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Farmers` application level of pro-environmental agricultural technology in the field of integrated pest management in Duhok governorate/ Iraqi Kurdistan.

Safeen Lazgeen Mahmood **Hashim Saeed Murad**
Agricultural Extension and Rural development department/ college of Agricultural Engineering Sciences/ Duhok University.
*Corresponding Author: safeenlazgeen@gmail.com.

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ABSTRACT

The level to which farmers utilize Integrated Pest Management (IPM) as an eco-friendly agricultural technology in Duhok Governorate, Kurdistan Region, Iraq, is evaluated in this research. The research further examines the socio-economic reasons behind its application. integrating bio-logical, cultural, mechanical, and chemical control practices is key to sustainable farming and environment-al health. data were collected from 266 farmers in 28 villages of seven districts with the help of an eight-dimension standardized questionnaire. The results showed that just 22.56% of the farmers applied IPM at a high level, while 59.02% applied IPM at a moderate level and 18.42% applied IPM at a minimal level. Statistical analysis revealed that there were significant positive correlations between application of IPM and factors such as age, education, land owner-ship, area under cultivation, mode of farming, and crop type. However, characteristics like training participation, practice of irrigation, and farm family size engaged in farming did not significantly influence, reflecting gaps in continuous extension work.

The study identified significant impediments constraining IPM application. They are a lack of government loans, high initial price of technology, lack of adequate availability of professional training, inadequacy in the availability of pro-environmental agricultural technology, low availability of experts, and lack of effective facilitation of technology transfer by government. These impediments reflect economic and institutional constraints that discourage farmers from applying more sustainable practices. Research underscores the urgent need for contextual policies, funding support, and enhanced extension services grounded in the actuality of the local farming communities. Promoting farmer-centered training, diminishing the price of technology, and investment in expert support represent important steps to enhance IPM application, promote environmental sustain-ability, and enhance food security in the region. The findings highlight the moderate application of IPM among them, influenced primly by socio-economic factors and hindered by financial and institutional barriers. Addressing these through tailored policies, accessible training, and expert support is crucial to enhancing application level.

***Keywords*:** Pro-environmental, (IPM), farmers` application level, socio-economic factors, obstacles.

INTRODUCTION

In the Duhok governorate within the Kurdistan Region, agriculture is not only the way of life, it's a back-bone for enrichment of economy and production of food. yet, conventional agricultural practices have resulted in inclining dependency on chemical pesticides, igniting concerns about long-term environmental damage and health perils. Integrated Pest Management (IPM), a pro-environmental agricultural approach that blends cultural, bio-logical, and chemical methods, has been globally recognized as an alternative that preserve both crop yields and eco-systems [1]. Even though IPM has been recognized and promoted worldwide for its environmental and economic advantages, yet its actual application by farmers in Duhok governorate remains finite. Majority of the existing studies tend to concentrate on general awareness, behavior, or pesticide utilization, but they rarely explore the extent to which farmers are actually implementing IPM practices and what actually is holding them back from their application. This lack of localized, practical insight highlights a clear gap in the research [2].

This study implements a close, meticulous, and concentrated inquiry on farmers in the Duhok governorate to identify to what extend they apply IPM practices in their daily agricultural work. It also investigates the socio-economic factors that impact their application level of these pro-environmental agricultural practices. by comprehending the real-life

obstacles and restrictions of local farmers, this research hopes to guide more convenient policy decisions and support services based on authentic recommendation from farmers that can help shift the region toward more pro-environmental agricultural technology.

Research objectives are to Identify farmers` application level of integrated pest management in the Duhok governorate in general. to Determine the correlation between farmers` application level of integrated pest management(IPM) and socio-economic factors (Age, Educational level, Land tenure, the cultivated area of the land, living status, Access to credit, cost of technologies, Market conditions, Devotion to agricultural work, Attitude towards pro-environmental agricultural technologies, Cultural Openness, Numbers of training courses, and Factors affecting the pro-environmental agricultural technology use. to determine the obstacles facing farmers in applying integrated pest management(IPM). To determine the suggestions to improve the farmers` application level of integrated pest management (IPM).

Integrated pest management (IPM) has gained widespread recognition as a sustainable method of pest control in response to these issues. IPM reduces the need for synthetic pesticides while minimizing insect damage by combining biological, cultural, mechanical, and chemical control methods. IPM application has been demonstrated to dramatically lower pesticide consumption while preserving or even raising crop out-put [3].

