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Adoption and Challenges of Agricultural Technology and Machinery: Insights from Farmers in Lupao, Nueva Ecija

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Abstract. This study explores the adoption and challenges of agricultural technology and machinery among 100 smallholder farmers in Lupao, Nueva Ecija. A descriptive survey design was employed, utilizing a structured questionnaire to gather data on respondents' demographic profiles, levels of awareness, extent of technology use, and the socio-economic, institutional, technological, environmental, and cultural factors influencing adoption. Findings reveal that most respondents are male, over 45 years old, with at least a high school education and extensive farming experience. Farms are generally under three hectares, and rice remains the predominant crop. Results further indicate that farmers exhibit substantial awareness of modern machinery, sustainable practices, and government support programs. Many integrate traditional and modern methods, often owning or renting machinery to complement their operations. Adoption of agricultural technology is shaped by factors such as cost, farm size, age, institutional support, ease of use, and climate variability. However, farmers continue to face barriers, including high investment costs, limited access to credit, low technical knowledge, inadequate facilities, policy constraints, and sociocultural resistance. These challenges restrict the full and efficient adoption of innovations. The study highlights the importance of strengthening agricultural extension services, creating accessible financial schemes, providing hands-on training, and improving rural infrastructure. It also emphasizes the role of inclusive policy-making and active community involvement in promoting technology adoption. It is recommended that government programs focus on targeted capacity-building and sustained support to enable smallholder farmers to maximize the benefits of modern agricultural technologies for resilient and sustainable farming.

Keywords: Agricultural Technology, Machinery Adoption, Smallholder Farmers, Barriers to Adoption, Sustainable Farming

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Introduction

According to Department of Agriculture, one of the main contributors to the Philippine economy is the farming sector., providing livelihoods for many rural households even if its GDP share has declined. As of 2022, roughly one in four Filipinos (≈25%) work in agriculture, and the sector contributes on the order of 8–9% of GDP (rsisinternational.org). Nueva Ecija exemplifies this importance: it is known as the "Rice Granary of the Philippines," a leading producer of rice, corn, and onions essential to national food. These staple crops and others (coconut, sugarcane, etc.) are concentrated in provinces like Nueva Ecija, reflecting both the historical and continuing role of agriculture in the region's. Department of Agriculture. (n.d.)

Agricultural modernization is proceeding on multiple fronts. Mechanization and farm equipment are increasingly promoted to raise productivity. For example, "Agriculture 4.0" initiatives have raised the national mechanization level from about 2.31 to 2.68 horsepower per hectare in recent years. New implements like small tract tractors, mechanical harvesters, and water-saving irrigation systems are being tested in provinces.

Digital and "precision" technologies are also expanding. The Department of Agriculture's "One DA" reform agenda explicitly targets digital platforms and data systems: for instance, e Kadiwa is an online farmer-market linking system, and government databases (RSBSA, PRiSM, RIICE) track farm inputs, weather, and yields to support data-driven decisions. Satellite imagery, drone mapping, and IoT sensors are being tested for crop monitoring and spraying. Workshops by IRRI and DA emphasize satellite remote sensing, drone surveys, and mobile apps like Agriconnect to help farmers optimize irrigation, predict yields, and respond to climate risks. In sum, modern tools ranging from mechanized tillers to precision drones and digital apps are being promoted to transform Philippine agriculture (especially rice-based systems).

Despite advancements in agricultural technology, many small-scale farmers in the Philippines, particularly in rural areas, face significant barriers to adoption due to financial limitations, high equipment costs, and limited access to infrastructure and credit. Innovations such as modern machinery, sensors, and digital tools often remain out of reach without subsidies, especially in areas with poor connectivity and electricity. Additionally, many farmers lack the technical skills to use new technologies, highlighting the need for training and support. Experts emphasize that successful adoption requires aligning technological solutions with local conditions and involving farmers in the design and implementation process. Programs must prioritize grassroots capacity-building, access, and inclusion to ensure that modernization efforts truly benefit communities like those in Lupao, Nueva Ecija.

Agriculture remains a strategic sector in ensuring global food security, yet the growing demand for agri-food driven by population increase necessitates a transition from traditional methods to smart farming systems, often referred to as Agriculture 4.0. Abbasi, Martinez, and Ahmad (2022) highlighted that digital technologies—such as autonomous robotic systems, the Internet of Things (IoT),

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and machine learning—are increasingly explored in agricultural research. However, most applications remain in the prototypical phase, and adoption is hindered by technical and socio-economic barriers.

