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RESEARCH PAPER

Farmers Attitude towards Climate Smart Agriculture in Bangladesh: A Case Study of Dhamrai Upazila, Dhaka

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ABSTRACT

Climate smart agricultural practices is a holistic way of agriculture, which tries to bridge the widening gap between demand from man and supply form nature by taking care of the environment. This study examines the perception of peri-urban farmers' attitude towards climate smart agriculture (CSA) and to find out the constraints to adoption of CSA techniques and practices for food production. Data was collected from May to September of 2022 from 160 randomly selected farmers in eight villages of Dhamrai upazila in Dhaka, Bangladesh. A pretested questionnaire was used to obtain data from the farmers and Key Informant Interviews and Focus Group Discussions were performed to collect supplementary information from the different farmers and stakeholders. SPSS software was used for data management and analysis. Results revealed that 11.76% and 41.18% of respondent farmers for rice production and 22.73% and 54.55% for vegetable production are regularly and partially practiced CSA techniques respectively. The study observed that the vegetable producers use more CSA technologies than rice grower. Results from the logit model indicate that farmer's level of education, cultivated farm size, farming experience, training experience and extension services showed significant positive attitude towards CSA. The study found that the lack of knowledge and understanding of the principles of CSA was the top-notch constraints followed by lacking training, insufficient financial and technical support services found the related hindrances to adoption of CSA techniques and practices. This study provides fundamental support for policymakers in-order to reinforce the adaption strategies of CSA to the peri-urban farmers and guide policies accordingly.

HIGHLIGHTS

- Favorable attitude of farmers towards Climate Smart Agriculture for vegetable and rice production
- Farmer's level of education, farm size, agricultural training and farming experience showed significant positive attitude towards climate smart agricultural practices.

Keywords: Attitude, Climate Smart Agriculture, Food Production, Peri-Urban, Principles

The agricultural sector of Bangladesh has grown progressively in recent years. Agriculture is a strong pillar of the Bangladesh economy, which contributes 16.5% of the country's Gross Domestic Product (GDP) and creates the greatest employment opportunity. Noteworthy investment in research, technologies and mechanization plays a remarkable role for increasing agricultural productivity and proficiency. Moreover, Bangladesh is the most climate change vulnerable country in the world (Harmeling, 2011). The country is more likely negatively affected by sea level rise and saline water

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intrusion in the coming decades. Besides, the mean temperature will be increased by 1.7°C by 2050. The country will face rainfall variability and an increase in the frequency and intensity of extreme weather events which is mentioned by the Global Climate Risk Index (GCRI).

The climate smart agriculture (CSA) focuses on sustainable agriculture development and climate responsiveness. It attempts to link the broadening gap between demand from man and supply from nature although taking care of the environment. Climate smart agricultural practices and technologies sustainably increase productivity, enhance resilience and reduce greenhouse gas emissions. Climate smart agriculture aims at achieving the same food security objectives as sustainable agriculture but has a different presentation by seeing through the lens of climate change. Climate smart agriculture is an integrated approach that is being applied in productive sectors, having significant impacts on food security and climate change. Climate smart agriculture reduces vulnerability to drought, pests, diseases and other climate related risks and shocks. It improves the capacity to face stresses like shortened seasons and erratic weather patterns.

Bangladesh's population is increasing quickly and will pass 200 million by 2045 (medium variant projection) (United Nations Department of Economic and Social Affairs Population Division [UNDESA] 2015). Population growth results in an increase in the absolute number of the population and an increase in the standard of living. These two determinants are associated with extraction and consumption of natural resources. The emission of greenhouse gasses (GHGs) is a function of the total population because every mouth has to be fed. The growing population is putting stress on agricultural production systems that aim to secure food production (Vetter *et al.* 2017). On the contrary, food production contributes a substantial amount of GHGs, including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (NO) to the atmosphere (Cohen 2010; Smith & Martino 2007; Steinfeld *et al.* 2006; Vetter *et al.* 2017; Wolf *et al,.* 2010). Agriculture has a remarkable contribution to ensure national food security, especially for developing countries like Bangladesh. Methane generated from agricultural practices is the second major source of GHGs emission in the world (United States Environmental Protection Agency [USEPA] 2018a). Moreover, industrialization and development initiatives contribute enormous GHGs emissions (He, 2014). GHGs are the most important driver of observed climate change on Earth since the mid-20th century (United States Environmental Protection Agency [USEPA] 2018b). In fact, the more population on earth indicates more production of agricultural and non-agricultural products, enhancing consumption and profuse emissions which intensifies climate change.

