

## Performance Evaluation of Remote Sensing Techniques for the Development of Farming Practices

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### Abstract

This research intends to evaluate the extent of efficiency to the remote sensing techniques participants in overall, and GIS contributes in farming advancement and environmental resources management. The study evaluates the agricultural holding condition, persistence of farming activities, and farmers' expertise regarding these tools. The research also explores their origins, financial requirements, benefits, constraints, and the required training and organizational backing to improve their usage.

The study employed an explanatory method, that combining on-site information with remote sensing applications, orbital imagery (Landsat, Sentinel-2, SPOT), uncrewed airborne platforms (UAVs), and GIS instruments to monitor agricultural and ecological changes. The research sample included 79 participants from the governorates of Diyala and Kirkuk. Data were examined quantitatively through SPSS, comprising frequencies, percentages, means, and standard deviations, as well as Chi-square ( $\chi^2$ ) and  $r_c$  to evaluate the significance of the results. The findings showed medium-sized farms were most prevalent, with farmers depending on family workforce and practical knowledge. Government institutions were the primary providers of advanced technologies, but elevated costs were a difficulty. The research affirmed the importance of remote sensing and GIS in irrigation management, land degradation, and output levels, highlighting the importance of applied training and institutional backing. The study recommends reinforcing support policies, offering flexible financing, expanding extension and demonstration sites, enhancing practical training, and encouraging local production to achieve sustainable agriculture.

**Keywords:** Agricultural Technology Adoption, Desertification Mitigation, Geographic Information Systems (GIS), extensional evaluation, Remote Sensing, Sustainable Agricultural Practices

### INTRODUCTION

An agriculture is representing economic activities that aim to exploit energies; backbone of Iraq economy; and providing livelihoods of millions & contributing of food security, today; agricultural sector is facing a numerous challenge; from water

scarcity & declining soil fertility of the effects to climate changes & poor resource management, these experiments have been led to lower agricultural yield & higher production cost while further burdening environment, in light of these experiments; adopting more sustainable methods have become an innovative option aimed with

increasing resource using efficiency; due to pressure for growing urbanization & population increase; agriculture presently going by a crucial time, utilizing sustainable practices which preserve natural resources & mitigate consequences climate change have become essential to the production to the food; and biofuels [1] [2] .

Thus, in this context, remote sensing (RS) provides a cost-effective and reliable way to continuously monitor crops, soils, and natural resources, offering precise data that improves decision-making, resource management, and food security strategies [3] . By detecting crop stress early and supporting yield forecasting, irrigation control, and soil assessment, RS has become a cornerstone of modern precision agriculture [4] [5] . Global organizations such as the World Bank Group, the United Nations Development Programme and the Food and Agricultural Organization FAO emphasize that the farming and food area can performance an significant role in countryside job formation and profits generation and relatedly, thus is an vital sector that can promote governmental and financial balance. The farming and food area in Iraq is workforce intensive and able to employ large quantities of labour, pre-production (input supply and primary production), processing stage (handling and processing) and post-production (distribution and marketing) [6] . Agrarian expansion has been shown to be an vital driver of deprivation decrease and employment formation, particularly within the countryside low-income. Remote sensing can support this by supplying accurate, timely information that enhances agricultural extension services and policy-making, particularly in contexts where conventional data collection is weak or delayed.

In addition to that, if agrarian progress can enhance the distribution of assets within families, it will probable result to improved health and nourishment results for young people as well, long-term viability of the countryside economic system, ecological and environmental sustainability inside agrarian frameworks and long-term viability of countryside community [7] . Farming is essential for human livelihood and financial evolution. That relates to both industrialized and developed countries. Nevertheless, it has a specific importance in nations where populations still reside in severe deprivation with small-scale farming as their primary source of nutrition and earnings. Commonly, in greatest evolving countries, the population rely on agriculture for their means of living [8] . The farming field is still a primary source of way of life for the poor and food vulnerable and is the greatest source of countryside jobs. The field share to GDP (decreased is the next share after oil revenues), decreased from about 9 percentage in 2002 to 3.3 percent in 2008 and 3.6 percentage in 2009, but it still supplies 20 percentage of labor, fragile organizations, the decline of basic public services and of communal indices in areas such as health status and education system, widespread joblessness about 50 percentage of the effort force rendering to some estimations, and extreme deprivation where more than 60 percentage of the population depends on the government's rationed food basket.

