ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2026): 4.97
IJAFS 2026; 8(8): 319-326
www.agriculturaljournals.com
Received: 13-06-2026
Accepted: 17-07-2026

Victor Sarkar
Malda Krishi Vigyan Kendra, Uttar Banga Krishi Vigyan Kendra, Ratua, Malda, West Bengal, India

S Chakraborty
Department of Agricultural Extension, Uttar Banga Krishi Vigyan Kendra, Pundibari, Cooch Behar, West Bengal, India

R Roy
Malda Krishi Vigyan Kendra, Uttar Banga Krishi Vigyan Kendra, Ratua, Malda, West Bengal, India

BC Rudra
Malda Krishi Vigyan Kendra, Uttar Banga Krishi Vigyan Kendra, Ratua, Malda, West Bengal, India

B Maity
Department of Agricultural Extension, Uttar Banga Krishi Vigyan Kendra, Pundibari, Cooch Behar, West Bengal, India

S Das
Malda Krishi Vigyan Kendra, Uttar Banga Krishi Vigyan Kendra, Ratua, Malda, West Bengal, India

PK Pal
Department of Agricultural Extension, Uttar Banga Krishi Vigyan Kendra, Pundibari, Cooch Behar, West Bengal, India

F Aktar
Malda Krishi Vigyan Kendra, Uttar Banga Krishi Vigyan Kendra, Ratua, Malda, West Bengal, India

Corresponding Author:
Victor Sarkar
Malda Krishi Vigyan Kendra, Uttar Banga Krishi Vigyan Kendra, Ratua, Malda, West Bengal, India

Assessment of adoption patterns of recommended maize production technology among Nicra village maize growers in Malda district of West Bengal

Victor Sarkar, S Chakraborty, R Roy, BC Rudra, B Maity, S Das, PK Pal and F Aktar

DOI: https://www.doi.org/10.33545/2664844X.2026.v8.i8d.1784

Abstract
Maize (Zea mays L.) has evolved into a strategic asset for the Indian agricultural economy, serving as a versatile staple for food, poultry feed, and industrial applications. Despite a significant expansion in acreage across West Bengal, a persistent productivity gap remains a challenge. This deficit is primarily driven by the sub-optimal adoption of scientific production technologies and climate-resilient practices. To address this, an investigation was conducted within the National Innovations on Climate Resilient Agriculture (NICRA) framework to evaluate adoption patterns and socio-economic determinants among farmers in the Malda district.The study utilized a descriptive-analytical design under the technical supervision of the Malda Krishi Vigyan Kendra (KVK). A multi-stage purposive sampling technique was applied to 70 respondents across two NICRA-adopted villages: Ramayanpur and Paschim Narayanpur. Data were synthesized through structured, pre-tested interviews and analysed using descriptive statistics to provide a clear picture of the regional agricultural landscape.
The demographic profile reveals a farming community in transition, characterized by a mix of high literacy and significant resource constraints:
A critical finding of the study is the marked disparity between the adoption of physical inputs and technical "know-how." While farmers are increasingly utilizing modern inputs, there is a profound awareness gap regarding scientific management:
The demographic and socioeconomic profile of the surveyed group reveals a mean age of 41.67 years, with 32.85% of the participants having achieved a graduate level of education or above. On average, these individuals possess 14.17 years of farming experience.
In terms of agricultural assets, Marginal Farmers represent the primary landholding class, accounting for 50.00% of the group, while the average landholding size is 7.62 bigha. Economically, the respondents report a mean annual income of ₹123,428.57. Furthermore, the data indicates a heavy reliance on traditional infrastructure, with shallow wells serving as the primary irrigation source for 74.29% of the farmers.
Input Adoption: Adoption of improved/hybrid seeds stands at 62.86%, followed by recommended sowing/spacing (52.86%) and soil testing (51.43%).
Technical Awareness: Approximately 87.14% of respondents reported a lack of comprehensive knowledge regarding the full suite of recommended technologies.
Management Gaps: Adoption of Integrated Pest Management (IPM) remains strikingly low at 12.86%, and only 30.00% of farmers utilize digital or mobile advisory services.
Mechanization: Only 38.57% have transitioned to mechanized farming, largely due to the high capital investment required for marginal landholdings.
While the attitude toward modern technology is generally positive 80% of respondents noted increased yields—economic disparities remain a significant hurdle. Roughly 26% of farmers did not experience a proportional increase in net income despite higher productivity, likely due to market imperfections and rising input costs. This "Knowledge-Action Gap" suggests that many farmers adopt inputs based on market availability or peer influence rather than formal technical training.
To bridge these gaps, future extension strategies must prioritize the following:
Strengthening IPM awareness through localized, practical demonstrations, improving access to institutional credit and subsidies to help marginal farmers adopt high-cost mechanization, expanding digital literacy to better leverage mobile advisory services for real-time decision-making, addressing input delivery mechanisms to ensure that yield gains translate directly into higher profitability for the grower.

