

## Extension management and its role in facing the challenges of using solar energy systems in the agricultural sector from the point of view of agricultural employees in Salah al-Din Governorate / Iraq

Ahmed Saker Abdullah<sup>1\*</sup>, Rasha Raad Adbullah<sup>2</sup>, Khalaf Jasim Salih<sup>3</sup>, Maha Saeed Shada<sup>4</sup>, Israa Sami Farhan<sup>5</sup>

<sup>1,2,3,4</sup>Tikrit University - College of Agriculture / Department of Economics and Agricultural Extension, Iraq;

ahmed.s.abdullah@tu.edu.iq (A.S.A.) rasha.ra.ab@uosamarra.edu.iq (R.R.A.) Khalaf.Jassim@tu.edu.iq (K.J.S.)

maha.saeed@tu.edu.iq (M.S.S.).

<sup>5</sup>Tikrit University - College of Engineering / Department of Mechanical Engineering, Iraq; israa.s.farhan@tu.edu.iq (I.S.F.).

**Abstract:** The research objective is to ascertain the role of extension management in addressing the obstacles associated with implementing solar energy systems in the agricultural sector from the perspective of agricultural employees in Salah al-Din Governorate. Additionally, it aims to find the significant differences in determining the role of extension management according to some personal variables and to identify the role of extension management in the following domains: extension planning, institutional coordination and cooperation, extension training and qualification, financing and financial support, raising awareness and extension media, evaluating extension programs, extension human resources management, and developing extension policies. Agricultural employees employed by the Salah al-Din Agriculture Directorate and its affiliated agricultural divisions, as well as the extension center in Salah al-Din Governorate, comprised the research community, where the number of employees reached 407. A random sample of 35% was selected, resulting in 142 employees who underwent the research procedures. The questionnaire was prepared in two main parts. The first part includes a set of variables related to the personal aspect, and the second part consists of 40 paragraphs distributed over eight main domains that are answered through a three-point scale (High role, Medium role, Weak role). The results showed that the role of extension management, in general, was medium, tending toward weak. We conclude from this that there is a deficiency in providing the required technical and extension support and weak awareness of the importance and benefits of solar energy systems, which requires strengthening extension programs and developing more effective strategies to address these challenges. The results also showed significant differences between determining the role of extension management and each of the following variables: educational level, job experience, participation in extension activities, academic specialization, interest in modern technologies, and job satisfaction. The researchers recommended organizing regular seminars and training courses for agricultural employees to enhance their understanding of solar energy technology and modern agricultural extension management tools.

**Keywords:** Agricultural employees, Extension management, Solar energy.

### 1. Introduction and Research Problem

Organization is a major administrative function in all organizations, including agricultural extension organizations. It is an important element and means to achieve the organization's goals. Its effectiveness and success largely depend on it, as it includes identifying the various aspects of activities in the organization and distributing them to its human elements in a way that clarifies their relationships with each other and determines the authorities and responsibilities of each of them [1].

