International Journal of Financial, Administrative, and Economic Sciences (IJFAES)

المجلة الدولية للعلوم المالية والإدارية والاقتصادية

Vol. (5), No. (9) September 2026 الإصدار (5)، العدد (9)

A Study of Farmers Awareness and Adoption of Disease and Pest Management Practices for Citrus Crops in Al-Hariq Governorate, Kingdom of Saudi Arabia

Adel M. Ghanem
Prof., Agricultural Economics Department, College of Food and Agricultural Sciences, King Saud University, Saudi Arabia
ORCID: 0000-0002-4852-1724
aghanem@ksu.edu.sa

Mutaher M. Farhan
PhD Student, Department of Agricultural Extension and Rural Sociology, College of Food and Agricultural Sciences, King Saud University, Saudi Arabia

Jamal M. Alotaibi
Dr., Department of Agricultural Extension and Rural Society, College of Food and Agricultural Sciences, King Saud University, Saudi Arabia

Abstract

In light of the emergence and spread of diseases and pests that affect citrus crops, this study aimed to measure the level of awareness and adoption of pest management practices among citrus farmers. The study used data from a random sample of 185 respondents, collected through questionnaires, personal interviews, and field visits to citrus farmers in Al-Hariq Governorate, Kingdom of Saudi Arabia.

The results of the study showed that about 51.3% of the farmers in the research sample were under 60 years of age, and a considerable proportion (50.3%) held a university degree. In addition, most of the farmers in the research sample (75.1%) owned agricultural land, which enables them to quickly adopt and make decisions related to modern technologies.

Statistical analysis revealed that farmers' awareness of citrus pests and diseases ranged between a minimum of 35.9% and a maximum of 50.1% at a 95% confidence level. The adoption rate of pest and disease control methods ranged between a minimum of 34.9% and a maximum of 49.1% at a 95% confidence level. Meanwhile, the level of farmers' knowledge regarding pest and disease management ranged between a minimum of 62.3% and a maximum of 75.7% at a 95% confidence level.

From the above, it is clear that there is a knowledge gap in the management of citrus pests and diseases. This gap can be addressed through financial and technical support to enhance farmers' awareness and adoption of modern agricultural practices, with the aim of improving productivity and ensuring the sustainability of citrus production.

Keywords: Awareness, Adoption, Citrus Diseases and Pests, Agricultural Extension, Sustainable Production.

1- Introduction

The agricultural sector plays a significant role in economic and social development, as it contributes to the provision of goods and food products to meet the growing consumption needs of the population, which reached 35.3 million in mid-2024. The agricultural sector also serves as a reservoir for unskilled labor, with 438.2 thousand workers employed in the sector, representing 4.04% of the total workforce of 10.84 million workers. Additionally, the agricultural sector contributes to income generation, accounting for approximately 2.54% of the total GDP of 4,649.3 billion Riyals in 2024 (Saudi Central Bank, 2024).

Due to the outbreak of wars and international crises, food provision has become a priority on the global agenda, especially amid growing concerns about global climate change (Alex, 2002). A major challenge facing policymakers in promoting sustainable pest control technologies lies in addressing the adoption gap (Farjam et al., 2019). Governments have undertaken various initiatives to promote integrated pest management (IPM) practices, such as providing policy guidance, financial support, and technical training. Despite these efforts, the adoption rate of integrated pest management remains insufficient (Deguine et al., 2021). This is attributed to the "adoption gap," which describes the discrepancy between farmers' willingness to adopt technology and their actual implementation (Che et al., 2023).

Citrus fruits belong to the Rutaceae family and are cultivated in tropical and subtropical regions, extending across more than 140 countries (Batool et al., 2007). Citrus is widely used in both fresh and processed forms and serves as a primary source of vitamins, minerals, and carbohydrates that play a vital role in preventing heart, lung, liver, and skin diseases, as well as promoting a balanced and healthy lifestyle. Moreover, citrus fruits occupy the largest cultivated area and have the highest yield among fruits worldwide, making them a valuable cash crop (Zhu, 2020).

Global citrus production increased from 130 million tons in 2017 to 158.5 million tons in 2022. Citrus is cultivated on an area of 10.1 million hectares, representing 15% of the total fruit crop area worldwide in 2022 (FAO, 2022). In this context, Saudi Arabia's citrus production reached 122.4 thousand tons from an area of 5,199 hectares (MEWA, 2022).

Given the importance of citrus as a cash crop, it is essential to improve its productivity and achieve the highest possible yield by transferring modern technologies to farmers. The Agricultural Extension Department is responsible for providing farmers with research-based agricultural knowledge (Khan et al., 2020).

Despite the economic and agricultural significance of citrus cultivation in Al-Hariq Governorate, Saudi Arabia, many farmers face challenges due to a lack of awareness regarding the management of citrus diseases and pest control. This has led to the spread of plant diseases and pests, resulting in

reduced crop productivity and quality. Moreover, production costs have increased due to the inefficient use of pesticides and reliance on traditional methods, along with the limited adoption of modern and effective agricultural practices for pest management.

2- Research Objectives

This study aims to evaluate the awareness and adoption of disease and pest management practices among citrus farmers in Al-Hariq Governorate, Saudi Arabia, through the following specific objectives:

1. To examine the social and economic factors—such as educational level, age, and occupation—that influence the adoption of modern agricultural practices.
2. To assess the level of awareness and knowledge of citrus farmers regarding disease and pest management practices.
3. To explore ways to enhance farmers' awareness and encourage them to adopt advanced agricultural technologies to improve productivity and ensure the sustainability of citrus crops.

