agriculture and Food Security and Nutrition. FAO, Rome.

Farhadi, M., & Ghanbari, R. (2024). Factors affecting the adaptation behavior of farmers to floods:(Case study: Aligudarz county). Iranian Journal of Agricultural Economics and Development Research, 55(2), 309-330. (In Persian)

Ghasemi, M., Javan, J. (2013). Explaining the relationship between diversification of economic activities and sustainable rural development, case study: Mashhad city. Quarterly Journal of Rural Research, 5 (2); 237-262. (In Persian)

Gloede, O., Menkhoff, L., & Waibel, H. (2015). Shocks, individual risk attitude, and vulnerability to poverty among rural households in Thailand and Vietnam. World Development, 71, 54-78.

Grasham, C. F., Calow, R., Casey, V., Charles, K. J., de Wit, S., Dyer, E., ... & Zaidi, H. (2021). Engaging with the politics of climate resilience towards clean water and sanitation for all. Npj Clean Water, 4(1), 42.

Haile, G.G., Tang, Q.H., Hosseini-Moghari, S.M., et al. (2020). Projected impacts of climate change on drought patterns over East Africa. Earth's Future 8 (7), e2020EF001502. https://doi.org/10.1029/2020EF001502.

Hansen, J. W., Vaughan, C., Kagabo, D. M., Dinku, T., Carr, E. R., Körner, J., & Zougmoré, R. B. (2019). Climate services can support African farmers' context-specific adaptation needs at scale. Frontiers in Sustainable Food Systems, 3, 21.

Harrington, D. (2009). Confirmatory factor analysis. Oxford university press.

Hoyle, R. H. (Ed.). (2012). Handbook of structural equation modeling. Guilford press.

Issahaku, G., & Abdulai, A. (2020). Adoption of climate-smart practices and its impact on farm performance and risk exposure among smallholder farmers in Ghana. Australian Journal of Agricultural and Resource Economics, 64(2), 396-420.

Karamouz, M., Zeynolabedin, A., & Olyaei, M. A. (2016). Regional drought resiliency and vulnerability. Journal of Hydrologic Engineering, 21(11), 05016028.

Khoshmaram, M., Shiri, N., Shinnar, R. S., & Savari, M. (2020). Environmental support and entrepreneurial behavior among Iranian farmers: The mediating roles of social and human capital. Journal of Small Business Management, 1-25.

Lanjouw, J., Lanjuow, P. (2001). The rural non-farm sector: issues and evidence from developing countries, Agricultural Economics, 26.pp 1-23.

Macours, K., Premand, P., & Vakis, R. (2022). Transfers, Diversification and Household Risk Strategies: Can productive safety nets help households manage climatic variability?. The Economic Journal, 132(647), 2438-2470.

Mase, A. S., & Prokopy, L. S. (2014). Unrealized potential: A review of perceptions and use of weather and climate information in agricultural decision making. Weather, Climate, and Society, 6(1), 47-61.

Memarbashi, P., Mojarradi, G., & Maleksaeidi, H. (2023). Identifying factors affecting flood risk perception among strawberry growers in Kurdistan province. Iranian Journal of Agricultural Economics and Development Research, 54(4), 881-896. (In Persian)

Milne, S. (2006). Tourism & Review of the South & Central Pacific Regional Tourism, Strategy Prepared for the south Central Pacific Tourism organization.

Mishra, A. K., & Chang, H. H. (2012). Can off farm employment affect the privatization of social safety net? The case of self-employed farm households. Food Policy, 37(1), 94-101.

Nguyen, D. L., Nguyen, T. T., & Grote, U. (2023). Shocks, household consumption, and livelihood diversification: a comparative evidence from panel data in rural Thailand and Vietnam. Economic Change and Restructuring, 56(5), 3223-3255.

Portner, O., D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Loschke, ¨ V. Moller,¨ A. Okem (Eds.), Climate Change (2022). Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, NY, USA, 2022, pp. 3–33.

Quandt, A. (2018). Measuring livelihood resilience: The household livelihood resilience approach (HLRA). World Development, 107, 253-263.