In such a fragile context, integrating RS technologies into agricultural practices can provide policymakers and farmers with the evidence needed to plan effectively, mitigate risks, and adapt to climate change. This research seeks to clarify the constraints confronting the farming field in Iraq to formulate some solutions in the framework of the available potentials to overawed these constraints in the farming area. **(Lucani & Saade, 2012)**

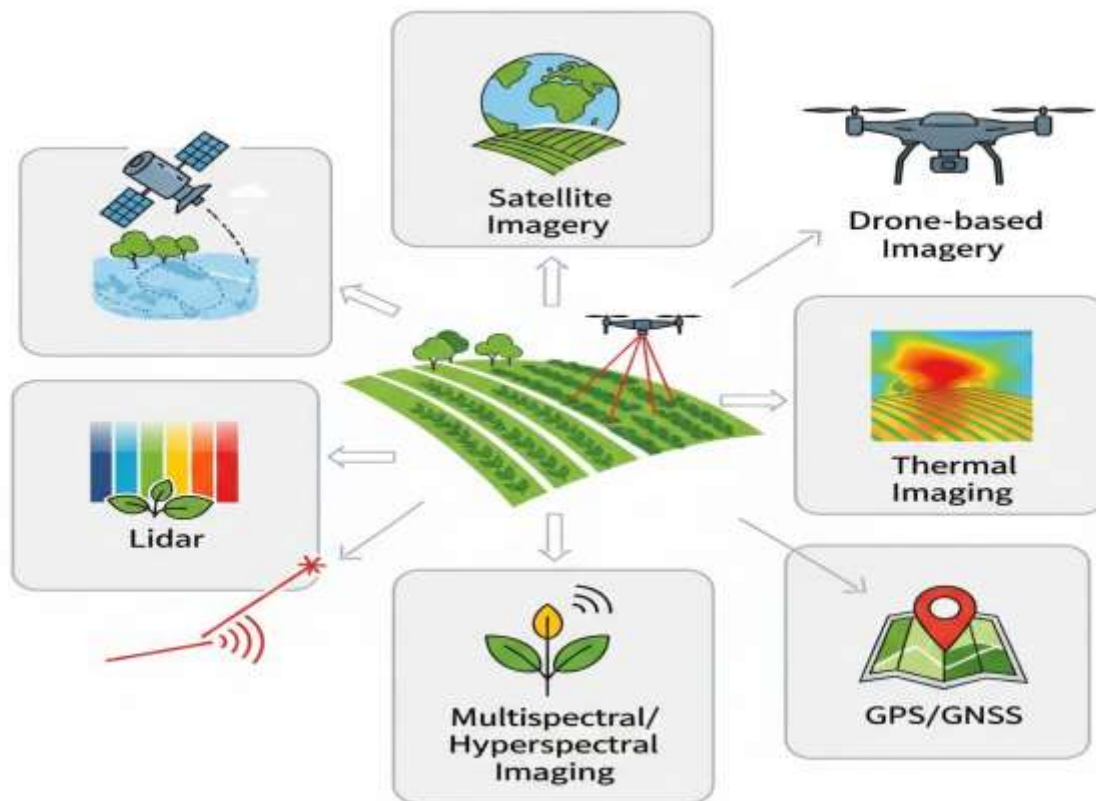


Figure 1: Demonstrate the types of Remote Sensing Techniques

improving their standard of living through increasing agricultural productivity, enhancing resource-use efficiency, and reducing production costs. [9] It has proven successful in agriculturally advanced countries such as the United States, Canada, Australia and Denmark, thanks a lot to their ownership of effective and efficient extension systems [10] [11] [12] As a vital system in the agricultural innovation system in every country [13] [14] and the system of facilitating farmers' and their organizations' access to understanding, facts, and modern applied technologies, and improving their relationship alongside associated parties such as scientific research centers, universities, suppliers, and agricultural input service providers [15]. This system aims to support farmers in enhancing their administrative, institutional, and technical competencies and methods, which enhances their ability to manage their agricultural activities and

increase their productivity and economic returns [16] [17] [18].

Although many modern agricultural technologies are available, there is a clear gap between the development of these technologies and their actual application in the fields by farmers. Remote sensing applications represent one of the most practical approaches to bridge this gap, by linking advanced scientific monitoring with everyday farming practices to raise productivity levels [19] [20].

thus; there are need to clarify steps such as providing targeted training programs, improving access to modern agricultural tools, and promoting practical demonstrations to reduce gap among awareness of agronomic techniques & their adoption, also; it is very required for supplying majority of important cultivators in agronomic techniques to crucial needs advantageous to confront environmental change; and contamination & ecological & increased agricultural

prices, since spread these techniques therefore we get it to reach increased output & efficiency level [21] farmers still need to enhance technical & material capabilities for supporting efficiency of agricultural production.

The Condition of the Iraqi agricultural sector country varied previously; although Iraq was net food-exporting country; due to its plenty of the freshwater & arable land, with comparatively of limited population [22], which has helped it improve the efficiency of using modern technologies and increase productivity. Among these technologies, RS has played an increasingly important role worldwide, enabling countries to strengthen their food security strategies.