3- Study Methodology

This study was conducted in Al-Hariq Governorate, which belongs to the Riyadh Region and is located about 220 kilometers southwest of the city of Riyadh (Figure 1). The population of Al-Hariq Governorate was 10,864 in 2022, with most residents engaged in agriculture, trade, livestock herding, and government work. The governorate covers an area of approximately 6,790 square kilometers and includes several administrative centers: Al-Rabwah, Al-Mulayhat, Abu Raml, Al-Na'am, and Al-Mufajir.

The region is known for cultivating a variety of crops such as oranges, tangerines, dates, tomatoes, grapes, peaches, apricots, melons, pomegranates, watermelons, cantaloupes, and a wide range of leafy vegetables. Al-Hariq also hosts one of the largest marketing festivals in the Riyadh Region—the annual Citrus Festival—which enjoys great popularity among local residents.

This area was selected for the study due to its high-quality groundwater, fertile soil, and favorable climate. Al-Hariq is surrounded by hilly terrain that acts as a natural wind barrier, creating ideal conditions for growing a wide range of high-quality citrus crops.

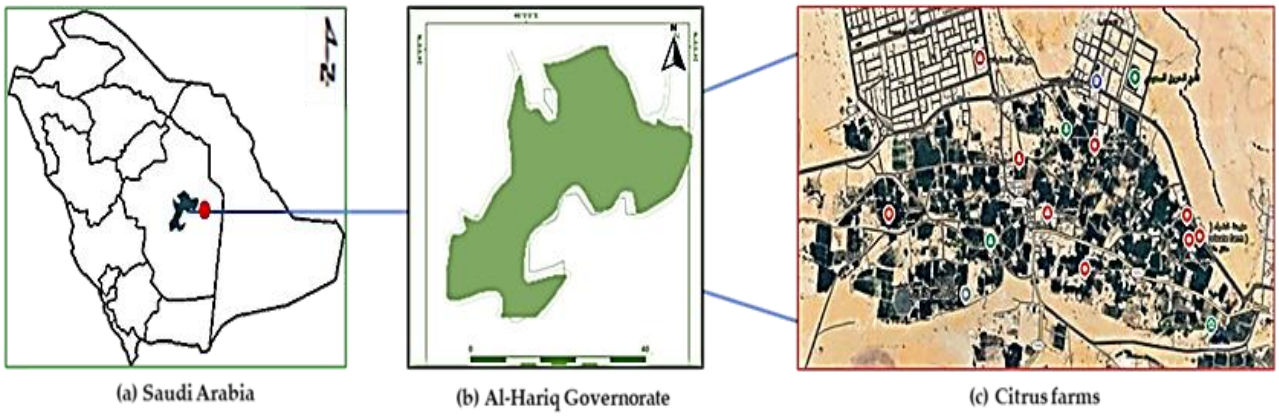

Figure (1): The Location of the study.

The number of citrus farmers in Al-Hariq Governorate was 340, and questionnaires were distributed among them. Responses were obtained from 185 farmers, representing 54.4% of the total citrus farmers in the governorate. The questionnaire was designed to collect information on citrus farming practices during the 2023 and 2024 growing seasons. It was randomly distributed to farmers in the study area through personal interviews and electronic means. The questionnaire included a mix of open-ended and closed-ended questions specifically designed to achieve the study's objectives. It covered farmers' personal characteristics such as age, educational background, and occupation, as well as detailed information about their farms, including cultivated areas and citrus production quantities. In addition, it gathered data on citrus diseases and pests and assessed the extent to which farmers adopted management practices for controlling these diseases and pests.

Since the data were descriptive in nature, numerical values were assigned to facilitate statistical analysis based on the Likert scale method (Likert, 1932). The data were then reviewed and prepared for processing using specific statistical techniques. The questionnaire data were analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics—including percentages, means, and standard deviations—were calculated.

The Bernoulli distribution—also known as the Binomial probability distribution—was used, along with standard errors at a 95% confidence level, to estimate the proportion or probability of knowledge and awareness among citrus farmers in Al-Hariq Governorate. When estimating the probability of knowledge and awareness among citrus farmers, the estimation is accompanied by standard errors that are taken into account when determining confidence intervals, as follows:

Standard error of probability at 95% confidence level =

$$\pm 1.96 * \sqrt{\frac{P(1-P)}{N}}$$

95% confidence interval for probability =

$$P \pm 1.96 * \sqrt{\frac{P(1-P)}{N}}$$

Where:
P represents the probability of knowledge, awareness, and adoption among citrus farmers, 1- P represents the probability of lack of knowledge, awareness, and adoption, N represents the number of respondents who completed the questionnaire (Gujarati, translated and reviewed by Odeh, 2015).

Finally, Logistic Regression Analysis was used. This is a type of statistical analysis employed to study the relationship between a binary dependent variable and several independent variables. The model used can be expressed by the following equation:

$$\hat{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_nX_n$$

Where:
$\hat{Y}$ represents the binary dependent variable; b_0 represents the constant term in the binary logistic regression equation; b_nX_n represents the logit value for the independent variables (age, education, occupation, land ownership, cultivated area, and production). The model was estimated using the Maximum Likelihood Estimation (MLE) method, through the SPSS software.