Quandt, A. (2019). Variability in perceptions of household livelihood resilience and drought at the intersection of gender and ethnicity. Climatic change, 152(1), 1-15.

Quandt, A. (2021). Coping with drought: Narratives from smallholder farmers in semi-arid Kenya. International Journal of Disaster Risk Reduction, 57, 102168.

Quandt, A., & Kimathi, Y. A. (2017). Perceptions of the effects of floods and droughts on livelihoods: lessons from arid Kenya. International Journal of Climate Change Strategies and Management.

Rouzaneh, D., & Savari, M. (2024). Redefining maladaptation to climate change: a conceptual examination of the unintended consequences of adaptation strategies on ecological-human systems. Frontiers in Forests and Global Change, 7, 1506295.

Ruttet, M., Thapar, A., Pine, D. S., Leckman, J. F., Scott, S., Snowling, M. J., & Taylor, E. (2015). Resilience: concepts, findings, and clinical implications. Ruttet's child and Adolescent Psychiatry, 341-351

Sarker, M.N.I., Wu, M., Alam, G.M., & Shouse, R. (2020). Livelihood resilience of riverine island dwellers in the face of natural disasters: Empirical evidence from Bangladesh. Journal of Land Use Policy, 95, 1-12. https://doi.org/10.1016/j.landusepol.2020.104599.

Savari, M., Shokati Amghani, M. (2019). Identifying adaptation strategies for small-scale farmers in dealing with agriculture in West Azerbaijan Province. Quarterly Journal of Spatial Planning, 3(9); 141-166. (In Persian)

Savari, M., & Amghani, M. S. (2022). SWOT-FAHP-TOWS analysis for adaptation strategies development among small-scale farmers in drought conditions. International Journal of Disaster Risk Reduction, 67, 102695.

Savari, M., & Khaleghi, B. (2024). Factors influencing the application of forest conservation behavior among rural communities in Iran. Environmental and Sustainability Indicators, 21, 100325.

Savari, M., & Khaleghi, B. (2025). Promoting safe and pro-environmental behaviors for sustainable forest management: Integrating technology acceptance model and the norm activation model. Socio-Economic Planning Sciences, 98, 102158.

Savari, M., & Noshad, M. (2022). Factors Affecting Improving Food Security of Rural Households (Case Study of Villages in Hindijan County). Agricultural Production and Marketing Economics, 1(1), 41-54.

Savari, M., Amghani, M. S., & Malekian, A. (2025c). Factors influencing the use of treated wastewater for irrigation in the agricultural sector: evidence from Iran. Cleaner Engineering and Technology, 100901.

Savari, M., Damaneh, H. E., & Damaneh, H. E. (2023). The effect of social capital in mitigating drought impacts and improving livability of Iranian rural households. International Journal of Disaster Risk Reduction, 89, 103630.

Savari, M., Damaneh, H. E., & Damaneh, H. E. (2023b). Effective factors to increase rural households' resilience under drought conditions in Iran. International Journal of Disaster Risk Reduction, 90, 103644.

Savari, M., Damaneh, H. E., & Damaneh, H. E. (2024a). Conservation behaviors of local communities towards mangrove forests in Iran. Global Ecology and Conservation, 56, e03311.

Savari, M., Damaneh, H. E., & Damaneh, H. E. (2024e). Managing the effects of drought through the use of risk reduction strategy in the agricultural sector of Iran. Climate Risk Management, 45, 100619.

Savari, M., Damaneh, H. E., & Damaneh, H. E. (2025d). Discover the determining factors of the use of mangrove forests conservation behaviors. Journal for Nature Conservation, 83, 126768.

Savari, M., Jafari, A., & Sheheytavi, A. (2024b). The impact of social capital to improve rural households' resilience against flooding: evidence from Iran. Frontiers in Water, 6, 1393226.

Savari, M., Jafari, A., & Sheheytavi, A. (2025a). Determining factors affecting flood risk perception among local communities in Iran. Scientific Reports, 15(1), 4076.