Keywords: Maize Production, Technology Adoption, NICRA, Socio-economic Determinants, Productivity Gap, K.V.K. Malda, Technology dissemination

Introduction
Agriculture continues to play a pivotal role in the Indian economy by ensuring food security, generating rural employment, and contributing substantially to national income. Among cereal crops, maize (Zea mays L.) has emerged as one of the most important and versatile crops due to its wide adaptability, high productivity potential, and diversified utilization in food, feed, fodder, poultry, starch, and industrial sectors. Over the past few decades, maize

cultivation in India has expanded considerably as a result of increasing demand from livestock feed industries, food processing sectors, and bio-based industries. Consequently, maize has gained strategic importance in the agricultural production system of the country. India presently ranks among the leading maize-producing countries of the world in terms of cultivated area. However, despite substantial expansion in acreage, the average productivity of maize in several regions remains below potential levels. This productivity gap is primarily attributed to the low adoption of recommended production technologies, dependence on traditional cultivation practices, inadequate access to quality agricultural inputs, poor extension support, and limited awareness regarding scientific crop management practices. In eastern India, particularly in West Bengal, maize cultivation has shown increasing importance in recent years; nevertheless, farmers still face numerous socio-economic, technological, and institutional constraints that hinder productivity enhancement. Malda district of West Bengal possesses considerable potential for maize cultivation due to its favorable agro-climatic conditions and increasing farmer interest in maize-based farming systems. However, the adoption of improved maize production technologies among farmers remains uneven. Recommended practices such as use of improved or hybrid seed varieties, scientific nutrient management, soil testing, integrated pest management, mechanization, and climate-resilient farming approaches are yet to be adopted widely at the grassroots level. The persistence of traditional farming methods, coupled with inadequate technical knowledge and insufficient institutional support, continues to limit farm productivity and profitability in the region.

In this context, Krishi Vigyan Kendra (K.V.K.), Malda has been actively engaged in disseminating improved agricultural technologies and promoting climate-resilient farming practices through frontline demonstrations, farmer training programs, advisory services, and extension interventions under the NICRA (National Innovations on Climate Resilient Agriculture) program. The effectiveness of such interventions largely depends on farmers' awareness, perception, and adoption behavior toward recommended technologies. Therefore, understanding the extent of technology adoption and the factors influencing farmers' decision-making processes is essential for designing effective extension strategies and policy interventions. The present study was undertaken to assess the adoption patterns of recommended maize production technologies among maize growers of NICRA villages in Malda district of West Bengal. The study specifically focuses on examining the socio-economic characteristics of farmers, evaluating their level of awareness and adoption of improved maize cultivation practices, identifying the major constraints affecting technology adoption, and analyzing the role of extension services and information dissemination mechanisms in influencing farmers' adoption behavior. The findings of the study are expected to provide valuable insights for researchers, extension personnel, policymakers, and development agencies in formulating suitable strategies for enhancing maize productivity, improving farmers' livelihoods, and promoting sustainable agricultural development in the region.

Materials and Methods

The present investigation was conducted by Malda Krishi Vigyan Kendra (K.V.K.), Malda under the NICRA (National Innovations on Climate Resilient Agriculture) program using a descriptive and analytical research design. The study was undertaken to assess the adoption patterns of recommended maize production technologies among maize growers in selected NICRA villages of Malda district, West Bengal. Both survey and fact-finding approaches were employed to collect comprehensive information from the respondents regarding their socio-economic characteristics, technological adoption behavior, and constraints associated with maize cultivation. The study was carried out in Malda district of West Bengal, which is recognized as one of the important maize-growing regions of the state. A multi-stage stratified sampling technique was followed for the selection of respondents. In the first stage, Malda district was purposively selected considering the increasing importance of maize cultivation and the active implementation of NICRA interventions by K.V.K., Malda. In the second stage, two NICRA villages, namely Ramayanpur village under Ratua block and Paschim Narayanpur village under Manikchak block, were selected for the study. These villages were chosen due to their significant involvement in maize cultivation and participation in climate-resilient agricultural activities promoted by K.V.K., Malda.

