Training Requirements for Protected Vegetable Farmers Who Use Well Water in The Field of Drip Irrigation in Mandali District, Diyala Province

[1]Saad Obaid Fayyadh

[1] Department of Agricultural Extension and Technology Transfer , College of Agricultural Engineering Sciences , University of Baghdad , Baghdad, Iraq

saad.o@coagri.uobaghdad.edu.iq

Abstract

This research aims to identify the training requirements of protected vegetable farmers who use well water in drip irrigation, through four main areas: installation and operation of the system, system maintenance, fertigation and nutrient management, and well water quality. The study relied on a questionnaire consisting of 38 items that was administered to a sample of 50 greenhouse vegetable farmers in Mandali Sub-District, Diyala Province. The data were analyzed using weighted means to determine the level of training needs. The results revealed a high level of training need among farmers across all studied areas, as all items exceeded the theoretical mean. The findings also showed that well water quality was the most important area, with a high overall weighted mean, reflecting the impact of water salinity and its components on system efficiency and plant health. The results further indicated that the most critical training needs were related to valve installation and network design, maintenance of filters and emitters, estimation of crop water requirements, and developing appropriate fertilization programs according to water quality. In addition, there was a clear deficiency in farmers' knowledge regarding the effects of mixing well water with fertilizers and pesticides. The study concluded that there is a need to develop specialized training programs focusing on the technical aspects of drip irrigation systems and water quality management, as well as strengthening the role of agricultural extension in transferring applied knowledge in greenhouses. This would contribute to developing farmers' skills and improving the efficiency of drip irrigation use.

Keywords: Agricultural sustainability, extension training, Groundwater, modern agriculture

Introduction

Water scarcity is considered one of the most serious challenges facing the agricultural sector in arid and semi-arid regions, particularly in Iraq. Climate change, declining surface water supplies, and the increasing reliance on groundwater resources have exerted growing pressure on agricultural sustainability [12, 9, 20]. Protected agriculture has emerged as one of the strategic solutions for increasing vegetable production and improving water-use efficiency, especially when integrated with modern irrigation technologies such as drip irrigation [11, 8, 10].

Drip irrigation is regarded as one of the most efficient irrigation systems in terms of water use, as it delivers water directly to the root zone, reduces losses caused by evaporation and surface runoff, and

ISSN 2072-3857

enhances water and fertilizer use efficiency compared with conventional irrigation methods [13, 1, 7]. Numerous studies have shown that the application of drip irrigation in greenhouse production systems contributes to higher productivity and improved crop quality, in addition to reducing soil salinity when the system is properly managed [23, 8, 16].

The decline in surface water availability in Diyala Province, particularly in Mandali Subdistrict, has led protected vegetable farmers to rely increasingly on groundwater as a primary source of irrigation, as confirmed by several studies [3, 14, 15, 2]. However, groundwater use is associated with several technical challenges, including elevated salinity levels and increased sediment loads, which negatively affect the performance of drip irrigation systems, soil properties, and crop productivity [19, 21]. The literature further indicates that the efficiency of drip irrigation systems under such conditions largely depends on farmers' knowledge of system design, operation, maintenance practices, and irrigation water quality management [6, 22].

Despite the relative expansion in the use of drip irrigation systems in Iraq, local and regional studies indicate deficiencies in farmers' technical and training capacities, particularly with regard to irrigation management, water scheduling, maintenance of filters and emitters, and dealing with clogging and salinity-related problems [18]. International studies have also demonstrated that inadequate training and agricultural extension services represent major barriers to the effective and sustainable adoption of modern irrigation technologies, leading to reduced economic and environmental efficiency [5].

Although extension-based training plays a crucial role in enhancing the adoption of modern technologies, the current situation indicates a lack of systematic and specialized studies that identify the actual training needs of protected vegetable farmers who rely on groundwater in Diyala Province, specifically in Mandali Sub-district. This gap limits the effectiveness of existing extension programs and contributes to the persistence of inefficient practices in drip irrigation management [4].

Accordingly, the research problem is represented by the existence of a knowledge and training gap among protected vegetable farmers in the study area the optimal use of drip irrigation systems when relying on groundwater. This gap negatively affects water-use efficiency, increases the risk of soil salinization, and constrains agricultural productivity. Therefore, there is a clear need to identify the technical and cognitive training requirements of these farmers in order to develop scientifically based training and extension programs that support agricultural sustainability under conditions of water scarcity in Iraq.