Nevertheless, agrarian agencies lack contemporary machinery. Therefore, the presence of farm machinery is 38.9%, cereal harvesters – 47.2%, and fodder harvesters – 48.6% [23]. Enhancing the government assistance for farmers producers and agro-industrial enterprises for the farming-industrial

sector led to the enhancing of equipment and technical capacity of the manufacturing sector. So, in 2020, the degree of self-reliance in plant oil, which is defined as the proportion of foodstuffs shaped in the state to their local consumption and is represented as a ratio, was 195.9% with a threshold value of 90%, cereals, respectively, 167.6 and 95%, sucrose, 99.9 and 90%, livestock products (in terms of meat) – 99.4 and 85% [24]. Output of this stuff was dependent on an extensive usage of introduced earnings of inputs (crop seeds, refinement material, agrochemicals, equipment, etc.) [25] [26]. Therefore, the challenge of bringing replacement in the agricultural sector, Manufacturing income of manufacture for farming under global restrictions yet has not been resolved. Achieving this objective is impossible without a comprehensive scientific study of the problems of agricultural production, as well as the development and implementation of advanced technologies that make the most of the available bio-potential and ensure environmental safety of the production [27],

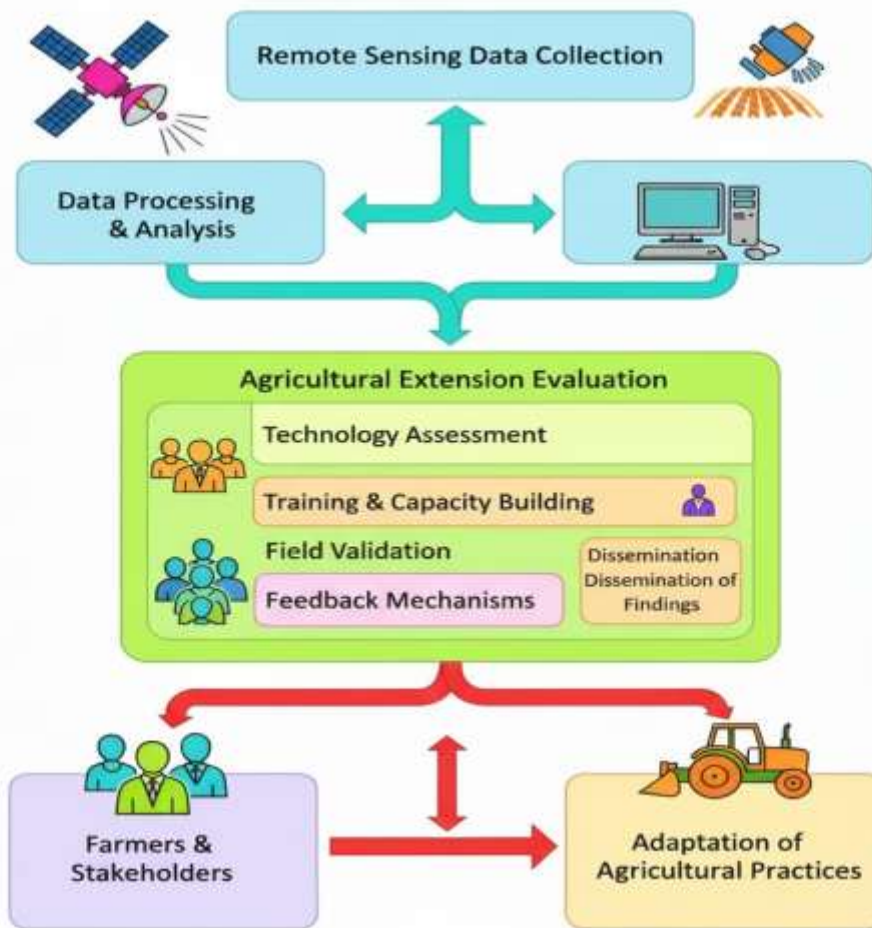


Figure 2: Demonstrate the relationship between evaluation & Remote Sensing Technique for millennia; humanity have been a struggled to the survive; and principal challenges of a human survival have been organization of sustainable food production and agricultural crop development, the entire history of the agriculture considers long chain one revolutionary innovation replacing with another, for most of the human history; nearly of all mankind's energies were devoted to be obtaining of food; & thoughts revolved round this same issue, the study of surrounding world; both accidental & deliberate experiments; & hard work; problem the feeding humanity is a largely solved, then present most important innovations which have transformed agriculture are [28], then according to an observations considering to many worldwide of countries; collective experience of developed countries could be the high benefits to others countries, since it played a crucial role in agriculture sector of general speech [29]. Thus; evaluating of the performance remote sensing techniques of the development to the farming practices which both timely & necessary; particularly in Governorate of Salah al-Din; that reflects broader challenges & opportunities in Iraqi agriculture, that to diffusion these techniques and facilitate use of them and treatment weak point which appears during application it.

