J Bangladesh Agril Univ 23(2): 211-221, 2025 https://doi.org/10.3329/jbau.v23i2.82590

ISSN 1810-3030 (Print) 2408-8684 (Online)

Journal of Bangladesh Agricultural University

Journal home page: http://baures.bau.edu.bd/jbau

Research Article

Evaluating the Feasibility of Integrating Climate-Smart Technologies at BAU-Adjacent Villages in Mymensingh, Bangladesh

Md. Saidur Rahman[1], Mahfuza Begum[2], Harunur Rashid[3], Mohammad Al-Mamun[4], Nasrin Sultana Juyena[5], Muhammad Ashik-E-Rabbani[6], Md. Harun Or Rashid[2], Md. Mahfuzul Hasan[7], Payel Ahmmed[8] and Md. Salauddin Palash[8]✉

[1]Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh, Bangladesh
[2]Department of Agronomy, Bangladesh Agricultural University, Mymensingh, Bangladesh
[3]Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh, Bangladesh
[4]Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh, Bangladesh
[5]Department of Surgery and Obstetrics, Bangladesh Agricultural University, Mymensingh, Bangladesh
[6]Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh, Bangladesh
[7]Department of Computer & GIS Unit, BARC, Dhaka, Bangladesh
[8]Department of Agribusiness and Marketing, Bangladesh Agricultural University, Mymensingh, Bangladesh

ARTICLE INFO

Article history
Received: 20 February 2025
Accepted: 22 June 2025
Published: 30 June 2025

Keywords
Feasibility,
Adoption,
Climate-smart,
Technology,
Bangladesh

Correspondence
Md. Salauddin Palash
✉: palash@bau.edu.bd

OPEN ACCESS

Abstract

Agriculture remains a vital pillar of Bangladesh's economy and rural livelihoods, employing nearly half of the workforce and contributing significantly to GDP, despite the nation's shift toward industrial and service sectors. That's why we are also attempting to shift from conventional practice to modern use of technology in order to cope with the situation. Because of this, it is essential to examines the adoption of modern and traditional agricultural methods in crop farming, livestock farming, and fish farming system. which will help us to identify the level of adoption, problems faced by farmers, and sustainable solutions that can increase agricultural productivity. Data from 219 farmers are collected through a quantitative survey and descriptive statistics are used for getting the result. The findings indicate that mechanization is gradually gaining ground, especially in using tractors, power tillers, and deep tubewells in crop cultivation. However, the traditional implements and practices still prevail because of the scarcity of modern technology, hands-on training, and high cost. In livestock, the situation improves a little as far as artificial insemination is concerned, though it still relies on conventional methods of feeding; fish farming has mainly adopted polyculture without following modern aquaculture technologies. The main constraints noted are financial, lack of availability of quality seeds and machinery, infestations, and lack of proper training. To support sustainable agriculture, it is important to offer targeted training programs, strengthen agricultural extension services, and improve farmers' access to affordable credit, quality inputs, and subsidies for machinery and materials. Promoting climate-smart technologies is also essential. Overcoming existing challenges will require stronger government support and better infrastructure.

Introduction

Agriculture is the foundation for many developing countries because it fulfills one of the most important basic human needs. In addition, it plays an important role in the reduction of poverty, economic growth, enhancing food security, and rural development (Yokamo, 2020). In Bangladesh, agriculture is one of the leading sectors and one of the foremost motivating forces of the economy. It contributes about 11.66% to the country's GDP, and crops and horticulture solely contribute 5.64% (BBS, 2023). Though the country is moving towards an industry led and service-oriented economy, agriculture is still the primary source of income for rural people in Bangladesh (Ahmed et al., 2015; Jolliffe et al., 2013). The labor force survey, 2022, indicates that the proportion of the population employed in agriculture (of total employed) is 45.3%, up by 4.7% from that of 2017 (LFS, 2023). The majority of the farmers in rural Bangladesh rely on traditional agricultural practices. For instance, over 70% of the maize production in developing countries is from

Cite This Article
Rahman, M.S., Begum, M., Rashid, H., Mamun, M.A., Juyena, N.S., E-Rabbani, M.A., Rashid, M.H.O. , Hasan, M.M., Ahmmed, P. and Palash, M.S. 2025.Evaluating the Feasibility of Integrating Climate-Smart Technologies in BAU-Adjacent Villages in Mymensingh, Bangladesh. *Journal of Bangladesh Agricultural University,* 23(2): 211-221. https://doi.org/10.3329/jbau.v23i2.82590

smallholders who use traditional methods of production. The yield that the farmers obtained is very low because the average farmer uses local cultivars, which have low yield potential (Muzari *et al.,* 2012).

The population of Bangladesh is increasing at an annual growth rate of 1.37 percent (BBS, 2020). It is predicted that the demand for cereals by the year 2030 will reach 43.82 million tons at a 2% annual growth rate in per capita income and 50.62 million tons at an income growth of 3% (Milon, 2015). However, cultivable land is decreasing because of rapid urbanization, industrialization, and the transformation of human activities (Ahmed, 2013). So, the scope for horizontal expansion of cultivable land is limited. To achieve the increased food production target, Bangladesh pursues vertical expansion of agricultural output above the current cultivable land scenario (Banik, 2024). However, achieving agricultural productivity growth will not be possible without applying modern technologies in the agricultural production (Challa and Tilahun, 2014). Therefore, the adoption of modern farming technology can be an important option for ensuring better access to food by increasing crop productivity and reducing food prices (Ahmed et al., 2021; Asfaw et al., 2012; Asfaw et al., 2012; Chandio and Yuansheng, 2018; Ghimire et al., 2015; Hossain et al., 2006; Islam, 2018; Mariano et al., 2012). Another research also shows adoption of modern agricultural technologies (innovations) is the core of agricultural growth (Mottaleb, 2018). This is also an important factor in the welfare of farmers livelihoods and achieving zero hunger (Ullah et al., 2023), which is actually one of the zeros of Nobel Peace Prize winner Dr. Muhammad Yunus. The adoption of good agricultural management practices is also important for sustainable agriculture (Farid et al., 2015). Adoption of agricultural technologies supports crop productivity, fosters employment creation, and improves household access to food. The importance of agricultural technology adoption in ending poverty and food insecurity was well discussed by many authors (Asfaw et al., 2012; Besley and Case, 1993; Shiferaw et al., 2009; Doss and Morris, 2000; Foster and Rosenzweig, 1995; Hailu et al., 2014). However, observations indicated that despite the visible benefits, many technologies are not adopted by the farmers, resulting in a yield gap between the farmers' field and the possible output of a specific technology (Mottaleb, 2018). This is because new agricultural technologies are often correlated with risks and uncertainties about appropriate application, scale appropriateness, and suitability with the prevailing climate, as well as farmers' perceptions and expectations (World Bank, 2008).