The role of information and communication technologies (ICTs) in agriculture has also been widely examined. Sasmita et al. (2025), in their study on young farmers in Indonesia, emphasized the importance of ICT interactivity, efficiency, and trust in improving productivity. They stressed the need for localized platforms and training, underscoring communication as a critical mediator between ICT use and farm performance. Similarly, Ong et al. (2022) proposed the Technology Adoption Journey Map (TAJM), combining the Diffusion of Innovation theory and customer journey mapping, to better capture the complexities of farmers' adoption processes.

Beyond digital platforms, innovations in crop varieties also play a role in enhancing farmer income. Kwan et al. (2025) reported that Special Purpose Rice (SPR) developed by Central Luzon State University not only yields higher returns than traditional varieties but also requires proper clustering, market assurance, and adherence to recommended practices for sustainable adoption.

Adoption studies also reveal that farmers' well-being and decision-making are closely linked to technology use. Abdul-Majid et al. (2024) found that while technology generally improves income and productivity, its effects on well-being remain nuanced, shaped by compatibility with local practices. Likewise, Alexander et al. (2020) in Lao PDR and Hermans et al. (2020) in climate-smart agriculture interventions emphasized that adoption is neither linear nor automatic, but influenced by personal attributes, perceptions of value chains, and social dynamics.

In the Philippine context, Fronda (2023) demonstrated that local knowledge, experiences, and risk attitudes play significant roles in shaping agricultural decision-making. Risk aversion was noted as a barrier, yet local knowledge served as an asset for adaptive strategies, reinforcing the need to integrate farmer perspectives in policy and training.

Comparative studies from other countries echo similar challenges. In Rwanda, Nshimiyimana and Rukundo (2020) observed that while modern technologies such as tissue culture, drones, IoT, and mechanization hold great promise, adoption remains low due to high costs, climate variability, and insufficient technical knowledge.

The reviewed literature emphasizes that while technological innovations offer significant opportunities to improve productivity and sustainability, their adoption is constrained by financial, institutional, and socio-cultural barriers. Importantly, the integration of local knowledge, effective extension services, and accessible financing mechanisms remain critical to bridging the gap between awareness and widespread adoption. These insights provide a strong foundation for examining the adoption challenges faced by smallholder farmers in Lupao, Nueva Ecija.

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Research Problem

The fast advancement of agricultural technology has significantly changed farming practices worldwide. However, the adoption of these technologies among farmers in Lupao, Nueva Ecija, remains unclear due to various factors such as awareness, accessibility, and challenges in implementation. Understanding the scope to which farmers embrace agricultural technology and the barriers they face is essential in improving agricultural productivity and sustainability.

This study aims to answer the following questions:

1. What is the profile of the respondents in terms of: Age, Sex, Educational Attainment, Years of Farming Experience, Farm Size, and Type of Crops Planted
2. What is the level of awareness of farmers in Lupao, Nueva Ecija, regarding agricultural technology?
3. What factors influence the adoption of agricultural technology among farmers?
4. What challenges and barriers prevent farmers from fully adopting agricultural technology?

1. Methodology

The study employed a descriptive-survey research design to examine the adoption and challenges of agricultural technology among farmers in Lupao, Nueva Ecija. Data were gathered through a validated questionnaire, supplemented with interviews, focusing on respondents' demographic profiles and their experiences with agricultural technology and machinery.

A purposive sampling technique was used to select 100 farmers who were directly engaged in farming and knowledgeable about technology use. This sample size ensured relevant, reliable, and manageable data aligned with the study's objectives.

The research site was Lupao, Nueva Ecija, a predominantly agricultural municipality known for rice, corn, and vegetable production. Data collection followed ethical standards, with confidentiality assured to all participants.

For data analysis, frequency counts, percentages, and weighted means were employed. These statistical tools measured the distribution of responses and summarized farmers' perceptions regarding awareness, adoption, and challenges of agricultural technologies.

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2. Results and Discussion

1. The Profile of the Respondents

1.1. Age

It is shown that the age distribution of the 100 farmers in Lupao, Nueva Ecija reveals a wide range of ages. The majority of the farmers are older, with 35 farmers (35%) aged 55 and above, followed by 30 farmers (30%) in the 45-54 age group. The 35-44 age group had 20 farmers (20%), while 8 farmers (8%) were in the 25-34 range, and only 7 farmers (7%) were below 25 years old. This suggests that the farming community in this area is generally older, with a larger proportion of farmers being in their 40s and 50s or older.

