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Identification of indigenous technical knowledges (ITKs) as climate smart agriculture (CSA) technology

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Abstract

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Indigenous Technical Knowledge (ITK) is the rural people's basic knowledge, which provides sufficient information for the decision-making of the small and marginal farmers, that helps in social upliftment. The focus of the study was to identify Indigenous Technical Knowledges (ITKs) as Climate Smart Agriculture (CSA) technology. The study was conducted at Chitalmari upazila of Bagerhat district with purposively selected 110 respondents and data were collected from the sampled respondents through personal interviews using an interview schedule. Results showed that the majority (53.6%) of the respondents were in the medium use category of ITKs. The respondents used fifty-one ITKs to a different extent in which 'Soaking vegetable seeds in water for better germination' was obtained as the highest extent (90.30%), followed by 'Feeding molasses and table salt to cattle. On the other hand, 'A mixture of catechu and *haritaki* (*Terminalia chebula*) extract in the water to protect fertilized eggs from damage' was observed as the lowest extent (1.82%). Knowledge of ITKs' had a significant positive correlation with the use of ITKs. Farmers had severe problems regarding the use of ITKs (79.1%) and 'Preference of farmers for sophistication with reliance on readymade inputs' ranked first among the identified 15 problems. Farmers perceived that the suitability of ITK-related solutions was medium and first position was ranked by the solution against ITK-related problems 'ITKs should be used combined with environment-friendly modern techniques to get solutions of almost all situations.' So, the adoption of ITKs as CSA technology is very crucial to overcome the challenges of the climate-changing world.

Keywords: Adoption; constraints; CSA technology; indigenous practices

Introduction

Agriculture is a vital sector for the livelihood of many communities around the world which not only provides food and income for farmers but also plays a crucial role in preserving cultural heritage and promoting sustainable development. ITKs are the fundamental knowledge of rural individuals that offer ample guidance for small and marginal farmers to make correct decisions and ultimately contribute to the betterment of society. Grenier (1998) specified indigenous knowledge as "the unique, historic, local knowledge existing within and developed around the specific condition of women and men indigenous to a particular geographic area". It helps in maintaining the organic matter content of the soil, gene pools, and conservation of indigenous varieties thus balancing biodiversity (Sharma et al., 2020). Such technical knowledge is passed down through daily life from generation to generation.

Currently, many ITKs are in danger of going extinct because of the excessive adoption of modern scientific knowledge. Many uneducated and underprivileged farmers are unable to use modern technologies. So, it must be reinvented in order to be used to their fullest potential for future applications. Modern technology benefits farmers in the short term but at the expense of long-term environmental degradation. In fact, the use of modern technology in Bangladesh's ag-

riculture has given rise to troubling sustainability concerns (Farouk & Salam, 1996). In the past year, it has become increasingly clear that high-external-input agriculture has negative environmental and social effects. At the same time, numerous disadvantaged communities of smallholders have been forced to use the resources that are available to them so intensively that environmental degradation is now becoming a great problem.

Besides, climate change also creates a great disaster for agriculture and poor farmers. In many parts of the world, millions of people's livelihoods, food security and agriculture are now seriously threatened by climate change (Field et al., 2014). According to a number of studies, changes in rainfall patterns (Prasanna, 2014); temperature changes; and variations in the frequency and intensity of extreme climatic events like floods and droughts (Singh et al., 2013) could all have a significant impact on agriculture production.

There are a number of potential adaptation solutions to lessen the moderate to severe climatic hazards to agriculture. CSA technology, practices and services are adaptation choices that sustainably boost productivity, improve resistance to climatic shocks and lower greenhouse gas emissions (FAO, 2010). The main objective of CSA is to build resilient food production systems that ensure both food and financial security in the face of ongoing climate change and variability (Lipper et al., 2014). Part of CSA technology such as minimum tillage, various crop establishment techniques, nutrient and irrigation management and residue incorporation can increase crop yields, increase the efficiency of the use of water and nutrients and lower greenhouse gas (GHG) emissions from agricultural activities (Sapkota et al., 2015).

Despite the many advantages of CSA technology, farmers are currently adopting it at a rather low rate (Palanisami et al., 2015). Major obstacles to scaling out CSA in various agroecological regions include the discovery, prioritization and promotion of existing CSA technologies while taking into account regional climate concerns and technology demand. So, there is a great potential for ITKs to be used as CSA technology. ITKs have significant benefits if explored. They are alternatives that can be widely adapted as they are simpler, safer, and less expensive to adopt than those of modern technology. They are a safer alternative to harmful chemicals, environmentally friendly and play a momentous role in sustainable development (Kanak Pervez et al., 2015). In Bangladesh, rural farmers play a vital role in developing, preserving and reinjecting ITKs into the livelihood system. To increase the production of farm inputs, it is crucial to conduct research and preserve local expertise. These priorities are necessary because there is an increasing need to record these ITKs. On this topic, very little research has been conducted in Bangladesh.

Considering the facts, this study was conducted to identify ITKs as an indicator of CSA technology to fulfill the following objectives:

i To identify the ITKs used by rural farmers and the adoption level of ITKs in agriculture.
ii To explore the relationship between selected demographic characteristics of farmers and the use of ITKs.
iii To identify the constraints and solutions for the adoption of ITKs in agriculture.

