



## Research Article

# Assessing Awareness Level of Agricultural Extension Agents Regarding Impacts of Climate Change on Agriculture Sector and Coping Strategies

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**Abstract** | This study was aimed at identifying the awareness level of the agricultural extension staff in the Agricultural Extension, Department of Training and its affiliated training centers in Baghdad Governorate, regarding climate change and its effects on the agricultural sector and identifying the mechanisms and procedures adopted by the agricultural extension regarding these risks. These procedures included five topics (administrative and technical, irrigation water, crops, agricultural land, and environment). Researchers included agricultural adviser staff in the Department of Agricultural Extension and its affiliated training centers so that the number of targeted staff was reached (161). The questionnaire used to collect data was adopted, it included two fields, The first included (20) statements to identify the level of awareness of agricultural extension staff for the risks of climate change on the agricultural sector, while the second field included (50) statements representing mechanisms and procedures adopted by agricultural extension in facing these risks. A statistical analysis program (SPSS) was used to process the research data. So this study showed that most agricultural extension staff have a high level of awareness regarding climate change and its impact on the agricultural sector especially in administrative and technical issues related to crops and irrigation water conservation, also there are no joint units and committees for emergency management and risks resulting from the consequences of climate change, lack of cooperation and coordination with local and international efforts in exchanging climate information and significant weakness in the application of laws and legislation that would hold parties that contribute to accountability and deterioration of the agricultural environment. The study recommends activating the role of agricultural extension due to the phenomenon of climate change in the agricultural sector.

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## Introduction

The agricultural sector in Iraq is one of the most important economic activities that contribute to the growth of the national economy, linking food security to national security; Achieving food security is primarily based on the provision of agricultural raw materials from local agricultural production. Developing the agricultural sector will help diversify the economy, reduce poverty and improve the balance of trade. The development of the agricultural sector will also contribute to combating unemployment, reducing the volume of imports, social development and the growth of the national economy (Saleh *et al.*, 2023). In addition, local products are safer and more reassuring to the health of the consumer than imported products. Studies have shown that most modern diseases are related to food and food consumption. The development of the agricultural sector will also have a positive impact on the improvement of the environmental reality (Hassan, 2022).

Agriculture is characterized by high vulnerability to risks, as agricultural production is affected by many factors and natural variables, such as climatic, environmental and technological fluctuations, infestation of insect pests, fungal diseases, soil erosion, and deterioration of its fertility, as well as international and local economic risks such as fluctuations in crop prices and production factors (Abu-Al-Enein *et al.*, 2020), and most scientific studies and research indicate that most agricultural risks are caused by natural hazards such as climate change, in addition to the human impact on forms of land use, such as increasing the use of both fertilizers and chemical pesticides, above the recommended rates, and excessive encroachment on forests and natural pastures (Saad, 2022).

Climate change is one of the most pressing global issues of our time, putting it high on the agenda of all international and regional meetings, and climate change has become one of the Sustainable Development Goals (SDGs), directly represented in Goal 13, and indirectly affecting the rest of the SDGs. For example, according to published scientific reports, climate change threatens the production of agricultural crops and thus threatens global food security, which may hinder the realization of the second goal of the United Nations Sustainable Development Goals (SDGs), the eradication of hunger. Africa's

Agenda 2063 also includes climate change and environmental issues among its goals, which include the identification of five regional technology centers, linked to dedicated national climate technology bodies, and climate change programs targeting women and youth (Al-Rawi, 2022).

There is no doubt that Iraq, like other countries in the world, has been affected by these climate changes on a large scale, as most of the headwaters of the Tigris and Euphrates rivers are located outside its territory, which allows neighboring countries to control these sources, and this has negatively affected the agricultural sector in Iraq, and the adoption of old agricultural practices and poor management of water resources have contributed to exacerbating the effects of climate change, such as increasing areas of desertification, losing agricultural land due to drought, and increasing soil salinity (Ministry of Planning, 2021).