In the final stage, a total of 70 maize-growing farmers were selected purposively from the two selected villages, comprising 35 respondents from Ramayanpur village and 35 respondents from Paschim Narayanpur village. The respondents were selected based on their active involvement in maize cultivation and exposure to recommended maize production technologies. Both primary and secondary data were utilized for the study. Primary data were collected through personal interviews with the help of a structured and pre-tested interview schedule. Secondary information was obtained from reports, journals, official records, and publications related to maize production and agricultural technology adoption. Appropriate statistical tools and techniques such as frequency, percentage, mean, and standard deviation were employed for analysis and interpretation of the collected data. The study primarily focused on analyzing the socio-economic profile of maize growers, their awareness and adoption level of recommended maize production technologies, attitudes toward improved cultivation practices, and the major constraints affecting technology adoption. The investigation also attempted to assess the role of extension services, training programs, and technology dissemination activities conducted by K.V.K., Malda in promoting climate-resilient maize production practices among farmers in the selected NICRA villages.

Table 1: A summary of the research design for quick reference

Feature	Details
Research Design	Descriptive–analytical
Study Area	Mahendra Tola village, Malda District, West Bengal
Sampling Method	Multi-stage stratified sampling
Sample Size	70 maize-cultivating farmers
Data Sources	Primary survey and secondary investigations
Key Agency	Malda Krishi Vigyan Kendra (K.V.K.)

Table 2: Summary Table of Measurement Scale

Result Category	Type of Scale	Options/Values
Attitude	3-Point Likert-Type	Agree, Undecided, Disagree
Adoption	Binary	Yes, No
Education	Ordinal/Scored	1 to 4 (Primary to Graduate)
Income/Land	Ratio	Actual Rupees / Bighas
Occupation	Categorical/Scored	1 to 4 (Service to Farming)

Results and Discussion

Table 3: Distribution of farmers according to their age

Sl. No.	Categories	Frequency	Percentage
1	Young (up-to 35 years)	26	37.14
2	Middle (36-50 years)	25	35.71
3	Old (above 50 years)	19	27.15
Total (35+35=70)		Mean-41.67, Sd- 14.01	

The age distribution of farmers indicates a balanced workforce, with young farmers constituting the largest group (37.14%), followed by middle-aged (35.71%) and older farmers (27.15%). The mean age was 41.67±14.01 years, reflecting considerable age variation. Higher youth participation suggests sustainability, while fewer older farmers may affect knowledge transfer and succession planning.

Table 4: Distribution of farmers according to their education

Sl. No.	Categories	Frequency	Percentage
1	Class I-IV	06	08.57
2	Class V-VIII	21	30
3	Class IX-XII	20	28.57
4	Graduate or above	23	32.85
Total (35+35=70)		Mean-03.01, Sd- 01.20	

The educational profile revealed that most farmers were graduates or above (32.85%), followed by middle (30%) and secondary education (28.57%), while only 8.57% had primary education. The mean education score was 3.01±1.20, indicating moderate variation and reflecting increasing participation of educated farmers in modern, knowledge-based agriculture.

Table 5: Distribution of farmers according to their Farming experience

Sl. No.	Categories	Frequency	Percentage
1	High (below 15)	43	61.43
2	Medium (15-25)	18	25.71
3	Low (above 25)	09	12.86
Total (35+35=70)		Mean-14.17, Sd- 06.75	

The farming experience distribution showed that 61.43% of farmers had less than 15 years of experience, while 25.71% and 12.86% possessed 15–25 years and above 25 years of experience, respectively. The mean farming experience was 14.17±6.75 years, indicating dominance of relatively new farmers and limited availability of highly experienced farmers.