Methodology

The study employed an ex-post facto explanatory cross-sectional research design and the nature of the study was quasi-experimental. It was carried out in several villages in the Chitalmari upazila of Bagerhat district. The unique characteristics of the study area include the fact that farming is the main source of income for the local population. Farmers in the Chitalmari upazila were engaged in crop cultivation, fisheries and livestock rearing. The population of the study consisted of all the rural farmers, women, local leaders and the stakeholders of the Chitalmari upazila, Bagerhat. One hundred and ten of them were purposefully selected to make up the study's sample. Data were collected by the researcher through the face-to-face interview of the respondents in the chosen area using the interview schedule.

Two different types of variables are found in every relationship; one is the independent variable and the other is the dependent variable. Age, educational status, family size, farming experience, farm size, annual income, organizational participation, training received, cosmopolitanism, extension media contact, farmers' knowledge of ITKs and farmers' attitude toward ITKs were the independent variables and ITKs' use were the dependent variable of the study.

Farmers were interviewed to collect data on whether they adopted each of the selected ITKs or not. The extent of adopting an ITK was determined based on the adoption index. The adoption score was determined by using the following formula:

$$AS= N_1\times3+N_2\times2+N_3\times1+N_4\times0,$$

where: AS = Adoption score;

N_1 = Number of respondents who did the practice regularly;

N_2 = Number of respondents who did the practice occasionally;

N_3 = Number of respondents who did the practice rarely;
N_4 = Number of respondents who did the practice not at all;

The possible range of practice scores was 0 to 330. After determining of AS, the adoption index was determined by the following formula:

$$(\%)\ \text{Adoption Index} = \frac{\text{Observe adoption score}}{\text{Possible highest adoption score}} \times 100$$

For determining the extent of adoption of ITKs, the percentage of each adopter category **(**innovators, early adopters, early majority, late majority and laggards) of crop-related ITKs was calculated by the following formula:

$$(\%)\ \text{Innovators} = \frac{\text{Total number of innovators in crop related ITKs}}{\text{Total number of respondents adopted crop related ITKs}} \times 100$$

The percentage of other adopter categories (early adopters, early majority, late majority and laggards) in the case of fisheries, livestock and weather forecasting-related ITKs were calculated using the same type of formula. After calculating all the percentages of each adopter category, a graph was formed using Microsoft Excel to show the extent of adoption of ITKs by the farmers.

The severity of a problem was determined based on the problem severity index (PSI). The PSI was determined by using the following formula:

$$PSS = N_1 \times 4 + N_2 \times 3 + N_3 \times 2 + N_4 \times 1 + N_5 \times 0,$$

where: PSS= Problem severity score;
N_1 = Number of respondents who marked the problem as highly severe;
N_2 = Number of respondents who marked the problem as severe;
N_3 = Number of respondents who marked the problem as moderately severe;
N_4 = Number of respondents who marked the problem as less severe;
N_5 = Number of respondents who did not mark the problem at all.

After determining PSS, the severity index of the problem was determined by the following formula:

$$(\%)\ \text{Severity index of the problem} = \frac{\text{Observed problem score}}{\text{Possible highest problem score}} \times 100$$

The suitability of a solution was determined based on the solution suitability index (SSI). The SSI was determined by using the following formula:

$$SSS = N_1 \times 4 + N_2 \times 3 + N_3 \times 2 + N_4 \times 1 + N_5 \times 0,$$

where: SS= Solution suitability score;
N_1 = Number of respondents who marked the solution as highly suitable;
N_2 = Number of respondents who marked the solution as suitable;
N_3 = Number of respondents who marked the solution as moderately suitable;
N_4 = Number of respondents who marked the solution as less suitable;
N_5 = Number of respondents who did not mark the solution at all.

The possible range of solution suitability score (SSS) was 0 to 440. After determining SSS, the suitability index of the solution was determined by the following formula:

$$(\%)\ \text{Suitability index of the solution} = \frac{\text{Observed solution score}}{\text{Possible highest solution score}} \times 100$$

Data were analyzed using Statistical Package for Social Science (SPSS) and Microsoft Excel. When applicable, Local units were converted into standard units and qualitative data were converted into quantitative ones by means of suitable scoring. Descriptive data were interpreted using basic statistics including frequency counts, percentages, ranges, means and standard deviations. Spearman rank correlation was employed to investigate the associations between the relevant variables.

Results and Discussion

Identification of the ITKs used by rural farmers and the adoption level of ITKs in agriculture

ITKs' use

The rural farmers' score on ITKs' use varies from 25 to 89 against a possible range of 0 to 153. The mean and standard deviation are 54.25 and 12.90, respectively. The majority of the respondents (53.6%) were in the medium-use category of ITKs followed by the low-use category (46.4%). (Table 1).

No respondents were found in the high-use category of ITKs because of their preference for readymade inputs and the low productivity of ITKs. Generally, young farmers with large land holdings were in the low-use category of ITKs due to the short-term benefits of modern technologies and easy management. On the other hand, old farmers with small to medium land holdings were in the medium-use category of ITKs.