While numerous studies have explored the adoption of modern agricultural technologies in general, such as Islam et al. (2022), they mentioned that positive attitudes, supportive norms, and perceived control enhance intention, which directly correlates with adoption. Piñeiro *et al.* (2020) found that programs with short-term economic benefits achieve higher adoption rates than those focused on ecological services alone. Long-term adoption is driven by perceived farm and environmental benefits, supported by technical assistance and extension services. Serebrennikov *et al.* (2020) revealed that environmental and economic attitudes, as well as farmers' age, education, and information access, significantly affect adopting sustainable practices like organic farming. de Souza Filho (2018) found that economic factors and time-varying variables significantly influence the adoption process. According to the study by Akila *et al.* (2015), rural women actively care for animals, but their responsibilities in marketing and sales are restricted. Although training increases the use of dairy technologies such as immunization, artificial insemination, and deworming, high feed costs and unfair milk pricing still exist. Mendola (2007) highlighted the potential of agricultural technology as a direct tool for poverty alleviation, advocating for targeted strategies to enhance adoption among marginalized farmers. Udoh (2016) revealed that women's adoption of agricultural production technology, including better crop varieties, is greatly influenced by several characteristics, including farming experience, education, family size, farm size, membership in social groups, and land purchase. Challa & Tilahun (2014) examined that education level, farm size, credit access, and off-farm income positively influence adoption decisions, while larger family size has a negative effect. Akter *et al.* (2023) revealed that significant spillover effects highlight the cost-effectiveness and sustainability of adopting climate-resilient practices. Anwar *et al.* (2017) found that the reorganization of cropping patterns increases gross output by 24%–53% and labor employment by 12%–47%, with a notable impact on food accessibility and employment generation in economically vulnerable areas. Jamal *et al.* (2023) found key challenges include rising temperatures, rainfall anomalies, and salinity.

Therefore, this idea of farmers' empowerment through climate smart technologies has been studied to examine the adoption of modern and traditional technologies and assess the major challenges and sustainable solutions to enhance their adoption. Because our motive is to is Bangladesh Agricultural University (BAU)-Adjacent villages are feasible to implement climate smart technology or not? Practically, the findings of this study can lead to several beneficial outcomes for various stakeholders in agriculture. Theoretically, this research contributes to building a more adaptive and sustainable agricultural system, by focusing on identifying and analyzing the modern and traditional technologies adopted by the rural farmers and the major challenges in agricultural technology adoption and can recommend sustainable solutions to the rural farmers. It will help them enhance their livelihood and benefit their economy.

Methodology

Study Area

In this research, the study area selected was all the villages of Char Nilakkhia union under Sadar Upazila of Mymensingh (Figure 1). It was selected due to its prominence as an agrarian region with significant agricultural dependence. The geographical area of Char Nilakkhia is about 29.15 square kilometers, representing a typical rural Bangladeshi setting, where farming forms the backbone of livelihoods and community well-being. There are 13 villages in this area. The villages' names are Char nilakkhia-1 (Vatipara), Char Nilakkhia-2 (Digapara), Bijoynagar, Char Durlabh, Char Nilakkiha-3, Char Raghurampur, Mahazzampur, Modarpur, Phuliamarirchar, Raghabpur, Rajganj, Rashidpur, and Shahbajpur. This selection allows for an in-depth exploration of the potential for climate-smart technologies to empower farmers in similar rural contexts in Bangladesh.