Table 1

Distribution of Respondents' Age

Age	*f*	*%*
Below 25	7	7%
25-34	8	8%
35-44	20	20%
45-54	30	30%
55 and above	35	35%
Total	**100**	**100**

This age distribution indicates that farming in Lupao, Nueva Ecija is largely managed by individuals with many years of experience. The presence of younger farmers is relatively small, with only 15% of respondents falling under 35 years old. This shows that farming in the region is mostly carried out by those who have been involved in the industry for a longer time.

1.2. Sex

It is shown that out of the 100 farmer respondents in Lupao, Nueva Ecija, 70 (70%) are male and 30 (30%) are female. This indicates that a larger proportion of the farming community is male, with men making up the majority of the respondents. The data suggests that men are more commonly involved in farming activities in this area, while women, though fewer in number, still play an important role in the agricultural sector.

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Table 2

Distribution of Respondents' Sex

Sex	*f*	%
Male	70	70%
Female	30	30%
Total	**100**	**100.0**

The gender distribution highlights the significant presence of male farmers in Lupao, Nueva Ecija. This may reflect broader patterns in agricultural work, where men are often the primary decision-makers in farming-related activities. The 30% female representation also suggests that women contribute to farming, and their participation could be important for understanding the challenges and opportunities related to agricultural technology adoption in the region.

1.3. Educational Background

It is shown that the educational background of the 100 farmer respondents in Lupao, Nueva Ecija varies. The majority of the farmers are high school graduates, with 40 farmers (40%) having completed secondary education. This is followed by 20 farmers (20%) who finished elementary, 15 farmers (15%) who r0078eached college level, 12 farmers (12%) with vocational training, and 8 farmers (8%) with no formal education. Only 5 farmers (5%) are graduate school level.

Table 3

Distribution of Respondents' Educational Background

Section	*f*	%
No formal education	8	8%
Elementary Graduate	20	20%
Secondary	40	40%
Vocational	12	12%
College	15	15%
Graduate Studies	5	5%
Total	**100**	**100.0**

This data shows that most of the farmers have at least basic education, with many completing high school or higher. A small number of farmers have reached college or graduate school, while a few have no formal schooling. This variety in educational background may influence how easily farmers understand and use agricultural technologies, but it clearly shows that farming in Lupao includes people from different levels of education.

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1.4. Years of Farming

It is shown that the years of farming experience of the 100 farmer respondents in Lupao, Nueva Ecija, vary. Most of the farmers have been in farming for a long time. A total of 36 farmers (36%) have more than 20 years of farming experience. Both the 6–10 years and 11–20 years categories have 25 farmers each, which is 25% for both groups. Only 14 farmers (14%) have 5 years or less of experience in farming.

Table 4.

Distribution of Respondents' Years of Farming Experience

Years of Farming Experience	***f***	***%***
5 years and below	14	14%
6-10 years	25	25%
11-20 years	25	25%
more than 20 years	36	36%
Total	**100**	**100.0**

This shows that farming in Lupao is mostly done by individuals with many years of experience. A total of 86% of the farmers have been farming for more than 5 years, which means they are already familiar with traditional practices. The smaller percentage of those with less than 5 years suggests that fewer people are new to farming in the area.

1.5. Farming size

It presents the data on the farm sizes of the 100 farmer respondents in Lupao, Nueva Ecija, showing that most of them manage small areas of land. A total of 33 farmers (33%) have less than 1 hectare of land, while 42 farmers (42%) have between 1 to 3 hectares. This means that most of the farmers in the area operate on small pieces of land, with 75% of them owning 3 hectares or less.

Table 5

Distribution of Respondents' Farming Size

Farming Size (in Hectares)	***f***	***%***
Less than 1 ha	33	33%
1-3 ha	42	42%
4-6 ha	15	15%
7-8 ha	10	10%
9-10 ha	0	0%
more than 10 ha	0	0%
Total	**100**	**100.0**

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Only a few farmers have bigger land areas. About 15 farmers (15%) have 4 to 6 hectares, and 10 farmers (10%) have 7 to 8 hectares. There are no respondents who own land between 9 to 10 hectares or more than 10 hectares. This shows that large-scale farming is not common in Lupao, and farming is mostly done on a small scale.

1.6. Types of farming

It presents the different types of farming practiced by the 100 farmer respondents in Lupao, Nueva Ecija, where farmers were allowed to select more than one type. The most common type is rice farming, with 75 farmers (75%) involved in it. This is followed by 33 farmers (33%) doing vegetable farming, 29 farmers (29%) in corn farming, 26 farmers (26%) practicing mixed farming, and only 3 farmers (3%) raising livestock.