Table 1. Distribution of respondents on the basis of their ITKs use

Categories	Score	N=110		Mean ± SD ($\bar{x} \pm \sigma$)	Range	
		Frequency	%		Min.	Max.
Low use of ITKs	≤51	51	46.4	54.25±12.90	25	89
Medium use of ITKs	52–102	59	53.6			
High use of ITKs	103–153	0	0			

Adoption index of ITKs

Data presented in Table 2 showed that the 1st position was ranked by 'Soaking vegetable seeds in water for better germination' on the basis of obtained highest score (298) followed by 'Feeding molasses and table salts to cattle' (2nd, score 265), 'Coarse grain rice varieties generally do not lodge' (3rd, score 258), 'Use of rice husk as fish feed' (4th, score 244) and 'Using *neem* (*Azadirachta indica*) leaves to store food grains like paddy and wheat'(5th, score 242). On the other hand, least score was obtained by the ITKs of 'A mixture of catechu and *haritaki* (*Terminalia chebula*) extract in the water to protect fertilized eggs from damage' (42nd, score 6) followed by 'Feeding *Sali* (raw paddy) to cows to remove retained placenta' (41st, score 8), 'Using dried *kacchu patta* (*Colocasia* sp.) as fish feed' (40th, score10), 'Application of poultry litter in the pond as fish feed' and 'Use of *biskatali* (*Persicaria hydropiper*) grass as a repellent of body lice of cattle' (39th, score 15) among all the ITKs adopted by the respondents.

Most of the marginal and small farmers are not economically solvent enough to adopt high-cost modern technology. So, they try to utilize the available household waste and farm by-products using their traditional knowledge properly. Additionally, the use of ITKs is independent of outside costs and depends on the community's own self-sufficient knowledge base therefore it has been practiced by the rural people for centuries.

Extent of adoption of ITKs

It is evident from Figure 1 that majority (58.43%) of the respondents were early adopters, followed by early majority (28.43%), late majority (12.5%) and laggards (0.65%) of crop-related ITKs. In case of fisheries-related ITKs, highest portion of the respondents were early adopters (39.88%) followed by early majority (39.74%), late majority (19.8%) and laggards (0.58%), respectively. ITKs in livestock, majority (56.89%) of the respondents were early adopters, followed by early majority (27.87%), late majority (14.59%) and laggards (0.66%), respectively. Highest portion (39.61%) of the respondents was early majority in case of ITKs in weather forecasting followed by early adopters (35.27%) and late majority (25.12%), respectively.

Table 2. Adoption index of ITKs

Sl. No.	ITKs	ITK score	ITK index, %	Rank
	Crop related ITKs			
1	Soaking vegetable seeds in water for better germination	298	90.30	1st
2	Burning crop residues	221	66.97	11th
3	Garlic-potato intercropping to reduce pest attack	34	10.30	35th
4	Use of fish cleaning water at the base of bottle gourd vine	26	7.88	36th=
5	Application of ash in leafy vegetables to control aphid	132	40	20th
6	Erecting scare-crow in standing crops to scare birds	121	36.67	23rd
7	Hand pollination in cucurbit vegetable	225	68.18	8th
8	Use of neem extract as a pesticide	54	16.36	32nd
9	Watering/ fumigating of rodent holes to control them	94	24.48	27th=
10	Coarse grain rice varieties generally do not lodge	258	78.18	3rd
11	Weed growth is faster in upland areas	234	70.91	6th
12	Greenish tillering during active tillering is an indication of poor yield in rice	122	36.97	22nd
13	Clayey soil is suitable for rice variety	230	69.70	7th
14	Application of casuarina or neem leaves or sand will correct soil alkalinity	18	5.45	37th
15	Intercropping cereals with legumes to increase N content in the soil	106	32.12	26th