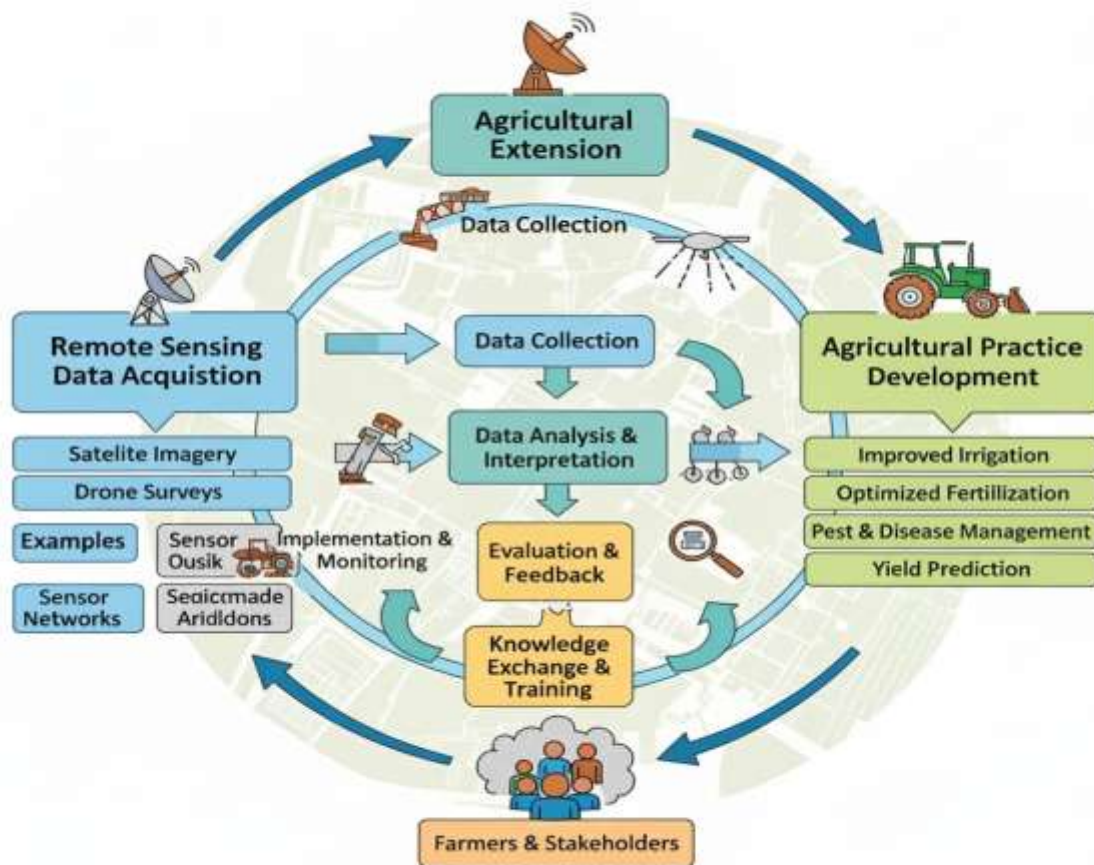


Figure 3: achieving agricultural practice development by applying Sensing Techniques

**Aims of the study:** This research intentions to:

1. Evaluate the level of performance to the remote sensing techniques respondents in general.
2. Evaluate the level existing condition of farm holdings and agricultural activity among respondents and continuity in the agricultural sector.
3. Evaluation Farm workers' participation levels to the Years of farming experience
4. Evaluation Farm workers to the participation type

5. Evaluation the suggestions for Strategies to Adopting Agricultural Technologies

6. Evaluation the suggestions procedures to improve the technology dissemination and marketing.

### Research Methodology

The study employed a descriptive approach to examine remote sensing and GIS in evaluating natural supplies and monitoring environmental and farming transformations. It also employed statistical methods to evaluate performance. Research has been conducted in the northern part of Baghdad Governorate; and particularly in Diyala Governorate & Kirkuk Governorate;

which facing diverse environmental & agricultural difficulties

- Satellite images like Landsat and SPOT, integrated with GIS, observed water resources, identified desertification, identified groundwater, and followed vegetation changes.
- Remote sensing data like Landsat, Sentinel-2, aerial photography, and UAVs evaluated crop health, observed drought, detected soil degradation, and enhanced water resource management.
- Diyala had nearly 22,168 farmers, and Kirkuk had 1,674. (Both Directorates of Diyala & Kirkuk)

**Sample & Size :** Random selection method has been chosen (79) respondents (40) from Diyala Governorate & (39) from Kirkuk Governorate to represent varied of farming communities; providing the data of evaluation

### Data Collection Tools

1. **Structured Questionnaire:** This included both closed and open-ended questions covering the following dimensions:
  - Evaluate the level of performance to the remote sensing techniques respondents in general.
  - Evaluate the level existing condition of farm holdings and agricultural activity among respondents and continuity in the agricultural sector.
  - Evaluation Farm workers' participation levels to the Years of farming experience
  - Evaluation Farm workers to the participation type
  - Evaluation the suggestions for Strategies to Adopting Agricultural Technology

- Evaluation the suggestions procedures to improve the technology dissemination and marketing.

2. **Interviews:** implemented with group of scholars & specialists in the agricultural extension; environmental management, and GIS to improve the findings and connect them with applied expertise.

### Data Analysis Methods

Data was categorized and examined using SPSS software with the following statistical techniques:

\*Frequencies and percentages for describing respondents' general characteristics

\*Means, medians, standard deviations, and weighted percentages used to evaluate overall trends.

