

The Role of Agricultural Extension in Field-Crop Farmers' Adaptation to Climate Change in Samarra District

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Abstract

This study investigated the overall role of agricultural extension in supporting field-crop farmers' adaptation to climate change in Samarra District. It further assessed farmers' perceptions of extension services in strengthening their adaptive capacity to adapt to climate change in each domain, ranked the study domains by percentage weight, examined their associations with selected personal and farm-related characteristics—age, educational attainment, participation in training courses, and years of farming experience—and identified and prioritized the constraints that impede farmers' adaptation to climate change.

The study was conducted in Samarra District, Salahuddin Governorate, between November 2025 and February 2026 using a descriptive–analytical survey design. The accessible study population comprised 244 farmers. Of these, 25 farmers participated in a pilot study to assess the reliability of the measurement scales. A total of 219 questionnaires were distributed for the main survey; 200 usable responses were obtained, while 19 incomplete questionnaires were excluded, yielding a final analytical sample of 200 respondents. Data were collected using a three-section questionnaire. The first section covered four independent variables. The second measured the dependent construct—the role of agricultural extension in farmers' adaptation—through 87 items distributed across three domains. The third section comprised 23 constraints affecting farmers' responses to climate change. The instrument demonstrated excellent internal consistency, with an overall Cronbach's alpha of 0.974. Data were analyzed using SPSS. The findings showed that the overall role of agricultural extension in farmers' adaptation was moderate but tended toward the lower end of the scale: 39% of respondents fell within the moderate category and 31% within the low category. Farmers' perceptions of extension support for capacity building were moderate and tended toward the higher end, whereas extension services were comparatively weak in developing scientifically grounded perceptions of climate change. Adaptation practices were relatively high, with 38.5% of respondents in the high category, indicating that much of the observed adaptation was autonomous and experience-based rather than the outcome of systematic extension programs. Significant associations were found between the extension role and age (negative association), educational attainment, participation in training courses, and years of farming experience. Participation in training courses showed the strongest association ($r = 0.508$), followed by educational attainment ($r = 0.464$). The leading constraints were declining rainfall and rising temperatures, market-price volatility, and the absence of agricultural insurance. The study recommends intensifying specialized extension programs on climate adaptation, shifting from general awareness raising to structured practical training, expanding farmers' access to training courses, and adopting a climate-smart agriculture framework.

Keywords: agricultural extension; climate change adaptation; field crops; Samarra District; farmers' perceptions; adaptation constraints.

1. Introduction and Research Problem

Development thinking has shifted from a narrow emphasis on increasing output and production toward building societies and production systems capable of resilience, adaptation, and continuity without depleting the resources on which future generations depend. The 2030 Agenda for Sustainable Development embodied this transition by framing development as an integrated project for people, planet, and prosperity, grounded in the interdependence of economic, social, and environmental dimensions and in partnerships among institutions and communities to address shared challenges (15). During recent decades, manifestations of climate change have accelerated, including rising temperatures, more frequent droughts and extreme events, and increasingly erratic rainfall patterns. These changes directly affect vital productive sectors, particularly agriculture. The Intergovernmental Panel on Climate Change has emphasized that climate change is an escalating source of pressure on ecological, economic, and social systems and that, although adaptive capacity exists, it is constrained by communities' institutional, financial, and knowledge resources (7).

Agriculture is particularly sensitive to climate change because it depends directly on variable climatic elements such as temperature, rainfall, humidity, and wind and is closely linked to limited natural resources, especially water and soil. This sensitivity is amplified in arid and semi-arid environments, including Iraq, where rainfall disruption or rising temperatures increase the risk of productivity losses, raise input costs, and intensify pressure on water resources. Consequently, the water–agriculture–poverty nexus represents a critical concern in any adaptation policy (17).

Within this context, agricultural extension serves as a strategic channel for translating climate knowledge into field-level practices

that can reduce adverse impacts. It does so through training, field demonstrations, dissemination of locally appropriate innovations, capacity development, and improved access to information and resources. International literature indicates that extension's contribution to climate adaptation extends beyond information dissemination to encompass decision support, trust building, and practical preparation for climate-risk management (10).

