Level of Application of Scientific Recommendations for the Management of Citrus Orchards in Semi-Arid Environments: The Case of Iraq

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Abstract

This study aims to assess the level of farmers' application of scientific recommendations related to citrus orchard management under semi-arid conditions, using a field survey conducted in Ishaqi district, Salah al-Din Governorate, Iraq. A structured questionnaire was administered to a random sample of 130 farmers, covering seven key management domains, including land preparation, planting, irrigation, fertilization, pest control, harvesting and marketing, and pruning. The results revealed that the overall level of application was moderate (mean = 136.93), indicating the existence of an application gap between scientific recommendations and actual farming practices. High levels of application were observed in harvesting, fertilization, and pruning, while lower levels were recorded in land preparation and weed control. The findings also showed significant positive relationships between application level and farmers' age, education, experience, access to information, and attitudes toward modern agricultural technologies, whereas no significant relationship was found with household income sources. The study concludes that farmers tend to adopt a selective application approach, prioritizing practices with immediate economic returns over foundational management practices. This highlights the need for strengthening agricultural extension systems by focusing on practical training and targeted interventions to enhance sustainable citrus production under resource-constrained environments.

Keywords: Application Level, Citrus Orchards, Agricultural Extension, Semi-Arid Agriculture, Adoption Gap, Iraq

Introduction

Agriculture is regarded as one of the principal productive sectors underpinning economic and social development in developing countries, given its central role in ensuring food security, generating employment opportunities, and promoting social stability in rural

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areas. [1]. Within this context, horticultural agriculture occupies an advanced position within the agricultural system, owing to its high economic value compared to field crops, in addition to its role in improving dietary patterns of the population. Fruit crops constitute a major component of this sector due to their nutritional and economic importance and the investment opportunities they offer when managed according to precise scientific principles [2].

Citrus (Citrus spp.) ranks among the most important horticultural fruit crops in terms of economic and nutritional value, due to its wide distribution and diversity of uses, whether for fresh consumption or food processing industries. This crop is considered administratively sensitive, as it requires a high level of precision in managing agricultural operations such as site selection, appropriate cultivar choice, regulation of irrigation, fertilization, pruning, integrated pest management, in addition to harvesting and marketing processes. Horticultural research indicates that any deviation in the implementation of these operations from approved scientific recommendations negatively affects tree productivity and fruit quality [3].

In arid and semi-arid environments, including the agricultural environment of Iraq in general and Salah Al-Din Governorate in particular, the importance of scientific management of citrus orchards increases due to limited water resources, high temperatures, and variability in the physical and chemical properties of soils. Agricultural references indicate that non-scientific management in such environments leads to reduced productive efficiency of trees, increased incidence of pests and diseases, as well as higher production costs without achieving proportional economic returns [4].

Within this framework, agricultural extension emerges as the primary applied tool that links agricultural research outputs with farmers by transferring modern knowledge and technologies and transforming them into applicable field practices. Agricultural extension is defined as an organized educational and developmental process aimed at bringing about planned change in farmers' knowledge, attitudes, and behaviors, thereby contributing to increased agricultural production efficiency and the achievement of sustainable agricultural development [5].

The relationship between agricultural extension and agricultural development is evident in its role as the fundamental approach for disseminating modern agricultural innovations, whether in field or horticultural crops, through a

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set of planned extension activities such as field visits, demonstration plots, training courses, and extension seminars. These activities aim to enable farmers to understand, evaluate, adopt, and apply scientific recommendations within their specific environmental and economic conditions [6].

From a methodological perspective, addressing the topic of the level of farmers' application of scientific recommendations requires distinguishing between concepts that may appear similar superficially but differ conceptually and in measurement. The existence of scientific recommendations as research or extension outputs does not necessarily imply their applicability in actual field conditions. Applicability is determined by the extent to which the recommendation aligns with local production environment conditions, available resource structures, farmers' organizational and economic capacities, as well as the suitability of the recommendation to agricultural timing and the technical skills required for its implementation. Accordingly, the transition of a recommendation from the level of normative knowledge to the level of practice is not automatic, but rather requires intermediary conditions that govern the transformation of knowledge into action.

Despite the availability of a considerable number of scientific recommendations related to the management of agricultural operations, particularly citrus orchard management—whether issued by research institutions or extension agencies—field reality indicates the existence of a clear gap between these recommendations and their actual level of application by farmers. In many agricultural areas, reliance on traditional practices or partial and irregular application of scientific recommendations persists, which limits production efficiency and reduces the effectiveness of extension efforts [7].