A pro-environmental method of controlling pests is integrated pest management (IPM), which combines a number of techniques to stop or lessen the effects of weeds, diseases, and invertebrate pests on crops. Utilizing synthetic chemical insecticides sparingly after all other options have been tried is part of comprehensive IPM strategy [4].

Extension interventions are vital elements of sustainable agricultural practices that strive to tackle the difficulties presented by climate change while guaranteeing food security and livelihoods for farmers. These interventions prioritize bolstering the resilience of farming systems, encouraging the efficient utilization of resources, and benefiting the lives of farmers [5].

In Duhok governorate to what extent farmers applying Integrated Pest Management (IPM), and what are the prime factors that impact their level of application?

Research Objectives

1 To Identify farmers` application level of integrated pest management in the Duhok governorate in general.

2. To Determine the correlation between farmers` application level of integrated pest management(IPM) and socio-economic factors (Age, Educational Level, Type of land ownership you cultivate, Area of land you cultivate, participated in training courses, Number of family members participating in agricultural work, Irrigation pattern, Farming pattern, Type of agricultural crops, Main occupation, Main source of income)

3.To Determine the obstacles facing farmers in applying integrated pest management(IPM).

Concept of IPM [6].

Prevention: Preparation of land, habitat and management of water**,** variety of plant, selection of seed, cropping pattern and rotation**,** Appropriate harvesting and storage hygiene.

Observation: Area wide management, Monitoring and threshold levels, Precision and digital techniques

Intervention: Mechanical and physical control**,** Bio-logical control, and Chemical control.

Principles of integrated pest management

The utilization of bio-logical control methods, such as predators, parasitoids, and pathogens, to regulate pest populations and maintain eco-logical balance; mechanical and physical control techniques, such as barriers, traps, and mechanical means, to manage pests with-out solely relying on chemical insecticides; implementation of cultural practices, such as crop rotation, sanitation, and habitat management, to reduce pest populations and minimize pesticide application; and, finally, the prudent and selective utilization of chemical control as a last resort when other control methods are in-sufficient in managing pest populations are among the prime integrated pest management principles [7].

These fundament-al elements are given top priority by IPM as a vital component of sustain-able agriculture: [8**].**

1. **Less reliance on pesticides**: This reduces the need for chemical pesticides, which lowers their harmful effects on the environment and human health.

2. **Improved pest management**: IPM provides improved pest control by utilizing a wide range of focused techniques that are applied to the particular pest and its life cycle. Addition-ally, IPM offers a more sustain-able method of managing pests by diminishing the possibility that pesticide-resistant species will emerge.

3. **Protecting beneficial organisms**: IPM takes into account how control strategies may affect beneficial organisms such as pollinators, natural predators, and soil microbes.

4. **Minimal environmental impact**: By diminishing the utilization of pesticides, reducing water pollution, and preserving soil health, IPM can lessen the negative effects of agriculture on the environment.
5. **Cost-effective**: By decreasing the need for frequent pesticide applications and the chance of pesticide-resistant pest emergence, integrated pest management (IPM) may ultimately prove to be cost-effective.
6. **Regulation observance**: By helping farms follow environment-al standards on the utilization of pesticides, IPM reduces the possibility of fines and legal action.

The advantages of IPM

By utilizing fewer pesticides, Integrated Pest Management (IPM) protects the environment. it only utilizes pesticides when all other methods of controlling pests have failed. They are also used to diminish the negative effects on the environment while reducing a pest organism to acceptable levels. IPM improves financial performance. Utilizing the most economic-al pest management techniques, the IPM program guarantees profit-ability for the farmer or producer. There is less chance of crop loss from pests. Pest control and monitoring methods should be employed to lessen agricultural losses or damage caused by pests [9]. it promotes bio-diversity conservation, protects eco-system services, and increases the stability of agricultural systems by reducing the over-all utilization of chemical pesticides. Additionally, the application of IPM techniques can help farmers financially by lowering input costs and increasing crop yields, while also improving consumer food safety and produce quality. IPM supports the larger goals of sustain-able development, such as the preservation of natural resources, the defense of public health, and the advancement of social and economic well-being, in addition to addressing the direct effects of pests on crop production. it reduced pesticide utilization and related dangers, better crop yields and quality, higher bio-diversity, and increased farming systems' resilience and profitability [10].