#### \*Chi\_square

Chi\_square test is the nonparametric which test used of two specific purposes: (a) to test hypothesis of the no association between both or more groups; population; or criteria (b) & to the test how the likely the observed distribution of the data equals with distribution that is expect (i.e., goodness\_of\_fit test) The following of formula calculates chi\_square; where the range of the chi-square from Zero to infinity [30].

$$\chi^2 = \sum (O-E)^2/E$$

O = Observed value

E = Expected value

#### \* Coefficient of contingency (rc) :

It has been aim to measure correlation between the two variables; one of them or both of which is the categorical variables with the two or more of levels & depends on use of chi\_squares [4] . It is calculated by the formula below:

$$rc = \sqrt{\frac{\chi^2}{N + \chi^2}}$$

Where :

$\chi^2 =$  Chi-square values  $N =$  Number of observations , it is value range between the range (0-1)

\*Comparative analysis by correlation results with international studies and adapting them to the local context

### Validity and Reliability

- The questionnaire was confirmed through evaluation by a panel of experts to ensure contents & faces validity
- A **pre-test** was carried out on a small trial sample to ensure the clarity and accuracy of the questions.
- Reliability of the research measure was confirmed using **Cronbach's Alpha** for internal consistency, applied to a trial sample of farmers outside the main sample, in the first 30 farmers had been chosen randomly equally between two governorates (out of the final sample) that to get stability which applied on it and was 0.88 that mean the questionnaire fit to collect the research data.

### Research Delimitations

- **Geographical Scope:** Diyala and Kirkuk Provinces
- **Temporal Scope:** Agricultural season 2024–2025
- **Target Population:** Farmers using or evaluating remote sensing and modern agricultural tech.

### Results and Discussion

**First: Evaluation the level of performance to the remote sensing techniques respondents in general.** Table 1 indicates that most participants have evaluation level of performance medium (61–120 degree) also indicate that (60.76%), High level (121+degree) is 22.78%, and lastly low level (0–60 degree) is 16.46%.

Figure 4 also confirms that, showing the evaluation levels, with medium being the most common, and smaller percentages of low and high levels.

Table 1: Evaluation the level of performance to the remote sensing techniques respondents in general

| Percentage (%) | Frequency | Value Range | Level        |
|----------------|-----------|-------------|--------------|
| 16.46          | 13        | 0 – 60      | Low level    |
| 60.76          | 48        | 61 – 120    | Medium level |
| 22.78          | 18        | 121+        | High level   |

| Percentage (%) | Frequency | Value Range | Level |
|----------------|-----------|-------------|-------|
| 100.00         | 79        | —           | Total |
|                | S.D.=7    | Mean=98     |       |

and as illustrated in the table (1) above when data have been distributed of the

respondents according to the evaluation of performance to the remote sensing techniques respondents in general, then reached to that category of Medium level trend to high level (61 – 120) gains first arrangement, that similar with stud [30]

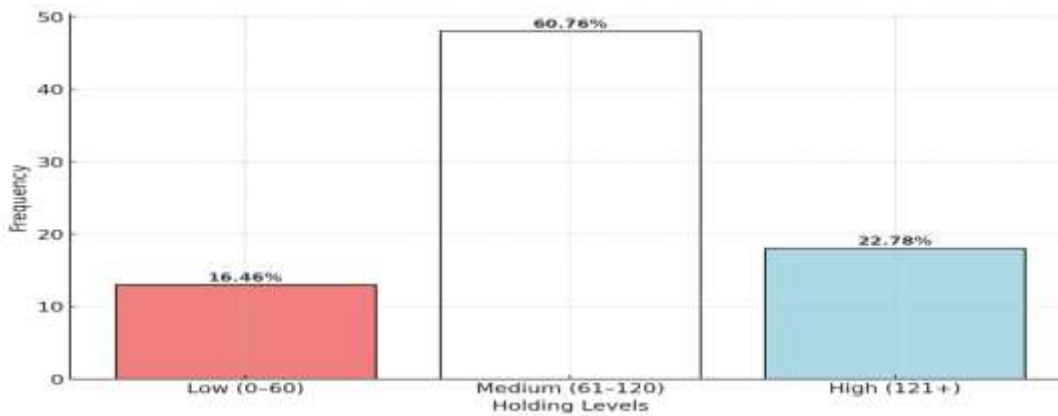


Figure 4: Evaluation the level of performance to the remote sensing techniques respondents in general

**Second: Evaluate the level existing condition of farm holdings and agricultural activity among respondents and continuity in the agricultural sector.**

Table 2 presents that most respondents (88.61%) continue to engage in farming, with a weighted percentage of 100%, whereas only 11.39% have abandoned it. The median (Median = 1) validates the main trend is ongoing tendency activity.

Table 3 further divides respondents into two categories: those who continued (88.61%) and those who abandoned (11.39%), highlighting

most respondents' strong link to the agricultural domain, in difference to the small number who withdrew.

Figure 5 depicts this pattern, presenting the dominance of continuing agricultural activity compared to those who left.