Table 2. Continued

16	Setting up bamboo sticks or branches of trees to control insect	213	64.55	12th
17	Using *neem* (*Azadirachta indica*) leaves to store food grains like paddy and wheat	242	73.33	5th
	Fisheries related ITKs			
18	Application of cow dung in the pond as fish feed	87	26.36	29th
19	Use of rice husk as fish feed	244	73.94	4th
20	Application of segmented banana plants for cleaning the pond water	125	37.88	21st
21	Use of banana leaves as a feed for carp fish	224	67.88	9th
22	Application of poultry litter in the pond as fish feed	15	4.55	39th =
23	Drying of excess fish for the lean period	52	15.76	33rd
24	Planting *mahogany* (*Swietenia macrophylla*) tree beside the pond to control fish disease	88	26.67	28th
25	Application of food wastage in the pond as feed	185	56.06	15th
26	Dragging fishing net for aeration	108	32.73	25th
27	Use of oil cakes in the pond for the rapid growth of fish	139	42.12	18th=
28	Use of termites as feed for fish in ponds	16	4.85	38th=
29	Use of common carp for natural seed rearing	0	0	43rd ≡
30	Use of salt and turmeric solution in a pond after the rainy season to have protection from disease infestation	49	14.85	34th
31	Using dried *kacchu patta* (*Colocasia sp*.) as fish feed	10	3.03	40th
32	Sowing *dhaincha* [*Sesbania bispinosa*] (green manure) during summer to enhance nutritional content for fish in the reservoir	70	21.21	31st
33	A mixture of catechu and *haritaki* extract in the water to protect fertilized eggs from damage	6	1.82	42nd
	Livestock related ITKs			
34	Feeding the flesh of oysters and snails to duck	199	60.30	14th
35	Feeding contraceptive pill for controlling Newcastle of poultry	0	0	43rd ≡
36	Feeding molasses and table salts to cattle	265	80.30	2nd
37	Feeding the *katanate* (*Amaranthus spinosus*) grass to livestock to improve lactation	139	42.12	18th=
38	Use of bamboo case to protect ducklings from snatched birds	203	61.52	13th
39	Deeping eggs in water for assessing the hatching quality	26	7.88	36th=
40	Feeding seeded bananas to cattle for curing loose motion	114	34.55	24th
41	Using an earthen pot for laying and hatching eggs of poultry	161	48.79	17th
42	Use of *biskatali* grass as a repellent of body lice of cattle	15	4.55	39th=
43	Feeding *hukkah* (tobacco filter) water to control worms of goat	16	4.85	38th=
44	Feeding *Sali* (raw paddy) to cows to remove retained placenta	8	2.42	41st
45	Drenching mixture of jaggery and onion to cure constipation	94	28.48	27th=
46	Moving FMD-infected animals through mud or hot dust to cure FMD infection	223	67.58	10th
37	Drenching castor oils to animals to cure tympany	0	0	43rd ≡
	Weather forecasting related ITKs			
48	If the wind is blowing east to west, it confirms that heavy rainfall will occur after a few days	137	41.52	19th
49	If grasshopper is in a group of 10–12 then, it is supposed that rain will occur in the next 24 hour	176	53.33	16th
50	If the rainbow is seen in the western sky, heavy rainfall will occur.	73	22.12	30th
51	When the rain is about to begin, the spider makes its web in the opposite direction i.e., vertically to the earth and sky and after rain, the direction of the web is horizontal to the earth and sky	0	0	43rd ≡

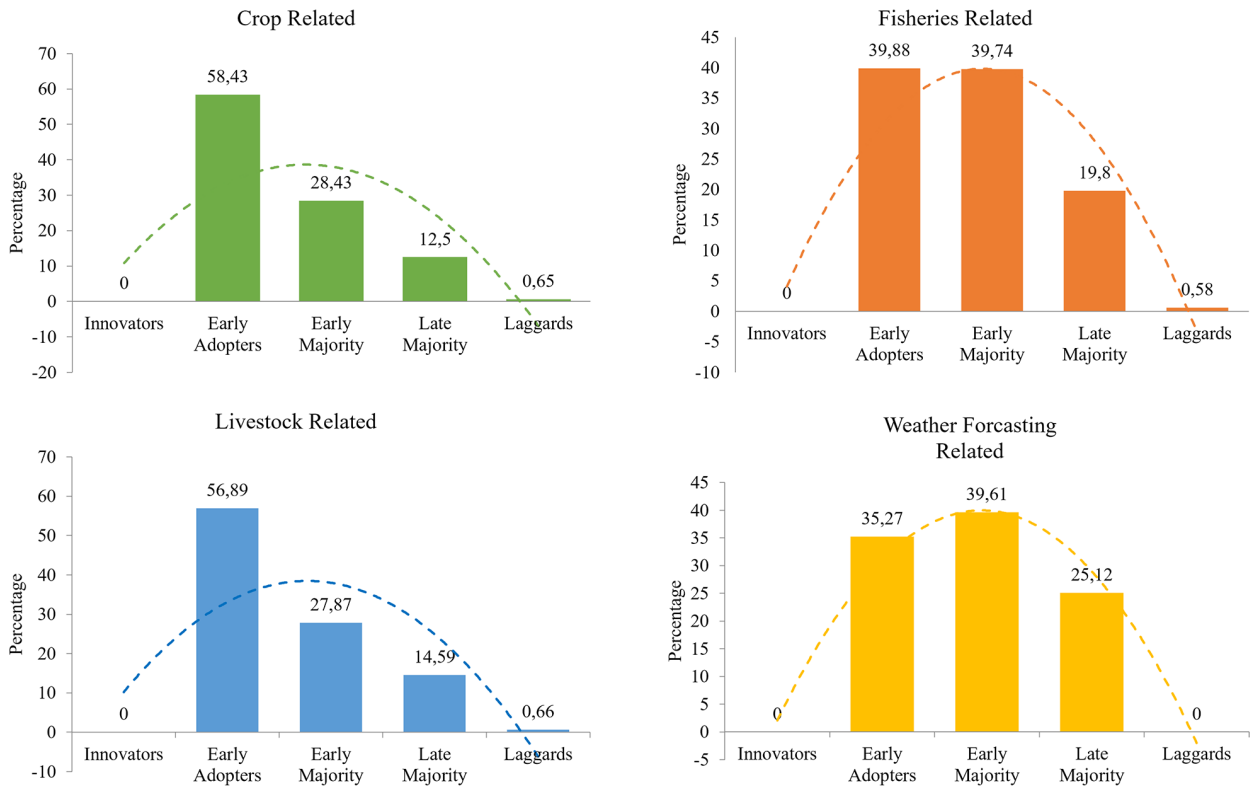

Fig. 1. Extent of adoption of ITKs

Rogers (1995) stated in his theory of diffusion of innovation that the innovators, early adopters, early majority, late majority and laggards occupied 2.5%, 13.5%, 34%, 34% and 16% of the total population of a social system which is very different from the findings of this study. Khatri et al. (2021) found that in the case of nutrient management, majority (83.07%) of the respondents were medium adopters. Majority (67.4%) of the respondents were medium adopters in the case of ITKs of plant protection. Maximum respondents (66.77%) were medium adopters in the case of ITKs of plant storage. ITKs in animal husbandry, majority (82.04%) of the respondents had medium adoption. Majority (79.86%) of the farmers were medium adopters in case of ITKs in weather forecasting.