The following significant weaknesses in IPM has been pointed out [8**]**:

1- There are several definitions of IPM that cause need-less confusion; 2- there are discrepancies between IPM concepts, practices, and policies; 3- farmers are not sufficiently involved in the development of IPM technology and frequently lack a fundamental knowledge of the eco-logical concepts that underlie it. 4- By departing from the core IPM principles, practice integration has taken random paths, turned out to be in-effectual, and produced un-satisfactory results. 5- it demonstrated for the most part, chemical management continues to be the corner-stone of plant health initiatives. 6- In addition, IPM research is frequently behind schedule, frequently erroneous, and fails to adequately consider eco-logy and the eco-logical functioning of agro-eco-systems. 7- Since the 1960s, IPM regulations have been misapplied, its fundamental ideas have deteriorated, and its implementation at the farm level has not progressed.

Research Materials and Methodology

The Duhok province of Kurdistan Region/ Iraq with its districts, sub-district and villages were selected as the research area,

Research population and sample: The target population of this study consists of all farmers in the villages of Duhok Governorate, which includes seven districts. Two sub-districts were chosen from each district, resulting in a total of 14 sub-districts. From each sub-district, two villages were selected, for a total of 28 villages. Based on the stratified random sampling method, 10% of farmers were selected from each village therefore the sample size amounted to (296) farmers, 30 samples were deducted to measure the stability of the questionnaire bring the total number pf farmers to (266) which were collected from total of 28 villages. The questionnaire was formed for the target of gathering the research data, which included the following parts: The first part: It included data related to the respondents' personal independent variables: Include a set of questions to recognize Some personal and socio-economic factors of Dohuk Governorate farmers, such as; (Age, Educational Level, Type of land ownership you cultivate, Area of land you cultivate, participated in training courses, Number of family members participating in agricultural work, Irrigation pattern, Farming pattern, Type of agricultural crops, Main occupation, Main source of income). The second part: This part included the dependent variable measuring the degree of farmers' application level of Integrated Pest Management (IPM) and included (8) areas with (26) item: 1-Monitoring, 2- Preventive methods, 3- Biological control, 4- Physical and mechanical control, 5- Chemical control, 6- Integrated pest management, 7- Education and training, 8- Factors affecting the decision, a set of paragraphs was developed in front of each paragraph with three alternatives (apply always, apply to a small degree, and do not apply) to be answered by the respondent, and each alternative was assigned numerical values (1,2,3,) respectively, and the total number of item was (26) item distributed among the research areas. The questionnaire was validated by a group of specialists in the Departments of agricultural extension, crop protection, horticulture, soil and water, and forestry and specialists in environment to ensure the validity of the item and how they were formulated, and the point of views the specialists showed the validity of the test with some amendments to some item and were modified according. The data collection process lasted from (1/2/2025) to

(15/5/2025).

Results & Discussion

First: Farmers` application level of integrated pest management in the Duhok governorate in general. the study surveyed 266 farmers across Duhok Governorate to evaluate their level of IPM application. The data, as presented in Table (1), classified farmers into three categories based on their application scores:

Table (1) Distribution of Farmers' categories according to their level of integrated pest management.

No	Classes	Frequency	Percentage %
1	35-42	49	18.42
2	43-50	157	59.02
3	51-58	60	22.56
	Total	266	100

18.42% (n=49) fell under the low application category (35–42 points)
59.02% (n=157) were in the medium application category (43–50 points)
22.56% (n=60) belonged to the high application category (51–58 points)

These findings unveil that 18.42% of farmers fall under low application category, 59.02% fall under medium application level and 22.56% fall under high application level so while a majority of farmers are moderately applying IPM techniques, a significant proportion still fall under low application. This reflects a partial but not yet sufficient application of integrated pest control methods. The results point to the necessity for more extensive educational out-reach and backing structure to move farmers toward higher application levels.

Such a findings are in alliance with the findings of [11]**,** who noted that in Bangladesh, despite efforts to promote IPM, the majority of farmers still extremely count on conventional chemical control methods, and only a minority apply integrated approaches due to limited awareness, access to technology, and practical training opportunities. Similarly, [12] reported that farmers in India exhibited low-to-moderate adoption of eco-friendly pest control practices, attributing this to knowledge gaps and weak extension linkages.

Second: Correlation between farmers` application level of integrated pest management (IPM) and socio-economic factors (Age, Education-al Level, Type of land owner-ship you cultivate, Area of land you cultivate, participated in training courses, Number of family members participating in agricultural work, Irrigation pattern, Farming pattern, Type of agricultural crops, Prime occupation, Main source of income).