Our study is consistent with [31] [32], associating farm status with factors like size. However, it differs from [33], who found that inadequate training caused agricultural withdrawal.

Table 2: Evaluation of Agricultural Activities

| Percentage (%) | Frequency | Value Range | Level        |
|----------------|-----------|-------------|--------------|
| 11.39          | 9         | Abandoned   | Low          |
| 88.61          | 70        | Continuing  | High         |
| <b>100</b>     | <b>79</b> | —           | <b>Total</b> |

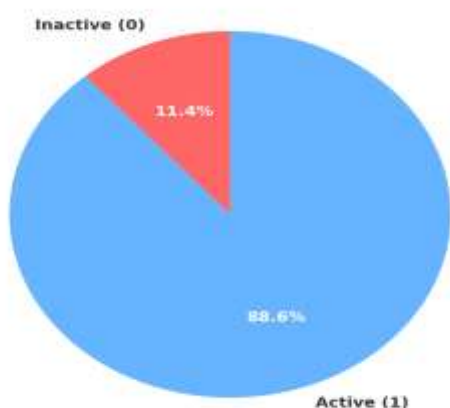


Figure 5: Distribution of the respondents by evaluation of the agricultural activity

**Third: Evaluation of Farm workers’ participation levels to the Years of farming experience**

Table 3 presents that most respondents (64.56%) have over ten years of experience, relative to 17.72% with 5–10 years and 5.06% with less than five. 12.66% left unanswered. The median (3) reflects a concentration in the high-experience group, and the weighted percentage (73.42%) shows a strong tendency toward high experience.

Figure 6 reinforces this, showing the spread of years of experience, with the more-than-ten-years category being the predominant, as opposed to the lower percentages in other categories.

This study contrasts with [34] [35] because it shows that family labor is the predominant form of agricultural labor, while those studies

indicate that more family labor might hinder the embracing of modern agriculture.

**Table 3: Respondent distribution by years of agricultural practice**

| Weighted % | Median | Percentage (%) | Frequency    | Value           |
|------------|--------|----------------|--------------|-----------------|
|            |        | 12.66          | 10           | 0 (No response) |
|            |        | 5.06           | 4            | 1 (<5 years)    |
| 73.42      | 3      | 17.72          | 14           | 2 (5–10 years)  |
|            |        | 64.56          | 51           | 3 (>10 years)   |
| <b>100</b> |        | <b>79</b>      | <b>Total</b> |                 |

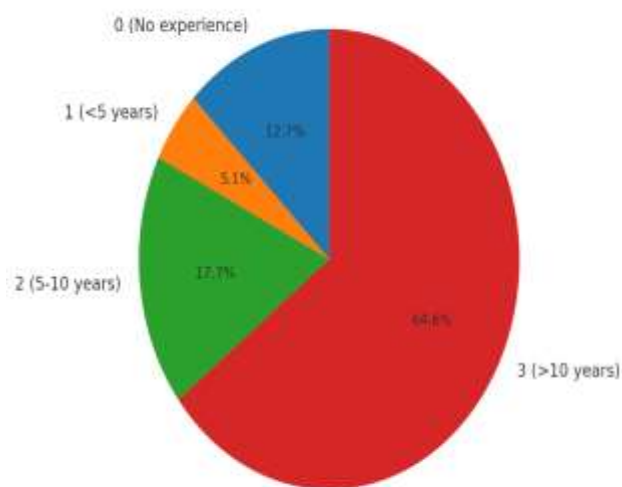


Figure 6: Distribution of respondents based on years of agricultural practice

**Fourth: Evaluation Farm workers to the participation type**

Table 4 indicates that most respondents (67.09%) engage in farming with family, backed by a median of 2.0 and a weighted percentage of 67.51%, highlighting the family's role. It also shows 22.78% depend on external labor, while 10.13% work alone.

Table 4 categorizes agricultural work into three stages: the most prevalent is medium (family participation) at 67.09%, followed by high (labor use) at 22.78%, and low (individual work) at 10.13%.

In Figure (7) depicts of farm workers' allocation; with the family participation as primary of pattern; compared with the smaller external labor & individuals work

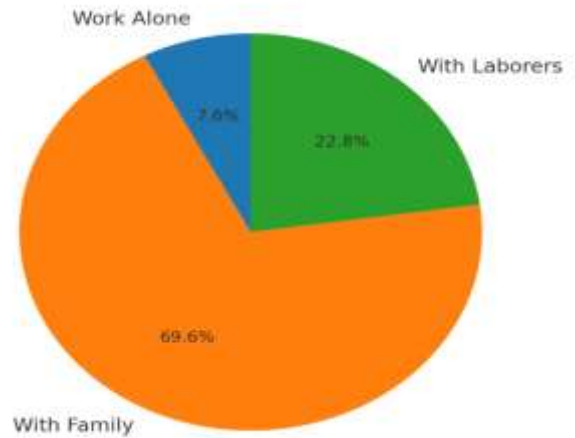


Figure 7: Distribution of agricultural participation type

Table 4: Distribution of evaluation farm workers' participation type

| Weighted % | Median | Percentage (%) | Frequency | Categories                |
|------------|--------|----------------|-----------|---------------------------|
|            |        | 10.13          | 8         | Work alone                |
| 67.51      | 2.0    | 67.09          | 53        | With family participation |
|            |        | 22.78          | 18        | Using hired labor         |
|            |        | 100            | 79        | Total                     |