Selected demographic characteristics of farmers

Data presented in Table 3 showed that the majority (54%) of the respondents belongs to middle-aged followed by young farmers 36% and old farmers 20% respectively. The farmers' age ranged from 23 to 72 with a mean of 44.45 and a standard deviation of 13.03. Mostly middle-aged farmers were involved in agricultural practices. The involvement of young and old farmers was less. The reasons behind the less involvement of young farmers in agriculture can be their preference for higher education, eagerness for getting government jobs and uncertainties of profit in agriculture. Mim & Islam (2022) found major proportion (52%) of respondents were middle-aged highly involved in agriculture followed by young (26%) and old farmers (22%) respectively.

Highest portion of the farmers (36.4%) belong to a secondary level of education followed by 22.7%, 11.9%, 11.7%, 10.0%, 6.4% and 0.9% of the farmers who belong to can sign only, primary, undergraduate, higher secondary, postgraduate and illiterate level of education. The score of educational status ranged from 0 to 17 with a mean of 7.95 and a standard deviation of 5.43. Mim & Islam (2022) observed 34% of the respondents had a secondary educational level followed by primary (29%), can sign only (22%), higher secondary (13%), undergraduate (1%) and postgraduate (1%) level of education.

Majority of the family sizes of the respondents were small (50%) followed by medium families 40.9% and 9.1% of the respondents had large families. The data of family size ranged from 2 to 12 with a mean of 4.73 and a standard de-

viation of 1.62. Large families are decreasing day by day in urban as well as rural areas. The number of children also decreases within the families. Mim & Islam (2022) obtained highest portion of the respondents (46%) had medium families followed by small (38%) and large families (16%) respectively.

The main occupation of most of the respondents was agriculture (84.5%). About 7.3% of the respondents were engaged with fisheries followed by business (4.5%) and service (3.6%) respectively.

In case of farming experience, maximum respondent (60%) had high farming experience followed by 30% low and 10% medium farming experience. The rural farmers' score on farming experience varies from 2 to 60. The mean and standard deviation are 24.57 and 15.19 respectively. High farming experiences indicates the farmers were well aware about ITKs and there is a great possibility of their maximum use of ITKs. Mim & Islam (2022) found that highest portion of the respondents (44%) had high farming experience followed by medium (35%) and low (21%) farming experience.

The farming system of majority of the farmers (69.1%) were Crop + Livestock + Fish compared to 24.5%, 4.5%, 0.9% and 0.9% of the farmers were engaged with Crop + Fish, Crop + Livestock, Livestock + Fish and Fish cultivation.

The farm size of majority of the farmers was small (74.5%). About 14.5% farmers were marginal and 10.9% were medium farmers. The farm size of the farmers ranged from 0.05 to 2.68 ha with a mean of 0.55 and a standard deviation 0.39. Farmers cannot make the expected amount of money if their farms are small, despite their best efforts. Growing the size of the farm is also crucial for improving the status of the farmers. Small farms may facilitate ITKs adoption, but they will obstruct efforts to reap financial rewards from them, since implementing ITKs practice roughly raises the cost of productivity. However, if the farm is small, the input expenditure might not produce the desired results. Mim & Islam (2022) found that more than half (56%) of the farmers had small farm size followed by marginal (26%), medium (15%) and large (3%) farm size.

Annual income of maximum respondents (42.7%) was low whereas 42.7% had medium income and 30% had high income. The annual income of the respondents varies from 20,300 BDT to 3,527,000 BDT. The mean and standard deviation are 320121.82 and 450,923 respectively. There was an exclusively high-income respondent who earned 3,527,000 BDT in a year by commercial fish farming. The respondents' mean income is only 320121.82 BDT, which is quite low. These days, it is really challenging to provide for a family with that wage. As a result, many are becoming less interested in farming and searching for alternative sources of income. Contrarily, low-income farmers are more likely to refrain from practices that would cost them money or cause a delay in the outcome of their input. Mim & Islam (2022) found that highest portion of the farmers (45%) had low income followed by medium income (32%) and high income (23%) respectively.

Majority of the respondents (61.8%) involved in different organization. Among them 97.1% had low level of organizational involvement and only 2.9% had medium level of organizational involvement. Mim & Islam (2022) found that only 44% of the total respondents participated in different organization.