The present study seeks to answer the following questions:

1. What are the training requirements of protected vegetable who use wells water in the field of drip irrigation in Mandali Sub-district?

2. What are the main constraints faced by protected vegetable farmers who use wells water in the field of drip irrigation?

Research objectives

1. To identify the training requirements for protected vegetable farmers who use wells

ISSN 2072-3857

water in the field of drip irrigation in Mandali Sub-district.

2. To identify the constraints faced by protected vegetable farmers who use wells water in the field of drip irrigation.

Research Hypotheses

1. There is consensus among all protected vegetable farmers using groundwater regarding the presence of high training requirements.

2. There is consensus among all protected vegetable farmers using groundwater regarding the existence of multiple problems they face.

Research Methodology Method: To achieve the research objectives, the descriptive method was employed, which involves studying the phenomenon or problem by collecting quantitative and/or qualitative data, organizing and classifying it systematically and clearly, for the purpose of reaching conclusions, analyzing results, and proposing appropriate solutions for the studied phenomenon.

Study Area and Population: The research population included all protected vegetable farmers using groundwater in Diyala Province\ Mandali Sub-district, totaling 77 farmers for the 2021/2022 agricultural season [17]. Farmers rely on groundwater for irrigation due to the interruption and scarcity of river water, which has created significant problems for protected vegetable cultivation and agriculture in the governorate in general. Consequently, farmers utilized groundwater extracted from wells as an alternative irrigation source.

Sample: Due to the difficulty of accessing all members of the population because of their work conditions, a simple random sample of 50 farmers was selected, representing 65% of the total population of protected vegetable farmers using groundwater in Mandali Sub-district.

Data Collection Tool: A structured questionnaire was developed after reviewing relevant literature, previous studies, and consulting several specialists in the field to ensure its suitability for the research objectives. The questionnaire consisted of two parts: Part 1: Focused on identifying the training requirements of protected vegetable farmers using groundwater for drip irrigation, comprising 38 items divided into four main domains: System installation and operation (11 items); System maintenance (6 items); Fertigation and nutrient management (8 items); Groundwater quality (13 items). Training requirements were measured using a five-point scale for the importance level of each requirement: (Very High Importance, High Importance, Moderate Importance, Low Importance, Not Important), assigned weights of (4, 3, 2, 1, 0) respectively, with a theoretical mean of 2 for the training requirements scale. Part 2: Addressed the constraints faced by farmers in irrigating their crops. **Constraints were measured using a four-point scale:** (Very Important Constraint, Moderately Important Constraint, Slightly Important Constraint, Not Important), assigned weights of (3, 2, 1, 0) respectively, with a theoretical mean of 1.5 for constraint importance.

Data Collection: After data collection, responses were coded and analyzed statistically using both manual and automated methods, with the assistance of SPSS software. The study relied on the weighted mean as the primary statistic to estimate the level of training requirements

ISSN 2072-3857

and the importance of constraints for each item.

Results and Discussion

First Objective: To identify the training requirements of protected vegetable farmers using groundwater for drip irrigation in Mandali Sub-district.

Based on the responses of the surveyed greenhouse farmers, the results showed that the weighted means of the 38 items ranged from 2.23 - 3.87, with an overall weighted mean of 3.07 for all items. All values were above the theoretical mean of the scale, indicating a very high training need for all items, despite variations in the weighted means across items and the four main domains, as detailed below:

1. Installation and Operation of the Drip Irrigation System:

Eleven items related to the installation and operation of the drip irrigation system were identified. Their weighted means ranged from 2.57 - 3.39, with an overall weighted mean of 2.90. These results indicate that all items related to system installation and operation are important to the farmers and reflect a high training need, as all items exceeded the theoretical mean of 2, as shown in Table 1.