Climate change and agriculture are climate change is an interconnected process. It occurs on a global scale. Climate change affects agriculture in a number of ways, including changes in temperature, reduced rainfall, extreme weather events such as heat waves, droughts, and changes in pests and diseases. In addition, the amounts of carbon dioxide in the atmosphere, as well as concentrations of ozone near the surface, and changes in the nutritional quality of food species (Gomaa *et al.*, 2021).

Essawy (2015) One of the most prominent causes of climate change is human causes, as humans are one of the main causes of climate change, due to their activities that lead to the emission of carbon dioxide and other greenhouse gases into the air, and as a result, the concentration of carbon dioxide in the atmosphere has become much greater than it was 800,000 years ago, its concentration in the twentieth and twenty-first centuries only increased by 40%, and the most important human practices that led to climate change are the burning of fossil fuels, Deforestation, agriculture and animal husbandry, cement production and factories, in addition to human misuse of natural wealth, and vegetation has threatened the existence of vegetation. Where humans carry out various activities that would pose a threat to plant life, such as: Expanding the area of agricultural and urban land at the expense of areas where natural vegetation grows, practicing overgrazing, continuing to cut down

trees for use in industry, and other activities that may destroy vegetation. It is worth noting that vegetation contributes to the production of oxygen, and oxygen is important for the continuation of life on the planet, and human mishandling of vegetation will exacerbate many issues such as desertification, drought and the extinction of many plants: Desertification, drought, the extinction of many animals and the spread of plant pests (Saleh *et al.*, 2016).

The most important manifestation of climate change in agriculture is that it is considered the first consumer of water, and one of the sources of agro-chemical pollution. Wetlands and swamps, rice cultivation, organic and chemical fertilizers, livestock waste, and the burning of agricultural residues contribute a percentage of greenhouse gases (carbon dioxide, methane, iron oxides and sulfur), on the other hand (Abdullah, 2021) attribute the causes of climate change to the following: Excessive human use of fossil and coal fuels, natural phenomena such as volcanoes, which leads to the emission of carbon dioxide, widespread deforestation, methane emission from rice farms, animal husbandry and waste.

Agricultural extension is one of the components of the agricultural process, as it represents the basic cornerstone of the development of the agricultural sector and an important and essential pillar to support and develop the agricultural process, which will have a major role in facing climate change and raising the productive and economic efficiency of agricultural products and guiding farmers to achieve production efficiency, and contributes to enhancing its contribution to the development process by reaching advanced agriculture based on modern methods of production and ensuring horizontal and vertical expansion in arable areas, and the importance of agricultural extension stands out if we look at the need for farmers to know the methods and techniques (Al-Mayali, 2023). From this point of view this study came as an attempt to answer the following research questions:

- What is the level of awareness of agricultural extension staff about dangers of climate change and its effects on agricultural sector?
- What are the procedures adopted by agricultural extension in facing the risks of climate change?

#### *Objectives*

1. Identify the level of awareness of agricultural

extension staff about climate change dangers on the agricultural sector.

2. Determine the procedures and mechanisms approved by agricultural extension to confront the risks and effects of climate change on agricultural sector.
3. Determine the mechanisms and procedures approved by agricultural extension to confront the risks of climate change related to following areas: (1) Administrative and technical, (2) Irrigation water, (3) Crop cultivation, (4) Agricultural lands, (5) Agricultural environment.

#### *Research hypothesis*

The research proceeds from following hypothesis: There is a low level of awareness of agricultural extension staff about dangers of climate change on agricultural sector, and the procedures are not commensurate with risks.

#### *Research importance*

1. This research contributes to focus on climate change and providing a realistic database on the level of awareness of this phenomenon and its effects on the agricultural sector.
2. The importance of this research is embodied in providing real information and data on role of agricultural extension in facing the risks of climate change and identifying the strengths and weaknesses of those procedures.
3. The importance of this research is also embodied in the fact that it is one of the few studies that dealt with issue of climate change and its effects on the agricultural sector and how to solve it.
4. The data collected could be used to inform future research in this area.