Extension management is considered an essential tool for achieving sustainable agricultural development, as it helps improve the efficiency of agricultural workers and encourages them to adopt modern technologies that improve productivity and reduce economic and environmental burdens [2]. Given the environmental and economic challenges facing the agricultural sector in Iraq, the use of solar energy systems is considered a strategic option to meet the growing energy needs of this sector. With the increasing pressure on traditional energy sources, the rise in their costs, and their impact on the total cost of agricultural production, it seemed necessary to adopt solutions. Therefore, as an innovative and sustainable energy saver, solar energy has received much attention as a clean, renewable, and environmentally friendly resource [3]. Management is a set of processes that aim to improve the effectiveness of individuals and agricultural communities through education, extension, and technical support. In the context of using solar energy systems, agricultural extension management plays a central role in explaining the benefits of these technologies and how to use them. And their positive impact on the environment and agricultural production. These efforts help overcome psychological and technical barriers preventing farmers from adopting modern technologies, such as lack of awareness or fear of initial investment costs. In addition, it is a major means of communication between government authorities and experts on the one hand and farmers and agricultural extension workers on the other hand. Therefore, understanding the role of extension management in the spread of solar energy systems requires analyzing the relationship between agricultural extension's theoretical and practical aspects. Theoretically, extension relies on adult education and skills development principles, focusing on the practical aspect of designing and implementing training programs in line with actual needs [4]. Solar energy is considered one of the most important sustainable energy sources that can be used in agriculture. Solar-powered water pumps help reduce the operating costs of irrigation systems. It is also considered an environmentally friendly alternative when compared to traditional energy sources and their pollutants, and it works to reduce carbon emissions. In addition, solar energy systems can also operate cooling and heating systems in greenhouses, which helps improve the productivity of various field crops. In addition, the independence of solar energy systems enables farmers in remote rural areas to rely on themselves without the need for central electricity networks and get rid of electricity bills [5]. Especially since there is a need to confront the economic and environmental crises that threaten the sustainability of the agricultural sector, in addition to the vital role that solar energy systems can play in solving many of these problems. There is huge potential to benefit from solar energy systems in Iraq due to the appropriate climate and geographical location. Still, usage rates are low due to insufficient awareness and weak necessary infrastructure and technical support. Hence, extension management is important in providing a supportive environment that encourages farmers to adopt these modern technologies and provides them with the necessary knowledge and skills [6]. Agricultural extension plays an important role in raising the efficiency of agricultural production, which means using production elements at rates that achieve the maximum possible profit from the production of agricultural goods by improving the means of production from the technical and administrative aspects [7]. The message of agricultural extension is not limited to merely working to increase agricultural production or seeking to achieve technological progress in agricultural methods and techniques. Still, its message goes beyond that scope. It extends to include creating a rural social renaissance by creating an economic renaissance by exploiting all the resources and capabilities in the countryside [8]. Agricultural extension plays an important role in the agricultural economy as it contributes to increasing and improving production efficiency. Hence, the role of extension management stems from its role as a fundamental element in achieving the objectives. Agricultural extension is not limited to providing skills and information but rather extends to stimulating innovation, building capacities, and enhancing communication between researchers, farmers, and executive bodies [9]. A significant role is played by agricultural extension in sustainable agricultural development. The tasks and responsibilities of extension services must be more comprehensive in their content and scope so that they extend beyond the transfer of agricultural technologies [10]. The traditional duties of disseminating appropriate agricultural technologies and sound agricultural practices to farmers have become

insufficient. As an alternative, extension institutions, services, and employees will be required to assume more participatory and effective roles. Appropriate strategies that support positive and transparent agricultural extension policies are also necessary for extension services [11].

In conclusion, this study is a scientific contribution that sheds light on the importance of extension management in achieving sustainable agricultural development by promoting solar energy systems. It provides a theoretical analysis of this topic. It includes a domain survey that provides a complete database that benefits researchers, decision-makers, and executive bodies concerned with developing the agricultural sector in Iraq. It also sheds light on the role that extension management can play in addressing the problems that prevent the widespread adoption of these systems. Thus, this study can be considered a step towards achieving a future vision based on resource sustainability and comprehensive and balanced development. Therefore, it came to answer the following question:

- What is the role of extension management in facing the challenges of using solar energy systems in the agricultural sector from the point of view of agricultural employees in Salah al-Din Governorate / Iraq?

### *1.1. Research Objectives*

1- Identify the role of extension management in facing the challenges of using solar energy systems in the agricultural sector from the point of view of agricultural employees in Salah al-Din Governorate in general.

2- Identify the role of extension management in facing the challenges of using solar energy systems in the agricultural sector from the point of view of agricultural employees in each of the following research domains (Extension planning, institutional coordination and cooperation, extension training and qualification, financing and financial support, raising awareness and extension media, evaluating extension programs, extension human resources management, developing extension policies).