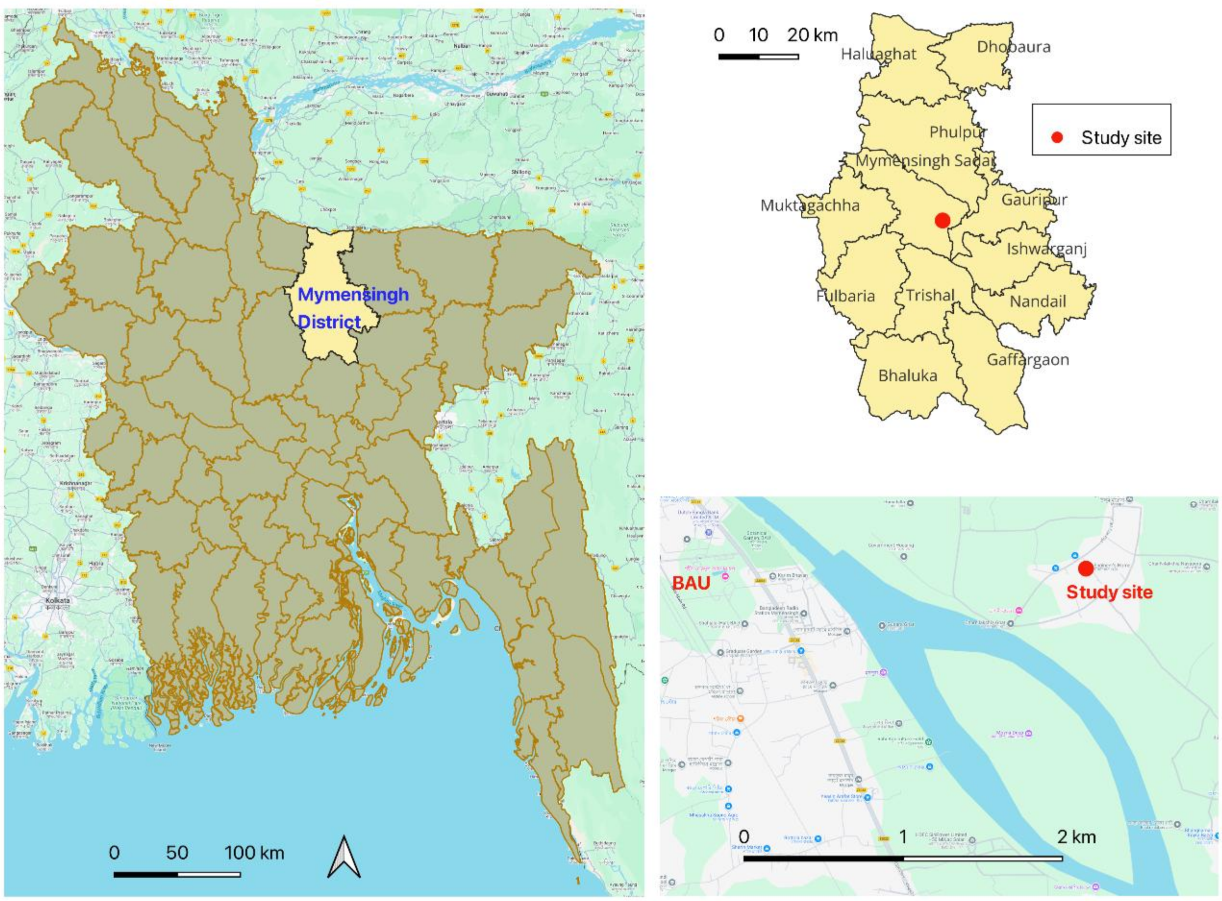

Figure 1. Aerial view of BAU and nearby villages

Sample size

The study involved 219 samples from all villages of Char Nilakkhia union, using a random sampling approach, and sampling distributions are shown in Table 1. We followed the proportionate sampling procedure (it is not very negligible percentage compared to population statistics of individual village) because of time and budget allocation, but we covered all 10 villages of char Nilakkhia union, Mymensingh, Bangladesh.

Table 1. Sample size of this research

District	Village Name	Sample Size
Mymensingh	Bijoynagar	12
	Char Durlabh	10
	Char Nilakkhia-1	34
	Char Nilakkhia-2	22
	Char Nilakkhia-3	21
	Char Raghurampur	22
	Modarpur	10
	Mahazzampur	23
	Puliamarirchar	10
	Raghabpur	25
	Rajganj	10
	Rashidpur	10
	Shahbajpur	10

Collection of data

The data for this study were gathered using a quantitative survey. Before full-scale implementation, the tool underwent pretesting with a subset of farmers to evaluate clarity, time requirements, and content relevance. Feedback from this pilot phase informed required modifications to the interview schedule. Twelve enumerators were selected for this data collection based on their experience. Before data collection, training on the Kobo-collect platform was provided to the qualified enumerators to ensure proper and efficient conduct of the interview schedule survey. Those enumerators clearly explained the study objectives to the respondents and were responsible for collecting the primary data. The field supervisor also conducted field visits to ensure the quality of data collection. Additionally, the research assistant maintains regular communication and monitors the enumerators' activities. They gathered field data during June 2024, a period strategically chosen to ensure reliability and relevance of the information.

Analytical techniques

Descriptive statistics were used to know the existing technology and what they used in their field, as well as what we may know about how much farmers wanted to adopt new technology. By using descriptive statistics, we may get the minimum, maximum, standard deviation, rank and mean value of each response. To find out the feasibility of using climate-smart technologies, we also employed descriptive statistics. The focus of our research is to identify the conditions that prevail in selected villages, like the obstacles people face while using existing technologies. This will help researchers make key decisions before implementing new climate-smart technologies among these people.

Results and Discussion

Socio-demographic characteristics

Agricultural practices in Char Nilakkhia Union exhibit a diverse array of methods and technologies employed across crop farming, livestock farming, and fish farming sectors. However, the efficiency and sustainability of these practices are crucial for addressing the numerous challenges faced by farmers, including machinery availability, insect infestations, training deficiencies, seed quality, pest control, and disease management. Because of this, initially from Figure 2, we may get an idea about the respondent's educational status, age group, and their main occupation because it will help us to provide appropriate suggestions. From this figure we may see that the majority are either illiterate or have completed their primary education, while 11.87% have completed their secondary education. In contrast, .46% have completed their graduation or PhD. The largest age group is 41 to 60 years, followed by 21 to 40 years. In the case of occupation, 81.74% of the respondents are engaged in agriculture, and the rest of the respondents are included as housewives, businesspeople, wage labors, service workers and others.

After knowing about the sociodemographic status from Figure 2, we may learn about their financial condition also from Figure 3. Because this will help us to decide which sector has more potential to enhance their livelihood. And from their existing income-generating activities, they earn mostly from crops, vegetables, and livestock sectors; that's why we may decide which sector is more concerned about promoting smart technology.