## **Materials and Methods**

#### *Research methodology*

This research is within the framework of social survey research. The descriptive analytical approach was used as the most appropriate approach, which is concerned with describing awareness. of agricultural extension staff in an accurate description, identifying the conscious actions of agricultural extension in facing the risks of climate change, and also identifying the relationships between research variables, analysing, interpreting and predicting them. Through realistic and accurate data and information related to the phenomenon, in the light of which results are given

(Saleh and Man, 2017).

#### *The research area*

The province of Baghdad was chosen as a region to conduct the study, specifically the agricultural extension staff working in the Agricultural Extension and Training Department and its affiliated training centres, because most of the extension programs and activities are formulated by the Agricultural Extension Department, as well as the existence of a wide research community that can be adopted in this study.

#### *Research community*

The research community included the agricultural extension staff working in Agricultural Extension, and Training Department and its extension centres, which are the Extension Training Centre Abu Ghraib, the Extension Training Centre in Rashidiya. The total number of those included in the study reached was 161 agricultural extension staff distributed as follows: 118 extension staff working in The Agricultural Extension and Training Department, 26, working guides at the Extension Training Centre in Abu Ghraib, 17 working guides at the Extension Training Centre in Rashidiya.

#### *Research plan development*

In order to reach the objectives of the study, a preliminary research plan was prepared and distributed over its objectives in its initial form by looking at scientific sources, so local and international reports and studies related to the subject of the study. it included two fields first included (20) statements to identify level of awareness of Agricultural Extension Staff for risks of climate change on agricultural sector, while for second field, it includes 50 paragraphs that represent the procedures approved by agricultural extension (agricultural extension programs and activities directed to farmers) to confront the risks of this phenomenon distributed over five issues as follows: Administrative procedures (10) statements Preserving irrigation water (10) statements, growing crops (9) statements, preserving agricultural lands (11) statements, preserving the agricultural environment 10 statements.

These fields and issues statements were presented to a group of experts specialized in field of agricultural extension and agricultural researchers for the purpose of verifying the apparent truthfulness and sincerity of the content (Agree, Slightly, Disagree). A numerical

value for each statement was assigned (1, 2, 3) degrees, respectively, and by calculating the average degrees of expert approval, all fields and statements obtained an approval rate that ranged from 93%.

For the purpose of collecting research data, a questionnaire consisting of two parts was prepared. The first part included 20 items representing the awareness level of agricultural extension staff of climate change and its effects on the agricultural sector. These items were placed under a quadruple scale composed of statements (no effect, little, medium, large), and the numerical values were given 0, 1, 2, 3 respectively, and thus determined the level of awareness of agricultural extension staff between 0-60 degrees, while the second part of the questionnaire included five domains with 50 items. They represent the extension activities and programs approved by the agricultural extension and presented to the farmers to confront the risks of climate change. These paragraphs were placed under a 3-scale made up of the following phrases (not implemented, to some extent, yes and to a great extent) and numerical values were given 0, 1, 2, 3, respectively, and thus determined the degree of those procedures in general between (0, 100) degree.

A preliminary test of the questionnaire was carried out on a random sample of (15) respondents from outside the community who were included in the research. To ensure the stability of the questionnaire. Its value is (88.3) and (84.5) degrees, which confirms the validity of the questionnaire for research field.

After checking the validity of the appearance, the truthfulness of the content and the stability of the questionnaire, we collect data from the research community. Data was collected in March 2023, and the SPSS statistical analysis program was used to analyse the data, obtain the results, and evaluate them in their final form.

## **Results and Discussion**

*To identify the level of awareness of agricultural extension staff regarding impacts of climate change on the agricultural sector*

The results showed that highest and lowest numerical value obtained by respondents ranged between 36-60 degrees, with an average of 51.73 degrees, and a standard deviation of 2.6 degrees, according to a scale representing the level of perception, whose degree

was determined between 0-60 degrees. The data in Table 1 shows that agricultural extension staff are fully aware of risks resulting from climate change that affect the agricultural sector, as more than 90% of them are aware of the importance of these risks and their impact on agricultural production. So this means that the agricultural extension staffs possess knowledge and information about climate change and the risks arising from it, which makes it easier to be solved. And this result is consistent with the findings of (Saleh *et al.*, 2023). With presence of good awareness of agricultural extension staff of effects resulting from Climate change in agricultural sector (Abdulmumini *et al.*, 2022).