3- Identify the variation in the role of extension management in addressing the challenges of utilizing solar energy systems in the agricultural sector from the perspective of agricultural employees, as determined by the following independent variables: (age, educational level, job experience, participation in extension activities, academic specialization, interest in modern technologies, job satisfaction).

### *1.2. Importance of the Research*

Solar energy research is important in improving the effectiveness of renewable energy technologies in agriculture. It highlights the role of extension management in providing extension and assistance to overcome the challenges of applying solar energy systems. The study also provides valuable insights into the needs and challenges facing workers in the Salah al-Din Governorate's agricultural sector, which helps develop effective strategies for expanding the use of solar energy. This research enhances agricultural sustainability and directs future policies toward using clean and efficient energy.

**Defining the Study Population and Sample:** A random sample of 35% of the agricultural employees in the Salah al-Din Governorate extension center, the Salah al-Din Agriculture Directorate, and its affiliated agricultural divisions were selected to ensure that 142 respondents underwent the research procedures. The research community itself consisted of 407 employees.

### *1.3. Preparing the Questionnaire Form*

The questionnaire form was designed in its initial form by reviewing scientific sources and previous research and consulting experts in agricultural extension and solar energy. It was formulated in a manner that is consistent with the research problem and consists of two main parts:

The first part includes a set of independent personal variables: (age, educational level, work experience, participation in extension activities, academic specialization, interest in modern technologies, and job satisfaction).

The second part: The scale consists of (40) paragraphs that are answered in the form of a three-point scale and answer alternatives (high role, medium role, weak role) distributed over eight main domains related to the role of extension management in facing the challenges of using solar energy systems. Each domain has five paragraphs, which are (the extension planning domain, institutional coordination and cooperation domain, extension training and qualification domain, financing and financial support domain, raising awareness and extension media domain, evaluating extension programs domain, managing extension human resources domain, and developing extension policies domain).

Validity measurement and statistical methods: The questionnaire form was presented to several agricultural extension and solar energy specialists in the College of Engineering to achieve apparent and content validity. After making the modifications, the data collection process was carried out from the first test sample to identify stability and validity. The split-half method extracted the stability coefficient; its value was 0.82. The value of the validity coefficient was 0.90. So, the questionnaire is ready to collect the final data. The data was collected, emptied, and processed statistically using Excel and SPSS.

## 2. Results and Discussion

The first objective: To identify the role of the extension management in facing the challenges of using solar energy systems in the agricultural sector from the point of view of agricultural employees in Salah al-Din Governorate in general.

The results showed that the lowest degree expressing the role of extension management was (40) degrees, and the highest degree was (120), and the respondents were divided into three categories according to the theoretical range, as shown in Table 1.

**Table 1.**  
Categories of the role of the extension management in facing the challenges of using solar energy systems

Categories	Number	%	Overall average	S.D
(40-66) Weak	29	20.42	88.54	13.91
(67-93) Medium	91	64.08		
(94-120) High	22	15.50		
Total	142	%100		

From Table 1, it is clear that 64.08% of the respondents are in the medium category, followed by the weak category with 20.42%. Therefore, the role of extension management is generally described as medium, and it tends to be weak. This may be due to several factors, including the lack of provision of the required technical and extension support and weak awareness of the importance and benefits of solar energy systems, which requires strengthening extension programs and developing more effective strategies to address these challenges in addition to a lack of available extension resources, and weak coordination between the relevant authorities. This deficiency may also be linked to ineffective policies that integrate solar energy as an essential part of agricultural development. This result reflects the need to strengthen extension infrastructure and improve administrative competencies to keep pace with technical developments in the agricultural sector.

The second objective: To identify the role of extension management in facing the challenges of using solar energy systems in the agricultural sector from the point of view of agricultural employees in each of the following research domains:

First: Extension planning domain

The results showed that the lowest degree expressing the role of extension management in the extension planning domain was (5) degrees, and the highest degree was (15). The participants were classified into three categories based on the range law., as shown in Table 2.