Table 6: Distribution of farmers according to their Land Holding

Sl. No.	Categories	Frequency	Percentage
1	Small farmers (up-to 4 bigha)	11	15.71
2	Marginal farmers (5-8 bigha)	35	50.00
3	Big Farmers (9 bigha or above)	24	34.29
Total (35+35=70)		Mean-07.62, Sd- 03.82	

The landholding distribution revealed that 50% of farmers were marginal farmers owning 5–8 bigha, followed by big farmers (34.29%) and small farmers (15.71%). The average landholding was 7.62±3.82 bigha, indicating moderate variation. The findings suggest dominance of medium-sized holdings with comparatively fewer small landholders in the study area.

Table 7: Distribution of farmers according to their Occupation

Sl. No.	Categories	Frequency	Percentage
1	Service	02	02.86
2	Business	05	07.14
3	labour	10	14.29
4	Farming	53	75.71
Total (35+35=70)		Mean-03.62, Sd- 00.74	

The occupational distribution showed that farming was the primary livelihood for 75.71% of respondents, followed by labour work (14.29%), business (7.14%), and service occupations (2.86%). The mean score was 3.62±0.74, indicating low variation. The findings highlight strong dependence on agriculture with limited occupational diversification among farmers.

Table 8: Distribution of farmers according to their Annual Income

Sl. No.	Categories	Frequency	Percentage
1	Low (up-to 100000)	30	42.86
2	Medium (10000-150000)	22	31.43
3	High (150000 or above)	18	25.71
Total (35+35=70)		Mean-123428.57, Sd- 47666.89	

The annual income distribution revealed that 42.86% of farmers belonged to the low-income group, followed by medium-income (31.43%) and high-income farmers (25.71%). The mean annual income was ₹123,428.57±47,666.89, indicating considerable income variation. The findings reflect income disparity among farmers and highlight the need for financial, technical, and market support interventions.

Table 9: Distribution of farmers according to their Source of irrigation

Sl. No.	Categories	Frequency	Percentage
1	Canal (1)	01	01.42
2	Shallow well (2)	52	74.29
3	Rain-fed (3)	10	14.29
4	Others (4)	07	10.00
Total (35+35=70)		Mean-02.32, Sd- 00.67	

The table provides the distribution of farmers based on their source of irrigation. Here's an analysis of the data:

The irrigation pattern revealed that 74.29% of farmers depended on shallow wells, making groundwater the dominant irrigation source. Rain-fed agriculture accounted for 14.29%, indicating vulnerability to rainfall variability, while canals were minimally used (1.42%). Other irrigation sources contributed 10%. The mean score (2.32±0.67) reflected moderate variation in irrigation practices. The findings emphasize the importance of sustainable groundwater management, improved rainwater harvesting, and strengthening canal infrastructure to ensure reliable irrigation and long-term agricultural sustainability in the study area.

Table 10: Distribution of farmers according to their Adoption of Recommended Technologies

Sl. No.	Statements	Yes	No
1	Are you aware of the recommended maize production technologies?	09	61
2	Do you attend training or demonstrations on maize technology?	23	47
3	Do you use improved/hybrid maize seeds?	44	26
4	Do you practice soil testing before fertilizer application?	36	34
6	Do you follow the recommended sowing time and spacing?	37	33
7	Do you practice integrated pest and disease management?	09	61
8	Do you adopt mechanized farming methods (Tractors, Planters, and Harvesters)?	27	43
9	Are you using any digital/mobile advisory services for maize farming?	21	49

The table provides insight into farmers' awareness and adoption of recommended maize production technologies. Below is an analysis of the responses:

1. **Awareness of Recommended Maize Production Technologies**

- Only 9 farmers (12.86%) are aware of the recommended technologies, while a significant 61 farmers (87.14%) are not.
- This indicates a lack of information dissemination, possibly due to limited extension services or low farmer engagement in training programs.

2. **Participation in Training/Demonstrations**

- **23 farmers (32.86%)** have attended training or demonstrations, while **47 (67.14%)** have not.
- This highlights the need for more accessible and effective training programs to increase technology adoption.

3. **Use of Improved/Hybrid Maize Seeds**

- 44 farmers (62.86%) use improved seeds, while 26 (37.14%) do not.
- This indicates a moderate level of adoption, suggesting some farmers recognize the benefits of improved seeds.

4. **Soil Testing Before Fertilizer Application**

- 36 farmers (51.43%) conduct soil testing, while 34 (48.57%) do not.
- This near-equal distribution suggests that awareness of soil health is growing but still needs reinforcement.