In order to stand on the level of awareness of each statement of climate change risks and its impact on agriculture, the data of Table 2 shows that there is a slight discrepancy in the level of awareness of respondents, as agricultural extension staff are aware of most of these risks, as they confirm that climate changes lead to decrease in the productivity of agricultural and livestock crops may contribute to

decrease in desire for agricultural, plant and animal work. And there will be a loss of part of agricultural lands due to drying and salinization of the agricultural lands, and the phenomenon of desertification will appear due to the loss of vegetation cover. On the other hand, the respondents believe that climate changes do not lead significantly to internal migration and spread of poverty among the people of countryside, and the reason for this realization may be explained by the fact that rural population in Iraq does not depend entirely on the agriculture only, so there are an income from other resources as a result of their practice of professions and government jobs.

**Table 1:** Numbers and percentages of respondents according to their level of awareness of climate change risks on agricultural sector.

Average level of awareness	Frequency	Percent- age	Categories
42.3	9	5%	Low (44 degrees below)
51.7	48	30%	Intermediate (45- 53)
58.1	104	64%	High (54 or more)
	161	100%	the total

**Table 2:** Distribution of respondents according to their perception or risks arising from climate change.

Risks associate to climate changes	Average	Weight percentile	Ranking
Low productivity of agricultural crops and livestock	2.97	99	1
Low yield of plant and animal agricultural work	2.96	98.6	2
There will be a loss of part of agricultural lands due to drying and salinization of agricultural lands	2.95	98.3	3
Decreased vegetation cover and increased areas of desertification as a result of decreased rainfall and increased drought	2.94	98	4
The decline and deterioration of natural resources related to agriculture	2.92	97.3	5
A decrease in the quantities of produced commodities and resort to importing agricultural products to fill the shortage in the markets	2.89	69.3	6
A change in the distribution of agricultural crops due to lack of water and high temperatures	2.86	95.3	7
High temperatures and lack of rain	2.85	95	8
Spread of different types of agricultural diseases and pests	2.83	94.3	9
Increasing the rate of water requirement for agricultural crops	2.81	93.6	10
It greatly affects agriculture and food security	2.69	89.6	11
Low price of agricultural products	2.65	88.3	12
Increased number and intensity of dust storms due to loss of vegetation cover	2.59	86.3	13
The farmer is required to adapt in managing available resources to carry out the production process	2.55	85	14
Low market value of crops due to low quality	2.41	80.3	15
Influencing the distribution and productivity of community formation of marine resources	2.24	74.6	16
Influencing the distribution and productivity of community formation of marine resources	2.11	70.3	17
Increased health risks for workers in agricultural sector	2.08	69.3	18
Increased rates of poverty and unemployment	2.01	67	19
High rate of internal migration of rural people	1.42	47.3	20

*Determining the procedures and mechanisms approved by agricultural extension to confront risks and effects of climate change on agricultural sector*

The respondents' opinions differed about the procedures followed by agricultural extension in facing the risks of climate change, as their scores ranged between 33-80 degrees as the highest and lowest numeric value according to a scale whose degree was determined between 0-100 degrees. The average of the respondents' opinions was 59.6 degrees and a standard deviation of 5.4 degrees, and the data presented in Table 3, according to the opinions of respondents, indicates that the procedures and mechanisms implemented by agricultural extension to confront the risks of climate change are not commensurate with those risks., as 82% of the respondents confirm that the level of risk response to a medium degree tends to rise slightly, while 18% of them believe that the measures adopted by agricultural extension are weak and regressing, and this result is consistent with the findings of researchers (Bakari *et al.*, 2023), that the roles of agricultural extension are very limited in educating farmers about facing the risks of climate change, and despite this, the result generates the impression that agricultural extension can develop its mechanisms and future procedures to confront these risks, the reason for this result may be due to procedure has been taken to face risks by agricultural extension, it concentrated in certain fields, aspects and neglected other aspects that may exceed the capacities and capabilities available in the extension organization.