Despite growing attention to climate change and its agricultural consequences, many farming contexts continue to exhibit a gap between knowledge and perceptions on the one hand and adaptive action on the other. Farmers' responses are shaped by several determining factors, including the availability of effective extension services, financial resources, access to appropriate technologies, and the credibility of climate information. In Iraq, climate pressures interact with complex water-governance, infrastructure, and institutional constraints, making it more difficult to move from risk awareness to the widespread implementation of adaptation practices (11).

The research problem therefore lies in the need for a rigorous diagnosis of the relationship between agricultural extension and the adaptation of field-crop farmers in Samarra District. This requires measuring the levels of extension support, farmers' perceptions, and adaptation practices; identifying the factors most strongly associated with climate adaptation; and ranking the constraints that impede adaptive action. The problem can be expressed through the following question: What role does agricultural extension play in field-crop farmers' adaptation to climate change in Samarra District, and what factors constrain that adaptation?

1.2 Significance of the Study

The study's scientific significance derives from its provision of field-based evidence from Samarra District on agricultural adaptation in an Iraqi context where climatic,

water-related, and institutional challenges intersect. It also offers an analytical framework linking agricultural extension, climate-change perceptions, and adaptive behavior, supported by decision and

behavioral literature such as the Theory of Planned Behavior, which distinguishes among intention, perceived behavioral control, and contextual constraints (1). Its practical significance lies in providing extension authorities in Samarra and Salahuddin with quantitative evidence on priority areas for intervention and in supporting the design of practical training programs and field-usable climate-information channels (5).

1.3 Objectives of the Study

The study aimed to:

1. Determine the overall role of agricultural extension in field-crop farmers' adaptation to climate change in Samarra District.
2. Assess the levels of farmers' perceptions of the extension role in strengthening their capacity to adapt to climate change in each domain.
3. Rank the study domains in descending order according to their percentage weights.
4. Examine the association to identify the correlation between the extension role and the following personal and farm-related variables: age, educational attainment, participation in training courses, and years of farming experience.
5. Identify the constraints facing farmers in adapting to climate change.

1.4 Research Hypotheses

The principal null hypotheses were formulated as follows:

- 1: There is no statistically significant association between the role of agricultural extension in field-crop farmers' adaptation to climate change and farmers' age.
- 2: There is no statistically significant association between the role of agricultural extension in field-crop farmers' adaptation to climate change and farmers' educational attainment.
- 3: There is no statistically significant association between the role of agricultural extension in field-crop farmers' adaptation to climate change and participation in training courses.

- 4: There is no statistically significant association between the role of agricultural extension in field-crop farmers' adaptation to climate change and years of farming experience.

2. Methodology

The study employed a descriptive-analytical cross-sectional survey design, a widely used approach in agricultural extension research for examining respondents' attitudes, perceptions, and practices and for analyzing relationships among variables at a single point in time.

This design was appropriate because agricultural adaptation is a behavioral process shaped by perceptual and institutional factors as well as by constraints affecting the implementation of farm operations (1).

The study was conducted in Samarra District, Salahuddin Governorate, an important agricultural area where field crops—particularly wheat, barley, maize, and several legumes—are widely cultivated. The district faces climate-related challenges, including rising temperatures, water scarcity, and rainfall variability. The target population comprised field-crop farmers in the district during the period from November 2025 to February 2026.

2.1 Study Sample

The accessible population comprised 244 field-crop farmers in Samarra District. Twenty-five farmers were assigned to the pilot study to assess the clarity and reliability of the instrument. The remaining 219 farmers constituted the near-total main-survey frame. Of the 219 questionnaires administered, 200 usable questionnaires were retained for analysis and 19 incomplete questionnaires were excluded. Given the high coverage of the accessible population, the study is described as a near-total survey of the accessible population rather than as a regression-based sample-size determination.

2.2 Research Instrument, Validity, and Reliability

A structured questionnaire was used as the principal data-collection instrument. It was developed through a sequential process

involving literature review, formulation of domains and items, expert appraisal, final design, and field administration, in accordance with adaptation literature (6); (7). The questionnaire comprised three sections. The first measured four independent variables—age, educational attainment, years of farming experience, and participation in training courses—as follows:

1. Age was measured as the respondent's age in completed years.
2. Educational attainment was measured using eight ordered categories: illiterate, reads and writes, primary school, intermediate school, secondary school, agricultural diploma, bachelor's degree, and postgraduate education. These categories were coded from 1 to 8 in ascending order.
3. Years of experience in field-crop farming were measured as the total number of years the respondent had worked in field-crop production.
4. Participation in climate-change-related training courses was measured dichotomously (participant = 2; non-participant = 1). For participants, the number of courses attended was also recorded.