Table 1: Ranking of items in the (Installation and Operation of the Drip Irrigation System) axis according to their importance to the respondents

Ranking by Importance	Weighted Mean	Items	N.
1	3.39	Installing valves in the irrigation system	6
2	3.24	Designing the drip irrigation network according to the size of the greenhouse	3
3.5	3.04	Distribution of emitters in each pipe within the greenhouse	7
3.5	3.04	Connecting pressure regulators in the system	10
5	2.95	Distribution of main and lateral pipes throughout the greenhouse	5
6	2.87	Connecting the drip irrigation system to the water pump	1
7	2.81	Installing the water tank with the pump in the drip irrigation system	2
8	2.79	Drilling pipes for emitter installation	8
9	2.69	Connecting system filters	9

ISSN 2072-3857

10.5	2.57	Connecting the pipes to each other within the system	4
10.5	2.57	How to install a fertilizer and pesticide injection pump within the system	11
	2.90	**Overall weighted mean**	

Table 1 shows that the item (Installing valves in the irrigation system) ranked first in terms of importance for the farmers, as it received the highest weighted mean of 3.39. This can be attributed to the fact that valves are a key component in controlling and managing water flow within the greenhouse, and any error in their installation leads to uneven water distribution and pressure fluctuations, which negatively affect plant growth in protected cultivation. The item (Irrigation network design according to greenhouse size) ranked second with a weighted mean of 3.24, reflecting farmers' awareness of the importance of proper system design in achieving uniform water distribution and preventing water loss or clogging. The other items followed in descending order of importance according to the farmers. Meanwhile, the items (Connecting the pipes to each other within the system) and (How to install a fertilizer and pesticide injection pump within the system) ranked last, with a weighted mean of only 2.57. Although these items were ranked lowest in importance, their levels are still above the hypothetical mean, indicating that farmers still require training in these areas, albeit to a lesser extent than for the other items. The relatively lower importance may be due to some farmers relying on skilled labor or technicians when installing these components, which reduces their perception of the difficulty of these tasks.

2. Drip Irrigation System Maintenance:

Six items related to the maintenance of drip irrigation systems within greenhouses were identified. The results showed that the respondents' weighted means ranged from 2.23 - 3.32, with an overall weighted mean of 2.80. All values are above the theoretical mean of 2, indicating that maintenance represents a critical and influential factor for the continued operation of drip irrigation systems among farmers. Therefore, farmers have a significant training need in this area, as shown in Table 2.

ISSN 2072-3857

Table 2: Ranking of items under the (Drip Irrigation System Maintenance) axis according to their importance to respondents

Sort by importance	weighted mean	Items	No.
1	3.32	Filter maintenance	3
2	3.17	Inspection and maintenance of drippers after each irrigation	5
3	2.81	Disassembly of the system at the end of the season	6
4	2.71	Cleaning of blocked drippers	2
5	2.61	Replacement of damaged or faulty pipes	1
6	2.23	Pump maintenance within the system	4
	2.80	**General weighted mean**	

Table 2, shows that the item (Filter Maintenance) ranked first in terms of importance for the farmers included in the study, as it received the highest weighted mean of 3.32. This can be attributed to the fact that filters serve as the first line of defense in protecting the system from clogging, especially since the well water used often contains sediments, salts, or fine impurities, making filter maintenance a crucial step to ensure the continuous flow of water. The item (Inspecting and Maintaining Drippers After Each Irrigation) ranked second with a weighted mean of 3.17. This high importance is due to the fact that drippers are the parts of the system most prone to clogging, which requires farmers to inspect them regularly to avoid uneven water distribution inside the greenhouse. The other items followed in order of importance according to the farmers. Meanwhile, the results showed that the item "Pump Maintenance" ranked last with a weighted mean of 2.23. This may be because most farmers do not consider the pump as a major source of problems, or they lack sufficient expertise to diagnose its malfunctions, as they usually rely on specialized technicians when a major issue occurs with the pump.

3. Fertilization and Nutrient Irrigation:

Eight items related to fertilization and nutrient irrigation in protected cultivation were identified. The results showed that the weighted averages of respondents' answers ranged from 2.33 - 3.87, with an overall weighted mean of 3.14. All of these values are higher than the theoretical mean of 2, indicating that fertilization and nutrient irrigation represent one of the most important technical challenges in protected agriculture. Therefore, farmers have a significant training need in this area, as shown in Table 3.