**Table 3:** Numbers and percentages of respondents according to their opinions about the procedures and mechanisms adopted by agricultural extension in facing climate change risks.

Approved mean measure	Percent-age	Fre-quency	Categories
43.7	18%	30	Low (49 degrees below)
61.5	60%	96	Intermediate (50- 66)
75.2	22%	35	High (67 or more)
	100%	161	Total

*Determining mechanisms and procedures approved by agricultural extension to confront risks of climate change*

Administrative and technical procedures: In order to adapt innovations used by agricultural extension to confront the repercussions of climate change on agricultural sector. It was found that the level of technical administrative measures adopted to confront climate change was modest. In addition, the average score for this scale, according to respondents' opinions was (8.34) for the measurement, so the score was between (0-20) degrees, and the results shown in Table 4 show that there is a significant weakness in application of administrative and accounting laws for those who contribute to discussing change. In addition to absence of creative innovation unity regarding climate change outcomes, absence committees joint from social associations to monitor farmers to develop practical solutions and weak participation with international and local efforts in exchanging climate information, while some members of the

**Table 4:** Administrative and technical measures adopted by agricultural extension in facing the risks of climate change.

Rank- ing	Weight percentile	Aver- age	Administrative and technical procedures
1	61	1.22	Initiating the preparation and planning of extension programs concerned with the dangers of climate change and its effects on agriculture
2	59	1.18	Using information and communication technology to create awareness about climate change issues
3	56	1.12	Coordinating and cooperating with agricultural research agencies to confront the risks of climate change
4	53	1.06	Training and qualifying agricultural extension cadres to face the risks of climate change
5	46.5	0.93	Existence of a national campaign using all extension channels to raise awareness of the risks and effects of climate change
6	39.5	0.79	Exchange of communications and information with early warning systems to monitor and analyse the climate phenomenon
7	35	0.70	Cooperating and coordinating with the local and international effort in exchanging climate information
8	30.5	0.61	The existence of joint research and extension committees to monitor the problems of farmers and translate them into solutions
9	23	0.46	Existence of an emergency management unit arising from the risks of climate change
10	13.5	0.27	Applying laws and legislations that will hold accountable those who contribute to the growing phenomenon of climate change

**Table 5:** Procedures approved by agricultural extension to face risks related to irrigation water.

Ranking	Weight percentile	Average	Procedures adopted to conserve irrigation water
1	94	1.88	Using modern irrigation technologies and not using traditional methods of watering agricultural crops
2	89	1.78	Reducing the waste of irrigation water and rationalizing its consumption
3	77.5	1.55	Spreading cooperation and solidarity among farmers to distribute irrigation water fairly
4	73.5	1.47	Preserving, maintaining and perpetuating water transport channels
5	65.5	1.31	Sustainable investment of groundwater and non-use of non-renewable water
6	57.5	1.15	Cultivation of crops with low water requirement
7	54	1.08	Coordinating with irrigation departments in agricultural areas to schedule irrigation
8	37	0.74	Implementing laws and regulations that urge farmers to rationalize irrigation water consumption
9	12.5	0.25	Spreading the technology of harvesting, collecting and storing water among farmers
10	11	0.22	Raising awareness of the importance of unfit water treatment systems and their use in crop irrigation

Agricultural Extension Service involved in raising awareness of farmers have weak information about climate changes. The results of this study (Khamis *et al.*, 2023) indicated that awareness-raising extension programs must be provided in this field and a comprehensive agricultural campaign must be carried out regarding climate change. Modern technological information must also be used to educate farmers about climate change. The reason for this poor performance may be due to financial or media obstacles, as well as weakness in selecting agricultural extension staff for this task (Khamis *et al.*, 2023).