The relationship between farmers' application levels and various socio-economic variables was assessed utilizing correlation analysis (Table 2). Significant and non-significant findings were observed:

Table (2) Distribution of Agricultural Extension according to personal and functional characteristics.

No.	Variables	Categories	Frequency	%	$\bar{X}$	s.d	Correlation	Sig
1	Age	28-43 years	47	17.67	51.62	8.613	0.212^{++}	0.000
		44-59 years	162	60.90				
		60-75 years	57	21.43				
		Total	266	100				
2	Educational Level	Illiterate	144	54.1			0.131^{+}	0.033
		Read and write	85	32.0				
		Primary	28	10.5				
		Intermediate	4	1.5				
		preparatory	1	0.4				
		Diploma	1	0.4				
		Bachelor	3	1.1				
		Total	266	100				
3	Type of land ownership you cultivate	Owned	196	73.7			0.252^{++}	0.000
		Rented	25	9.3				
		Shared	2	0.75				
		Government	4	1.5				
		Other type	40	15				

		Total	266	100				
4	Area of land you cultivate	1-29 30-59 More than 60 Total	183 63 20 266	68.8 23.7 7.5 100	25.27	29.4	0.145^{+}	0.018
5	participated in training courses	Yes No Total	260 6 266	97.7 2.3 100			0.046	0.452 Ns
6	Number of family members participating in agricultural work	1 2 3 4 5 6 and more Total	47 82 61 41 18 17 266	17.7 30.8 22.6 15.4 6.8 6.4 100	2.87	1.56	0.052	0.398 Ns
7	Irrigation pattern	Traditional irrigation Irrigation with modern systems Demi All Total	45 111 51 59 266	16.9 41.7 19.2 22.2 100			0.055	0.374 Ns
8	Farming pattern	Traditional farming Modern farming Total	114 152 266	42.9 57.1 100			0.531^{++}	0.000
9	Type of agricultural crops	Vegetable crops Fruit trees Field crops Mix Total	6 53 95 112 266	2.3 19.9 35.7 42.1 100			0.328^{++}	0.000
10	Main occupation	Agriculture Self-employment Employee Mix Total	228 27 3 8 266	85.7 10.2 1.1 3 100			-0.075	0.222 Ns
11	Main source of income	Agricultural Non-agricultural Total	232 34 266	87.2 10.2 100			-0.131^{+}	0.032

Significant Positive Correlations

- **Age (r = 0.212, p < 0.01):** Older farmers demonstrated higher levels of IPM application. This aligns with the findings of [13], who emphasized that aged cucumber farmers in Bangladesh applied IPM more efficiently due to accumulated knowledge and practical experience over the years, which fostered a more careful and integrated approach to pest control.
- **Educational Level (r = 0.131, p < 0.05):** Farmers with higher educational qualifications applied IPM more frequently. This supports the conclusions of [14], who found that educational attainment had a direct influence on farmers' ability to comprehend and implement environmentally-friendly agricultural practices, including IPM.
- **Land Ownership Type (r = 0.252, p < 0.01):** Farmers who owned their cultivated land were significantly more likely to apply IPM practices, which reflects the results of [15]. They asserted that land tenure security is strongly linked with the willing-ness to invest in sustain-able agricultural practices due to long-term steward-ship of the land.
- **Land Area Cultivated (r = 0.145, p < 0.05):** Larger landholders were more inclined to adopt IPM, echoing

the findings of [16], who reported that expansive cultivation areas positively influenced the application of sustainable agriculture technologies due to resource avail-ability and higher exposure to diverse pest problems.

- **Farming Pattern (r = 0.531, p < 0.01):** A very strong correlation was found between modern farming patterns and IPM application. This is in agreement with [17], who documented that IPM integration is significantly more prevalent in farming systems utilizing modern techniques and technologies such as UAVs, AI, and precision monitoring tools.
- **Type of Crops Grown (r = 0.328, p < 0.01):** Farmers growing a mix of crops or field crops applied IPM more robustly. This aligns with [18], who found that diversified cropping systems presented more complex pest scenarios, pushing farmers toward integrated pest management approaches.
- **Prime Source of Income – Agricultural (r = -0.131, p < 0.05):** Farmers whose prime income was from agriculture had slightly higher IPM application. As [13] explained, economic reliance on farming often drives producers to applied sustain-able practices to protect long-term productivity and diminish risk.