**Table 2.**

The role of extension management in the extension planning domain

Categories	Number	%	Overall average	S.D
(5-8) Weak	22	15.50	9.94	2.11
(9-12) Medium	100	70.42		
(13- and above) High	20	14.08		
Total	142	%100		

From Table 2 it is clear that 70.42% of the respondents are in the medium category, followed by the weak category with a percentage of 15.50%. Therefore, the role of the extension administration in the extension planning domain is described as average, which indicates a deficiency in planning to develop extension programs that suit the needs and circumstances of farmers. This reflects the weakness in analyzing the challenges associated with using solar energy and developing well-studied strategic plans to overcome them. It also indicates the lack of coordination between agricultural and extension administrations and relevant parties, in addition to the weak involvement of farmers in the planning process to ensure that programs are compatible with their needs. This result reflects the need to improve the planning capabilities of the extension administration by providing appropriate training and developing methodologies based on data and best practices to adopt solar energy technologies in agriculture. Second: institutional coordination and cooperation domain

The results showed that the lowest degree expressing the role of extension management in the extension planning domain was (6) degrees, and the highest degree was (14), and The participants were classified into three categories based on the range law., as shown in Table (3):

**Table 3.**

The role of extension management in the institutional coordination and cooperation domain

Categories	Number	%	Overall average	S.D
(6-8) Weak	37	26.07	10.04	2.11
(9-11) Medium	75	52.81		
(12- 14) High	30	21.12		
Total	142	%100		

From Table 3 it is clear that 52.81% of the respondents are in the medium category, followed by the weak category with a percentage of 26.07%. Therefore, the extension administration's role in institutional coordination and cooperation is described as medium, tending to weak, indicating gaps in integration between the concerned parties, such as extension administrations, agricultural institutions, and supporting organizations. This reflects the absence of effective mechanisms for coordination and exchange of information and expertise, which leads to weak support provided to farmers. In addition, the lack of cooperation between institutions has limited opportunities to provide the necessary resources, such as financing and training, to encourage using these technologies. This result reflects the need to build strategic partnerships and enhance communication channels between relevant parties to improve the effectiveness of extension programs and facilitate the adoption of solar energy systems in agriculture.

Third: Extension training and qualification domain

The results showed that the lowest degree expressing the role of extension management in the extension training and qualification domain was (5) degrees, and the highest degree was (15), and the participants were classified into three categories based on the range law., as shown in Table 4.

**Table 4.**

The role of extension management in the extension training and qualification domain

Categories	Number	%	Overall average	S.D
(5-8) Weak	27	19.01	10.11	3.11
(9-12) Medium	95	66.90		
(13- and above) High	20	14.09		
Total	142	%100		

From Table 4 shows clear that 66.90% of the respondents are in the medium category, followed by the weak category with a percentage of 19.01%. Therefore, the role of extension management in the extension training and qualification domain is described as medium tending to weak, which indicates the limited training programs provided to agricultural extension workers and farmers alike. This reflects a lack of interest in developing technical and extension competencies related to solar energy, in addition to the absence of specialized training curricula that meet the needs of the practical application of these technologies. It also indicates the scarcity of resources allocated to continuous qualification and weak cooperation with academic institutions and experts to develop effective training content. This result confirms the need to increase investment in extension training and qualification and adopt innovative training programs focusing on domain application to enhance the adoption of solar energy systems and achieve sustainability in the agricultural sector.

Fourth: Financing and financial support domain

The results showed that the lowest degree expressing the role of extension management in the financing and financial support domain was (5) degrees, and the highest degree was (15), and The participants were classified into three categories based on the range law., as shown in Table (5):

**Table 5.**

The role of extension management in the financing and financial support domain.