*Procedures adopted to face risks related to irrigation water*

The average of procedures adopted by agricultural extension to conserve irrigation water was (11.43) degrees according to a scale for this field whose degree was set between (0-20) degrees, and data contained in Table 5 show that there are effective measures for agricultural extension in this field. This is consistent with studies by researchers (Saad, 2022; Abdullah, 2021) on the importance of raising awareness about using modern irrigation techniques, and not using traditional methods in watering agricultural crops. The necessity of reducing the waste of irrigation water, rationalizing its consumption and spreading the spirit of cooperation and solidarity among farmers to distribute irrigation water fairly. In addition, water transport channels must be preserved and kept maintained. On the other hand, we see that the level of implementation of extension activities related to irrigation and rationalization of its use was weak, according to the studies above and the results of the current study. This is why it is necessary to raise awareness of importance of unusable water treatment systems and their use in irrigating crops.

And spreading the technology of harvesting, collecting and storing water among farmers, as well as implementing laws and regulations which urge farmers to rationalize irrigation water consumption. The reason for poor treatment may be attributed to the fact that some procedures exceed the capabilities available in the Agricultural Extension Department, and although the procedures in this area are not within the level. However, the general impression about the role of agricultural extension and the procedures followed in this field was moderate and could be developed in the future (Gomaa *et al.*, 2021).

*Procedures adopted to face risks related to crop cultivation*

According to the respondents opinions about indicative activities and events implemented to protect agricultural crops from the risks of climate change, the average of those measures was 8.58 degrees in a scale whose degree was determined between 0-18 degrees. The results appear in Table 6 that the level of implementation of measures protecting agricultural crops below medium. There is a weakness in some measures foremost of which using agricultural land improvements that allow soil to retain moisture content, spread of intercropping farming techniques to reduce effects of climate change on crops and cultivation of short-lived varieties to contribute to reducing water consumption. On the other hand, there were some extension activities that need more implementation, such as raising awareness of planting windbreaks around agricultural fields to reduce effects of heat and evaporation, and developing agricultural practices in order to achieve adaptation to face climate changes (Mohamed, 2015).

**Table 6:** Procedures adopted by agricultural extension to face risks related to the cultivation of field crops.

Ranking	Weight percentile	Average	Procedures adopted in the protection of agricultural crops
1	89.5	1.79	Planting windbreaks around agricultural fields to reduce effects of heat and evaporation
2	68.5	1.37	Developing agricultural practices to achieve adaptation to climate change
3	59	1.18	Dissemination of agricultural crop varieties with high resistance to soil salinity
4	52	1.04	Importance of adopting organic farming and leaving cultivation of genetically modified crops
5	46	0.92	Propagation and cultivation of crop varieties with high productivity and resistance to drought and heat
6	44	0.88	Coordinating with research agencies to derive genotypes to improve rates of return per unit of used water
7	36	0.72	Cultivation of short-lived varieties to contribute to reducing water consumption
8	20.5	0.41	Spreading intercropping techniques to reduce effects of climate change on crops
9	13.5	0.27	Use of agricultural land conditioners that allow soil to retain moisture content

**Table 7:** Procedures approved by agricultural extension to face risks related to agricultural lands.

Ranking	Weight percentile	Average	Procedures adopted in preserving agricultural lands
1	94.5	1.89	Adopting modern irrigation systems and leaving the traditional methods
2	92	1.84	Use of organic fertilizers and animal waste to improve soil properties
3	88.5	1,77	The importance of planting a fence of trees around agricultural fields to reduce the impact of wind and heat
4	88	1.76	Risks of bulldozing orchards and urban expansion at the expense of agricultural lands
5	87.5	1.75	The importance of deep plowing to aerate soil and break hard layer using a plow under the soil
6	86	1.72	Raising awareness of the dangers of desertification and degradation of agricultural lands
7	84.5	1.69	The importance of preserving and maintaining drainage channels to get rid of excess water for irrigation
8	80	1.60	Application of agricultural cycle system and crop exchange
9	71	1.42	Risks of illegal cutting of trees and natural forests
10	69.5	1.39	Reducing the phenomenon of overgrazing and preserving natural pastures
11	66.5	1.33	Conservation of vegetation cover and the importance of its development and sustainability