Table 6

Distribution of Respondents' Types of farming

Types of farming	*f*	*%*
Rice Farming	75	75%
Corn Farming	29	29%
Vegetable Farming	33	33%
Livestock Farming	3	3%
Mixed Farming (Combination of two or more)	26	26%
others	0	0%
Total	**100**	**100.0**

This shows that rice farming is the main type of farming in the area. Vegetable and corn farming are also common among some farmers. A number of them are engaged in mixed farming, which means they combine two or more types of farming. Only a few respondents raise livestock, showing that it is not a major activity in the area. These results suggest that most farmers focus on crop production, especially rice, which plays an important role in their livelihood.

2. Level of Awareness on Agricultural Technology

2.1. *Agricultural Innovation*

It shows the level of awareness of the respondents about agricultural technology, especially in terms of agricultural innovation. The overall mean is 2.84, which is interpreted as "Evident." This means that most respondents are aware of new farming methods and tools. The highest mean is 2.98, which shows that many are familiar with modern farming equipment like drones, planters, and automated irrigation systems. Other indicators such as knowledge of smart farming techniques, biotechnology, and understanding the benefits of modern innovations also received a rating of "Evident," with means ranging from 2.80 to

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2.89. This means they know these technologies and how they help improve farming.

Table 7

Level of Awareness on Agricultural Innovation

Indicators	Mean	Verbal Interpretation
1. I am familiar with modern farming equipment such as mechanized planters, drones, and automated irrigation systems.	2.98	Aware
2. I have knowledge of smart farming techniques such as precision farming, hydroponics, and vertical farming.	2.80	Aware
3. I am aware of biotechnology applications such as genetically modified crops and biofertilizers.	2.80	Aware
4. I understand how modern farming innovations can improve productivity and reduce labor costs.	2.89	Aware
5.I regularly seek information about new agricultural technologies through training, online resources, and experts.	2.76	Aware
OVERALL MEAN	**2.84**	**AWARE**

Legend: 3.26 – 4.00 (Highly Aware); 2.51 – 3.25 (Aware); 1.76 – 2.50 (Slightly Aware); and 1.00 – 1.75 (Not Aware)

The lowest mean is **2.76**, which refers to seeking information through training, online sources, or experts. This shows that while respondents are aware of modern farming methods, they do not often look for new information or updates. This means their awareness is present but could be improved if they actively searched for more knowledge. Overall, the results show that the respondents have a good awareness of agricultural technology, but there is still a need to encourage continuous learning and exposure to new innovations.

2.2 Sustainable Farming Practices

This presents the level of awareness of the respondents on sustainable farming practices. The overall mean is ***2.78***, which falls under the verbal interpretation ***"Evident."*** This indicates that respondents are generally aware of sustainable farming methods that promote environmental protection and responsible farming. The highest mean is ***2.88***, which shows that many respondents have a good understanding of organic farming and eco-friendly pest control. Knowledge of integrated pest management (IPM) also scored high with a mean of ***2.86***, suggesting that respondents are familiar with ways to manage pests and diseases without harming the environment. Conservation practices such as crop rotation, agroforestry, and cover cropping had a mean of ***2.77***, while

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the importance of reducing synthetic fertilizers and pesticides scored ***2.75***, both still rated as "Evident."

Table 8

Level of Awareness on Sustainable Farming Practices

Indicators	Mean	Verbal Interpretation
1. I have a good understanding of organic farming methods and eco-friendly pest management techniques.	2.88	Aware
2. I am aware of conservation practices such as crop rotation, agroforestry, and cover cropping.	2.77	Aware
3. I understand the importance of reducing synthetic fertilizers and pesticides for sustainable farming.	2.75	Aware
4. I have knowledge of integrated pest management (IPM) strategies to control pests and diseases.	2.86	Aware
5. I am familiar with soil conservation techniques such as mulching and minimum tillage.	2.67	Aware
OVERALL MEAN	**2.78**	**AWARE**

Legend: 3.26 – 4.00 (Highly Aware); 2.51 – 3.25 (Aware); 1.76 – 2.50 (Slightly Aware); and 1.00 – 1.75 (Not Aware)

This presents the level of awareness of the respondents on sustainable farming practices. The overall mean is ***2.78***, which falls under the verbal interpretation ***"Evident."*** This indicates that respondents are generally aware of sustainable farming methods that promote environmental protection and responsible farming. The highest mean is ***2.88***, which shows that many respondents have a good understanding of organic farming and eco-friendly pest control. Knowledge of integrated pest management (IPM) also scored high with a mean of ***2.86***, suggesting that respondents are familiar with ways to manage pests and diseases without harming the environment. Conservation practices such as crop rotation, agroforestry, and cover cropping had a mean of ***2.77***, while the importance of reducing synthetic fertilizers and pesticides scored ***2.75***, both still rated as "Evident."