Only 40.9% of the respondents received agricultural training. Among them 75.6% received short duration training and 24.4% received long duration training. Training duration ranged from 1 to 180 days with a mean of 4.05 and a standard deviation of 17.78. Mim & Islam (2022) found that only 46% of the total respondents received training. Among them, majority (60.9%) had low level of training followed by medium (39.1%) level of training.

In case of cosmopolitanism, majority of the respondents (50%) is low followed by 43.6% had medium and only 6.4% had high cosmopolitanism. The score of cosmopolitanism ranged from 2 to 14 with a mean of 5.88 and a standard deviation of 2.57.

Higher level of cosmopolitanism serves to extend farmers' perspectives, whereas a lower level of cosmopolitanism restricts their viewpoint. Low levels of cosmopolitanism can also be a factor in farm operations not adopting high-quality environment friendly techniques as well as ITKs. Mim & Islam (2022) found that majority of the respondents (58%) had low level of cosmopolitanism followed by medium (40%) and high (2%) level of cosmopolitanism respectively.

According to Table 3, the majority of respondents (64.5%) had only occasional level of extension media contact, while 28.2% had rare level of extension media contact and 3% contacted with the extension media often. The score of extension media contact ranged from 10 to 57 with a mean of 30.42 and a standard deviation of 8.54. Mim & Islam (2022) found that majority of respondents (66%) had occasional level of extension media contact followed by often (31%) and rare (3%) level of extension media contact.

The data presented in Table 3 indicated that 64.5% of the surveyed farmers had a good knowledge of ITKs while approximately 1.8% was found to have limited knowledge. Additionally, 33.6% of farmers were found to possess an excellent level of knowledge about ITKs. The knowledge score ranged from 7 to 22 with a mean of 14.75 and a standard deviation of 2.83. Here the knowledge of farmers is mainly

Table 3. Distribution of respondents according to their personal characteristics

Characteristics	Categories	Score	N=110		Mean± SD ($\bar{x} \pm \sigma$)	Range	
			F.	%		Min.	Max.
Age (years)	Young	≤35	36	32.7	44.45±13.03	23	72
	Middle-aged	36-55	54	49.1			
	Old	>55	20	18.2			
Educational status (schooling years)	Illiterate	0	1	0.9	7.95±5.43	0	17
	Can sign only	0.5	25	22.7			
	Primary	1-5	13	11.9			
	Secondary	6-10	40	36.4			
	Higher Secondary	11-12	11	10.0			
	Undergraduate	13-16	13	11.7			
	Postgraduate	>16	7	6.4			
Family size (number of family members)	Small	≤4	55	50.0	4.73±1.62	2	12
	Medium	5-6	45	40.9			
	Large	>6	10	9.1			
Main occupation	Agriculture		93	84.5			
	Business		5	4.5			
	Service		4	3.6			
	Day laborer		0	0			
	Fisheries		8	7.3			
	Other (If any)		0	0			
Farming experience (years)	Low	≤10	33	30.0	24.57±15.19	2	60
	Medium	11-20	11	10.0			
	High	>20	66	60.0			
Farming system	Crop		0	0			
	Livestock		0	0			
	Fisheries		1	0.9			
	Crop + Fish		27	24.5			
	Crop + Livestock		5	4.5			
	Livestock + Fish		1	0.9			
	Crop + Livestock + Fish		76	69.1			
Farm size (ha.)	Landless	≤0.02	0	0	0.55±0.39	0.05	2.68
	Marginal	0.021-0.2	16	14.5			
	Small	0.21-1.0	82	74.5			
	Medium	1-3	12	10.9			
	Large	>3	0	0			
Income (‘000’ BDT year^{-1})	Low	<180	47	42.7	320.1±450.9	20.3	3527
	Medium	180-300	30	27.3			
	High	>300	33	30.0			
Organizational involvement	Yes		68	61.8			
	No		42	38.2			
Organizational participation (score)	Low	≤6	66	97.1	1.38±0.49	1	2
	Medium	7-12	2	2.9			
	High	>12	0	0			
Training received	Yes		45	40.9			
	No		65	59.1			

Table 3. Continued

Duration of training received (days)	Low	≤15	34	75.6	4.05±17.78	1	180
	High	>15	11	24.4			
Cosmopolitanism (score)	Low	≤5	55	50.0	5.88±2.57	2	14
	Medium	6-10	48	43.6			
	High	>10	7	6.4			
Extension media contact (score)	No	0	0	0	30.42±8.54	10	57
	Rare	1-24	31	28.2			
	Occasional	25-48	71	64.5			
	Often	49-72	8	7.3			
	Regular	>72	0	0			
Farmers' knowledge on ITKs (score)	Low	≤8	2	1.8	14.75±2.83	7	22
	Good	9-16	71	64.5			
	Excellent	>16	37	33.6			
Farmers' attitude towards ITKs (score)	Highly unfavorable	0-10	0	0	39.16±6.90	19	50
	Unfavorable	11-20	1	0.9			
	Neutral	21-30	15	13.6			
	Favorable	31-40	58	52.7			
	Highly favorable	41-50	36	32.7			

[F. = Frequency, %= Percentage, $\bar{x}$= Mean, σ = Standard Deviation, Min.= Minimum and Max.= Maximum]

on the selected questions related to ITKs. Respondents' good knowledge cannot guarantee the high use of ITKs. According to the respondents' knowledge level, farmers have a lot of information gaps about ITKs. It might be because of the proper identification, documentation and validation of ITKs and also extension workers provide less information about the benefits of ITKs. Farmers' knowledge of ITKs can be considerably increased by training. Khatri et al. (2021) found that 64.89% of the respondent had medium level of knowledge and 9.27% of them had low level of knowledge about ITKs. He also found that 25.84% of the farmers were having high knowledge of ITKs.