Categories	Number	%	Overall average	S.D
(5-8) Weak	80	56.33	9.31	2.11
(9-12) Medium	40	28.17		
(13- and above) High	22	15.50		
Total	142	%100		

From Table (5), it is clear that 56.33% of the respondents are in the weak category, followed by the medium category with a percentage of 28.17%. Therefore, the role of extension management in the financing and financial support domain is described as weak. This deficiency may be due to the government policy orientations related to investment in renewable energy or the limited funding provided by donors and financial institutions. It also reflects the absence of strategic plans to provide sufficient financial support or encourage the private sector to invest. In addition, there may be a lack of interest in solar energy systems and their positive impact on the sustainability of the agricultural sector.

Fifth: Raising awareness and extension media domain

The results showed that the lowest degree expressing the role of extension management in raising awareness and extension media domain was (7) degrees and the highest degree was (12). The participants were classified into three categories based on the range law., as shown in Table (6)

**Table 6.**

The role of extension management in raising awareness and extension media domain

Categories	Number	%	Overall average	S.D
(7-8) Weak	21	14.79	9.81	2.41
(9-10) Medium	80	56.33		
(11- 12) High	41	28.88		
Total	142	%100		

From Table 6, it is clear that 56.33% of the respondents are in the medium category, followed by the High category with a percentage of 28.88%. Therefore, the role is described as medium-tend to high in raising awareness and extension media domain in response to noticeable efforts to disseminate knowledge about solar energy systems in the agricultural sector in Salah al-Din Governorate. These efforts may include organizing awareness programs, workshops, and media campaigns directed at agricultural employees and farmers. However, these initiatives may lack full coverage or focus on practical solutions that enhance the application of technologies on a large scale, with the need to enhance continuous efforts to improve knowledge and practical extension.

Sixth: The Evaluating extension programs domain

The results showed that the lowest degree expressing the role of extension management in the evaluating extension programs domain was (6) degrees, and the highest degree was (14), and The participants were classified into three categories based on the range law., as shown in Table (7)

**Table 7.**

The role of extension management in the evaluating extension programs domain

Categories	Number	%	Overall average	S.D
(6-8) Weak	33	23.24	10.21	2.63
(9-11) Medium	76	53.52		
(12- 14) High	33	23.24		
Total	142	%100		

From Table (7), it is clear that 53.52% of the respondents are in the medium category. Evaluating the extension programs indicates that there are acceptable efforts to assess the effectiveness of the extension programs related to solar energy systems. Still, they are insufficient to achieve a strong impact. This may be due to limited or non-comprehensive evaluation methods that fail to measure the impact of the programs on improving the use of technologies in the agricultural sector. This deficiency in evaluation may also reflect a variation in the quality of the programs or a weakness in the feedback that helps develop them to achieve better results. Therefore, it is necessary to adopt more comprehensive and effective evaluation methodologies that focus on the needs of the beneficiaries and contribute to improving the extension outputs.

Seventh: Extension human resources management domain

The results showed that the lowest degree expressing the role of extension management in the extension human resources management domain was (6) degrees, and the highest degree was (15), and The participants were classified into three categories based on the range law., as shown in Table (8)

**Table 8.**

The role of extension management in the extension human resources management domain

Categories	Number	%	Overall average	S.D
(6-8) Weak	30	21.13	10.71	3.03
(9-11) Medium	82	57.74		
(12- and above) High	30	21.13		
Total	142	%100		

Table 8 shows that 57.74% of the respondents are in the medium category. The result indicates the role of the extension human resources management in the existence of an acceptable level of administrative efforts in organizing and developing the capabilities of the cadres working in agricultural extension. Still, it is insufficient to achieve the desired goals. This may be due to weak continuous training or a lack of specialized competencies in solar energy systems. Human resources management may also suffer from the absence of strategic plans to distribute and qualify cadres in line with modern challenges in the agricultural sector. To improve performance, the focus must be on building employee capabilities through specialized training programs and effective management to employ appropriate expertise in facing technical challenges.