The Ishaqi Subdistrict / Salah Al-Din Governorate occupies a distinctive position in this regard, as it is one of the agricultural areas that increasingly rely on citrus orchards as a main source of agricultural income, amid environmental and managerial challenges that necessitate an accurate scientific assessment of the reality of applying approved agricultural recommendations. Accordingly, this study aims to shed light on the level of farmers' application of scientific recommendations related to the management of citrus orchards in the Ishaqi Subdistrict / Salah Al-Din Governorate, as a fundamental entry point for evaluating the effectiveness of extension efforts and diagnosing prevailing agricultural practices, thereby contributing to supporting extension planning and developing

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sustainable agricultural development programs in the region.

Research Problem

The research problem is represented by the following questions:

- What is the level of farmers' application of scientific recommendations related to citrus orchard management in the Ishaqi Subdistrict / Salah Al-Din Governorate?
- What is the level of farmers' application of scientific recommendations related to citrus orchard management in each of the following study domains (land preparation, tree planting, irrigation, fertilization, pest control, harvesting and marketing, pruning)?
- What is the level of farmers' application of scientific recommendations related to citrus orchard management in each of the following research axes (cultivar selection, planting method, planting date, insect control, disease control, weed control)?
- What is the descending order of the study domains and their respective axes according to percentage weight?
- What is the relationship between farmers' application of scientific recommendations and the studied independent variables?

Research Objectives

This study seeks to achieve the following objectives:

1. To measure and analyze the level of farmers' application of scientific recommendations related to the management of citrus orchards in the Ishaqi Subdistrict / Salah Al-Din Governorate, and to identify the factors affecting it, with the aim of diagnosing the gap between approved recommendations and actual field application (in general).
2. To determine the level of farmers' application of scientific recommendations related to citrus orchard management in the following domains: land preparation, tree planting, irrigation management, fertilization management, pest management within the framework of integrated management, harvesting and marketing, and pruning.
3. To rank the research domains and axes in descending order and to classify farmers according to application levels (high, medium, low).
4. To determine the correlation between the level of citrus orchard owners' application of scientific recommendations related to citrus orchard management and each of the following independent variables: age, educational level, number of years of experience in citrus cultivation, household income

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source, area of land utilized for citrus cultivation, sources of information on citrus cultivation, ownership of machinery, equipment, or agricultural tools, and attitude toward modern technologies.

5. To identify the most important problems facing citrus orchard owners in applying scientific recommendations related to citrus orchard management in the Ishaqi Subdistrict / Salah Al-Din Governorate, and to rank them according to their importance.
6. To estimate the gap between the scientifically recommended level and the actually applied level.
7. To propose scientific and extension-based mechanisms to improve the level of application in the study area.

Hypotheses

1. There is no significant correlation between farmers' level of application of scientific recommendations for citrus orchard management in the Ishaqi Subdistrict / Salah Al-Din Governorate and age.
2. There is no significant correlation between farmers' level of application of scientific recommendations for citrus orchard management in the Ishaqi Subdistrict / Salah Al-Din Governorate and educational level.
3. There is no significant correlation between farmers' level of application of scientific recommendations for citrus orchard management in the Ishaqi Subdistrict / Salah Al-Din Governorate and the number of years of experience in citrus cultivation.
4. There is no significant correlation between farmers' level of application of scientific recommendations for citrus orchard management in the Ishaqi Subdistrict / Salah Al-Din Governorate and household income source.
5. There is no significant correlation between farmers' level of application of scientific recommendations for citrus orchard management in the Ishaqi Subdistrict / Salah Al-Din Governorate and the area of land used for citrus cultivation.
6. There is no significant correlation between farmers' level of application of scientific recommendations for citrus orchard management in the Ishaqi Subdistrict / Salah Al-Din Governorate and sources of information on citrus cultivation.
7. There is no significant correlation between farmers' level of application of scientific recommendations for citrus orchard management in the Ishaqi Subdistrict / Salah Al-Din Governorate and ownership of machinery, equipment, or agricultural tools.
8. There is no statistically significant correlation between

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farmers' level of application of scientific recommendations for citrus orchard management in Ishaqi Subdistrict / Salah Al-Din Governorate and their attitudes toward modern agricultural technologies.

Significance of the Study

The significance of this study stems from its focus not only on analyzing the productivity of citrus crops but also on addressing a deeper issue: the transformation of scientific recommendations from theoretical knowledge into actual practical application by farmers. The mere availability of recommendations does not guarantee their implementation, and formal adoption alone does not achieve the desired productive impact.

The importance of the study can be summarized in several key aspects:

First – CognitiveSignificance

The study contributes to distinguishing between levels of knowledge, attitudes, and application, moving from focusing on the existence of recommendations to measuring the gap in actual implementation, while redefining the efficiency of the agricultural system based on sustainable scientific management.

Second – Theoretical Significance

The research provides a conceptual framework for analyzing farmers' behavior in semi-arid environments and clarifies the impact of individual and economic factors on the level of application, allowing generalization of findings to other horticultural crops.