Majority of the respondents (52.7%) had a favorable attitude toward ITKs followed by 32.7% highly favorable, 13.6% neutral attitude and an unfavorable attitude (0.9%) respectively. The attitude score ranged from 19 to 50 with a mean of 39.16 and a standard deviation of 6.90. The favorable attitude of respondents towards ITKs indicates that they are able to understand the benefits of ITKs' use in agricultural practices. They also understood that agricultural practices using ITKs are simple, cost-effective, and beneficial for the health of humans and the environment can cope with climate change and ensures sustainable agricultural development. Khatri et al. (2021) found that majority of the majority of the respondents (53.93%) had a favorable attitude toward ITKs. 20.79% of the respondents had a highly favorable attitude followed by highly unfavorable attitude (9.55%), neutral attitude (8.99%) and unfavorable attitude (6.74%), respectively.

Relationships between the selected demographic characteristics of farmers and the use of ITKs

Results of Table 4 showed that knowledge of ITKs had significant positive correlation with use of ITKs at 1% level of significance. This indicates that with the increase of "knowledge of ITKs', practicing rate also increased among the respondents. Here 'knowledge of ITKs' is farmers' knowledge on the standard form of practices. A farmer is more or less likely to practice them in his farm for better production if the farmer is aware of the standard practices.

Table 4. Relationships between the selected demographic characteristics of farmers and use of ITKs

Selected Characteristics	Use of ITKs
Age	.174
Educational status	.038
Family size	.081
Farming experience	.160
Farm size	-.041
Annual income	.206*
Organizational participation	-.030
Duration of training received	.050
Cosmopolitanism	.241*
Extension media contact	.231*
Knowledge of ITKs	.493**
Attitude towards ITKs	-.021

** Correlation is significant at the 0.01 level * Correlation is significant at the 0.05 level

In case of annual income, cosmopolitanism and extension media contact a positive correlation was obtained with the use of ITKs at 5% level of significance. This may occur due to young peoples' high literacy rate as their family income is more to afford higher education, their cosmopolitanism also increased and they had more extension media contact. That's why the knowledge of ITKs also increased among the respondents and they became more interested to practice ITKs for their betterment. On the contrary, farm size had negative correlation with the use of ITKs. That means with the increase of farm size, the use of ITKs decreased and *vice versa*. The causes may be due to increased number of laborers, shortage of infrastructure related to practice, unwillingness of farmers to maintain every detail in large scale (Table 5).

From Table 6, it is found that the 1st position was ranked by the ITK related problem 'Preference of farmers for sophistication with reliance on readymade inputs' on the basis of obtained highest score (383) followed by 'Low productivity' (2nd, score 366) and 'ITK has no written document' (3rd, score 346). The least scores were obtained by the ITK related problems 'Weak coordination between Research and Development Organizations' (15th, score 188), 'Lack of full confidence of applying ITKs as Govt. officials and educated people give less recognition to this knowledge' (14th, score 194) and 'Lack of expert guidance/ extension support for the adoption of ITKs' (13th, score 207). Most of the farmers knew about the importance of using ITKs and the severity ITK related problems.

Khatri et al. (2021) found that the major constraints for the adoption of ITKs were 'Preference of farmers for sophistication with reliance on readymade inputs' followed by 'More time required to get the desired results from adoption of ITKs', 'Sociological constraints', 'Labor-intensive nature of ITKs', 'Lack of expert guidance/ extension support for adoption of ITKs' and 'Weak coordination between Research and Development Organizations'.

Solutions for the adoption of ITKs in agriculture

The data presented in Table 7 indicated that 81.8% of the surveyed farmers perceived that the suitability of ITK related solutions was medium while approximately 18.2% perceived that the suitability of ITK related solutions was high. The suitability score of ITK related solutions ranged from 21 to 47 with a mean of 34.77 and a standard deviation of 5.57.

Table 5. Distribution of respondents on the basis of their perception of the severity of ITKs related problems

Categories	Score	N=110		Mean ± SD ($\bar{x} \pm \sigma$)	Range	
		Frequency	Percentage		Min.	Max.
Less severe	≤20	0	0	36.96±4.50	23	48
Severe	21-40	87	79.1			
Highly severe	>40	23	20.9			