4- Research Results

4.1 Citrus Cultivation Area and Production in Al-Hariq Governorate:

Data presented in Figure (2) show that the total area cultivated with citrus crops in Al-Hariq Governorate reached 138 hectares, with a total production of 2,532 tons, and an average yield of 18.3 tons per hectare. Significant variations in productivity were observed among different citrus varieties.

Grapefruit recorded the highest average yield of 20 tons per hectare, followed by Valencia orange with 19.5 tons per hectare, and kumquat with 19 tons per hectare. Clementine had an average yield of 18.5 tons per hectare, while Navel orange produced an average of 18.6 tons per hectare. Lemon recorded an average yield of 17.6 tons per hectare, whereas Eureka lemon had the lowest average yield at 16.8 tons per hectare.

These variations in productivity reflect differences in the efficiency and adaptability of the varieties to agricultural and climatic conditions. To improve overall productivity, emphasis should be placed on high-yield varieties such as grapefruit, Valencia orange, and kumquat. Furthermore, it is essential to study the factors contributing to the lower yields of other varieties, such as Eureka lemon, which may include soil quality, climatic conditions, and agricultural practices.

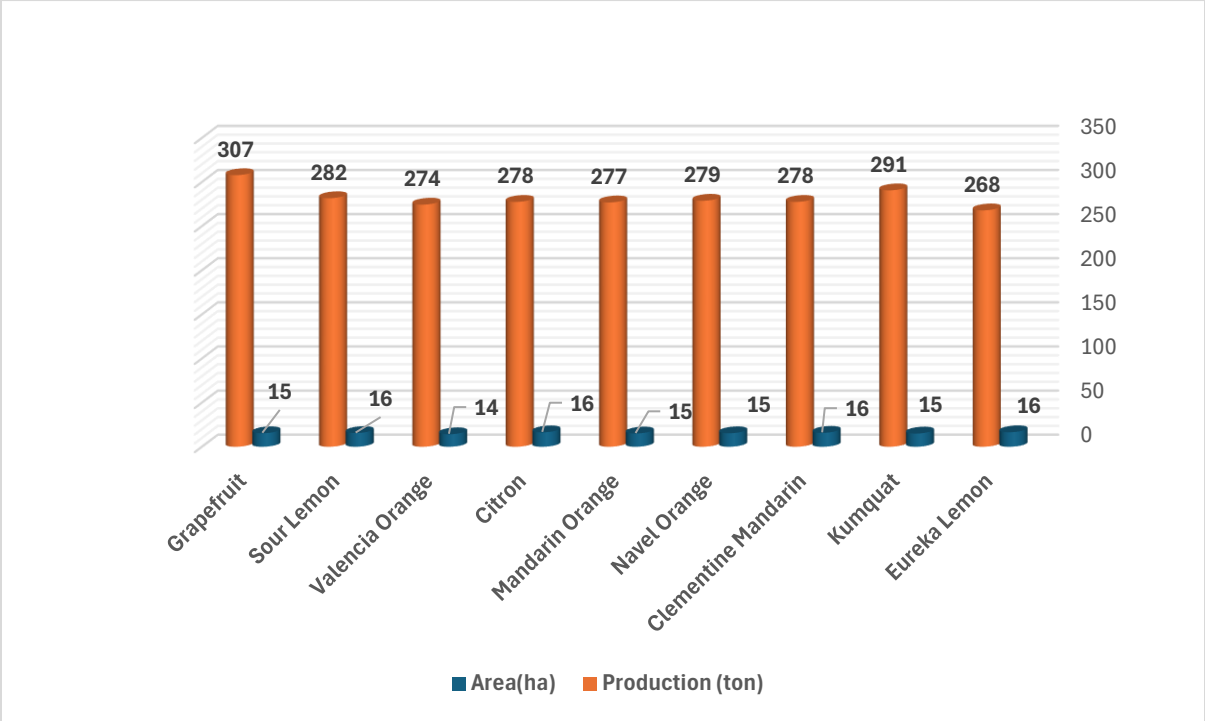

Figure (2): Citrus Cultivation Area and Production in Al-Hariq Governorate

4-2 The Socio-Economic Characteristics of Citrus Farmers:

The demographic characteristics of respondents play a vital role in how agricultural extension methods or models are utilized. The study by (Mwololo et al.2019) highlighted the importance of farmers' social and economic characteristics when examining their preferences for applying agricultural extension approaches. Similarly, a study conducted in Pakistan by (Luqman et al.2024) concluded that farmers' socio-economic characteristics play a significant role in enhancing their knowledge levels.

Given the importance of these socio-economic characteristics among citrus farmers in the study area, data presented in Table (1) show that the age distribution of citrus farmers ranged between 30 and 80 years (at the time of data collection), with an average age of 60 years and a standard deviation of 13.08 years.

The results revealed that 13.5% of the participants were under 40 years old, 37.8% were between 41 and 60 years old, and 48.6% were 60 years or older. Overall, 51.3% of the participants belonged to age groups under 60 years, typically described as being more mature, energetic, and productive.

This demographic distribution suggests the potential to enhance the adoption of modern agricultural technologies, as younger and middle-aged farmers tend to be more open to innovation and adaptable to change—highlighting the crucial role of age in influencing technology adoption rates in agriculture.

The study also confirmed the significant impact of farmers' knowledge and education levels on their adoption of modern agricultural technologies. Among the participants, 50.3% had university education**,** 29.2% completed secondary education**,** 17.8% had intermediate education**,** and 2.7% had primary education.