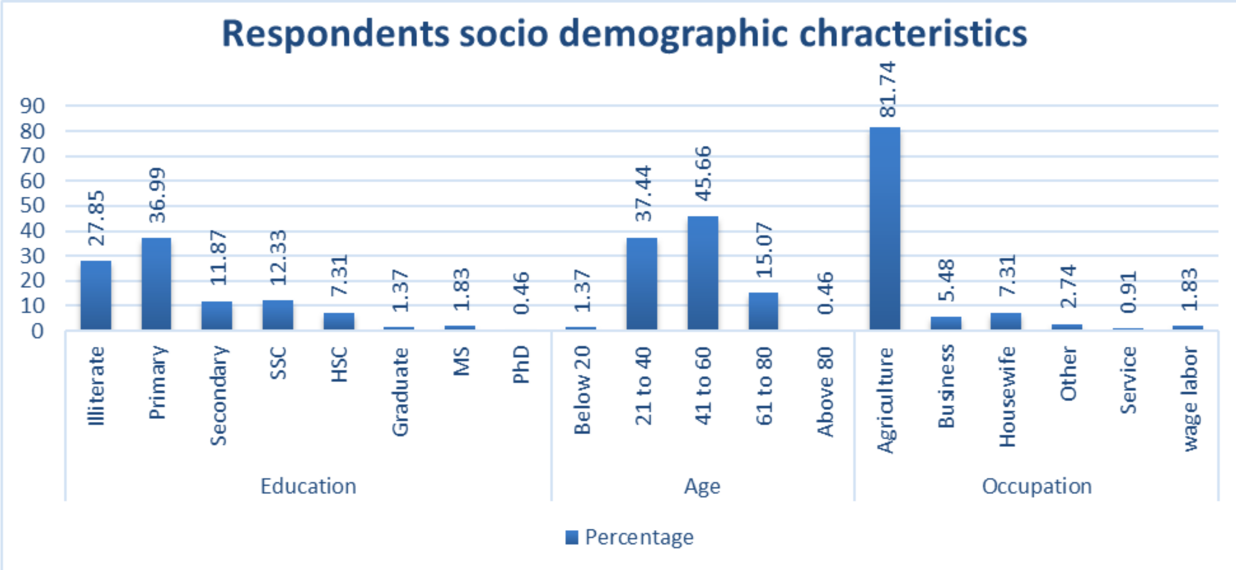

Figure 2. Socio-demographic status of the respondents

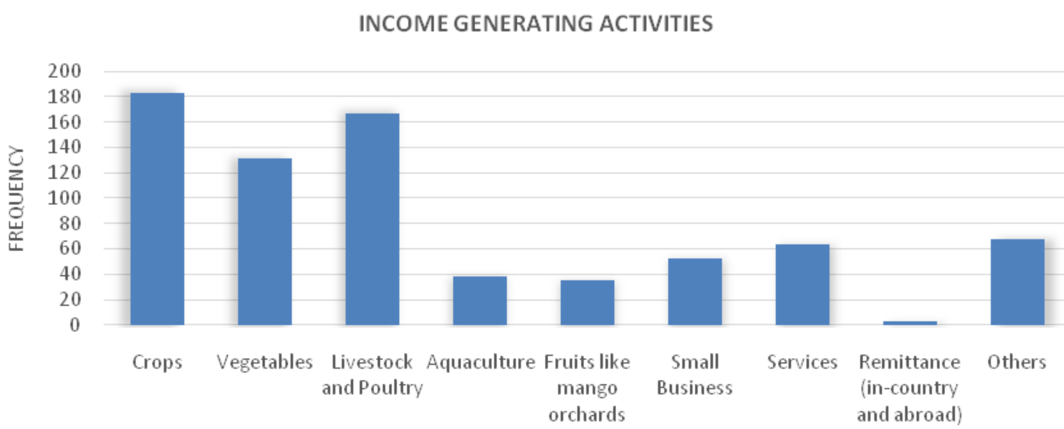

Figure 3. Income generating activities status of the respondents

Crop Farming

In crop farming, a significant portion of farmers (70.3%) utilize tractors for land preparation, while 35.2% rely on power tillers, and only a small fraction (3.2%) uses traditional hoes and ploughs. Intercultural operations are predominantly manual, with 48.9% of farmers using manual weeders and 11.4% employing weedicides. The use of modern irrigation methods, such as deep tube wells by 65.8% of farmers, highlights the shift towards more efficient water management techniques. However, traditional methods like the use of scarecrows and thinning are still present, albeit minimally. The adoption of modern technologies and sustainable practices is crucial for them. Given that 70.3% of farmers already use tractors and 35.2% use power tillers, training can further optimize their usage and maintenance. This can reduce dependency on traditional hoes and ploughs, which are still used by a small fraction of farmers. With 48.9% of farmers using manual weeders, there is potential to introduce and train farmers on the benefits and operation of automatic weeders and more effective weedicides. Training in the installing and maintaining of deep tube wells, currently used by 65.8% of farmers, can improve water use efficiency. Introducing farmers to alternative irrigation methods like sprinkler systems could further enhance irrigation practices. Training on IPM can help farmers manage pests more effectively, reducing reliance on chemical pesticides and promoting sustainable farming practices.

Table 2. Technology used for crop farming

Category	Technology	Frequency	Percent in case
Land Preparation	Power tiller	77	35.2
	Tractor	154	70.3
	Hoe	3	1.4
	Plough	4	1.8
Intercultural	Sprayer	17	7.8
	Weedicide	25	11.4
	Weeder	107	48.9
	Pheromone trap	1	0.5
	Scarecrow	2	0.9
	Thinning	1	0.5
Irrigation	DTW	144	65.8
	LLP	1	0.5
	Sprinkler	1	0.5
	STW -electric	9	4.1
	STW- diesel	71	29.1
Harvesting	Reaper	20	9.1
	Harvester	14	6.4
Post-harvest	Auto thresher	94	43.0
	Combined harvester	15	6.8
	Manual thresher	6	2.8

Source: Field Survey, 2024

Livestock Farming

Livestock farming practices reveal a reliance on crop residues (straw & stover) and roadside grass, with 100 per cent of farmers using conventional feed. Despite the introduction of mechanical feed processing methods, such as choppers (34.85%), traditional techniques like the use of sickles also persist. Adopting artificial insemination for breeding by 66.67% of farmers indicates a move towards enhancing livestock productivity, yet significant gaps remain in areas such as pregnancy diagnosis and stress management. Training on cultivating and using leguminous (e.g., Maskalai, Khesari, Dhaincha) and non-leguminous fodder (e.g., Napier, maize) can improve livestock nutrition and productivity. Educating farmers on modern feed processing methods (e.g. silage, hay, urea-molasses treatment of straw), including the use of straw/grass cutting machines, and storage/preservation techniques can enhance feed efficiency and reduce wastage. Finally, training in artificial insemination and pregnancy diagnosis methods can improve breeding outcomes. Additionally, farmers should be trained to identify and manage common livestock diseases and stress factors, including the use of fans, mosquito nets, and shaded areas.

Table 3. Technology used for livestock farming

Category	Technology	Frequency	Percent in livestock case
Fodder	Napier grass	19	28.79
	Maskalai	1	1.52
Feed	Conventional (Straw, rice/wheat bran, polish)	66	100.00
	Broken maize	2	3.03
	MOC (Mustard Oil Cake)	1	1.52
	Poultry feed	9	13.64
	Cattle feed	6	9.09
Feed Processing	Boiled broken rice	8	12.12
	Chopper (grass, straw)	23	34.85
	Sickle	2	3.03
Feed Supplements	Bio-Premix Vitamin	1	1.52
	Molasses	1	1.52
	Medicine	2	3.03
	Vitamins	11	16.67
Unconventional Feed	Water hyacinth	4	6.06
Breeding Technique	Artificial Insemination	44	66.67
Pregnancy diagnosis	Village doctor	11	16.67
	Veterinarian (sometimes)	1	1.52
	Rectal Palpation	5	7.58
Avoiding stress	Fan	28	42.42
	Mosquito net and coil	9	13.64
	Concrete floor	8	12.12

Shower	13	19.70
Rubber mat	1	1.52

Source: Field Survey, 2024

Fish Farming

The predominance of polyculture in fish farming (48.72%) indicates a preference for diversified aquaculture practices, which can enhance productivity and environmental sustainability. Kumar & Kumar (2015) implied that the majority of the fish farmers in the study area adopted the polyculture fish practices to a medium to a high extent, which might be due to the fact that most of the fish farmers have correct information and knowledge about polyculture fish practices (Nagarajaiah, 2002; Goswami *et al.,* 2010). Water supply for aquaculture is primarily managed through deep tube wells (28.21%). Other advanced technologies, including the use of high-quality fish fingerlings (5.13%) and oxygen tablets (2.56%), are minimally adopted. Post-harvest handling remains underdeveloped, with only 12.82% of farmers using turmeric for drying fish and 2.56% employing salting methods (Table 4). This limited adoption of preservation technologies restricts opportunities for value addition and market expansion. This finding contrasts with the study by Entee (2015), which found that the principal fish processing methods in Africa are smoking, salting, sun drying, fermentation, grilling and frying. FAO (2024) also highlighted that preserving fish in the absence of a cold chain, such as drying, salting, and smoking, are important ways of controlling spoilage and improving shelf life. Training in using polyculture methods and the benefits of high-quality fingerlings can increase fish production. Farmers should also be educated on using antibiotics and vitamins to maintain fish health. Educating farmers on the operation and maintenance of water supply systems and quality can ensure consistent and adequate quality water for fish farming. Training in modern post-harvest methods, such as drying fish with turmeric and salting, can improve the quality and marketability of fish products.