Agriculture as a whole and food production systems must undertake significant transformations in order to meet the associated challenges of food security and climate change. Aggregate resource efficiency is crucial both to increase and ensure food security in the long term and to contribute to mitigate climate change. In another part, to cope up with every type of risk, building resilience is essential and you have to be prepared for facing any sort of uncertainty and change. Efficiency and resilience have to be considered at every stage of the food production system, nonetheless give emphasis on environmental, economic and social perspectives also. Implementing climate-smart agriculture could be a major driver of a green economy and a solid way to operationalize sustainable development. Addressing food security and climate change requires concerted and coordinated involvement and action of all stakeholders who are engaged in the agricultural commodity production arena on a long-term perspective. Climate smart agriculture is not a new agricultural system, nor a set of practices. It is a new approach, a way to guide the needed changes of agricultural systems, given the necessity to jointly address food security and climate change. Climate smart agriculture is an integrated approach which can manage most of the productive sectors like cropland, livestock, forests and fisheries. It discourses the interlinked challenges of food security and accelerating climate change. Climate smart agriculture aims to achieve three outcomes like increased productivity, enhanced resilience and reduce emission. FINCA International shows that more than 75% of the world's poor live in rural areas and mainly rely on agriculture for their livelihoods. Nonetheless, in developing countries, the poor spend almost 60 to 80% of their income on food purchase and consumption (World Poverty

Facts, FINCA International, 2022). Climate smart agriculture will address productivity and no land can be left as a fellow by taking care of natural biodiversity and environment. For enhancing climate resilience CSA can reduce vulnerability to drought, pests, diseases and other climate related risks and shocks and improve capacity by introducing modern technologies and variety of seeds, using high yielding cropping patterns etc. Furthermore, for reducing emission, it pursues lower emissions for each calorie or kilo of food produced, avoid deforestation from agriculture and identify ways to absorb carbon out of the atmosphere. While built on existing knowledge, technologies and principles of sustainable agriculture, CSA is distinct in several ways. First, it has an explicit focus on addressing climate change. Second, CSA systematically considers the synergies and tradeoffs that exist between productivity, adaptation and mitigation. Finally, CSA aims to capture new funding opportunities to close the deficit in investment. By this study we are looking forward to find out the government interventions towards promoting climate smart agriculture in the rural areas moreover we want to investigate an insight into farmers' attitude to climate smart agriculture and the coping practices they follow finally to identify the constraints and challenges to adoption of climate smart agricultural techniques and practices to food production. The findings will help to formulate a comprehensive plan in terms of food security and climate resilient for the government, researchers and policy makers. The objectives of the study were (i) to have an insight into farmers' attitude towards climate smart agricultural technologies and practices and (ii) to find out the constraints and challenges to adoption of climate smart agricultural techniques and practices to food production.