These figures indicate that farmers with at least secondary education are more likely to adopt modern agricultural practices. Moreover, more than 79% of the participants had either secondary or university education, enhancing their ability to understand, implement, and disseminate new technologies.

This finding aligns with the research conducted by (García-Cortijo et al. 2019) and the results of (Siddiqui et al. 2006)**,** which supported the significant correlation between education and awareness **(**Salehin et al., 2009). The study also documented an important relationship between education and awareness, as education fosters a tendency among farmers to adopt cost-effective technologies, demonstrating that higher education levels are associated with greater responsiveness to agricultural innovations and improved collaboration with researchers.

Regarding professional backgrounds, the study found a wide diversity among the participants. Approximately 68.6% of them did not consider agriculture as their primary occupation. Specifically, 50.8% were employed in the public sector, 16.8% were self-employed, and 1% worked in the private sector**.** In contrast, only 31.4% of the participants practiced farming as their main occupation**.**

This diversity in professional backgrounds enriches farmers' experiences and knowledge, enabling them to adopt and apply modern technologies more effectively in their agricultural activities. It also highlights the benefits of cross-sector knowledge transfer in enhancing agricultural productivity.

The study by (García-Cortijo et al. 2019) indicated that land ownership was another critical factor influencing technology adoption. The findings showed that 75.1% of farmers owned their farms, while 24.9% leased agricultural land.

Land ownership provides farmers with greater decision-making autonomy, allowing them to focus on product quality**,** safety, and cost reduction while maximizing profits—particularly in citrus production. Farmers who cultivate their own land are generally more willing to adopt technological innovations, contributing to improved productivity and profitability.

This behavior reflects a positive response to developments in the agricultural sector and underscores the importance of land ownership as a key factor in achieving sustainable agricultural development.

Table (1): Socio-Economic Characteristics of the Respondents

Farmers' Characteristics	Number of Farmers (n = 185)			
	Frequency	%	**Mean**	**Standard Deviation**
Age			60	13.08
Less than 40 years	25	13.6		
40–60 years	70	37.8		
More than 60 years	90	48.6		
Education level			6	0.85
primary	5	2.7		
Middle	33	17.8		
Secondary	54	29.2		
University	93	50.3		
Profession			3	0.92
Agriculture only	58	31.4		
Freelance	31	16.8		
Governmental	94	50.8		
Private sector	2	1		
Farm data			1	0.40
Private single farm	139	75.1		
Farm for rent	46	24.9		

4-3. Farmers' Awareness Level of Citrus Diseases and Pests:

Data presented in Figure (3) illustrate the extent of farmers' awareness of citrus pests. It was found that 43% of farmers had a general understanding of harmful insects, while a considerable 57% lacked sufficient awareness. Farmers showed the highest levels of awareness regarding fruit fly and thrips, both at 49%, followed closely by citrus insects (46%) and scale insects (44%). Awareness levels were slightly lower for flower bud worms (43%) and leaf miners (42%), while the lowest awareness level was recorded for mealybugs, at only 30%.

To address these gaps in citrus pest awareness, educational workshops and awareness campaigns are essential to improve farmers' understanding of pest identification and management. Strengthening agricultural extension services and fostering collaboration with experts can provide practical, field-based support.

Furthermore, promoting Integrated Pest Management (IPM) strategies and leveraging digital tools can empower farmers to adopt sustainable and effective pest control practices. These measures can significantly enhance farmers' capacity for pest management, ultimately leading to improved crop productivity and reduced economic losses.

These findings are consistent with the results of the study by (Choudhary & Bangarva, 2013).

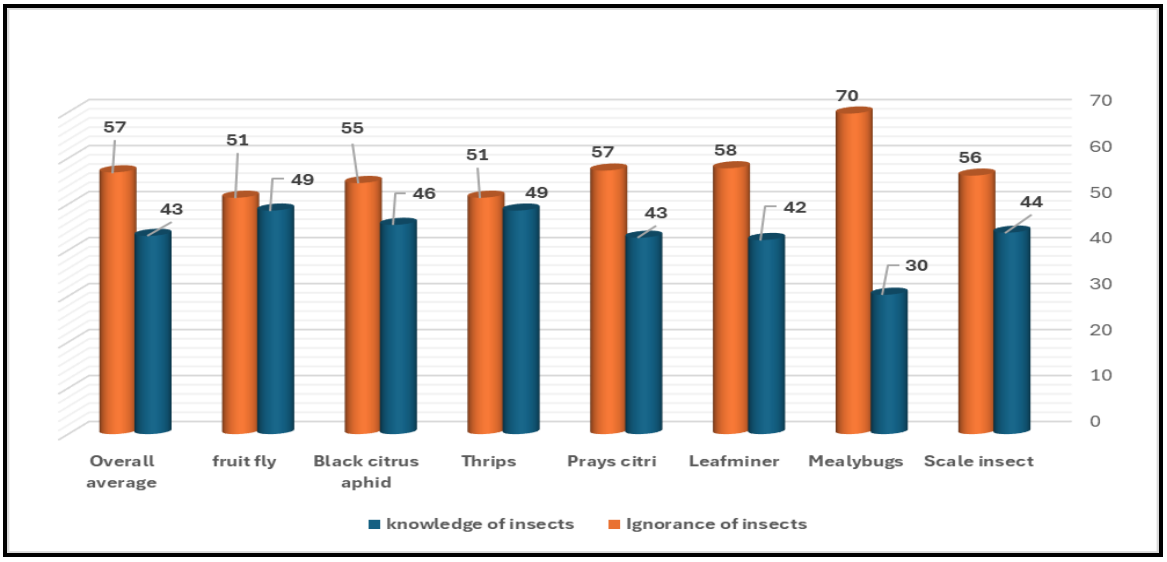

Figure (3): Farmers' Awareness Level of Citrus Pests

By examining the awareness level of citrus farmers regarding pest and disease management, data presented in Table (2) show that the estimated probability of awareness of citrus pest and disease management ranged between a minimum of 35.9% and a maximum of 50.1%, at a 95% confidence level.