Table 4. Technology used for fish farming

Category	Technology	Frequency	Percent in fisheries case
Aquaculture	Antibiotics	1	2.56
	Water supply	11	28.21
	High quality fingerling	2	5.13
	Oxygen tablets apply	1	2.56
	Polyculture	19	48.72
	Vitamin	1	2.56
Post-harvest	Drying with Turmeric	5	12.82
	Salting	1	2.56

Source: Field Survey, 2024

Major challenges

The most pressing issue, mentioned by farmers 42 (19.18%) times, is the availability and maintenance of agricultural machinery. This aligns with findings by Al Mamun *et al.* (2018), who noted that farmer's thoughts on the fragmented land, high machinery prices, lack of maintenance, inadequate extension service, poor transportation, lack of loan service, and big machinery size are the main drawbacks for mechanization, respectively. The study by Rashid & Islam (2016) also revealed that education, participation in training, usages of e-Agriculture, attitude towards e-Agriculture, and availability of e-Agriculture had significant contributions towards the problems faced by farmers in using e-Agriculture. Insect infestations and pest attacks were reported by 18.72% and 14.16% of farmers, respectively. These issues are exacerbated by a lack of training in modern pest control methods, as highlighted by 18.72% of respondents. Parsa *et al.* (2014) similarly revealed 51 unique statements on obstacles to Integrated Pest Management (IPM) adoption, the most frequent of which was "insufficient training and technical support to farmers." Mishra *et al.* (2024) identified that technical constraints such as lack of awareness, lack of training, and complexity of climate-smart practices were the major barriers to the adoption of climate-smart agricultural practices among the farmers of non-climate smart villages. Problems such as lack of machinery and training of these findings also align with the study by Mekonnen *et al.* (2010).

The concern over seed quality, affecting 15.53% of farmers, is critical, as high-quality seeds are fundamental to achieving optimal crop yields. Sarkar *et al.* (2024) found that the use of good-quality seeds increased rice yields from the base yield by 0.07–0.28 t/ha. We found a 48% gap in accessing good-quality seeds, indicating significant potential for scaling up the seed systems. Disease problems were reported by 12.33% of farmers. Additionally, 11.42% of respondents cited a lack of information as a significant barrier. Singh *et al.* (2015) identified similar issues: that dissemination of information about modern agricultural development projects/schemes is a necessary factor for adopting modern technology.

Economic factors, such as increasing production costs and the rising cost of pesticides, were mentioned by 9.13% of farmers. These findings are consistent with the study by Nuruzzaman *et al.* (2023), which found that access to quality seeds boosted yields and livelihoods. Still, challenges included high production costs and the absence of a moisture meter. Another study also highlighted the economic constraints as the factors that influence the adoption of agricultural innovations (Mishra *et al.,* 2024; Balzani and Hanlon, 2020).

Table 5. Problems in farming

Statements	Frequency	Percentage
Lack of machineries	42	19.18
Insect infestation	41	18.72
Lack of training	41	18.72
Quality seed	34	15.53
Increasing pest attack	31	14.16
Disease problem	27	12.33
Lack of information	25	11.42
Increase production cost	20	9.13
Increase the cost of pesticides	20	9.13

Source: Field Survey, 2024

Sustainable solutions to enhance technology adoption

Provide training

Training programs on sustainable farming practices, modern technologies, pest control, and crop disease management to reduce dependency on traditional methods were prioritized by 35.62% of respondents. Training can further optimize advanced technology usage and maintenance. This recommendation aligns with research by Day *et al.* (2022) that farmers who have received farm management training adopt modern technology more intensively than other farmers.

Strengthening extension services

Strengthening extension services to deliver practical knowledge and skill-building workshops can significantly influence farmers' adoption. Extension and advisory services play a major role in promoting and adopting sustainable aquaculture practices (Engle, 2017; Kumar *et al.,* 2018). Frequent visits to farmers coupled with issuing simple materials for reading and constant communication by extension agents positively influence adoption behavior for fish farming (Wetengere, 2011; Joffre *et al.,* 2017; Kumar *et al.,* 2018; Bundi *et al.,* 2018).

Increase access to loans and financial support

Financial constraints remain a key barrier to adopting advanced technologies and purchasing quality inputs. Access to affordable credit was recommended by 18.26% of farmers. Studies, such as Day *et al.* (2022), have exhibited that the intensity of technology adoption is higher for the farmers who have better credit access and have engagement in the farmers' group compared to others.

Introduction of climate smart technologies

Mechanization and environmentally adaptive tools can mitigate climate-related risks and reduce labor intensity. Marketplace, FBA (2024), highlighted those sustainable practices not only support the environment but also contribute to the economic stability of rural communities. By adopting sustainable farming practices, small farmers can improve their productivity and reduce their reliance on external resources. Several farm-level studies also suggest that the adoption of climate-smart technologies can improve crop yields, increase input use efficiency, increase net income, and reduce GHG emissions (Khatri-Chhetri *et al.,* 2016; Sapkota *et al.,* 2014; Gathala *et al.,* 2011). By promoting the potential of CSA or sustainable farming practices, adoption of these technologies should be increased.