Savari, M., Khaleghi, B., & Sheheytavi, A. (2024d). Iranian farmers' response to the drought crisis: How can the consequences of drought be reduced?. International Journal of Disaster Risk Reduction, 114, 104910.

Savari, M., Khaleghi, B., & Sheheytavi, A. (2025b). How to reduce the risk of climate change for the sustainability of rural farmers? Based on evidence from Iran. Environmental and Sustainability Indicators, 25, 100581.

Savari, M., & Moradi, M. (2022). The effectiveness of drought adaptation strategies in explaining the livability of Iranian rural households. Habitat International, 124, 102560.

Savari, S., Shabanali Fami, H., & Daneshvar Ameri, Z. (2015). Rural women's empowerment in improving household food security in the Divandarreh county. Journal of Research and Rural Planning, 3(4), 107-121.

Savari, M., Zhoolideh, M., & Limuie, M. (2024c). The combination of climate information services in the decision-making process of farmers to reduce climate risks: application of social cognition theory. Climate Services, 35, 100500.

Shokati Amghani, M., Mojtahedi, M., & Savari, M. (2023). An economic effect assessment of extension services of agricultural extension model sites for the irrigated wheat production in Iran. Scientific Reports, 13(1), 16947.

Smith, L. C., & Frankenberger, T. R. (2018). Does resilience capacity reduce the negative impact of shocks on household food security? Evidence from the 2014 floods in Northern Bangladesh. World Development, 102, 358-376.

UNDRR, Special Report on Drought. (2021). Global Assessment Report on Disaster Risk Reduction, United Nations Office for Disaster Risk Reduction (UNDRR), Geneva, 2021.

UNISDR. (2009). Drought Risk Reduction Framework and Practices: Contributing to the Implementation of the Hyogo Framework for Action, United Nations secretariat of the International Strategy for Disaster Reduction (UNISDR), Geneva, Switzerland, Geneva, Switzerland, 2009.

Upton, J., Constenla-Villoslada, S., & Barrett, C. B. (2022). Caveat utilitor: A comparative assessment of resilience measurement approaches. Journal of Development Economics, 157, 102873.

Vaughan, C., Hansen, J., Roudier, P., Watkiss, P., Carr, E. (2019). Evaluating agricultural weather and climate services in Africa: Evidence, methods, and a learning agenda. Wiley Interdiscip. Rev. Clim. Change 10 (4), 1–33. https://doi.org/10.1002/wcc.586.

Wamalwa, I. W., Mburu, B. K., & Mang'uriu, D. G. (2016). Agro climate and weather information dissemination and its influence on adoption of climate smart practices among small scale farmers of Kisii country, Kenya. J Biol Agric Healthc, 6(10), 14-23.

Wassie, S. B., Mengistu, D. A., & Birlie, A. B. (2023). Agricultural livelihood resilience in the face of recurring droughts: Empirical evidence from northeast Ethiopia. Heliyon, 9(6).

Wossen, T., Berger, T., Swamikannu, N., & Ramilan, T. (2014). Climate variability, consumption risk and poverty in semi-arid Northern Ghana: Adaptation options for poor farm households. Environmental Development, 12, 2-15.

World Bank, Agriculture and Food. (2022). Retrieved from, https://www.worldbank.org/en/topic/agriculture/overview. (Accessed 22 July 2022).

Yegbemey, R. N., & Egah, J. (2021). Reaching out to smallholder farmers in developing countries with climate services: A literature review of current information delivery channels. Climate Services, 23, 100253.

Zhang, L., Hu, J., Li, Y., & Pradhan, N. S. (2018). Public-private partnership in enhancing farmers' adaptation to drought: Insights from the Lujiang Flatland in the Nu River (Upper Salween) valley, China. Land use policy, 71, 138-145.

Zhang, Y., Zhou, D., Li, Z., & Qi, L. (2020). Spatial and temporal dynamics of social-ecological resilience in Nepal from 2000 to 2015. Physics and Chemistry of the Earth, Parts A/B/C, 120, 102894.

Zhou, H., Wang, J. A., Wan, J., & Jia, H. (2010). Resilience to natural hazards: a geographic perspective. Natural hazards, 53, 21-41.