MATERIALS AND METHODS

Study Area and Methods of Data Collection

The study was conducted in the Dhamrai upazila, located about 40 kilometers northwest of the capital city of Dhaka. The study area has been selected based on the expected fair representation of peri-urban farmers who have been experiencing the year-round farming activities of rice and vegetable production and marketing. A household survey was conducted in May-September 2022 where 160 farmers were randomly sampled from eight union mainly with farming communities Balia, Kushura, Bhararia, Sonora, Ganggutia, Sutipara, Nannar and Saupur (Fig. 1) using the random sampling method. Pretested semi-structured interview schedules have been used to collect data through face-to-face personal interviews. The respondents were Bengali speaking people, and accordingly the interview schedule was translated into Bengali. The interview schedule was pretested with 15 respondents from the sampling frame. Necessary modification and correction were done based on pre-test experience. Length of interview schedule was calibrated with the willingness of the respondents to spend time and the extent of the information needed for the research. Data was also collected from the farmers through two focus group discussions with the rice and vegetable producer group (having 12 farmers in each FGD). Moreover, eight key informant interviews (KII) conducted within them include two agricultural input marketing companies; two government officials from the department of agriculture extension; two researchers and two academicians who have been working to invent and disseminate Climate Smart Agriculture (CSA) practices among the farmers. A total 2 FGD and 8 KII was conducted. At the end of each of the interviews, spot editing of the collected information was done to check if there was any missing information, blank items or need for further clarification.

Hypothesis of Explanatory Variables

The dependent variables in this study are Climate Smart Agriculture (CLA) adaptation attitudes, while the explanatory variables are based on available data that includes: household characteristics (the level of education, occupation, family size, income of the household), years of farming experience, cultivated farm size, training experience and extension services. The independent variables and climate-smart agricultural practices were defined based on Hasan *et al.* (2018) and Hasan and Kumar, (2019). The hypothesis explains how explanatory variables influence the adoption of CSA to climate change.

Measurement of Attitude Variables on Climate Smart Agriculture

Attitude towards climate smart agriculture of a respondent referred to his/her feelings, belief and action tendency on the way to different components of agriculture and its practices. Likert scale was used (Likert, 1932) to determine the attitude. The attitude scale contained six statements consisting both positive and negative statements. A statement was considered positive only when it reflected the idea of favorableness towards the CSA and vice-versa. The respondents were asked to express his/her opinions in the form of strongly agree, agree, undecided, disagree and strongly disagree. Scores of 5, 4, 3, 2, and 1 were assigned, respectively for a positive statement and reverse scoring was followed for the negative statements. Hence the attitude of a respondent towards climate smart agriculture was determined by summing up the scores obtained by him/her for all statements in the scale. Six personal and socio-economic characteristics of the respondents namely: age, educational qualification, family size, farm size, microcredit/loan recipient, agricultural training recipient were selected to understand the factors contributing farmers' attitude towards CSA. Standard and conventional procedures were maintained to measure these explanatory variables.

$$\text{Attitude score} = 5 \times SA + 4 \times A + 3 \times U + 2 \times DA + 1 \times SDA$$

Where,

SA = Number of respondents expressing their attitude 'strongly agree' for the statement

A = Number of respondents expressing their attitude 'agree' for the statement

U = Number of respondents expressing their attitude 'undecided' for the statement

DA = Number of respondents expressing their attitude 'disagree' for the statement

SDA = Number of respondents expressing their attitude 'strongly disagree' for the statement

Measurement of Constraints and Challenges Faced by the Farmers for Applying or Practicing Climate Smart Agriculture

Constraints Facing Index (CFI) was computed taking ten selected constraints by using following formula (Roy, 2014).

$$\text{Constraints facing index } (CFI) = Ch \times 3 + Cm \times 2 + Cl \times 1 + Cn \times 0;$$

Where,

Ch = Number of respondents indicating high constraint facing;

Cm = Number of respondents indicating medium constraint facing;

Cl = Number of respondents indicating low constraint facing and

Cn = Number of respondents indicating no constraint facing.

Data Analysis

The collected data were coded, compiled, tabulated and analyzed for interpretation. The SPSS (version 22) computer program was used for analyzing the data. Different descriptive statistical measures such as frequency, number, percentage, mean, standard deviation and rank order were used for categorization and describing the variables. Karl Pearson's Product Moment Correlation coefficient (r) (Pearson, 1895) was used for testing the relationship between the concerned variables. Nevertheless, correlation analysis only indicates the direction of relationship of selected variables with farmers' attitude towards practicing climate smart agriculture but cannot show their influences quantitatively so that attitude can be explained. So, regression analysis (both enter and stepwise method) was run to explore the effect of explanatory variables (selected characteristics) on farmers' attitude towards practicing CSA. Thus, the influential factors were identified that have effects on farmers' attitude towards practicing climate smart agriculture. It helps to reveal highest coefficient of determination (R), that is, amount of change of dependent variable by the independent (selected) variables.