#### Eighth: Developing extension policies domain

The results showed that the lowest degree expressing the role of extension management in the developing extension policies domain was (5) degrees, and the highest degree was (15), and The participants were classified into three categories based on the range law., as shown in Table (9)

**Table 9.**

The role of extension management in the developing extension policies domain

Categories	Number	%	Overall average	S.D
(5-8) Weak	34	23.94	10.01	2.09
(9-12) Medium	74	52.12		
(13- and above) High	34	23.94		
Total	142	%100		

From Table 8, it is clear that 52.12% of the respondents are in the medium category. The result indicates the role of developing extension policies. There are partial efforts in formulating policies that support solar energy systems in the agricultural sector, but they lack the required integration and effectiveness. This may be due to weak coordination between the relevant parties or the absence of a comprehensive strategic vision to develop agricultural extension in line with the challenges of solar energy. The result may also reflect the limited legislation or regulations that stimulate the adoption of these technologies. To enhance the role, flexible and integrated extension policies based on scientific research should be adopted, and relevant parties should participate in achieving a sustainable and wide-ranging impact.

Third objective: Identifying the variance in determining the role of extension management in facing the challenges of using solar energy systems in the agricultural sector from the point of view of agricultural employees according to the independent variables:

The significance of the differences in determining the role of extension management in facing the challenges of using solar energy systems and the personal independent variables of employees were identified by extracting the value of the F coefficient, as shown in Table 10:



**Table 10.**

Shows the distribution of respondents according to the categories of personal independent variables

Variable Name	Categories	Number	%	Average role	F- calculated value	F-value Table	Significance
Age	22-33 years	38	26.77	50	1.059	2.995	Statistically non-significant
	34-45 years	76	53.52	88			
	46-57 years	28	19.71	98			
	Total	142	%100				
Educational level	Agricultural Preparatory School	27	19.01	51.2	3.128	2.995	Statistically significant
	Diploma in Agriculture	22	15.50	68.5			
	Bachelor's Degree in Agriculture	75	52.81	92.9			
	Postgraduate Degree	18	12.68	106.3			
	Total	142	%100				
Job experience	Less than 10 years	41	28.87	61.3	3.020 3.217	2.995 2.995	Statistically significant Statistically significant
	10- 20 years	67	47.19	85			
	More than 20 years	34	23.94	97.4			
	Total	142	%100				
Participation in extension activities	Not participating	91	64.08	81.9			
	Participant	51	35.92	95.4			
	Total	142	%100				
Academic specialization	Non-Extension Specialization	120	84.50	83.8	2.999	2.995	Statistically significant
	Extension Specialization	22	15.49	102.4			
	Total	142	%100				
Interest in modern technologies	Not interested	19	13.39	61	3.347	2.995	Statistically significant
	Somewhat interested	55	38.73	79.9			
	Very interested	68	47.88	90.8			
	Total	142	%100				
Job satisfaction	Not satisfied	65	45.78	63	3.446	2.995	Statistically significant
	Somewhat satisfied	52	36.61	81.2			
	Very satisfied	25	17.61	100.2			
	Total	142	%100				

Table 10 shows the variance in determining the role of extension management according to the independent Variables listed below:

1. Age: The results showed that the medium age category of (34-45) years is the highest percentage, and to identify the significance of the differences in determining the role of extension management in facing the challenges of using solar energy systems. In the agricultural sector and age, the F test was used, and the result of the relationship was statistically non-significant, meaning that the effect of the age variable on the role of extension management in facing the challenges of using solar energy systems is limited or that the challenges are similar regardless of the age category of the employee.
2. Educational level: The results showed that the category of bachelor's degree graduates has the highest percentage of employees, and to identify the significance of the differences in determining the role of extension management in facing the challenges of using solar energy systems in the agricultural sector and the educational level, the F test was used. The

relationship was significant, meaning that the academic level affects determining the role of extension management. The higher the employee's educational level, the better he can choose the size of the role of extension management, as he is more cognizant of these technologies than others.