**In the five: Evaluation level of the suggestion on strategies to the adopting agricultural technologies**

At table 5 indicates to that respondent prioritized continuing government supported policies 88.61% incorporating various technologies 86.08% & adopting quick processing mechanism 84.81% emphasis was placed on the prioritizing of small farmers 82.28% then developing system for their need 81.01%., the strategy of the reducing import reliance && ensuring local production was the less favored 77.22%

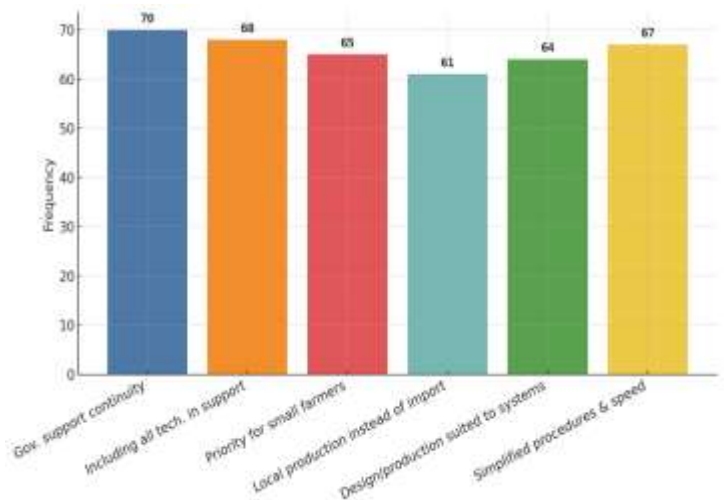
At figure (8) showing most proposed strategy focus on the government support & simplified procedure with the less on reducing import, statistical analysis confirm all strategy are significant; with Chi-squares 42.12–52.34  $p < 0.01$ ) and Rc (0.04-0.15  $p < 0.01$ ) values , results highlight that financial support; stable policies; & streamlined procedures are vital for increasing an agricultural technology of adoption

Table ( 5): Respondents suggested strategies evaluation for adopting agricultural technology

| Rc               | $\chi^2$ Test     | S    | Median | Mean | Percentage % | Frequency | Strategy  |
|------------------|-------------------|------|--------|------|--------------|-----------|---|
| 0.11<br>(p<0.01) | 52.34<br>(p<0.01) | 0.31 | 1      | 0.89 | 88.61        | 70        | 1. Continuity of support policy (governmental support)                        |
| 0.15<br>(p<0.01) | 49.11<br>(p<0.01) | 0.34 | 1      | 0.86 | 86.08        | 68        | 2. Inclusion of all types of technologies under the same governmental support |
| 0.04<br>(p<0.01) | 45.76<br>(p<0.01) | 0.38 | 1      | 0.82 | 82.28        | 65        | 3. Priority for smallholder farmers with systems suitable for them            |
| 0.12<br>(p<0.01) | 42.12<br>(p<0.01) | 0.42 | 1      | 0.77 | 77.22        | 61        | 4. Reducing dependence on imports and providing local products                |

| Rc               | $\chi^2$ Test     | S    | Median | Mean | Percentage % | Frequency  | Strategy  |
|------------------|-------------------|------|--------|------|--------------|------------|---|
| 0.13<br>(p<0.01) | 44.25<br>(p<0.01) | 0.39 | 1      | 0.81 | 81.01        | 64         | 5. Designing or producing systems adaptable to different farming patterns |
| 0.14<br>(p<0.01) | 47.88<br>(p<0.01) | 0.35 | 1      | 0.85 | 84.81        | 67         | 6. Appropriate, simple, and rapid supply mechanisms                       |
| -                | -                 | -    | -      | -    | <b>100</b>   | <b>395</b> | <b>Total (N=79)</b>   |

Table value of (rc): 1%=0.2324  
value of (rc): 5%=0.1654



The figure (8) : Respondents suggested of strategies evaluation of adopting agricultural technology

Table 6 : Respondents' suggested procedures to an improve the technology dissemination & marketing

**six: Evaluate suggested procedure that to improve technology dissemination & marketing**

In table 15 the highest endorsement of granting farmer with modern system without any advance payment 84.81% followed by the annual instalment payment 83.54% & postponement of payment of environmental damage 81.01% , establishing demonstration field 78.48% & conducting extension activities on the modern irrigation 77.22% also received high approval, the lowest approval which was at media advertising 67.09% & training technical staff 64.56%, the overall mean 0.77 & median 1.00 show a tendency toward approval; with moderate variation SD. = 0.42.