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2.3 Government Institutional Support

Table 9

Level of Awareness on Government and Institutional Support

Indicators	Mean	Verbal Interpretation
1. I am aware of agricultural subsidies, grants, and loan programs available to farmers.	2.83	Aware
2. I have knowledge of training programs and extension services provided by DA, LGUs, and NGOs.	2.88	Aware
3. I am familiar with agricultural policies and regulations that affect my farming activities.	2.74	Aware
4. I understand the importance of government support in promoting modern agricultural practices.	2.82	Aware
5. I have participated in at least one training program or seminar related to agricultural advancements.	2.90	Aware
OVERALL MEAN	**2.83**	**AWARE**

Legend: 3.26 – 4.00 (Highly Aware); 2.51 – 3.25 (Aware); 1.76 – 2.50 (Slightly Aware); and 1.00 – 1.75 (Not Aware)

The results in Table 9 show that farmers are generally aware of the support given by the government and other institutions. The overall mean score is 2.83, which means the awareness is "Evident." This includes knowing about agricultural loans, grants, and subsidies, as well as training programs from the Department of Agriculture (DA), local government units (LGUs), and NGOs. The highest score is 2.90, which means many farmers have joined training or seminars about farming. This shows that these programs are reaching the farmers and helping them learn more about modern farming.

The lowest score is 2.74, which is about knowing agricultural policies and rules. This means that some farmers are not very familiar with the laws or guidelines related to farming. While most farmers understand the importance of government help and have some knowledge of programs and services, there is still a need to improve how these are shared with them. The government and other groups should continue to give training and make information easier to understand so that more farmers can benefit.

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3. Factors Influencing the Adoption of Agricultural Technology Among Farmers

3.1 Socio-Economic Factors

Table 11

Factors Influencing the Adoption of Agricultural Technology Among Farmers in Terms of Socio-Economic Factors

Indicators	Mean	Verbal Interpretation
1. I am familiar with modern farming equipment such as mechanized planters, drones, and automated irrigation systems.	2.86	Evident
2. My age influences my willingness to adopt new agricultural practices.	2.75	Evident
3. I can afford to invest in modern farming equipment and technologies.	2.55	Evident
4. My farm size is sufficient to justify the use of advanced farming tools.	2.70	Evident
5. I can easily access financial assistance (e.g., loans, grants) to support the adoption of new technologies.	2.70	Evident
OVERALL MEAN	**2.71**	**EVIDENT**

Legend: 3.26 – 4.00 (Highly Evident); 2.51 – 3.25 (Evident); 1.76 – 2.50 (Slightly Evident); and 1.00 – 1.75 (Not Evident)

The results in Table 11 show that socio-economic factors clearly affect how farmers use new farming technologies. The overall mean is 2.71, which means most farmers know that their money, age, and farm size can affect how they use modern tools. The highest score is 2.86, which shows that many farmers are aware of equipment like drones, planters, and automatic watering systems. This means they are getting information about new ways to improve their farming.

The factors age, farm size, and getting financial help also got evident ratings, showing these are important in deciding whether to use new tools. The lowest score is 2.55, which shows that many farmers cannot afford modern equipment for their farm. So even if they want to try new technology, money is a big problem. Because of this, farmers still need support, especially in financial assistance, to be able to use modern farming methods.

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3.2 Institutional and Policy Factor

Table 12

Factors Influencing the Adoption of Agricultural Technology Among Farmers in Terms of Institutional and Policy Factors

Indicators	Mean	Verbal Interpretation
1. I am aware of government subsidies and financial assistance programs for adopting agricultural technologies.	2.83	Evident
2. Government policies and regulations encourage farmers to use modern technologies.	2.79	Evident
3. I have attended training programs or workshops related to modern agricultural technologies.	2.77	Evident
4. The agricultural extension services in my area provide sufficient guidance on technology adoption.	2.73	Evident
5. I receive adequate support from agricultural cooperatives or farmer organizations in adopting new technologies.	2.84	Evident
OVERALL MEAN	**2.79**	**EVIDENT**

Legend: 3.26 – 4.00 (Highly Evident); 2.51 – 3.25 (Evident); 1.76 – 2.50 (Slightly Evident); and 1.00 – 1.75 (Not Evident)

The results in Table 12 show that institutional and policy factors have an evident influence on farmers in using modern agricultural technologies. The overall mean is 2.79, which means most farmers are aware of the support and programs from the government and other organizations. The highest score is 2.84, which shows that many farmers receive enough support from cooperatives or farmer groups. Awareness of government subsidies and financial help also scored high (2.83), showing that these programs are known to many farmers.