5. **Following Recommended Sowing Time and Spacing**

- 37 farmers (52.86%) adhere to recommended sowing practices, while 33 (47.14%) do not.
- This indicates a balanced trend, showing that some farmers recognize the benefits of proper sowing practices.

6. **Integrated Pest and Disease Management (IPM)**

- Only 9 farmers (12.86%) practice IPM, while 61 (87.14%) do not.
- This is a major gap in pest control, which may lead to lower yields and increased pesticide dependency.

7. **Mechanized Farming Methods (Tractors, Planters, Harvesters)**

- 27 farmers (38.57%) adopt mechanization, while 43 (61.43%) do not.
- The relatively low mechanization rate suggests a need for more accessibility to machinery and financial support.

8. **Use of Digital/Mobile Advisory Services**

- 21 farmers (30%) use digital/mobile advisory services, while 49 (70%) do not.
- This indicates a lack of awareness or access to digital farming solutions, which could improve knowledge and efficiency.
- Awareness and training participation are low, which affects technology adoption.
- Farmers are more inclined to adopt improved seeds and soil testing but lag behind in pest management and mechanization.
- Digital services are underutilized, highlighting the need for better digital literacy and access.
- Strengthen extension services to improve farmer awareness.
- Increase training and demonstration programs to promote better technology adoption.
- Encourage mechanization and digital services through subsidies or farmer cooperatives.
- Promote integrated pest management to ensure sustainable maize farming.

Table 11: Attitude of Farmer towards in adopting patterns of recommended maize production technology

Sl. No.	Statements	Agree	Undecided	Disagree
1	I am well-informed about the recommended maize production technologies.	50	09	11
2	Agricultural extension services provide adequate information on maize farming.	56	14	00
3	Training programs and demonstrations help in understanding new maize technologies.	28	13	29
4	Fellow farmers influence my decision to adopt new farming practices.	11	41	18
5	Government initiatives effectively promote improved maize farming methods.	16	36	18
6	I prefer using improved/hybrid maize seeds over traditional varieties.	42	09	19
7	I follow the recommended seed rate and plant spacing.	47	02	21
8	Soil testing is essential before fertilizer application.	19	43	08
9	I use organic farming practices along with chemical fertilizers.	50	00	20
10	I adopt Integrated Pest Management (IPM) techniques.	49	18	03
11	I practice crop rotation to maintain soil fertility.	60	00	10
12	Mechanized farming (tractors, seed drills, and harvesters) improves productivity.	59	00	11
13	Mobile apps and digital advisory services are helpful for maize farming decisions.	46	11	13

14	The high cost of improved seeds and fertilizers prevents me from adopting new technologies.	06	00	64
15	Lack of access to quality inputs (seeds, fertilizers, pesticides) is a major challenge.	21	08	41
16	I need financial support or subsidies to adopt advanced farming technologies.	49	00	21
17	Market demand influences my decision to adopt improved maize production methods.	57	02	11
18	Climate change and unpredictable weather affect my willingness to adopt new technologies.	52	02	09
19	I would adopt new technologies if they were easily accessible and affordable.	49	02	19
20	Using recommended technology has increased my maize yield.	56	03	11
21	My income has improved after adopting modern maize farming methods.	41	03	26
22	Technology adoption has reduced my production costs over time.	51	00	19
23	Improved practices have helped me manage pests and diseases effectively.	51	00	19
24	I am satisfied with the government's support in promoting maize farming.	45	06	19
25	I would recommend these improved technologies to other farmers.	58	00	12

The table presents farmers' attitudes towards adopting recommended maize production technologies based on their level of agreement with various statements. The responses are categorized as Agree, Undecided, and Disagree. Below is a detailed analysis based on key themes.

1. Awareness and Information Sources

- 50 farmers believe they are well-informed about maize production technologies.
- 56 farmers agree that agricultural extension services provide adequate information.
- However, 41 farmers are undecided about the influence of fellow farmers, and 36 are unsure about the effectiveness of government initiatives.
- 46 farmers agree that mobile apps and digital services are helpful.
- While many farmers receive adequate information from agricultural extension services, uncertainty about the role of peer influence and government initiatives suggests a gap in awareness-building efforts.