ISSN 2072-3857

Table 3: Ranking of items in the (Fertilization and Nutrient Irrigation) axis according to their importance to the respondents

Sort by importance	weighted mean	Items	No.
1	3.87	How to calculate and estimate the water requirements of cultivated plants	6
2	3.68	How to develop a successful fertilization program compatible with the quality of well water	8
3	3.44	How to determine the efficiency of the irrigation system in distributing water to the plants	7
4	3.14	How to measure the fertilizer added to the fertilization system	1
5	2.95	How to calibrate the pressure of the irrigation system	4
6	2.93	How to operate a drip irrigation system	5
7	2.78	Howto add fertilizer through the irrigation system	3
8	2.33	How to add pesticides with the irrigation water	2
	3.14	**General weighted mean**	

Table (3) shows that the item (How to calculate and estimate the water requirements of the planted crops) ranked first, achieving the highest weighted mean of 3.87. This result may reflect the high awareness among farmers of the importance of knowing the water requirements to avoid over-irrigation or under-irrigation, as improper irrigation directly affects nutrient uptake and the growth balance inside the greenhouse. The item (How to develop a fertilization program compatible with the quality of well water) came in second with a weighted mean of 3.68. This can be attributed to the fact that most farmers rely on well water for drip irrigation, which varies in salinity and pH, making the choice and quantity of fertilizer directly related to the quality of the water. The other items followed in order of importance according to the farmers. Meanwhile, the item (Adding pesticides through irrigation water) ranked last with a low weighted mean of 2.33. This decline may be due to several reasons, including farmers' insufficient knowledge of the chemical compatibility between pesticides and water, fear of clogging the drippers when using pesticides, or the lack of adequate guidance on mixing pesticides in the irrigation systems.

4. Well Water Quality:

Thirteen items related to the quality of well water and its impact on the system and plants inside the greenhouses were identified. The results showed that the weighted means of

ISSN 2072-3857

respondents' answers ranged from 3.17 - 3.77, with an overall weighted mean of 3.46. This was the highest set of weighted means among the four axes, indicating that well water represents the greatest challenge for farmers when using drip irrigation in greenhouses. Therefore, farmers have a significant training need in this area, as shown in Table 4.

Table 4. Ranking of items in the (Well Water Quality) axis according to their importance to the respondents

Sort by importance	weighted mean	Items	No.
1	3.77	Determining soil characteristics in terms of pH, fertility, and organic matter compatible with well water.	6
3.5	3.63	Reducing the effects of saline well water on drip irrigation systems.	3
3.5	3.63	How to determine the quality of well water in terms of its content of calcium, sodium, and sulfates.	9
3.5	3.63	How to assess the effect of mixing well water with pesticides.	11
3.5	3.63	How to determine the impact of well water on pesticide effectiveness and its effect on pests in greenhouses.	12
6	3.58	Measuring nutrient concentrations in the soil.	13
7	3.46	Reducing the impact of well water on the quantity and types of fertilizers used with irrigation water.	4
8	3.40	Testing the salinity of well water used in drip irrigation.	1
9	3.37	Minimizing damage to plants caused by well water combined with added fertilizers.	5
10	3.29	Introducing acids and their appropriate quantities to reduce irrigation water pH, thereby lowering soil pH.	10
11	3.26	Introducing the optimal crop rotation for protected agriculture compatible with well water quality.	7

ISSN 2072-3857

12	3.24	Reducing the negative effects of saline well water on plants.	2
13	3.17	Identifying the best crops suitable for cultivation with well water.	8
	3.46	**General weighted mean**	

Table 4, showed that the item (Knowing the soil type in terms of pH, fertility, and organic matter) ranked first, with a very high weighted mean of 3.77, reflecting farmers' awareness of the negative impact of well water quality on soil inside the greenhouses, especially when salinity levels are high. Four other items (Reducing the effects of saline well water on the irrigation system), (Knowing the content of calcium, sodium, and sulfates in well water), (Understanding the effect of mixing well water with pesticides)and (Knowing the impact of well water on the effectiveness of pesticides and pests) ranked second, also with a high weighted mean of 3.77. The high weighted means indicate that farmers face real problems related to salt deposition, pipe clogging, and water–pesticide interactions, making these areas among the top training needs. The other items followed in order of importance for the farmers. Meanwhile, the item (Identifying the best crops compatible with well water) ranked last, with a weighted mean of 3.17, yet it remains well above the hypothetical mean. This suggests limited knowledge among some farmers about crop varieties that can tolerate certain salinity levels or how to adjust the cropping system according to water quality.