*Procedures adopted to face risks related to agricultural lands*

The data contained in Table 7 show that agricultural extension measures in reducing risks of climate change and its impact on agricultural lands were at a high level, as the average value was 18.2 degrees according to a scale whose degree was determined (0-22) degrees. It is clear according to opinions of respondents, the study of (Saad, 2022), along with the results of current study, indicated that agricultural extension played a distinguished role in this field by implementing various educational extension activities, most important of awareness program on adopting modern irrigation systems and abandoning traditional methods. In addition, use organic fertilizers and animal waste to improve soil properties. There is also the importance of planting a fence of trees around agricultural fields, to reduce impact of winds and high temperatures. Also risks arising from process of bulldozing orchards

and urban expansion at expense of agricultural lands, with the importance of conducting deep ploughing to aerate soil to break up dead layer using deep subterranean plow to raise awareness of dangers of desertification and degradation of agricultural lands. Those in charge of extension system must be aware of the importance for preserving agricultural lands and that their deterioration and loss of value will negatively affect farmers encouragement to continue farming, and thus leave the agricultural field (Abdulmumini et al., 2022).

*Procedures adopted to face risks related to the agricultural environment*

According to a scale that shows opinions of respondents about the measures adopted to preserve agricultural environment in Table 8, so its degree was set between (0-20) degrees. The average of those measures was (13.1) degrees. They emphasize the



**Table 8:** Procedures adopted by agricultural extension to face risks related to agricultural environment.

Ranking	Weight percentile	Average	Procedures adopted to preserve the agricultural environment
1	92	1.84	The importance of planting windbreaks around agricultural fields and residential areas
2	88.5	1.77	Reducing the excessive use of chemical pesticides and adopting biological control as an alternative
3	87.5	1.75	Using organic fertilizers as an alternative to chemical fertilizers
4	80	1.60	The effects of throwing waste (agricultural and chemical) into irrigation canals and drains
5	79.5	1.59	Carrying out educational and awareness campaigns to take care of the cleanliness and preservation of the environment
6	74	1.48	The dangers of burning agricultural waste and its effects on the environment
7	55.5	1.11	The importance of preserving fish wealth and dangers of overfishing
8	54	1.08	The importance of recycling waste and agricultural residues and using them to improve agricultural lands
9	27	0.54	Applying laws that preserve the environment and holding transgressors accountable
10	15	0.30	The importance of using equipment and machines (environmentally friendly) as an alternative to those that generate gases and heat in their work

**Table 9:** Arrangement of measures adopted by agricultural extension in facing risks of climate change according to each agricultural field.

Ranking	Weight percentile	Weighted mean	General mean	Agricultural extension procedures
1	85	1.7	18.7	Procedures adopted in facing risks related to agricultural lands
2	65.5	1.31	13.1	Procedures adopted in face of risks related to the agricultural environment
3	57.2	1.14	11.43	Procedures adopted to face risks related to irrigation water
4	49.2	0.98	8.85	Procedures adopted to face risks related to crop cultivation
5	41.7	0.83	8.34	Administrative and technical procedures

implementation of many extension activities in this field, the most important of which is raising awareness of the importance of planting windbreaks around agricultural fields and residential areas. In addition, the excessive use of chemical pesticides must be reduced, and biological control must be adopted as an alternative. The need to raise awareness about the use of organic fertilizers, as an alternative to chemical fertilizers, and the dangers and effects of throwing waste (agricultural and chemical) into irrigation or sewage canals. On other hand, some measures were weak, such as educating farmers about the importance of using (environmentally friendly) equipment and machines as an alternative to those that generate gases and heat in their work. So importance of implementing laws that preserves the environment, and holding violators of those laws and regulations accountable. Given the importance of environment and its effects on life of living organisms, it requires responsible authorities to make diligent efforts to preserve it, through planning and implementing educational and awareness programs, to maintain a pure, unpolluted environment (Bakari *et al.*, 2023).