2. Adoption of Specific Technologies

- Crop rotation (60 farmers) and mechanized farming (59 farmers) receive the highest agreement.
- IPM (49 farmers) and organic farming (50 farmers)** are widely adopted.
- Fertilizer application decisions (soil testing) have 43 undecided responses, indicating a lack of awareness or access.
- Farmers are more confident about adopting mechanization and crop management practices but show uncertainty in practices like soil testing.

3. Economic and Access Challenges

- 64 farmers disagree that the cost of improved seeds and fertilizers is a barrier, suggesting affordability may not be the biggest issue.
- However, 21 farmers agree that lack of access to quality inputs is a challenge.
- 49 farmers agree that financial support is necessary for adoption.
- Market demand (57 farmers) influences adoption decisions.
- While cost alone may not be the primary issue, access to quality inputs and financial support remain crucial factors for adoption.

4. Impact of Technology Adoption

- 56 farmers report an increase in yield.
- 51 farmers agree that improved practices have reduced production costs.
- However, 26 farmers disagree that technology adoption has improved their income.
- Yield improvements are recognized, but the financial benefits are not equally felt by all, possibly due to market fluctuations or high input costs.
- 45 farmers are satisfied with government support.
- 58 farmers would recommend improved technologies to others.
- Overall satisfaction with maize production technologies is high, and most farmers are willing to promote them within their community.
- Farmers show a positive attitude toward adopting maize production technologies, especially in areas like mechanization, crop management, and Integrated Pest Management. However, challenges such as access to quality inputs, financial support, and uncertainty about some practices (soil testing, government initiatives) remain. Addressing these gaps through better extension services, targeted subsidies, and improved market linkages could further enhance adoption rates.

The "Knowledge-Action" Gap Table

This table compares the percentage of farmers who are aware of or trained in a technology versus those who actually adopt certain physical components, revealing where extension services are failing.

Technology Component	Awareness/Training (%)	Actual Practice/Adoption (%)	Gap (Action without Awareness)
Improved Seeds	12.86% (Aware)	62.86% (Use)	+50.00%
Technical Training	32.86% (Attended)	—	—
Soil Health	32.86% (Attended)	51.43% (Testing)	+18.57%
Mechanization	32.86% (Attended)	38.57% (Use)	+5.71%
Integrated Pest Management	12.86% (Aware)	12.86% (Practice)	0.00%

Barriers to Technology Adoption: Based on the Abstract and Results, this table categorizes the "bottlenecks" preventing higher productivity in the region.

Barrier Category	Specific Constraints Identified	Impact on Farmers
Market Imperfections	Input availability, credit access, and information flow.	Prevents widespread adoption of modern technologies.
Information Gaps	Limited awareness (87% unaware) and low training participation.	Reliance on traditional farming practices.
Infrastructural	Reliance on groundwater (74%) and lack of canal/transport infrastructure.	Potential for groundwater overexploitation.
Financial/Economic	High income disparity and lack of financial support/subsidies.	26% see no income improvement despite yield gains.

Perceived Impacts of Technology Adoption: This table focuses on the "Attitude" section of the study to show how farmers feel about the outcomes of using recommended technologies.

Reported Outcome	Agree (%)	Disagree (%)	Status
Increased Yield	80.00%	15.71%	Highly Positive
Reduced Production Cost	72.85%	27.15%	Positive
Improved Income	58.57%	37.14%	Moderately Positive
Pest/Disease Management	72.85%	27.15%	Positive
Peer Recommendation	82.85%	17.14%	Extremely Positive

Table 12: Adoption of Recommended Maize Technologies

Technology / Practice	Adopted (Yes)	Not Adopted (No)	Adoption Percentage
Improved/Hybrid Maize Seeds	44	26	62.86%
Recommended Sowing Time & Spacing	37	33	52.86%
Soil Testing (Before Fertilizer Use)	36	34	51.43%
Mechanized Farming Methods	27	43	38.57%
Training or Demonstrations	23	47	32.86%
Digital/Mobile Advisory Services	21	49	30.00%
Awareness of Recommended Tech	09	61	12.86%
Integrated Pest Management (IPM)	09	61	12.86%

1. High-Adoption "Frontrunners"

The most successful areas of adoption involve physical inputs and basic field management:

- Improved Seeds (62.86%): This is the most adopted technology. It suggests that farmers recognize the yield benefits of hybrid varieties over traditional cultivars.
- Sowing and Soil Health (51%–53%): Over half of the farmers follow recommended sowing times and spacing and practice soil testing. This indicates a growing awareness of scientific field preparation.