The second section measured the dependent construct—the role of agricultural extension in field-crop farmers' adaptation in Samarra District—using 87 items

distributed across three domains. Responses were recorded on a three-point Likert-type scale ranging from 1 to 3, producing a possible total score from 87 to 261.

The three domains were: (1) field-crop farmers' perceptions of extension support for strengthening their adaptive capacity (30 items); (2) farmers' perceptions of climate change and its effects on agricultural activity (37 items); and (3) farmers' climate-adaptation practices (20 items). The third section measured 23 constraints facing field-crop farmers in adapting to climate change. Each constraint was rated as high, moderate, or low and scored 3, 2, and 1, respectively.

Face and content validity were assessed by a panel of 26 specialists in agricultural extension, statistics, plant and crop physiology, environmental and water engineering, climatological geography, and psychology. Two criteria were used: the experts' mean agreement score, with 2.40 set as the minimum acceptance threshold, and the content validity ratio (CVR), calculated using Lawshe's formula and the revised critical values reported by Ayre and Scally (2014) (3). Expert agreement means ranged from 2.80 to 2.88, all exceeding the acceptance threshold. Reliability was assessed using Cronbach's alpha, and all coefficients were high, as shown in Table 1.

Table 1. Reliability coefficients (Cronbach's alpha) for the questionnaire scales and domains (n = 200)

No.	Scale/Domain	No. of Items	Cronbach's Alpha (α)
1	Extension role in climate-change adaptation	30	0.967
2	Farmers' perceptions of climate change	37	0.976
3	Climate-adaptation practices	20	0.971
4	Constraints to climate-change adaptation	23	0.950
—	Overall instrument	127	0.974

2.3 Statistical Analysis

Data were processed and analyzed using the Statistical Package for the Social Sciences (SPSS), with significance levels of 0.05 and 0.01. Descriptive statistics—frequencies,

percentages, arithmetic means, standard deviations, and percentage weights—were used to describe variables and rank items and domains. Pearson's correlation coefficient was used to examine relationships between

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quantitative independent variables and the dependent construct, whereas Spearman's rank correlation coefficient was used for categorical and ordinal variables. Means obtained on the three-point scale were converted to percentage weights using the range method.

3. Results and Discussion

3.1 Determine the overall role of agricultural extension in field-crop farmers' adaptation to climate change in Samarra District.

The observed extension-role scores ranged

Table 2. Distribution of respondents by level of agricultural extension's role in adaptation (n = 200)

No.	Category	Frequency	%	Mean
1	Low role (92–147)	62	31.0	122.45
2	Moderate role (148–203)	78	39.0	173.27
3	High role (204–259)	60	30.0	231.22
	Total	200	100%	174.90

This level may be attributed to the fact that extension activities addressing climate adaptation were neither sufficiently regular nor comprehensive. This finding is consistent with (13), who noted that limited specialized climate-adaptation activities are common in many extension systems in developing countries because of shortages of qualified personnel and inadequate funding. It also accords with Al-Adly (1973) (2), who

from 92 to 259, with a mean of 174.90 and a standard deviation of 45.77. After respondents were divided into three categories using the range method, the largest proportion (39%) fell within the moderate-role category, followed by the low-role category (31%) and the high-role category (30%), as shown in Table 2. Accordingly, the overall role of agricultural extension can be characterized as moderate, tending toward the lower end of the scale.

emphasized that extension effectiveness depends on the regularity and diversity of activities and on their ability to reach all categories of farmers. The 30% of respondents who reported a high extension role may have had more frequent contact with extension services, which is consistent with Rogers's (12) characterization of early adopters as being more connected to information sources and more responsive to recommendations.