3. Job experience: The results showed that the category of medium experience (10-20) years is the highest percentage, and to identify the significance of the differences in determining the role of the extension management in facing the Challenges of using solar energy systems in the agricultural sector and job experience, the F test was used. The result of the relationship was significant, meaning that the increase in the job experience, the more the ability of agricultural employees to determine their role is enhanced effectively.
4. Participation in extension activities: The results showed that the non-participant category has the highest percentage of employees, and to identify the significance of the differences in determining the role of the extension management in facing the challenges of using solar energy systems in the agricultural sector and participating in extension activities, the F test was used and the result of the relationship was significant, meaning that agricultural employees, through participation in extension activities, will have the opportunity to exchange information and experiences, which enhances their awareness of the responsibilities of management and their ability to determine its role.
5. Academic specialization: The results showed that the non-extension specialization category has the highest percentage of employees. To identify the significance of the differences in determining the role of extension management in facing the challenges of using solar energy systems in the agricultural sector and specialization, the F test was used, and the result of the relationship was significant. This means that specialization has a high role. For example, the agricultural extension specialization provides the employee with deep knowledge and high skills, which makes him able to understand the challenges and determine the role of extension management, especially since among the domains of study are planning, coordination, evaluation, and financing. These are considered among the components of the curricula taught for the specialization of agricultural extension.
6. Interest in modern technologies: The results showed that the very interested category has the highest percentage of employees, and to identify the significance of the differences in determining the role of extension management in facing the challenges of using solar energy systems in the agricultural sector and interest in modern technologies, the F test was used and the result of the relationship was significant, meaning that employees who are interested in modern agricultural technologies usually have a greater motivation to understand and learn solar energy applications, which contributes to improving the employee's ability to determine the role of extension management.
7. Job satisfaction: The results showed that the non-satisfied category has the highest percentage of employees, and to identify the significance of the differences in determining the role of extension management in facing the challenges of using solar energy systems in the agricultural sector and job satisfaction, the F test was used and the result of the relationship was significant, meaning that job satisfaction has a great impact in determining the role of extension management in facing the challenges of using solar energy systems. Employees who feel satisfied with their jobs are more enthusiastic and interested in developing their roles, which enhances their efficiency in dealing with modern technologies. Job satisfaction also enhances commitment, which contributes to providing support for an effective understanding of extension roles.

### 3. Conclusions

1. The results showed that the role of extension management in general is medium, tending to weak. There is a deficiency in providing the required technical and extension support and a

weak awareness of the importance and benefits of solar energy systems, which requires strengthening extension programs and developing more effective strategies to address these challenges.

2. The results showed that the role of extension management in facing the challenges of using solar energy systems in the agricultural sector in the following domains (Extension planning, coordination and cooperation, training and qualification, and financing) is medium, tending to decrease. In conclusion, there is a lack of administrative activities and a need to improve skills and develop an administrative strategy to address these challenges.
3. The results showed that the role of the extension management in facing the challenges of using solar energy systems in the agricultural sector in the domain of: (raising awareness and extension media), is medium, tending to high; conclude from this, the effectiveness of the efforts made to raise the level of awareness among farmers and society as a whole about the importance of solar energy technology, which helps to increase its acceptance and application on a wider scale in the agricultural sector.
4. The results showed that there were significant differences between determining the role of extension management in facing the challenges of using solar energy systems in the agricultural sector from the point of view of agricultural employees and each of the following variables: (educational level, job experience, participation in extension activities, academic specialization, interest in modern technologies, job satisfaction). Conclude from this the importance of these variables and that they affect determining the role of extension management in facing the challenges of using solar energy systems.

#### 4. Recommendations

1. Organize regular seminars and training courses for agricultural employees to enhance their understanding of solar energy technology and modern agricultural extension management tools.
2. Enhance cooperation between agricultural extension, academic institutions, and companies specialized in solar energy to provide consultations and technical support.
3. Encourage agricultural workers to participate in extension activities and exchange knowledge, experiences, and skills to improve solar energy systems strategies.
4. Develop a mechanism to evaluate the role of extension management: A mechanism should be developed to assess the role of extension management regularly to identify performance gaps and effectively direct efforts to improve the use of solar energy technology in the agricultural sector.

#### Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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