Non-Significant Correlations

- **Participation in Training Courses (r = 0.046, p > 0.05):** Surprisingly, training had no significant correlation with IPM application. This contrasts with the theoretical assumption in [19], who emphasized that training is a cornerstone of IPM success. However, the in-effectiveness here could suggest that current training programs in the Duhok context lack relevance, practicality, or consistency.
- **Number of Family Members in Agriculture (r = 0.052) and Irrigation Pattern (r = 0.055):** Neither factor showed meaningful influence on IPM use. These findings are consistent with [16], who mentioned that although house-hold labor and irrigation influence general farm productivity, they may not directly affect IPM-specific decision-making un-less linked with training or extension support.
- **Main Occupation (r = -0.075, p > 0.05):** Farmers' employment status (whether agriculture was their main job or not) had no significant correlation with IPM usage. This may reflect a universal lack of awareness or capacity across occupation groups, echoing insights from [20], who found that wide-spread constraints (technical, financial, and institutional) limit IPM uptake regardless of occupation.

The study's conclusions provide a complex prospective of the farmers` application level of IPM in Duhok Governorate. Even though IPM's agronomic and environment-al advantages are well acknowledged, majority of farmers still fall under the moderate or low application category. This partial involvement points to a confluence of structural boundaries and awareness that avert absolute application.

Fundamental Elements influencing Application Levels

Farmers who were older and more seasoned indicated a stronger propensity to utilize IPM techniques. This could be a result of elevated field experience and a better comprehension of the long-term dangers associated with excessive pesticide utilization. Higher education levels were also associated with elevated application level of IPM practices, high-lighting the importance of formal education and literacy in facilitating environment-ally conscious decision-making.

Because land-owners have long-term interests in soil fertility and land productivity, there was a strong association between land owner-ship and a higher devotion to sustain-able practices. application of IPM techniques was positively connected with larger land-holdings as well, indicating that the avail-ability of resources may encourage the purchase of more advanced pest management techniques. applying IPM techniques was substantially more common among farmers who cultivated a variety of crop kinds and utilized modern agricultural practices. This bolsters the body of research linking pro-active pest management techniques to contemporary farming methods and crop diversification.

It's intriguing to note that there was no significant correlation between training participation and IPM application. This calls into question the current training programs' delivery, content, and practical application. It can also suggest that training programs are not well tailored to farmers' everyday lives. like-wise, there were no significant correlations found between the utilization of IPM techniques and family labor, primary occupation, or irrigation systems. These findings imply that although certain structural factors are significant, others that are typically thought to have a significant influence could not have much of an impact in this particular situation.

Third: Obstacles facing farmers in applying integrated pest management(IPM).

Table (4) showing the most important obstacles to environmentally friendly technologies

No	Obstacles	Fi	%

1	Lack of government loans for farmers	212	79.7
2	Rising prices of modern technologies	206	77.5
3	Lack of specialized courses	156	58.6
4	Lack of modern technology	152	57.15
5	Lack of experts specialized in the field of modern technologies	149	56.00
6	Lack of government funding for technology transfer	93	35

Clarification and Interpretation

Government Loan Absence (79.7%): this was determined to be the biggest challenge. Almost 80% of farmers stated that the government does not provide them with financial assistance. Many farmers are unwilling to engage in current pest management instrument or practices that demand up-front capital because they do not have access to governmental loans. Increasing Costs of Contemporary Technologies (77.5%) Costs are still a big turn-off. Smallholder farmers frequently lack the financial means to implement modern IPM techniques, such as eco-friendly insecticides, surveillance equipment, and bio-logical control agents, despite the potential advantages. This re-affirms the necessity of price control or assistance initiatives. In-sufficient Specialized Training (58.6%) Over 50% of the farmers stated that they do not have access to IPM-specific teaching programs. This implies that gaps in understanding continue to be a significant obstacle. With-out the right guidance or examples, even farmers that are interested in utilizing sustain-able practices might not know how to do so success-fully.

Modern technology is lacking (57.15%). A-side from price, another issue is the accessibility of contemporary tools and equipment. The technologies needed for integrated pest control are not readily avail-able to many farmers in their area. This suggests a deficiency in the agricultural support system's infrastructure or supply chain. Absence of Specialists (56.0%). The lack of competent extension agents or field experts who could advise them on IPM practices was mentioned by more than half of the farmers. Farmers are forced to utilize conventional techniques or potentially hazardous chemical substitutes in the absence of professional extension. In-sufficient Government Investment in Technology Transfer (35.0%): The lack of government assistance for technology transfer from research institutes to the field was only mentioned by roughly one-third of farmers. This is a significant barrier to converting scientific discoveries into practical on-farm methods, even if it is less common than other challenges.