While in figure 15 there is highlights financial procedures dominance over the awareness or the training activities; with highest percentages on financial support and direct provision. Statistical analysis shows high significance: Chi-square ( $\chi^2 = 85.64, p < 0.01$ ) & Rc (Rc= 11.25, p<0.01), confirming that economic of dimension mainly to influence farmer adoption at modern agricultural techno.

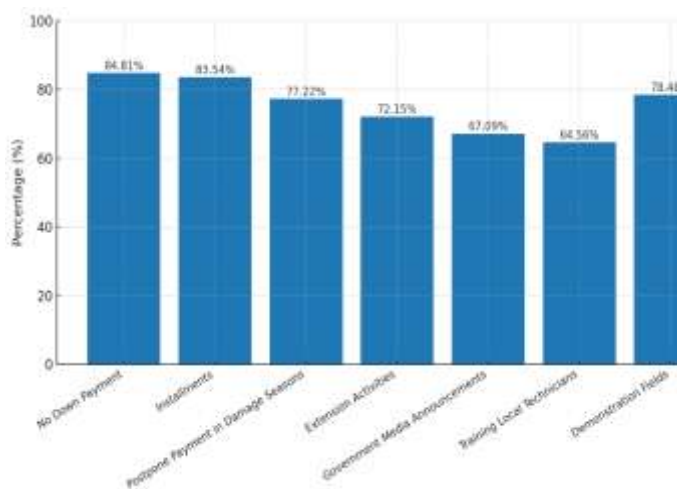
Mean (0.77) & median 1.00 indicate tendency toward approval; while the SD 0.42 have been show moderate response variation, figure 9 highlights dominance of the financial procedure over awareness or a training; with highest percentage on a financial support & direct provision

The analysis showed a highly significant result with the Chi-square ( $\chi^2 = 85.64, p < 0.01, 0.05$ ) & Rc (rc = 0.25, p < 0.01 ,0.05). This confirm economic dimension mainly influence farmer decisions to the adopt modern technology

| Yes % | No (Freq) | Yes (Freq) | Procedure   |
|-------|-----------|------------|---|
| 84.81 | 12        | 67         | 1. Provide farmers with a modern method without upfront payment.                                    |
| 83.54 | 13        | 66         | 2. Recompense of the system cost in the annual installment  |
| 81.01 | 15        | 64         | 3. Postponement of the payments that in case of environmental damages                               |
| 77.22 | 18        | 61         | 4. Strengthening of the extension activities at modern irrigation.                                  |
| 67.09 | 26        | 53         | 5.Regard Government activity announced through figure media   |
| 64.56 | 28        | 51         | 6. Concern on raining technical staff on the installation & maintenance of the precision technology |
| 78.48 | 17        | 62         | 7. Concern on establishing  |

| Yes %        | No (Freq) | Yes (Freq) | Procedure  |
|--------------|-----------|------------|--|
|              |           |            | demonstration fields in extension farms                    |
| <b>0.77</b>  | —         | —          | <b>Mean</b>  |
| <b>1.00</b>  | —         | —          | <b>Median</b>  |
| <b>0.42</b>  | —         | —          | <b>SD</b>  |
| <b>85.64</b> | —         | —          | <b>Chi-square (<math>\chi^2</math>) (calculated value)</b> |
| <b>0.15</b>  | —         | —          | <b>Rc(calculated value)</b>                                |

Table value of (rc): 1%=0.2324, Table value of (rc): 5%=0.1654



The figure 9 : Distribution of the respondents on procedures to improve technology dissemination & marketing

**Conclusions**

1. Respondents have moderate\_ sized farm holdings' and have broad basis of could benefits from the modern innovation with the sufficient support

2. Majority of the respondents be constantly with working in the farming; primarily with the family member managing farms; that to emphasize the social aspect of the agriculture
3. Lengthy experience was crucial of most participants; providing the basis to adopt modern agricultural technology
4. Findings indicated to government agencies which the main sources of agricultural innovations; with the limited influences from other to other
5. Elevated incidentals were main economic barrier that to adopt an agricultural technology; limiting of their use
6. Respondents understanding importance of the farming technology; particularly at water management & productivity; but also emphasized on an issues in its implementations
7. Results highlight of the need, practical operation & maintenance training on enhance performance of the innovations
8. Suggestions of farmers emphasized on government support; rationalization procedures, & improving supply mechanisms; pointing to importance of the economic factors in adoption choices

**Recommendations**

1. Reinforce Government support of policies of agricultural technology; making sure of they include to various types & continue consistently
2. Establishing adaptable finance options; such as the annual installment schedule or, postponed payment during the environmental tragedies; to the lessen farmers' finance difficulties
3. Increase the activities & the demonstration areas to motivate farmers

towards the adopt technology that through of hands\_ on experience

4. Expand the training program that to cover operations; maintenance; & management; focusing on the experiential practice\_ based training
5. Create & produce locally suitable skills that to decline dependence on the imports
6. Reinforcement the families' which participation & skilled labor that through social & economic finding to the

programs that to progress of agricultural sustainability

7. Address challenges by offering ongoing assistance to farmers and supervising their use of agricultural technologies.

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