3.2 Assess the levels of farmers' perceptions of the extension role in strengthening their capacity to adapt to climate change in each domain

Farmers' perceptions of extension support for capacity building recorded a mean of 60.46 and a standard deviation of 17.47. The largest proportion of respondents (38%) was in the moderate category, followed by 32.5% in the high category; thus, this domain was moderate, tending toward the higher end. This is consistent with (16), who regarded capacity building as a core function of agricultural extension. Farmers' perceptions of climate change recorded a mean of 74.15 and a standard deviation of 21.79, with respondents

distributed almost evenly across the three categories (33%, 33%, and 34%). This pattern indicates a weak extension contribution to the formation of scientifically grounded climate-change perceptions and reveals a knowledge gap between farmers' observations and their understanding of the underlying climatic processes (7). Climate-adaptation practices recorded a mean of 40.29 and a standard deviation of 13.65, with the high category accounting for the largest share (38.5%). This finding suggests that adaptation was largely autonomous and based on accumulated experience and observation rather than on systematic extension programs.

Table 3. Distribution of respondents across the three study domains (n = 200)

Domain / Categories	Low / Increased	Moderate / Unchanged	High / Decreased	Mean (SD)
Perceived extension support for capacity building	29.5%	38.0%	32.5%	60.46 (17.47)
Farmers' perceptions of climate change	33%	33%	34%	74.15 (21.79)
Climate-adaptation practices	35.0%	26.5%	38.5%	40.29 (13.65)

In Table 3, the abbreviated columns represent the low/increased category, the moderate/unchanged category, and the

high/decreased category, depending on the direction and nature of the relevant scale.

3.3 Rank the study domains in descending order according to their percentage weights

The three domains had very similar percentage weights. Farmers' perceptions of extension support for capacity building ranked first (67.17%), followed by farmers' adaptation practices (67.15%) and perceptions of climate change (66.80%), as shown in Table 4. This close clustering indicates relative balance across the dimensions of

extension performance, with a slight advantage for capacity building, which occupies a central position in contemporary extension models (16). The slightly lower ranking of adaptation practices may reflect the difficulty of moving from awareness to action, as adoption generally follows the knowledge and persuasion stages in the innovation-decision process (12).

Table 4. Descending rank of the study domains by percentage weight

No.	Domain	No. of Items	Mean		Percentage Weight	Rank
1	Perceived extension support for capacity building	30	60.46	90	67.17	1
2	Farmers' perceptions of climate change	37	74.15	111	66.80	3
3	Field-crop farmers' adaptation practices	20	40.29	60	67.15	2

3.4 Research hypotheses

The principal null hypotheses were formulated as follows:

- 1: There is no statistically significant association between the role of agricultural extension in field-crop farmers' adaptation to climate change and farmers' age.
- 2: There is no statistically significant association between the role of agricultural extension in field-crop farmers' adaptation to climate change and farmers' educational attainment.
- 3: There is no statistically significant association between the role of agricultural extension in field-crop farmers' adaptation to

climate change and participation in training courses.

- 4: There is no statistically significant association between the role of agricultural extension in field-crop farmers' adaptation to climate change and years of farming experience

3.5 Associations Between the Extension Role and Independent Variables

Correlation analysis revealed statistically significant associations between the extension role and all four independent variables examined, as shown in Table 5. Participation

in training courses had the strongest association ($r_s = 0.508$), followed by educational attainment ($r_s = 0.464$), underscoring the central importance of training and education in strengthening farmers' adaptive capacity. This finding is consistent with Swanson's (13) view that structured training is among the most influential mechanisms for building farmers'

capacities. The significant negative association between the extension role and age ($r = -0.324$) indicates that younger farmers were more willing to engage with extension services and adopt climate-adaptation practices. Years of farming experience were also positively associated with the extension role ($r = 0.348$).

Table 5. Associations between the role of agricultural extension and the independent variables (n = 200)

No.	Independent Variable	Categories	Repertition	Coefficient	Value	Significance
1	Age	Young(22-37)	42	Pearson's r	-0.324	$p < 0.01$
		Middle(38-53)	123			
		Elderly(54-70)	35			
2	Educational attainment	illiterate	18	Spearman's r_s	0.464	$p < 0.01$
		R&w	27			
		Elementary	33			
		Intermediate	38			
		Preparatory	35			
		Agri. Diploma	14			
		Bachelor	23			
3	Participation in training courses	participant	77	Spearman's r_s	0.508	$p < 0.01$
		Non- participant	123			
4	Years of farming experience	Low(2-15)	32	Pearson's r	0.348	$p < 0.01$
		Medium(16-29)	95			
		High(30-more)	73			