Table (2): Relative Importance of Farmers' Knowledge, Awareness, and Adoption of Citrus Pest and Disease Management in Al-Hariq Governorate

Indicator	Knowledge, Awareness, and Adoption Rates at a 95% Confidence Level		
	Knowledge	Awareness,	Adoption
Sample Mean	%69	%43	%42
Probability of Knowledge, Awareness, and Adoption	0.69	0.43	0.42
Probability of Lack of Knowledge, Awareness, and Adoption	0.31	0.57	0.58
Standard Error of the Probability of Knowledge, Awareness, and Adoption	0.0340	0.0364	0.0363
Standard Error at a 95% Confidence Level	0.0666	0.0713	0.0711
Contribution Probability at a 95% Confidence Level	± 0.69 0.0666	0.0713 ± 0.43	0.0711 ± 0.42
Knowledge and Awareness Rate at a 95% Confidence Level: Lower Limit Upper Limit	%62.3 %75.7	%35.9 %50.1	%34.9 %49.1

Source: Compiled and calculated from the data presented in Figures (3, 4, and 5).

4-4. Adoption Rate of Citrus Pest Control Practices:

As illustrated in Figure (4), the adoption rate of pest control methods among citrus farmers in the study sample was 42%, while 58% faced difficulties in adopting these practices due to a lack of knowledge or financial resources.

The details indicate that adoption rates varied depending on the type of pest. The highest adoption rate was recorded for mealybug control (45%), followed by fruit fly control (44%), black citrus aphid control (43%), scale insect control (42%), and flower moth control (41%). The lowest adoption rates were observed for thrips and leaf miner control, both at 40%.

The study by (Wason et al. 2009) showed that farmers' adoption of integrated pest management (IPM) was influenced by several factors, including education level, environmental attitude, scientific orientation, and extension communication. Therefore, factors such as education, extension interaction, and farmer training are crucial for enhancing knowledge and promoting the adoption of IPM practices.

Similarly, the findings of (Kumari et al. 2022) indicated a partial awareness of pest control methods, but financial and knowledge-related challenges continue to limit broader application. To improve adoption rates, farmers' financial capacities can be strengthened through support programs or low-interest loans, alongside increasing awareness via workshops and IPM training sessions.

Moreover, an analysis of the adoption rate of citrus pest and disease management practices based on data presented in Table (2) shows that the estimated probability of adoption ranged between a minimum of 34.9% and a maximum of 49.1%, at a 95% confidence level

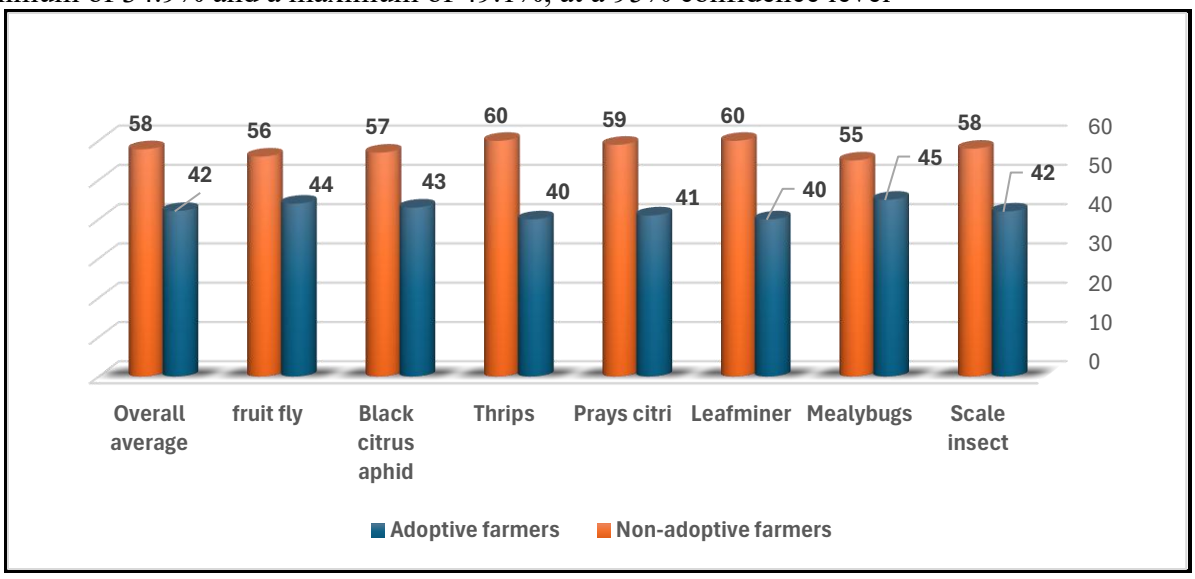

Figure (4): Level of Adoption of Pest Control Practices by Citrus Farmers

4-5. Farmers' Knowledge Level of Citrus Diseases:

Figure (5) illustrates the level of farmers' knowledge of citrus diseases, which averaged 69%, indicating a moderate to good understanding among farmers. However, variations were observed in their awareness of specific diseases, reflecting differences in agricultural health knowledge.