Table 6. Problems regarding ITKs index

Sl. No	Problems of ITKs adoption	Problem score	Problem index, %	Rank
1.	ITK has no written document	346	78.64	3rd
2.	Lack of knowledge of ITK practices	308	70	5th
3.	Lack of interest among young farmers	271	61.59	8th
4.	More time is required to get the desired results	303	68.86	6th
5.	Labor intensive nature of ITKs	313	71.14	4th
6.	Ambiguous in treatment	242	55	9th
7.	Unavailability of medicinal plants/ ingredients used for ITKs in the local market	241	54.77	10th
8.	Low productivity	366	83.18	2nd
9.	ITK is not a complete solution in all situations	275	62.50	7th
10.	Preference of farmers for sophistication with reliance on readymade inputs	383	87.05	1st
11.	Lack of expert guidance/ extension support for the adoption of ITKs	207	47.05	13th
12.	Weak coordination between Research and Development Organizations	188	42.73	15th
13.	Many new problems have no traditional cure	217	49.32	11th
14.	Lack of full confidence of applying ITKs as Govt. officials and educated people give less recognition to this knowledge	194	44.09	14th
15.	Experienced farmers do not transfer their knowledge to any person except their family member	212	48.18	12th

Table 7. Distribution of respondents on the basis of their perception of the suitability of ITKs related solutions

Categories	Score	N=110		Mean ± SD ($\bar{x} \pm \sigma$)	Range	
		Frequency	%		Min.	Max.
Less suitable	≤20	0	0	34.77±5.57	21	47
Medium suitable	21-40	90	81.8			
Highly suitable	>40	20	18.2			

Table 8. Solutions regarding ITKs index

Sl. No.	Solutions to ITKs adoption	Solution Score	Solution index, %	Rank
1.	Proper identification and documentation of ITKs	337	76.59	3rd
2.	Building upon local people's knowledge	279	63.41	5th
3.	Increase awareness among the younger generation and develop an appreciation of an indigenous system	234	53.18	10th
4.	Using ITKs in a scientific way to get desired results within a short time	245	55.68	8th
5.	Using updated tools and implements to reduce the labor-intensive nature of ITKs	264	60	6th
6.	Validation of the ITKs/Assessment of the ITK for scientific logic	185	42.05	13th
7.	Making the ingredients used for ITKs available in the local market by different agencies	240	54.55	9th
8.	Discovering the ways to increase the productivity of ITKs by the researchers	345	78.41	2nd
9.	ITKs should be used combined with environment-friendly modern techniques to get solutions of almost all situations.	370	84.09	1st
10.	Changing the poor social perception of farmers	174	39.55	14th
11.	Focus on future research on the adoption of ITK	164	37.27	15th
12.	Financial support from Government and other agencies	310	70.45	4th
13.	Experts should provide solutions to new problems using ITKs	259	58.86	7th
14.	Govt. officials and educated people should give more importance to ITK using	197	44.77	12th
15.	Experienced farmers should transfer their knowledge to others during different social gatherings	220	50	11th

It is evident from Table 8 that the 1st position was ranked by the solution against ITK related problem 'ITKs should be used combined with environment-friendly modern techniques to get solutions of almost all situations' on the basis of obtained highest score (370) which was followed by 'Discovering the ways to increase the productivity of ITKs by the researchers' (2nd, score 345) and 'Proper identification and documentation of ITKs' (3rd, score 337). The least scores were obtained by the solution against ITK related problems 'Focus on future research on the adoption of ITK' (15th, score 164), 'Changing the poor social perception of farmers' (14th, score 174) and 'Validation of the ITKs/Assessment of the ITK for scientific logic' (13th, score 185).

Khatri et al. (2021) found that strategies to increase adoption of ITKs were 'Validate the ITKs/Assess the ITK for scientific logic', followed by 'Building upon local people's knowledge', 'Changing poor social perception of farmers', 'Increase awareness among the younger generation' and 'Develop appreciation of indigenous system', 'Financial support from Government and other agencies' and 'Focus on future research on adoption of ITK'.

Conclusion

Highest portion of the respondents was in the medium-use category of ITKs followed by the low-use category. The respondents of the study used the selected ITKs to different extent in which 'Soaking vegetable seeds in water for better germination' was observed as highest extent followed by 'Feeding molasses and table salt to cattle. On the other hand, 'A mixture of catechu and *haritaki* extract in the water to protect fertilized eggs from damage' was used to the lowest extent. Majority of the respondents were early adopters, followed by early majority, late majority and laggards of crop-related, fisheries-related and livestock-related ITKs. Majority of the respondents were early majority in case of ITKs in weather forecasting followed by early adopters and late majority, respectively. In the case of ITK practice, annual income, cosmopolitanism and extension media contact had a positive correlation with the use of ITKs whereas knowledge of ITKs' had a significant positive correlation with use of ITKs. Majority of the surveyed farmers perceived that the severity of ITK-related problems was medium. The 1st posi-

tion was ranked by the ITK-related problem 'Preference of farmers for sophistication with reliance on readymade inputs' on the basis of obtained highest score which was followed by 'Low productivity' and 'ITK has no written document'. On the other hand, least score was obtained by the ITK-related problems 'Weak coordination between Research and Development Organizations'. Highest portion of the respondents perceived that the suitability of ITK-related solutions was medium. 1st position was ranked by the solution against ITK related problem 'ITKs should be used combined with environment-friendly modern techniques to get solutions of almost all situations' on the basis of obtained highest score which was followed by 'Discovering the ways to increase the productivity of ITKs by the researchers' and 'Proper identification and documentation of ITKs'. On the other hand, least score was obtained the solution against ITK-related problems 'Focus on future research on the adoption of ITK'.

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Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this article.

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