Summary of Chapter Four

This chapter presents and analyzes the results of the study concerning the training requirements of protected vegetable farmers who use wells water in drip irrigation in Mandali District, Diyala Province. The data were analyzed using weighted means to determine the level of training needs.

The results revealed a high level of training need among farmers across all studied axes, as all items exceeded the hypothetical mean. The findings also showed that well water quality represented the most important axis, with a high overall weighted mean, reflecting the impact of water salinity and its components on system efficiency and plant health. The results also indicated that the most critical training needs were related to valve installation and network design, maintenance of filters and emitters, estimation of crop water requirements, and development of appropriate fertilization programs according to water quality. In addition, there was a clear deficiency in farmers' knowledge regarding the effects of mixing well water with fertilizers and pesticides.

Conclusions

In light of the study's findings, the following conclusions can be drawn:

1. There is a high training need for farmers in all areas of drip irrigation, as all

ISSN 2072-3857

items exceeded the theoretical mean of the training needs scale.

2. The groundwater quality axis is considered the most important for farmers due to the effects of salinity and high salts in irrigation water.

3. Farmers face a clear weakness in the skills of installing and operating the system, especially in valve installation and designing the irrigation network.

4. There is a significant lack of skills in maintaining filters and drippers due to frequent blockages in well water.

5. The results showed low knowledge in fertilization, estimating water requirements, and setting appropriate fertilization programs according to water quality.

6. Farmers lack information about the effects of mixing well water with fertilizers or pesticides, which causes problems for both plants and the system.

7. The low importance of some items (such as pump maintenance) is attributed to farmers' reliance on technicians for these tasks.

Recommendations

In light of the findings, the research recommends the following to the relevant authorities in the Diyala Agriculture Directorate:

1. Develop comprehensive training programs covering the operation and maintenance of drip irrigation systems, with a focus on maintaining filters and emitters to reduce clogging.

2. Train farmers on designing irrigation networks, estimating water requirements, and preparing fertilization programs compatible with the quality of well water.

3. Conduct field workshops to demonstrate water quality management, especially regarding salinity, methods to reduce pH, and their effects on the system and plants.

4. Provide simplified guidance materials on fertilizer and pesticide application and how to handle chemical compatibility issues.

5. Strengthen the role of agricultural extension in continuous technical follow-up inside greenhouses to ensure the correct application of acquired knowledge.

References

1. Abdul Rahman . 2025. Effectiveness of Drip Irrigation Systems in Agriculture: A Step Towards Water Conservation. *International Journal of Agriculture Natural Farming Research* , 1(2), pp. 05-09.
2. Al-Sudani, H. I. Z. 2025. Assessment of Groundwater Resources and Hydro-Geochemical Characteristics of Mandali Basin - East Iraq. *Resources Environment and Information Engineering*, 5(1), 295-304. https://doi.org/10.25082/REIE.2024.01.003
3. Al-Sulttani, A. O., Ali, S. K., Abdulhameed, A. A., Jassim, D. T. (2024). Artificial Neural Network Assessment of Groundwater Quality for Agricultural Use in Babylon City: An Evaluation of Salinity and Ionic Composition. *International Journal of Design&Nature and Ecodynamics*,19