The highest awareness level was recorded for leaf spot disease (74%), followed by twig wilt (73%), and twig blight (71%). Awareness of citrus gummosis reached 69%, matching the overall average. The yellowing disease and sunburn both had awareness levels of 68%. In contrast, citrus canker awareness stood at 65%, while the lowest level was observed for fruit cracking disease, at 63%.

Overall, farmers' knowledge of citrus diseases ranges from moderate to good, with varying levels of awareness across different diseases.

Furthermore, an analysis of the knowledge level of citrus farmers regarding pest and disease management, based on data presented in Table (2), shows that the estimated probability of knowledge ranged between a minimum of 62.3% and a maximum of 75.7%, at a 95% confidence level.

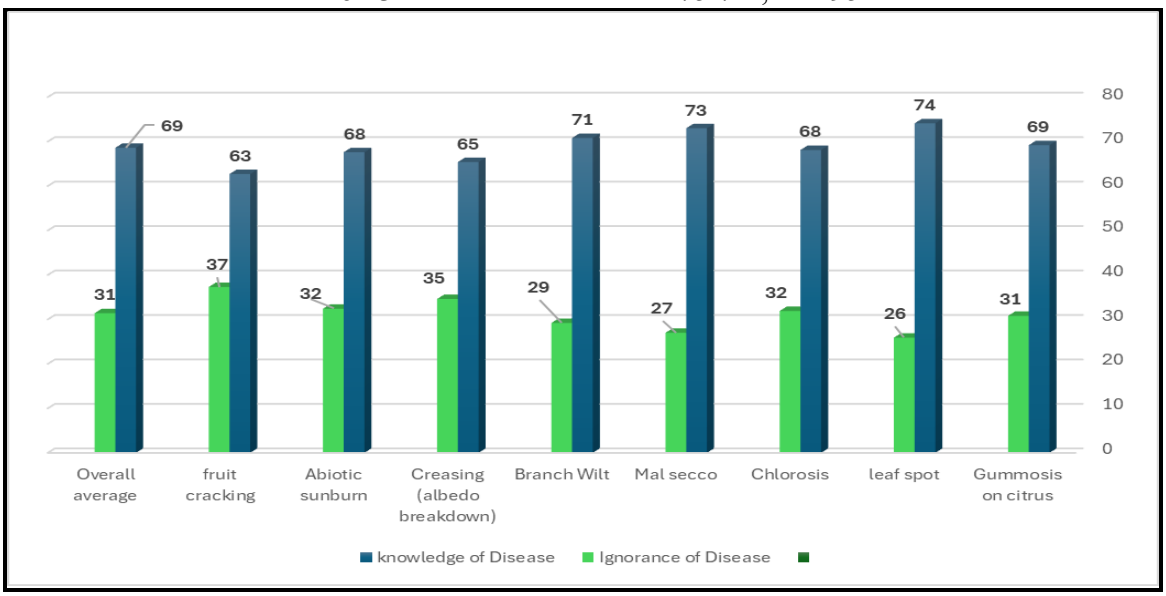

Figure (5): Farmers' Knowledge Level of Citrus Diseases

4-6. Level of Beginner Farmers' Adoption of Disease Control Methods:

Figure (6) illustrates the level of adoption of disease control methods among beginner farmers, with an overall adoption rate of 66%. However, variations exist depending on the type of disease and the farmers' ability to apply diverse control methods.

The success rate for controlling fruit cracking disease was 60%, representing the lowest among the diseases. In contrast, the initiation rate for controlling sunburn disease was the highest at 68%. The

acceptance rate for citrus canker control reached 62%, while twig blight control recorded 65%, and dieback disease control reached 68%.

The results also indicated that the acceptance rate for greening disease control was 67%, contributing to the prevention of this serious condition. Meanwhile, the highest rate of application among all diseases was recorded for plant wilt disease, at 70%. For citrus gummosis, the acceptance rate was 68%.

These findings demonstrate that while beginner farmers generally show a moderate to high engagement in adopting disease control methods, targeted training and support can further enhance their effectiveness and consistency in managing citrus diseases.