The factors policies, training, and extension services also got evident ratings, but with slightly lower scores. The lowest score is 2.73, which means some farmers feel that guidance from extension services could be improved. Even if farmers know about the programs and attend training, more effort is needed to give them full support and clear guidance. Overall, farmers are aware of the available help, but they still need more direct support to fully use modern technologies in farming.

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3.3 Technological Factors

Table 13

Factors Influencing the Adoption of Agricultural Technology Among Farmers in Terms of Technological Factors

Indicators	Mean	Verbal Interpretation
1. Modern farming technologies are easy to use and understand.	2.82	Evident
2. The cost of modern agricultural technologies affects my decision to adopt them.	2.65	Evident
3. The benefits of agricultural technology outweigh its cost.	2.65	Evident
4. New farming technologies are compatible with my current farming practices.	2.88	Evident
5. I believe technology adoption can improve my farm's productivity.	2.75	Evident
OVERALL MEAN	**2.75**	**EVIDENT**

Legend: 3.26 – 4.00 (Highly Evident); 2.51 – 3.25 (Evident); 1.76 – 2.50 (Slightly Evident); and 1.00 – 1.75 (Not Evident)

The results in Table 13 show that technological factors clearly affect the use of modern tools and equipment in farming. The overall mean is 2.75, which means that farmers find these factors important in deciding whether to adopt new technologies. The highest score is 2.88, showing that many farmers think modern technologies fit well with their current farming methods. A score of 2.82 also shows that farmers find these technologies easy to use and understand. These results mean that many farmers are open to using technology if it suits their farming style and is simple to apply.

Some indicators received lower scores, such as the cost of technology and whether its benefits are worth the expense, both with a mean of 2.65. This shows that while farmers are interested in using modern tools and machineries, the price still affects their decision. The belief that technology can help improve their harvest got a mean of 2.75, which means many farmers see its value. In general, farmers are open to using new farming technologies, but making them more affordable and easier to access would encourage more farmers to use them.

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3.4. Environmental and Climatic Factors

Table 14

Factors Influencing the Adoption of Agricultural Technology Among Farmers in Terms of Environmental and Climatic Factors

Indicators	Mean	Verbal Interpretation
1. Climate change influences my decision to adopt new agricultural technologies.	2.84	Evident
2. I adopt modern farming techniques to cope with drought and extreme weather.	2.85	Evident
3. Soil conditions in my farm influence my willingness to use advanced farming methods.	2.82	Evident
4. The availability of water resources affects my adoption of irrigation technologies.	2.79	Evident
5. I use climate-smart agricultural technologies (e.g., drought-resistant crops, precision irrigation).	2.83	Evident
OVERALL MEAN	**2.82**	**EVIDENT**

Legend: 3.26 – 4.00 (Highly Evident); 2.51 – 3.25 (Evident); 1.76 – 2.50 (Slightly Evident); and 1.00 – 1.75 (Not Evident)

The results in Table 14 show that environmental and climate factors clearly affect farmers' decisions to use modern farming technologies. The overall mean score of 2.82 means most farmers understand that changes in weather and the environment influence how they farm. The highest scores, 2.85 and 2.84, show that many farmers use new farming methods to handle problems like drought and extreme weather. They also believe that climate change makes it important to try new technologies.

While other factors such as soil conditions, water availability, and the use of climate-smart tools like drought-resistant crops also got high scores, meaning these are important to farmers when choosing technologies. This shows that farmers are aware of how nature and weather affect their farms and are willing to adopt new ways to protect their crops and improve farming. Overall, farmers are motivated to use modern technology to better deal with environmental challenges.