Availability of machinery and subsidizing machinery

Availability of machinery was suggested by 14.16% of farmers, which enhances the adoption of technologies. This is consistent with findings by Alam (2021), who reported that scarcity, inefficiency, and high cost of draft animal power, as well as the availability of associated machinery such as tractors and power tillers, have all led to the adoption of 90% mechanization in tillage activities. According to recent statistics, there are 60 thousand tractors and 700 thousand power tillers in use. Additionally, the recommendation of subsidizing machinery (4.57%) would also encourage broader adoption. This is aligned with the study by Al Mamun *et al.* (2018), who recommended that the government should set up agricultural machinery industries that should be developed or purchased and hired out to small-scale farmers at a subsidized rate to increase the level of mechanization of certain farm operations in the middle belt states of the country. Research by Omotilewa *et al.* (2019) also revealed that when there is uncertainty about the effectiveness of a new agricultural technology, and the private sector market for the technology is weak or nascent, a one-time use of subsidy to build awareness and reduce risk can help generate demand for the new technology and thus crowd-in commercial demand for it.

Enhance access to quality seeds and inputs

Ensuring the availability of quality seeds and inputs was emphasized by 17.35% and 8.68% of respondents, respectively. A strong supply chain system and partnerships with seed companies can address this issue. A study by Shiferaw *et al.* (2015) revealed that an adequate seed supply significantly enhances adoption of technology.

Reduce input costs and provide input subsidies

High input costs (5.94%) deter farmers from adopting modern practices. Government intervention in providing subsidies for fertilizers, pesticides, and machinery would reduce the economic burden and enhance adoption. To accelerate diffusion of agricultural technologies and enhance use, many countries subsidize these inputs. However, one of the key issues when subsidies are introduced becomes the extent to which they foster or hamper commercial market participation (Ricker-Gilbert *et al.,* 2011; Mason and Ricker-Gilbert, 2013).

Strengthening government support and infrastructure development

Increasing government support (13.25%) and developing infrastructure (5.94%) were identified as critical areas in technology adoption. Al Mamun *et al.* (2018) found that a healthy agricultural mechanization policy from the government must be formulated immediately, including machine development and manufacturing, quality protection by standardization of machines, skill development of researchers, farmers, mechanics, and machine operators, and marketing system improvement. In 2008, the Bangladesh Institute of ICT in Development (BIID), in collaboration with Catalyst (a partner of Swiss Contact and a local agro-based NGO) and Grameenphone, launched the e-krishok initiative (e-Krishok, 2015). The purpose of this project was to lessen the inadequacy of information in the agriculture sector and keep farmers abreast of up-to-date knowledge and advisory services, which they often required. After that, the Bangladesh government came up with the idea of "Digital Bangladesh" with a vision to leverage the power of ICT in each and every public sector and service. These interventions support the enhancement of broader technology adoption, which helps to achieve sustainable agricultural development.

Table 6. Suggestions to overcome the problems

Statement	Frequency	Percentage
Provide training	78	35.62
Access to loan	40	18.26
Provide machinery	31	14.16
Provide subsidy	22	10.05
Provide quality inputs	19	8.68
Provide quality seed	38	17.35
Reduce input price	13	5.94
Increase government support	13	13.25
Development of infrastructure facilities	13	5.94
Give subsidy on machinery	10	4.57
Pesticide supply on time	10	4.57

Source: Field Survey, 2024

Conclusion

Bangladesh's rising population and declining agricultural workforce pose substantial challenges to food security. The adoption of modern agricultural technology is critical to increasing farm output, which may lead to a sufficient food supply for a growing population. The ongoing movement towards mechanization and modern farming practices in Mymensingh, Bangladesh, emphasizing the importance of technology in improving agricultural output and sustainability.

In crop farming, the extensive use of advanced land preparation equipment such as tractors and power tillers indicate progress in modernization, yet traditional tools persist in limited use. Irrigation practices remain largely reliant on groundwater resources, particularly deep and shallow tube wells, underlying the importance of sustainable water management. However, the low adoption of advanced irrigation practices and post-harvest technologies highlights gaps in access and awareness. Similarly, intercultural practices and pest control continue to depend predominantly on manual and traditional methods. Livestock farming practices present a moderate uptake of mechanization, with artificial insemination being widely adopted, indicating positive progress in breeding practices. However, traditional feeding methods dominate, and the use of advanced stress management technologies remains minimal. This indicates the need for greater awareness, accessibility, and training to improve animal welfare and productivity.

Fish farming predominantly uses polyculture methods, which reflects a preference for sustainable and diversified aquaculture practices. However, the adoption of modern aquaculture technologies, such as high-quality fish fingerlings and oxygen tablets, is minimal. The study identifies several challenges to technology adoption, including financial limitations, lack of training, limited access to quality inputs, and inadequate government support. In addition, farmers also deal with issues including seed quality, pest infestations, the availability of machinery, and growing production costs. Sustainable actions are needed to address these problems, such as providing training programs, improving extension services, increasing access to credit, and strengthening government support through subsidies and infrastructure development. Encouraging climate-smart technology and other sustainable agricultural approaches can increase productivity, lessen reliance on traditional methods, and mitigate environmental risks. A coordinated effort among policymakers, agricultural research institutions, and private stakeholders is necessary to establish a favorable environment for the broader adoption of modern agricultural technologies.

References

Ahmed, A.U., Hernandez, R. and Naher, F. 2021. Agricultural technology adoption in the Feed the Future zone of influence in Bangladesh. *Securing food for all in Bangladesh,* 19.

Ahmed, M.T., Bhandari, H., Gordoncillo, P.U., Quicoy, C.B. and Carnaje, G.P. 2015. Diversification of rural livelihoods in Bangladesh. *Journal of Agricultural Economics and Rural Development*, *2*(2): 32-38.

Ahmed, S., 2013. Food and agriculture in Bangladesh. *Encyclopedia of Food and Agricultural Ethics*, *1*:1-8.

Akila, N., Senthilvel, K. and Bharathy, N. 2015. Adoption of dairy farming technologies by rural women: role and constraints. *Marketing*, *49*: 29-69.

Akter, A., Jahan, M.S., Geng, X., Mwalupaso, G.E., Hoque, F. and Adeel, A. 2023. Building smallholder farmers' capacity to adopt climate-smart agricultural practices in flood prone areas: Lessons from Bangladesh. *Review of Development Economics*, *27*(4): 2301-2330.

Al Mamun, M.R., Shahed, A.B.M. and Tamanna, T.A. 2018. Identification of Hindrances to Adapt Agricultural Machinery in Selected Areas of Bangladesh. *Journal of Agricultural Science and Food Technology*, *4*(7): 134-144.

Alam, M.M. 2021. Emerging Fourth Industrial Revolution (4IR) and Agricultural Mechanization in Bangladesh. In *a Seminar Organized by Bangladesh Agricultural Economist Association* (Vol. 26).