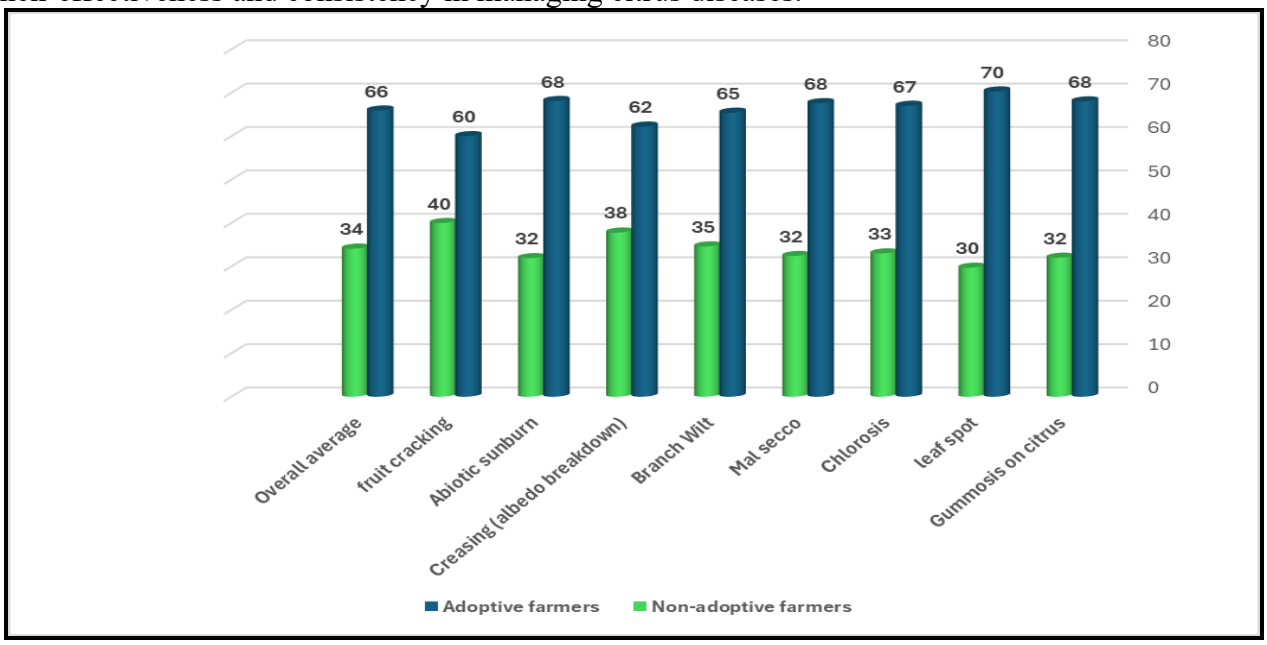

Figure (6): Percentage of Farmers Adopting Citrus Disease Control Methods

4-7. Factors Influencing Farmers' Knowledge and Awareness Levels in Al-Hariq Governorate:

Table (3) presents the results of the logistic regression analysis of the factors influencing farmers' knowledge and awareness levels regarding citrus pests and diseases in Al-Hariq Governorate. The personal characteristics—including age, education, occupation, land ownership, cultivated area, and production—were included as independent variables.

The analysis revealed that four out of the six variables in the knowledge level model were statistically significant at $p < 0.05$ and $p < 0.01$, whereas no variables were found to be statistically significant in the awareness model. This outcome can be partially explained by the generally high level of awareness among farmers.

The observed Chi-square value of 68 indicates that the likelihood ratio statistics are highly significant ($p < 0.01$), suggesting that the independent variables included in the model have a strong influence on the knowledge level of farmers.

Table (3): Factors Influencing Citrus Farmers' Knowledge of Pests and Diseases in Al-Hariq Governorate

Independent variables	B	S.E.	Wald	d.f.	Sig.
Constant	-8.15	3.12	6.84	1	.009
age	.056	.021	6.81**	1	.009
education	1.11	.32	11.98**	1	.001
Profession	1.36	.266	25.98**	1	.001
Ownership	1.49	.578	6.66**	1	.010
Citrus area	-.454	.184	6.09**	1	.014
Citrus production	-.029	.019	2.32	1	.128

* P≤ 0.05, ** P ≤ 0.01

Table (4) presents the results of the logistic regression analysis of the factors influencing the adoption level of citrus disease control methods among farmers in Al-Hariq Governorate. The personal characteristics—including age, education, occupation, land ownership, cultivated area, and production—were included as independent variables.

The analysis revealed that five out of the six variables in the adoption level model were statistically significant at $p < 0.05$ and $p < 0.01$, while no variables were found to be statistically significant in the adoption model. This result can be partially explained by the generally high adoption level among farmers.

The observed Chi-square value of 72 indicates that the likelihood ratio statistics are highly significant ($p < 0.01$), demonstrating that the independent variables in the model exert a strong influence on the adoption level of citrus pest and disease control practices.

Table (4): Factors Influencing Citrus Farmers' Adoption of Pest and Disease Control Methods in Al-Hariq Governorate

Independent variables	B	S.E.	Wald	d.f.	Sig.
Constant	-9.9	3.09	10.33	1	.001
age	.066	.021	9.9**	1	.002
education	1.25	.315	15.8**	1	.001
Profession	1.16	.525	22.6**	1	.001
Ownership	1.11	.506	4.88*	1	.027
Citrus area	-.380	.175	4.74*	1	.684
Citrus production	-.021	.018	1.36	1	.979

* P≤ 0.05, ** P ≤ 0.01

5- Conclusion

This study provided insight into farmers' awareness and adoption of pest and disease control practices in Al-Hariq Governorate. The findings revealed that farmers' awareness of citrus pests and diseases ranged between a minimum of 35.9% and a maximum of 50.1% at a 95% confidence level, indicating

the presence of significant gaps—particularly in identifying and managing pests such as mealybugs and diseases like fruit cracking.

The rate of adoption of pest and disease control methods ranged between 34.9% and 49.1% at a 95% confidence level, which was attributed to financial constraints and limited knowledge. Conversely, citrus farmers' knowledge level regarding pest and disease management ranged between 62.3% and 75.7% at a 95% confidence level, suggesting a relatively better understanding of disease management practices.

The study also examined the impact of socioeconomic factors on farmers' knowledge levels and their adoption of modern agricultural practices. It was found that age, education, occupation, and land ownership significantly influenced farmers' awareness and adoption rates. Younger and more educated farmers, as well as those who owned their land, were more likely to adopt modern pest and disease control practices. This underscores the importance of education and land ownership in facilitating the adoption of innovative agricultural technologies.