3.6 Identify the Constraints to Farmers' Adaptation to Climate Change

Mean constraint scores ranged from 1.64 to 2.19. Declining rainfall and rising temperatures ranked first, with a mean of 2.19, reflecting climatic pressures that farmers readily recognize because of their direct effects on day-to-day farming operations. This finding is consistent with the IPCC (2014) and

FAO in identifying drought, heat stress, and water deficits as major constraints on agricultural production in the region. Volatility in local and international market

prices ranked second ($M = 2.15$), followed by the absence of agricultural insurance against climate-related disasters ($M = 2.10$). The lowest-ranked constraint was resistance to

change and adherence to traditional methods ($M = 1.64$), possibly because farmers perceive inherited practices as well adapted to local conditions. Overall, the results demonstrate that climatic pressures interact with economic

factors—particularly price volatility and the absence of insurance—and institutional constraints, including weak financing and legislation, to shape farmers' adaptive capacity.

Table 6. Leading adaptation constraints ranked by descending mean

Rank	Constraint	Mean	SD
1	Declining rainfall and rising temperatures	2.19	0.80
2	Volatility in local and international market prices	2.15	0.84
3	Absence of agricultural insurance against climate-related disasters	2.10	0.84
	Youth migration from rural areas and the ageing of farmers	2.06	0.79
5	Limited financial resources and the high cost of appropriate technologies	2.02	0.84
...	...	...	...
23	Resistance to change and adherence to traditional methods	1.64	0.75

4. Conclusions

1. Agricultural extension's role in supporting field-crop farmers' adaptation to climate change in Samarra District was moderate but tended toward the lower end, indicating that adaptation-related extension activities have not yet achieved sufficient regularity or coverage.
2. Farmers' perceptions of extension support for capacity building were relatively favorable and fell within the moderate category, tending toward the higher end. This reflects recognition among a substantial proportion of farmers of extension efforts to develop their knowledge and skills.
3. Agricultural extension played a limited role in developing farmers' scientifically grounded perceptions of climate change, revealing a knowledge gap between the changes farmers observe and their understanding of the climatic processes underlying them.
4. Climate-adaptation practices were relatively high, suggesting a pattern of autonomous adaptation acquired through experience and observation rather than through organized extension programs.
5. The three study domains had closely

clustered percentage weights, with capacity building ranking slightly higher than the other domains.

6. The extension role was significantly associated with age (negatively), educational attainment, participation in training courses, and years of experience. Participation in training courses showed the strongest association, followed by educational attainment.
7. The leading constraints were declining rainfall and rising temperatures, price volatility, the absence of agricultural insurance, youth migration from rural areas, and limited financial capacity, demonstrating the interconnected nature of climatic, economic, and institutional constraints.
8. Although agricultural extension was present, its current role remained below the level required by the climate challenge. Strengthening this role requires a transition from information transfer to an integrated extension system combining training, financing, enabling legislation, and institutional partnership.

5. Recommendations

1. Intensify specialized agricultural extension

activities and programs on climate-change adaptation and ensure that they are regular and inclusive of different categories of farmers.

2. Strengthen farmers' capacity-building programs through training courses, field demonstrations, and field days, as these represent some of the most influential extension interventions.
3. Address the climate-knowledge gap through intensive awareness programs that explain the scientific basis of climate change and its effects on crops, using diverse audio, visual, and printed extension media.
4. Give greater attention to technical areas in which extension performance was weak—particularly soil and water management, sustainable agriculture, and early-warning systems—through specialized long-term training programs.
5. Expand the number of training courses and deliver them closer to farmers' communities, given that training participation showed the strongest association with the extension role.
6. Develop tailored extension programs for older farmers and those with lower levels of education, as these groups showed comparatively weaker engagement with extension services.
7. Diversify information sources and extension communication channels and strengthen farmers' readiness to receive and use climate-adaptation information.
8. Address the identified constraints by promoting modern irrigation technologies and efficient water use, providing financial support, establishing an agricultural insurance system, and enacting legislation that facilitates adaptation practices.
9. Strengthen coordination and integration among extension services, research centers, and agricultural cooperatives, and establish effective feedback mechanisms from farmers' fields to research institutions.

10. Adopt climate-smart agriculture as an integrated framework linking training, finance, legislation, and institutional partnerships (FAO, 2024).

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