Third – Methodological Significance

The study is based on the construction of a quantitative Likert-type scale to measure the level of farmers' application of scientific recommendations, and data were analyzed using appropriate statistical methods, including descriptive and inferential techniques.

Fourth – Practical and Extension Significance

The research offers scientific indicators to identify weaknesses in the implementation of agricultural practices and supports the development of evidence-based extension programs, thereby improving the efficiency of citrus orchard management.

Fifth – Economic and Developmental Significance

Enhancing the level of application contributes to more efficient use of resources, increased production sustainability, reduced costs and risks, and supports the stability of farmers' incomes.

Sixth – Local Significance

The study gains importance from its application in a semi-arid agricultural environment (Ishaqi

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Subdistrict), making the results relevant and applicable to similar areas facing resource and agricultural management challenges.

Material and Methods

This Research Area:

Al-Ishaqi Subdistrict in Salahuddin Governorate was selected as the study area due to the widespread cultivation of citrus orchards among farmers in this region. Citrus farming is extensively practiced across large areas within Al-Ishaqi. Since citrus orchards constitute a significant source of farmers' income, their productivity largely depends on the degree to which farmers implement scientific recommendations in orchard management and proper care. Maintaining and continuously applying these key agricultural practices is essential for achieving high-quality and high-quantity yields, thereby ensuring adequate financial returns for the farmers.

Study Population and Sample:

The study population comprised all citrus orchard farmers, totaling 520 individuals. A random sample representing 25% of the population, consisting of 130 farmers, was initially selected. Subsequently, an additional random sample of 8% (31 farmers) was drawn from the study population outside the initial sample.

Data Collection Tool

The study relied on a questionnaire as the primary data collection tool, due to its widespread use in scientific research and its ability to obtain information related to knowledge, behaviors, and attitudes relevant to the study topic [8]. The questionnaire was designed based on a review of the scientific literature, previous studies, expert opinions, and field visits to ensure its suitability for the study variables and objectives [9]. The research instrument consisted of two parts:

- **Part One:** Independent variables (age, education, experience, land area, sources of information, and attitude toward modern technologies).
- **Part Two:** A scale measuring the level of application, consisting of 56 items distributed across seven domains: land preparation, tree planting, irrigation, fertilization, pest control, pruning, and harvesting and marketing. A three-point Likert scale was used to measure responses (3 = always applied, 2 = sometimes applied, 1 = not applied), with these values assigned as numerical weights for statistical analysis.pest management, harvesting and marketing, and pruning.

Instrument Properties (Validity and Reliability)

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The psychometric properties of the instrument were verified to ensure result accuracy. Content validity was confirmed by presenting the questionnaire to a group of experts, who recommended necessary adjustments. A pre-test was conducted on a pilot sample to ensure the clarity of items and ease of response. Reliability was assessed using the split-half method, yielding a reliability coefficient of 0.863, indicating high consistency. The validity value reached 0.928, confirming the instrument's suitability for application.

Data Collection:

Data were collected in the field using the questionnaire through face-to-face interviews with respondents during 2025.

Measurement of Study Variables

- Dependent Variable (Level of Application): Measured using a 56-item scale with a three-point Likert scale (Apply, Sometimes Apply, Do Not Apply), with a theoretical range of 56–168 points.
- Independent Variables: Measured using quantitative and descriptive scales, including:
  - Age (years)
  - Educational level (ordinal scale)
  - Years of experience
  - Land area (donums)
  - Sources of information
  - Attitude toward modern technologies

Statistical Methods

Data were analyzed using SPSS software, employing a range of statistical techniques, including frequencies and percentages, mean and standard deviation, percentile weights, Pearson correlation coefficient, Spearman rank correlation coefficient, and t-test for assessing the significance of relationships. The measurement scale ranged from 1 (not applied) to 3 (always applied), representing the minimum and maximum possible scores for the study instrument.

Results and Discussion

1. Level of Implementation of Scientific Recommendations in Citrus Orchard Management in Semi-Arid Environments

The results presented in Table.1 indicate that the farmers' level of implementation of scientific recommendations in managing citrus orchards had a mean score of 136.93, suggesting a moderate-to-high level of application. This reflects a gap between knowledge and practice, as a portion of the farmers still implement the recommendations only partially. These findings underscore the need to strengthen extension services and effectively translate knowledge into practical, actionable farming practices.

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Table 1. Distribution of Farmers According to the Level of Implementation of Citrus Orchard. Management in Semi-Arid Environments

Category	Frequency	Percentage (%)
Low	3	2.3
Moderate	66	50.8
High	61	46.9
Total	130	100

Source: Prepared by the researcher based on study data.