The study further highlighted the need for targeted interventions to bridge the knowledge gap and enhance the adoption of modern agricultural practices. Farmers' awareness of pest and disease management can be improved through educational workshops, training programs, and awareness campaigns. Additionally, providing financial support, such as subsidies or low-interest loans, can help overcome the financial barriers that hinder the adoption of effective pest control methods.

Finally, the study's findings are valuable for policymakers and agricultural extension services, as they provide guidance for promoting sustainable and effective pest and disease management practices aimed at improving productivity, product quality, and the profitability of citrus farmers in Al-Hariq Governorate.

6- References

1. Alex, G. (2002). Rural extension and advisory services: New directions. http://www. worldbank. org/wbi/sdruralpoverty/ag_extension1/Materials/additional/Rural_extension. pdf.
2. Batool, A., Iftikhar, Y., Mughal, S., Khan, M., Jaskani, M., Abbas, M., & Khan, I. (2007). Citrus greening disease-a major cause of citrus decline in the world-a review. Hort. Sci. (Prague), 34(4), 159-166.
3. Che, Y., Feng, H., & Hennessy, D. A. (2023). Will adoption occur if a practice is win-win for profit and the environment? An application to a rancher's grazing practice choices. Ecological Economics, 209, 107826.
4. Choudhary, H., & Bangarva, G. (2013). Knowledge and constraints in recommended kinnow production technology among the kinnow growers.

5. Deguine, J.-P., Aubertot, J.-N., Flor, R. J., Lescourret, F., Wyckhuys, K. A., & Ratnadass, A. (2021). Integrated pest management: good intentions, hard realities. A review. Agronomy for Sustainable Development, 41(3), 38.
6. FAO, F. (2022). Food and Agriculture Organization of the United Nations. FAO Statistical Databases (https://www.fao.org/faostat/ (accessed on 18 October 2024).).
7. Farjam, M., Nikolaychuk, O., & Bravo, G. (2019). Experimental evidence of an environmental attitude-behavior gap in high-cost situations. Ecological Economics, 166, 106434.
8. García-Cortijo, M. C., Castillo-Valero, J. S., & Carrasco, I. (2019). Innovation in rural Spain. What drives innovation in the rural-peripheral areas of southern Europe? Journal of Rural Studies, 71, 114-124.
9. Gujarati, Damodar N., Arabization and review by Odeh, Hind Abdel Ghaffar and Al-Dash, Afaf Ali Hassan (2015). Basic Econometrics, the Second Part, Marekh House of Publishing, Cairo, P:1145- 1146.
10. Khan, N. A., Qijie, G., Sertse, S. F., Nabi, M. N., & Khan, P. (2020). Farmers' use of mobile phone-based farm advisory services in Punjab, Pakistan. Information Development, 36(3), 390-402.
11. Kumari, V., Chander, S., & Sharma, S. (2022). Knowledge and adoption of drip irrigation in citrus crops among farmers of western Haryana. Indian Journal of Extension Education, 58(1), 151-156.
12. Luqman, M., Mustafa, A., Yaseen, M., Butt, T. M., Majeed, M. Z., Ullah, S., Usman, M., & Mehmood, M. U. (2024). Assessing Knowledge Gap and Adoption Level of Citrus Growers Regarding IPM Practices in the Punjab, Pakistan. Planta Animalia, 3(2), 179-195.
13. Luqman, M., Saqib, R., Karim, M., Nawab, K., Rehman, A., & Yaseen, M. (2018). Socio-economic impacts of agro-forestry on livelihoods of rural households in southern region of the Punjab, Pakistan. Sarhad J. Agric, 34, 880-887.
14. Ministry of Environment, Water and Agriculture (2022). Statistical Book, Kingdom of Saudi Arabia.
15. Mohamed Amine Daich and Mohamed Sari (2017). Logistic Regression Model: Concept, characteristics, applications with an example of abinary logistic regression in SPSS, Al-Sirraj Journal in Education and Community Issues, Issue No. 1, March, p: 124–133.
16. Mwololo, H., Nzuma, J., & Ritho, C. (2019). Do farmers' socio-economic characteristics influence their preference for agricultural extension methods? Development in Practice, 29(7), 844-853.
17. rg/wbi/sdruralpoverty/ag_extension1/Materials/additional/Rural_extension. Pdf.

18. Salehin, M., Kabir, M., Morshed, K., & Farid, K. (2009). Socioeconomic changes of farmers due to adoption of rice production technologies in selected areas of Sherpur district. Journal of the Bangladesh Agricultural University, 7 .(2).
19. Saudi Central Bank, Open Data Platform, 2024.
20. Siddiqui, B. N., Muhammad, S., & Malik, N. H. (2006). Effect of socio-economic aspects on the awareness and adoption of recommended horticultural practices by apple growers in Baluchistan, Pakistan. Pakistan Journal of Agricultural Sciences, 43(1-2), 73-76.
21. Wason, M., Padaria, R., Singh, B., & Kumar, A. (2009). Farmers perception and propensity for adoption of integrated pest management practices in vegetable cultivation. Indian Journal of Extension Education, 45(3and4), 21-25.
22. Zhu, Q. (2020). A Study on Citrus Production Efficiency in China Zhongnan University of Economics and Law Wuhan, China.