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4. Challenges and Barriers Prevent Farmers from Fully Adopting Agricultural Technology

4.1 Financial Constraints

Table 15

Challenges and Barriers Prevent Farmers from Fully Adopting Agricultural Technology in terms of Financial Constraints

Indicators	Mean	Verbal Interpretation
1. High initial investment costs for machinery and modern equipment.	2.96	Challenge
2. Limited access to credit, loans, or financial assistance.	2.69	Challenge
3. High maintenance and operational costs of advanced technology.	2.76	Challenge
4. Uncertain return on investment (ROI) for new technologies.	2.76	Challenge
5. High cost of fertilizers, pesticides, and improved seed varieties.	2.87	Challenge
OVERALL MEAN	**2.80**	**CHALLENGE**

Legend: 3.26 – 4.00 (Always a Challenge); 2.51 – 3.25 (Challenge); 1.76 – 2.50 (Rarely a Challenge Aware); and 1.00 – 1.75 (Never a Challenge)

In Table 15 show that financial problems are a clear barrier for farmers in using modern farming technology. The overall mean score of 2.80 means that money issues are a big challenge. The highest score, 2.96, shows that many farmers find the high cost of buying new machines and equipment very difficult. Other costs like fertilizers, pesticides, and better seeds also got a high score of 2.87, showing that these expenses add to the financial burden.

Financial problems include limited access to loans or financial help, with a score of 2.69, and high costs for maintaining and using new technology, scoring 2.76. Farmers also worry about not getting enough return from investing in new agricultural technology, which scored 2.76. These results show that even if farmers want to use modern technology, the cost and money risks stop them from fully adopting it. More financial support and affordable options are needed to help farmers use better farming methods.

4.2 Lack of Awareness and Knowledge

Table 16

Challenges and Barriers Prevent Farmers from Fully Adopting Agricultural Technology in Terms of a Lack *of Awareness and Knowledge*

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Indicators	Mean	Verbal Interpretation
1. Limited technical knowledge about modern agricultural tools.	2.97	Challenge
2. Low awareness of available agricultural technologies.	2.75	Challenge
3. Lack of training programs or educational resources for farmers.	2.78	Challenge
4. Resistance to change due to a preference for traditional farming methods.	2.84	Challenge
5. Misinformation or skepticism about the effectiveness of new technologies.	2.95	Challenge
OVERALL MEAN	2.85	**CHALLENGE**

Legend: 3.26 – 4.00 (Always a Challenge); 2.51 – 3.25 (Challenge); 1.76 – 2.50 (Rarely a Challenge Aware); and 1.00 – 1.75 (Never a Challenge)

Table 16 shows that lack of awareness and knowledge is a clear barrier that stops farmers from fully using modern farming technology. The overall mean score is 2.85, which means many farmers do not have enough information or training about new technology and methods. The highest score, 2.97, shows that farmers have limited technical knowledge about how to use modern technology equipment for farming. Another high score, 2.95, shows that some farmers doubt if new technology works, which makes them hesitant to try it.

The problems are low awareness of available technologies (2.75) and not enough training programs or learning materials for farmers (2.78). Some farmers also prefer to stick with traditional farming methods, scoring 2.84, which makes it harder to adopt new ways. These results show that even if technology is available, farmers need more education and support to understand and trust agricultural technology and machineries. Providing more training and clear information can help farmers use better farming technology.

4.3 *Limited Access to Infrastructure and Resources*

Table 17

Challenges and Barriers Prevent Farmers from Fully Adopting Agricultural Technology in Terms of Limited Access to Infrastructure and Resources

Indicators	Mean	Verbal Interpretation
1. Poor rural infrastructure (e.g., roads, electricity, and internet).	2.83	Challenge
2. Inadequate irrigation facilities and unreliable water sources.	2.93	Challenge
3. Limited access to agricultural research and innovation centers.	2.87	Challenge

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4. Unavailability of spare parts and repair services for modern equipment.	2.81	Challenge
5. Poor market linkages and distribution channels for technology-based produce.	2.67	Challenge
OVERALL MEAN	**2.82**	**CHALLENGE**

Legend: 3.26 – 4.00 (Always a Challenge); 2.51 – 3.25 (Challenge); 1.76 – 2.50 (Rarely a Challenge Aware); and 1.00 – 1.75 (Never a Challenge)

The results in Table 17 show that limited access to infrastructure and resources is a clear problem that prevents farmers from fully using modern farming technology. The overall mean score is 2.82, which means many farmers face challenges related to basic facilities and resources. The highest score is 2.93 for poor irrigation and unreliable water sources, showing that water is a big issue for farmers. Problems like bad roads, lack of electricity, and poor internet also scored high at 2.83, which makes it hard for farmers to access and use new technology.

While limited access to research centers got (2.87) and the unavailability of spare parts and repair services for modern equipment (2.81). Farmers also face problems with poor market connections and how they sell products made with new technology, scoring 2.67. These results show that farmers need better roads, water, and support services to help them use modern farming tools. Improving these basic needs will make it easier for farmers to adopt and benefit from new agricultural technology and machine.