2. Level of Application by Orchard Management Domains

The results show variation in the level of application across different management domains. High levels of application were observed in harvesting and marketing, pruning, fertilization, and irrigation, whereas moderate application levels were recorded in land preparation and tree planting. This indicates that farmers tend to focus on practices with immediate returns, while showing less attention to fundamental operations, as presented in Table.2 .

Table 2. Level of Application by Orchard Management Domains

Domain	Mean	Level of Application
Land Preparation	13.65	Moderate
Tree Planting	30.94	Moderate
Irrigation	14.42	High
Fertilization	18.13	High
Pest Management	35.75	High
Harvesting and Marketing	13.09	Very High
Pruning	9.96	High

Source: Prepared by the researcher based on the questionnaire data.

3. Descending Order of Application Areas

The results in Table.3 indicate that the harvesting and marketing domain ranked first, whereas the land preparation domain ranked last. This reflects the farmers' tendency to prioritize maximizing direct

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economic returns while showing relative neglect of fundamental practices essential for sustainable production.

Table 3. Descending Order of Application Areas

Percentage (%)	Domain	Rank
87.27	Harvesting and Marketing	1
85.94	Tree Planting	2
83.00	Pruning	3
80.11	Irrigation	4
79.71	Fertilization	5
79.44	Pest and Disease Control	6
64.76	Land Preparation	7

Source: Prepared by the researcher based on the questionnaire.

4. Level of Application According to Detailed Axes

The results, as presented in Table .4 , indicate that the level of application was high in the areas of variety selection, planting method, planting timing, and disease control. In contrast, application was at a medium level for pest control and at a medium-to-low level for weed management, reflecting a deficiency in practical knowledge related to integrated pest management.

Table 4. Level of Application According to the Axes

Level of Application	Axis
High	Variety Selection
High	Planting Method
High	Planting Timing

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Medium	Pest Control
High	Disease Control
Medium-Low	Weed Management

Source: Prepared by the researcher based on the questionnaire.

5. Relationship Between Application and Studied Variables

The results presented in Table.5 indicate significant positive correlations between the level of application and each of the following variables: age, educational level, experience, land area, information sources, and attitude toward modern technologies. This suggests that cognitive and experiential factors play a fundamental role in enhancing the level of application. In contrast, the income source variable did not show a significant relationship, indicating that application depends more on knowledge than on financial resources.

Table 5. Correlation Relationships of the Studied Variables

Significance	Correlation Coefficient	Variable
Significant	0.19	Age
Significant	0.25	Education
Significant	0.14	Experience
Significant	0.17	Land Area
Significant	0.31	Information Sources
Significant	0.33	Attitude Toward Technologies
Not Significant	0.11	Income Source

Source: Prepared by the researcher based on the questionnaire.

The results indicate that farmers in semi-arid environments engage in selective application of scientific recommendations, focusing primarily on practices directly linked to economic returns, while showing weak implementation of essential management operations. This reflects an existing application gap that necessitates strengthening agricultural extension services and developing practical training programs.

Conclusion

1. The study revealed that the level of farmers' application of scientific recommendations in citrus orchard management was moderate tending toward high, indicating a gap

between theoretical knowledge and actual field practice.

2. Variation in application levels across management domains was observed, with higher implementation in practices associated with direct economic returns (harvesting and fertilization), compared to relatively lower implementation in fundamental operations such as land preparation.
3. Farmers tend to apply scientific recommendations selectively, prioritizing practices that provide immediate economic benefits, while giving less attention to certain technical aspects essential for long-term sustainable productivity.
4. The results indicated that human and cognitive factors (age, education, experience, information sources, and attitude toward modern technologies) have a significant positive effect on the level of application.
5. The income source variable did not show a statistically significant effect, suggesting that the level of application depends more on knowledge and experience than on financial capacity.
6. A relative weakness was identified in the application of certain management domains, particularly weed control and land preparation, which may indicate insufficient specialized extension support in these areas.
7. The findings suggest deficiencies in the effectiveness of the agricultural extension system in translating scientific recommendations into sustained practical applications. The study cautions that continued neglect of land preparation and weed control practices may gradually reduce orchard productivity and long-term sustainability.

8. **Recommendations**

1. Develop agricultural extension programs with a focus on practical, hands-on training rather than solely theoretical aspects.
2. Direct extension efforts toward management domains with low application levels, particularly land preparation and weed control, to enhance overall farm management efficiency.
3. Strengthen the role of agricultural information sources (extension agents, bulletins, digital media) to raise farmers' awareness of scientific recommendations.
4. Design extension programs based on the actual needs of farmers, taking into account the conditions of semi-arid environments.
5. Support the adoption of modern agricultural technologies by fostering positive attitudes among farmers toward innovation.
6. Integrate extension programs with agricultural policies that promote sustainability and efficient use of resources, especially water and agricultural inputs.
7. Encourage future studies that link the level of application with production and economic efficiency of orchard crops.

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