Anwar, M., Ferdous, Z., Sarker, M., Hasan, A. K., Akhter, M. B., Zaman, M. A. U., ... and Ullah, H. 2017. Employment generation, increasing productivity and improving food security through farming systems technologies in the Monga regions of Bangladesh. *Annual Research & Review in Biology*, *16*(6): 1-15.

Asfaw, S., Kassie, M., Simtowe, F. and Lipper, L. 2012. Poverty reduction effects of agricultural technology adoption: micro-evidence from rural Tanzania. *Journal of development studies*, *48*(9):1288-1305.

Asfaw, S., Shiferaw, B., Simtowe, F. and Lipper, L. 2012. Impact of modern agricultural technologies on smallholder welfare: Evidence from Tanzania and Ethiopia. *Food policy*, *37*(3): 283-295.

Balzani, A. and Hanlon, A. 2020. Factors that influence farmers' views on farm animal welfare: A semi-systematic review and thematic analysis. *Animals*, *10*(9): 1524.

Banik, B. 2024. Adoption of agricultural machineries at farm level in northern Bangladesh.

BBS 2023. Quarterly Labor Force Survey 2022 Provisional Report. Ministry of Planning. *Govt. of Bangladesh, Dhaka*.

BBS 2023. Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning. *Govt. of Bangladesh, Dhaka*.

BBS 2020. *Report on Bangladesh Sample Vital Statistical 2020*. Dhaka, Bangladesh: Bangladesh Bureau of Statistics (BBS), Statistics and Informatics Division (SID), Ministry of Planning. *Govt. of Bangladesh, Dhaka*.

Besley, T. and Case, A. 1993. Modeling technology adoption in developing countries. *The American economic review*, *83*(2): 396-402.

Bundi, J.M., Ngugi, C.C., Fitzsimmons, K., Manyala, J., Kimotho, A.N., Amadiva, J.M., Ndogoni, J.N. and Munguti, J. 2018. Assessment of growth performance of monosex Nile tilapia (Oreochromis niloticus) in cages using low-cost, locally produced supplemental feeds and training fish farmers on best management practices in Kenya.

Challa, M. and Tilahun, U. 2014. Determinants and impacts of modern agricultural technology adoption in west Wollega: the case of Gulliso district. *Journal of Biology, Agriculture and Healthcare*, *4*(20): 63-77.

Chandio, A.A. and Yuansheng, J.I.A.N.G. 2018. Determinants of adoption of improved rice varieties in northern Sindh, Pakistan. *Rice Science*, *25*(2): 103-110.

Day, M., Haider, M.Z. and Datta, A.K. 2022. Modern technology adoption by the rice farmers in the South-West Region of Bangladesh. *Khulna University Studies*, 175-188.

de Souza Filho, H.M. 2018. The adoption of sustainable agricultural technologies: a case study in the State of Espirito Santo, Brazil. *Routledge.*

Doss, C.R. and Morris, M.L. 2000. How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana. *Agricultural economics*, *25*(1): 27-39.

Engle, C.R. 2017. The case for effective public funding of aquaculture research and extension. *Journal of the World Aquaculture Society*, *48*(6): 851-853.

Entee, S. 2015. Post-harvest processing value chain literature review report. *The USAID/Ghana sustainable fisheries management project (SFMP). Narragansett, RI: Coastal Resources Center, Graduate School of Oceanography, University of Rhode Island and SNV Netherlands Development Organization*.

Farid, K.S., Tanny, N.Z. and Sarma, P.K. 2015. Factors affecting adoption of improved farm practices by the farmers of Northern Bangladesh. *Journal of the Bangladesh Agricultural University*, *13*(2): 291-298.

FAO (2024). Food and Agriculture Organization of the United Nations.

Foster, A.D. and Rosenzweig, M.R. 1995. Learning by doing and learning from others: Human capital and technical change in agriculture. *Journal of political Economy*, *103*(6): 1176-1209.

Gathala, M.K., Ladha, J.K., Kumar, V., Saharawat, Y.S., Kumar, V., Sharma, P.K., Sharma, S. and Pathak, H. 2011. Tillage and crop establishment affects sustainability of South Asian rice–wheat system. *Agronomy Journal*, *103*(4): 961-971.

Ghimire, R., Wen-Chi, H.U.A.N.G. and Shrestha, R.B. 2015. Factors affecting adoption of improved rice varieties among rural farm households in Central Nepal. *Rice Science*, *22*(1): 35-43.

Goswami, B., Ziauddin, G. and Datta, S.N. 2010. Adoption behaviour of fish farmers in relation to scientific fish culture practices in West Bengal. *Indian Research Journal of Extension Education*, *10*(1): 24-28.

Hailu, B.K., Abrha, B.K. and Weldegiorgis, K.A. 2014. Adoption and impact of agricultural technologies on farm income: Evidence from Southern Tigray, Northern Ethiopia. *International Journal of Food and Agricultural Economics (IJFAEC)*, *2*(4): 91-106.

Hossain, M., Bose, M.L. and Mustafi, B.A. 2006. Adoption and productivity impact of modern rice varieties in Bangladesh. *The developing economies*, *44*(2): 149-166.

Islam, A. 2018. Impact of Improved Rice Varieties Adoption on Farmers' Well-Being (Livelihood) in Rural Bangladesh. *Bangladesh Journal of Agricultural Economics*, *38*(1).

Islam, M.N., Rahman, M.H., Mozumdar, L., Islam, M.A. and Zulfikar, M.R. 2022. Adoption of modern agricultural technologies transferred through farmer field schools in Bangladesh. *Indian J Ecol*, *49*(5): 2026-2032.

Jamal, M.R., Kristiansen, P., Kabir, M.J. and Lobry de Bruyn, L. 2023. Challenges and adaptations for resilient rice production under changing environments in Bangladesh. *Land*, *12*(6): 1217.

Joffre, O.M., Klerkx, L., Dickson, M. and Verdegem, M. 2017. How is innovation in aquaculture conceptualized and managed? A systematic literature review and reflection framework to inform analysis and action. *Aquaculture*, *470*: 129-148.

Jolliffe, D., Sharif, I., Gimenez, L. and Ahmed, F. 2013. Bangladesh-Poverty assessment: assessing a decade of progress in reducing poverty, 2000-2010.

Khatri-Chhetri, A., Aryal, J.P., Sapkota, T.B. and Khurana, R. 2016. Economic benefits of climate-smart agricultural practices to smallholder farmers in the Indo-Gangetic Plains of India. *Current Science*, 1251-1256.