Findings are well-supported by findings in previous studies. [20] emphasized that the absence of institutional loans remains one of the fore-most challenges hindering the application of environmentally-friendly pest control methods among horticultural farmers, consistent with the high percentage of respondents citing financial constraints in this research. Similarly, [21] and [22] highlighted that the **cost and limited availability of IPM tools and bio-insecticides** create critical barriers for smallholders, particularly in low-resource settings. The deficiency in **specialized training and extension services** echoes concerns raised by [19] and [18], who asserted that IPM application fails when practical, localized training and skilled field agents are absent. Further-more, the **lack of institutional mechanisms** to support technology transfer from research institutions to rural areas has been under-scored by [17], who noted that with-out pro-active government investment in dissemination and on-ground application, even scientifically validated IPM technologies remain unutilized at the farm level. These studies collectively reinforce the systemic and structural nature of the barriers found in your Duhok-based research.

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مستوى تطبيق المزارعين للتقنيات الزراعية الصديقة للبيئة في مجال المكافحة المتكاملة للآفات في محافظة دهوك / كردستان العراق.

سفين لزكين محمود **هاشم سعيد مراد**
كلية علوم الهندسة الزراعية – جامعة دهوك.

الخلاصة
استهدفت الدراسة قياس مستوى تطبيق استخدام المزارعين للإدارة المتكاملة للآفات وهدفت الدراسة التعرف على العلاقة بين الخصائص الاجتماعية والاقتصادية ومستوى تطبيقها. يعد دمج ممارسات المكافحة البيولوجية والثقافية والميكانيكية والكيميائية أمرًا أساسيًا للزراعة المستدامة والصحة البيئية. تم جمع البيانات من 266 مزارعًا في 28 قرية في سبع اقضية بمساعدة استبيان ذي ثمانية مجالات. أظهرت النتائج أن 22.56٪ فقط من المزارعين يطبقوا الادارة المتكاملة للآفات على مستوى عالٍ، بينما طبق 59.02٪ منهم إدارة متكاملة للآفات على مستوى متوسط وطبق 18.42٪ منهم إدارة متكاملة للآفات على مستوى أدنى. كشف التحليل الإحصائي عن

وجود علاقات إيجابية كبيرة بين تطبيق إدارة متكاملة للآفات وعوامل مثل العمر والتعليم وملكية الأرض والمساحة المزروعة وطريقة الزراعة ونوع المحصول. ومع ذلك، لم تؤثر خصائص مثل المشاركة في التدريب وممارسة الري وحجم الأسرة الزراعية العاملة في الزراعة بشكل كبير، مما يعكس وجود فجوات في العمل الإرشادي المستمر. حددت الدراسة عوائق كبيرة تعيق تطبيق إدارة الآفات المتكاملة. وهي نقص القروض الحكومية، وارتفاع السعر الأولي للتكنولوجيا، ونقص توافر التدريب المهني الكافي، وعدم كفاية توافر التكنولوجيا الزراعية الصديقة للبيئة، وقلة توافر الخبراء، ونقص التسهيلات الفعالة لنقل التكنولوجيا من قبل الحكومة. تعكس هذه العوائق القيود الاقتصادية والمؤسسية التي تثني الفلاحين عن تطبيق ممارسات أكثر استدامة. يؤكد البحث على الحاجة الملحة إلى سياسات سياقية، ودعم تمويلي، وخدمات إرشادية محسنة تستند إلى واقع المجتمعات الزراعية المحلية. يمثل تعزيز التدريب الذي يركز على المزارعين، وخفض تكلفة التكنولوجيا، والاستثمار في دعم الخبراء خطوات مهمة لتعزيز تطبيق إدارة الآفات المتكاملة، وتعزيز الاستدامة البيئية، وتعزيز الأمن الغذائي في المنطقة.

الكلمات المفتاحية: تكنولوجيا الزراعة الصديقة للبيئة، الإدارة المتكاملة للآفات، مستوى تطبيق المزارعين، العوامل الاجتماعية والاقتصادية، العوائق، الإرشاد الزراعي، دهوك.