2. The "Knowledge Paradox"

There is a striking disconnect between what farmers **do** and what they know technically:

- The Awareness Gap: While 62.86% use improved seeds, only 12.86% claim to be "aware" of the full suite of recommended technologies.
- Training Deficit: Only 32.86% of farmers have attended formal training or demonstrations. This suggests that many farmers may be adopting seeds based on market availability or peer observation rather than formal technical education.

3. Critical Barriers and Low-Adoption Areas

The lowest adoption rates point toward specialized knowledge and high-resource requirements:

- Integrated Pest Management (IPM) (12.86%): This is the most neglected area. The reliance on traditional pest control methods likely leads to lower yields and higher chemical dependency.
- Digital and Mechanized Farming (30%–38%): Adoption of mobile advisory services (30%) and heavy machinery like planters or harvesters (38.57%) remains low. This is likely tied to the fact that 50% of these farmers are marginal landholders (5-8 bigha) , making large-scale mechanization or expensive digital subscriptions less accessible.

4. Economic Disconnect

- Yield vs. Income: While 56% of farmers reported a yield increase from these technologies, 26% of farmers disagreed that their income had improved.
- Profitability Pressure: This indicates that even when technology works, market imperfections—such as high input costs or lack of credit access—prevent increased productivity from translating into higher household wealth.

Table 13: several variables that correlate with or significantly influence the adoption of maize technology

Independent Variable	Statistical Characteristic	Stated Relationship to Adoption
Education Level	Mean: 3.01 (Secondary level)	Positive Correlation: Higher education is "conducive to the adoption of improved agricultural technologies" and better decision-making.
Age	Mean: 41.67 years	Mixed Influence: Youthful workforce (72.85% under 50) is seen as vital for innovation, though older farmers have more experience.
Farming Experience	Mean: 14.17 years	Significant Factor: Limited experience (61.43% < 15 years) suggests a need for additional training to improve productivity.
Landholding Size	Mean: 7.62 bigha	Structural Constraint: Predominance of marginal farmers (50%) directly limits the "scalability of recommended technologies" and mechanization.
Annual Income	Mean: ₹123,428.57	Economic Barrier: High income disparity (high SD) and low-income status for 42.86% of farmers limit adoption of high-cost tech.
Information Flow	87% lack awareness	Primary Bottleneck: Low awareness and limited training (32.86%) are identified as the main barriers to widespread adoption.

Table 14: Coefficient correlation adoption of maize technology

Variables	Coefficient correlation (R)
Age	0.15**
Education level	-0.13
Farming Experience	0.18**
Landholding	-0.09
Annual Income	-0.01
Source of irrigation	0.01
Type of maize grown	0.05

**. Correlation is significant at the 0.01 level (2-tailed)

1. **Farming Experience (0.18)**: This has the strongest positive correlation in the table. As a farmer's years of experience increase, their likelihood of adopting new maize technology also increases. This suggests that seasoned farmers may have more confidence or a better understanding of the benefits of new agricultural techniques.
2. **Age (0.15)**: There is a significant positive relationship here. Older farmers in this study are more likely to adopt the technology than younger ones. This often correlates with having more resources or more established farming practices where they see the value of optimization.
3. **Education Level (-0.13):** There is a slight "negative" trend. This suggests that in this group, higher formal education does not necessarily lead to higher technology adoption; in fact, there is a minor trend in the opposite direction, though it isn't strong enough to be certain.
4. **Landholding (-0.09):** A very weak negative correlation. This implies that the size of the farm doesn't strongly dictate whether a farmer uses the technology.
5. **Annual Income (-0.01):** This value is almost zero, meaning there is **no relationship** between how much money a farmer makes and their decision to adopt this specific maize technology.
6. **Source of Irrigation (0.01) and Type of Maize Grown (0.05):** Both are near zero, indicating these factors have little to no influence on adoption rates.

Conclusions

The present study conducted under the supervision of Krishi Vigyan Kendra (K.V.K.), Malda under the NICRA programme revealed that the adoption of recommended maize production technologies among maize growers in Malda district of West Bengal remains moderate, despite the increasing availability of improved agricultural technologies and extension interventions. The findings demonstrated that socio-economic characteristics such as education, farming experience, landholding size, annual income, and access to extension services significantly influenced farmers' adoption behaviour toward improved maize cultivation practices.