Kumar, G., Engle, C. and Tucker, C. 2018. Factors driving aquaculture technology adoption. *Journal of the world aquaculture society*, *49*(3): 447-476.

Kumar, S. P. and Kumar, K. S. 2015. Adoption Level of Poly Culture Fish Practices in Southern Andhra Pradesh. *The Andhra Agric. J 62*(3): 720-724

Mariano, M.J., Villano, R. and Fleming, E. 2012. Factors influencing farmers’ adoption of modern rice technologies and good management practices in the Philippines. *Agricultural systems*, *110*: 41-53.

FBA (2024). How to empower smallholder farmers in Agribusiness.

Mason, N.M. and Ricker-Gilbert, J. 2013. Disrupting demand for commercial seed: Input subsidies in Malawi and Zambia. *World Development*, *45*: 75-91.

Mekonnen, H., Dehninet, G. and Kelay, B. 2010. Dairy technology adoption in smallholder farms in “Dejen” district, Ethiopia. *Tropical animal health and production*, *42*: 209-216.

Mendola, M. 2007. Agricultural technology adoption and poverty reduction: A propensity-score matching analysis for rural Bangladesh. *Food policy*, *32*(3): 372-393.

Milon, M.K. 2015. Present status, future and constraints of farm mechanization in Bangladesh. *FMPHT Division, Bangladesh Rice Research Institute, Gazipur-1701*.

Mishra, A., Malik, J. S. and Bhavesh 2024. Constraints Faced by Paddy Farmers in Adoption of Climate Smart Agricultural Practices: A Comparative Study. *Indian Society of Extension Education, ICAR- Indian Agricultural Research Institute, New Delhi.*

Mottaleb, K.A., 2018. Perception and adoption of a new agricultural technology: Evidence from a developing country. *Technology in society*, *55*: 126-135.

Muzari, W., Gatsi, W. and Muvhunzi, S. 2012. The impacts of technology adoption on smallholder agricultural productivity in sub-Saharan Africa: A review. *Journal of Sustainable development*, *5*(8): 69.

Nagarajaiah, C.S. 2002. *Study On Knowledge, Attitude and Extent of Adoption of Composite Fish Culture Practices In Southern Karnataka* (Doctoral dissertation, Central Institute of Fisheries Education; Mumbai).

e-Krishok 2015. Promoting ICTs to farmers in Bangladesh.

Nuruzzaman, Islam, A.M.S., Haque, M.E., Nahar, A., Habib, M.A., Nayak, S., Islam, S., Rashid, M.M. and Biswas, A. 2023. Women-led community-based rice seed entrepreneurship model in Bangladesh: Status, challenges and opportunities. *Cogent Food & Agriculture*, *9*(1): 2242138.

Omotilewa, O.J., Ricker-Gilbert, J. and Ainembabazi, J.H. 2019. Subsidies for agricultural technology adoption: Evidence from a randomized experiment with improved grain storage bags in Uganda. *American Journal of Agricultural Economics*, *101*(3): 753-772.

Parsa, S., Morse, S., Bonifacio, A., Chancellor, T.C., Condori, B., Crespo-Pérez, V., Hobbs, S.L., Kroschel, J., Ba, M.N., Rebaudo, F. and Sherwood, S.G. 2014. Obstacles to integrated pest management adoption in developing countries. *Proceedings of the National Academy of Sciences*, *111*(10): 3889-3894.

Piñeiro, V., Arias, J., Dürr, J., Elverdin, P., Ibáñez, A.M., Kinengyere, A., Opazo, C.M., Owoo, N., Page, J.R., Prager, S.D. and Torero, M. 2020. A scoping review on incentives for adoption of sustainable agricultural practices and their outcomes. *Nature Sustainability*, *3*(10): 809-820.

Rashid, S.M.M. and Islam, M.R. 2016. Problems faced by farmers in application of e-Agriculture in Bangladesh. *Journal of Agricultural Economics and Rural Development*, *3*(1): 79-84.

Ricker-Gilbert, J., Jayne, T.S. and Chirwa, E. 2011. Subsidies and crowding out: A double-hurdle model of fertilizer demand in Malawi. *American journal of agricultural economics*, *93*(1): 26-42.

Sapkota, T.B., Majumdar, K., Jat, M.L., Kumar, A., Bishnoi, D.K., McDonald, A.J. and Pampolino, M. 2014. Precision nutrient management in conservation agriculture based wheat production of Northwest India: Profitability, nutrient use efficiency and environmental footprint. *Field Crops Research*, *155*: 233-244.

Sarkar, M.A.R., Habib, M.A., Sarker, M.R., Rahman, M.M., Alam, S., Manik, M.N.I., Nayak, S. and Bhandari, H., 2024. Rice farmers’ preferences for seed quality, packaging, and source: A study from northern Bangladesh. *Plos one*, *19*(6): 306059.

Serebrennikov, D., Thorne, F., Kallas, Z. and McCarthy, S.N. 2020. Factors influencing adoption of sustainable farming practices in Europe: A systemic review of empirical literature. *Sustainability*, *12*(22): 9719.

Shiferaw, B.A., Okello, J. and Reddy, R.V. 2009. Adoption and adaptation of natural resource management innovations in smallholder agriculture: reflections on key lessons and best practices. *Environment, development and sustainability*, *11*: 601-619.

Shiferaw, B., Kebede, T., Kassie, M. and Fisher, M. 2015. Market imperfections, access to information and technology adoption in Uganda: Challenges of overcoming multiple constraints. *Agricultural economics*, *46*(4): 475-488.

Singh, R.K.P., Singh, K.M. and Kumar, A. 2015. A study on adoption of modern agricultural technologies at farm level in Bihar. *Economic Affairs*, *60*(1): 49-56.

Udoh, A.J. 2016. Assessing Crop Production Technologies Adoption by Women Farmers: Some Empirical Evidence. 120-123

Ullah, A., Shah, A.A., Bavorova, M., Kandel, G.P. and Kächele, H. 2023. Adoption of hand tractor technology in terrace farming: Evidence from the Hindu Kush Himalayan (HKH), Pakistan. *Heliyon*, *9*(3).

Wetengere, K. 2011. Socio-economic factors critical for intensification of fish farming technology. A case of selected villages in Morogoro and Dar es Salaam regions, Tanzania. *Aquaculture International*, *19*(1): 33-49.

World Bank 2008. Agriculture for Development. World Development Report, Washington D.C

Yokamo, S., 2020. Adoption of improved agricultural technologies in developing countries: Literature review. *International Journal of Food Science and Agriculture*, *4*(2).