(1): 329-336 https://doi.org/10.18280/ijdne.190136

4. Al-Taye, H. K., S. O. Fayyadh, I. R. Hassooni. 2021. A Vision to Develop the Effectiveness of the Dissemination of Innovations to Rationalize the Use of Irrigation Water in Iraqi Agriculture. *IOP conference series: Earth and Environmental Science*, 735 (17557307)
5. Anyangoa, G. W., Bhowmicka, G. D., Bhattacharyab, N. S. (2024). A critical review of irrigation water quality index and water quality management practices in micro-irrigation for efficient policy making. *Journal of Desalination and Water Treatment* 318, 100304 https://doi.org/10.1016/j.dwt.2024.100304
6. Ashok, AD., Arunadevi, K., and Sujitha, E. (2020). Improving water use efficiency in greenhouse cultivation: A review. *International Journal of Chemical Studies*, 8(5): 543-546. DOI: https://doi.org/10.22271/chemi.2020.v8.i5h.10351
7. Ati, A. S., Abdulhamza, A. (2025). Improving Water Use Efficiency and Productivity of Lactuca sativa L. under Management of Surface, Subsurface Drip Irrigation and Furrow Systems. *Journal of Water Resources and Geosciences*, 4(1): 87-109.
8. Bwire, D., Watanabe, F., Suzuki, S., Suzuki, K. (2024).Improving Irrigation Water Use Efficiency and Maximizing Vegetable Yields with Drip Irrigation and Poly-Mulching: A Climate-Smart Approach. *Water, MDPI*,16, 3458. https://doi.org/10.3390/w16233458
9. FAO. 2023. Protecting Iraqi farmers by anticipating drought and water shortages. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
10. FAO. 2024. The rome declaration on water scarcity in agriculture. Food and Agriculture Organization (FAO), Rome, Italy. https://openknowledge.fao.org/server/api/core/bitstreams/8d5f706a-4219-4d57-9517-8a83c34957f5/content
11. Guo, H. and S. Li . 2024. A Review of Drip Irrigation's Effect on Water, Carbon Fluxes, and Crop Growth in Farmland. *MDPI/ Water*, 16(15), 2206; https://doi.org/10.3390/w16152206
12. IOM Iraq . 2022. Migration, environment, and climate change in Iraq. International Organization for Migration-Iraq(IOM Iraq), UNAMI Compound (Diwan 2), International Zone, Baghdad/ Iraq.
13. Khalifa, A. B. A., E. H. M. Hamid, A. B. Saeed, A. M. Magboul & S. B. Ahmed . 2024. Effect of drip irrigation regimes and mulching on cucumber production under cooled plastic tunnel conditions, Kassala State, Sudan. *Asian Journal of Agricultural and Horticultural Research*, 11(4), 107–114. https://doi.org/10.9734/ajahr/2024/v11i4345
14. Mahmoud, D. A. & S. S. Ali (2022). Integrated Groundwater Management in Diyala Governorate 2020. Journal of the College of Education, 49(1), 329-344. https://doi.org/10.31185/eduj.Vol49.Iss1.3246
15. Mahmoud, Z. A. 2024. Economic impacts of using modern irrigation techniques in Diyala Governorate. *Madad Al-Adab Journal*, 14(36), 1519-1550.
16. Mahmoud, Z. A. 2026. The Effect of Irrigation with Groundwater Wells on Soil Salinity in Baladruz District. *Al-Adab Journal*, 68 (1), 387-422.
17. MDAR. 2022. Mandali Agriculture Division Records for 2022 (MDAR),

Diyala Governorate Agriculture Directorate.
18. Rasmira, R., D. P. Lubis, S. Sumardjo, A. Fatchiya & S. Supriyanto .2025. Adapting to smart farming: Communication media and local knowledge in overcoming technical challenges. *BIO Web of Conferences*, 171, 04007. https://doi.org/10.1051/bioconf/2025171 04007
19. Tuama, L. A., Yaseen, M. M., Shabeeb, Y. J.(2024). The effect of irrigation management with saline and fresh water on some soil properties and wheat crop growth (Triticum aestivum L.). *Thi-Qar Journal of agricultural research*, 13(1): 380-396.
20. UNESCO. 2026. Water Scarcity And Climate Risks in Iraq. Advocacy Note, Article on https://www.unesco.org/en/articles/advocacy-note-water-scarcity-and-climate-risks-iraq?utm_source=chatgpt.com
21. Wadhieh. 2025. Well salinity threatens the lives of thousands of farmers in Diyala as drought worsens. Report on https://wadhieh.com/5358-.html
22. Xiuling, D., Qian, L., Lipeng, L., Sarkar, A. (2023). The Impact of Technical Training on Farmers Adopting Water-Saving Irrigation Technology: An Empirical Evidence from China. *Agriculture*, *MDPI*, 13, 956. https://doi.org/10.3390/agriculture13050 956
23. Yang, P., L. Wu, M. Cheng, J. Fan, S. Li, H. Wang & L. Qian. 2023. Review on Drip Irrigation: Impact on Crop Yield, Quality, and Water Productivity in China. *Water*, *Licensee MDPI*, Basel, Switzerland, 15, 1733. https://doi.org/10.3390/w15091733