In order to stand on the level of implementation of procedures followed by the extension to protect agricultural sector from the risks of climate change according to each of the agricultural fields, the data contained in Table 9 show that the procedures adopted in facing risks related to agricultural lands have topped the ranking ladder, followed by measures related to the environment agricultural, while administrative and technical measures were the weakest and most implemented, with a weight percentage value of 41.7%.

### Conclusions and Recommendations

According to results this study reached the following conclusions:

- A high percentage of agricultural extension staff working in Agricultural Extension Department and its affiliated research centres possess sufficient information and knowledge about phenomenon of climate change and risks arising from it and its effects on agricultural sector.
- Although agricultural extension staff are aware

of phenomenon of climate change, and the level of preparations and measures taken in this regard are not at the required level. Measures adopted by agricultural extension to confront these risks are deficient in many aspects and fields, specifically in administrative and technical aspects and protection of agricultural crops and irrigation water.

- This study showed that the procedures adopted by agricultural extension in facing risks of climate change in areas of agricultural lands and environment were the most implemented compared to administrative and technical procedures and extension activities related to cultivation of agricultural crops which it weakest implementation.
- The absence of joint committees for managing emergencies and risks resulting from climate change related to the following areas: (administrative and technical, irrigation water, crop cultivation, agricultural lands, and the agricultural environment), the absence of cooperation and coordination with local and international efforts in exchanging climate information, and a significant weakness in applying Laws and legislation that would hold those who contribute to this accountable. Deterioration of the agricultural environment.
- The results of the study showed a clear weakness in determining the procedures and mechanisms adopted by agricultural extension to confront the risks and effects of climate change on the agricultural sector. This is due to a significant weakness in agricultural extension's efforts to educate farmers about adopting and applying some technologies that address the effects of climate change, such as water harvesting, collecting and storing, the use of inappropriate water treatment devices, and the use of environmentally friendly machinery and equipment.

#### *Recommendations*

- Despite the awareness of agricultural extension staff of phenomenon of climate change and its effects on agricultural sector, this study recommends requirements for extension and training department to continue developing knowledge, skills and capabilities of workers to face risks resulting from this phenomenon.
- Intensifying extension activities and events to educate farmers about phenomenon of climate

change its causes and serious effects on agricultural sector.

- Activating more effective mechanisms and procedures by agricultural extension to confront risks arising from phenomenon of climate change for agricultural fields in general and areas related to crop cultivation and irrigation water conservation, as well as administrative procedures in particular.
- Coordinating and cooperating with agricultural induction agencies to devise early and highly productive genotypes and varieties characterized by their resistance to drought, heat, salinity and agricultural pests.
- Establishing a specialized centre for managing emergencies resulting from phenomenon of climate change and activating coordination and cooperation in exchanging climate-related information with international and local agencies.
- Enacting laws and legislations and applying them to persons and entities that contribute to the exacerbation of climate change and environmental degradation.
- Adopting modern technologies that have proven effective in most countries of the world to face risks of climate change, such as harvesting, collecting and storing water, and using treatment devices to divert unfit water and use it in the irrigation process.

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#### **Novelty Statement**

The necessity of developing the capacities of agricultural extension staff on climate change, through continuous training to keep pace with changes, using sustainable agricultural techniques, and preserving biological diversity.

#### **Author's Contribution**

The manuscript was written by Jasim Saleh, Najwa, and Adnan Khamis, then the data was analysed by Adnan, and the data was collected by Jasim Saleh, the format of the manuscript was coordinated by Jasim Saleh and coordination was done with all the authors

together to submit the manuscript in the required form.

#### *Conflict of interest*

The authors have declared no conflict of interest.

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