The study identified a substantial "Knowledge–Action Gap" among respondents. Although a considerable proportion of farmers adopted improved or hybrid maize seeds (62.86%), recommended sowing practices (52.86%), and soil testing methods (51.43%), awareness regarding the complete package of recommended maize production technologies remained very low (12.86%). Similarly, the adoption of Integrated Pest Management (IPM) practices and digital advisory services was limited, indicating inadequate technical literacy and insufficient participation in formal training programmes. The predominance of marginal landholders, dependence on shallow tube well irrigation, limited institutional credit, and rising input costs emerged as major constraints affecting technology adoption and long-term sustainability. Furthermore, although most respondents reported increased crop productivity after adopting improved technologies, a notable proportion did not experience proportional improvement in farm income due to market imperfections and high production costs. The study highlights the significant role of K.V.K., Malda in promoting climate-resilient maize production technologies through demonstrations, training, and extension activities. Therefore, strengthening extension education, improving access to quality inputs and institutional support, and promoting mechanization, IPM, soil health management, and digital agricultural services are essential for enhancing maize productivity, profitability, and sustainable agricultural development in Malda district of West Bengal.

References

1. Berkeley Oostendorp RH, Zaal F. Understanding adoption of soil and water conservation techniques: the role of new owners. CSAE Working Paper WPS/2011-05. Oxford: Department of Economics, Oxford University; 2011.
2. Rausser G, editor. Handbook of Agricultural and Resource Economics. Amsterdam: Elsevier, North Holland; 2001. p. 2001.
3. McGuirk DF, Mundlak Y. Incentives and constraints in the transformation of Punjab agriculture. IFPRI Research Paper No. 87. Washington, DC: International Food Policy Research Institute (IFPRI); 1991.
4. Mellor JW. The New Economics of Growth: A Strategy for India and the Developing World. Ithaca: Cornell University Press; 1976.
5. International Grain Council. International Grain Council report. 2015 Sep.
6. Koundouri P, Nauges C, Tzouvelekas V. Technology adoption under production uncertainty: theory and application to irrigation technology. American Journal of Agricultural Economics. 2006;88(3):657-670.
7. Maddala GS. Limited-Dependent and Qualitative Variables in Econometrics. New York: Cambridge University Press; 1983.
8. Makokha S, Kimani S, Mwangi W, Verkuijl H, Musembi F. Determinants of fertilizer and manure use for maize production in Kiambu District, Kenya. Mexico: CIMMYT (International Maize and Wheat Improvement Center); 2001.
9. Ogada MJ, Nyangena W, Yesuf M. Production risk and farm technology adoption in rain-fed semi-arid lands of Kenya. AfJARE. 2010;4(2).
10. Olwande J, Sikei G, Mathenge M. Agricultural technology adoption: a panel analysis of smallholder farmers' fertilizer use in Kenya. CEGA Working Paper Series No. AfD-0908. California: Centre of Evaluation for Global Action, University of California; 2009.
11. Ouma J, Murithi F, Mwangi W, Verkuijl H, Gethi M, De Groote H. Adoption of maize seed and fertilizer technologies in Embu District, Kenya. Mexico: CIMMYT (International Maize and Wheat Improvement Center); 2002.

12. Suchan RC, Sharma AK, Jha SK. Adoption pattern of recommended mustard production technology in Bharatpur District of Rajasthan. Rajasthan Journal of Extension Education. 2005;5(1):27-30.
13. Simtowe FJ, Mduma AP, Alban T, Zeller M. Can risk-aversion towards fertilizer explain part of the non-adoption puzzle for hybrid maize? Empirical evidence from Malawi. Journal of Applied Sciences. 2006;6(7):1490-1498.
14. Sunding DL, Zilberman D. The agricultural innovation process: research and technology adoption in a changing agricultural sector. In: Gardner B, Rausser G, editors. Handbook of Agricultural and Resource Economics. Amsterdam: Elsevier, North Holland; 2001.
15. Wekesa E, Mwangi W, Verkuijl H, Danda VK, De Groote H. Adoption of maize technologies in the coastal lowlands of Kenya. Mexico: CIMMYT; 2003.