4.4 *Institutional and Policy Barriers*

Table 18

Challenges and Barriers Prevent Farmers from Fully Adopting Agricultural Technology in Terms of Institutional and Policy Barriers

Indicators	Mean	Verbal Interpretation
1. Lack of government incentives or subsidies for technology adoption.	3.04	Challenge
2. Bureaucratic hurdles in accessing financial support programs.	2.85	Challenge
3. Weak enforcement of agricultural policies promoting technological advancements.	2.81	Challenge
4. Limited agricultural extension services to guide farmers on technology use.	2.92	Challenge
5. Inconsistent government support for research and development in agriculture.	2.86	Challenge
OVERALL MEAN	**2.89**	**CHALLENGE**

Legend: 3.26 – 4.00 (Always a Challenge); 2.51 – 3.25 (Challenge); 1.76 – 2.50 (Rarely a Challenge Aware); and 1.00 – 1.75 (Never a Challenge)

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The results in Table 18 show that problems in government policies and institutions make it hard for farmers to fully use modern farming technology. The overall mean score is 2.89, which means these issues are clear barriers. The highest score is 3.04, showing that many farmers feel there are not enough government incentives or help for adopting new technology. Other problems include difficulties in getting financial support because of complicated procedures, which scored 2.85, and weak enforcement of policies that encourage the use of new technology, with a score of 2.81.

Farmers has limited extension services to guide them on how to use technology, scoring 2.92, and inconsistent government support for agricultural research, which scored 2.86. These results show that farmers need more help from the government, especially in making support easier to get and more consistent. Improving government programs and services can encourage more farmers to use modern farming technology.

5.5 Socio-Cultural Resistance

Table 19

Challenges and Barriers Prevent Farmers from Fully Adopting Agricultural Technology in terms of Socio-Cultural Resistance

INDICATORS	MEAN	VERBAL INTERPRETATION
1. Farmers' reluctance to adopt new technologies due to cultural traditions.	2.82	Evident
2. Influence of older generations who prefer conventional farming methods.	2.87	Evident
3. Fear of failure and uncertainty about the outcomes of new practices.	2.76	Evident
4. Social pressure from the farming community to stick to traditional methods.	2.78	Evident
5. Limited involvement of younger farmers who are more open to innovation.	2.85	Evident
OVERALL	2.81	Evident

Legend: 3.26 – 4.00 (Always a Challenge); 2.51 – 3.25 (Challenge); 1.76 – 2.50 (Rarely a Challenge Aware); and 1.00 – 1.75 (Never a Challenge)

The results in Table 19 show that social and cultural factors are clear barriers that stop farmers from fully using modern farming technology. The overall mean score of 2.81 means many farmers face challenges related to traditions and community pressure. The highest score is 2.87, showing that older generations prefer to use traditional farming methods. Many farmers also feel afraid to try new practices because they worry about failure, which scored 2.76. The pressure from neighbors to keep farming the old way, which scored 2.78,

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and farmers not wanting to change because of their habits, scoring 2.82. Younger farmers who are open to new ideas are not involved much, scoring 2.85. These results show that old habits and community pressure make it hard for farmers to use new technology. Farmers need more help and support to feel safe trying new farming ways.

7. Conclusions

The findings of this study revealed that farming in Lupao, Nueva Ecija is predominantly managed by older, male farmers with long years of experience, small farm sizes, and rice as the major crop cultivated. While most respondents have attained at least a basic level of education, only a small proportion of younger farmers are engaged in agriculture, which may affect the long-term sustainability of farming in the area.

The level of awareness of farmers toward agricultural technology—including innovations, sustainable practices, and government or institutional support—was generally evident, indicating that while farmers are knowledgeable of modern techniques and programs, their awareness does not necessarily translate into full adoption. Socio-economic conditions, institutional and policy support, technological considerations, and environmental factors were all identified as significant influences in farmers' decisions to adopt agricultural technologies. However, financial limitations, lack of technical knowledge, insufficient infrastructure, weak institutional support, and socio-cultural resistance remain major barriers preventing full utilization of these technologies.

The study concludes that although farmers in Lupao are aware of and recognize the potential benefits of modern agricultural technologies, their adoption is hindered by structural, economic, and cultural constraints. Addressing these challenges through stronger financial assistance, accessible training, improved infrastructure, and consistent government support will be essential in encouraging greater technology adoption and ensuring more sustainable and productive farming practices in the community.

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