RESULTS AND DISCUSSION

Government Interventions towards Promoting Climate Smart Agricultural of Rural Areas in Bangladesh

The Government of Bangladesh and its line ministry have taken tremendous interventions towards promoting climate smart agriculture. The notable and important activities are taken by the government as follows- reinforce research and development, enhancing capacity development activity, strengthen extension work, technology demonstration, providing incentives, build public-private partnership with various academic-research and service providers etc. Government as allotted a significant budgetary portion for improving climate smart agriculture throughout the country. Moreover, different development agencies like The World Bank, The Asian Development Bank, International Fund for Agricultural Development (IFAD), The United Nations Development Programme (UNDP) and International Rice Research Institute (IRRI) are proving financial and technical support to disseminate climate smart agricultural technologies and practices in rural and urban areas through different project and programs. Government has formulated delta plan, five year plan, national agriculture extension policy, GAP policy, national agricultural mechanization policy, integrated micro irrigation policy, underground water use in agriculture rules, national organic agriculture policy, inbred wheat and rice variety evaluation & release method, AIP policy, potato production tissue culture lab establishment & operation guidelines, agriculture farm labor recruitment and control policy, fertilizer (management) guidelines and amendment etc. Some of the key interventions made by the government towards promoting climate smart agriculture are (i) agricultural innovation system, (ii) gender-sensitive development of homestead production, (iii) resilience through diversification, (iv) livestock upstream value chain development and (v) climate resilient agri-livelihood development in special natural water body-haor areas.

Climate Smart Agricultural Technologies and Practices which are used by Farmers

Table 1 and 2 representing farmers' performing scenarios on selected CSA technologies and practices in case of rice and vegetable production. It was observed that 11.76% and 41.18% of respondent farmers regularly practiced and partially practiced climate smart agriculture for rice production respectively. Moreover, 22.73% and 54.55% of respondent farmers are regularly practicing and partially practicing climate smart agriculture for vegetable production respectively. It was revealed that the climate smart agricultural technologies using scenario is comparatively better in case of vegetable production than rice production.

Table 1: CSA technologies and practices scenario for rice production

Sl. No.	Name of the technology	Regularly practiced	Partially practiced	Not practiced
Boro/Aus Rice Production				
1	Alternative wetting and drying			
2	Deep placed briquetted urea fertilizer for rice			
3	Use of submergence resistant and high yielding verities			
4	Use of short duration high yielding varieties			
5	Use of lodging resistant (tall) high yielding varieties			
6	Use of drought resistant varieties			
7	Use of solar power irrigation			
8	Direct seeding			
9	Moving to non-rice crops			
10	Mid-season drainage			
11	Off season incorporation of rice straw			
12	Substitution of urea with ammonium sulphate			
13	Residue management			
14	High efficiency fertilizer application			
15	Farm mechanization			
16	Use of porous pipe			
17	Use of leaf color chart			

Table 2: Climate smart agricultural technologies and their practice scenario in vegetable production

Sl. No.	Name of the technology	Regularly practiced	Partially practiced	Not practiced
Vegetable Production				
1	Sorjan cultivation method			
2	Mulching			
3	Floating bed cultivation on water bodies			
4	Use of drip irrigation			
5	Vertical gardens			
6	Rooftop gardening			
7	Crop rotation			
8	Relay crop			
9	Use of modified varieties			
10	Zero or minimum tillage/conservation techniques			
11	Potted vegetable supported by bamboo and polythene			
12	Grassland management			
13	Water and irrigation management			
14	Landscape and level pollination management			
15	Organic agriculture/use of vermi-compost/other compost			
16	Cover cropping			
17	Integrated nutrient and soil management			
18	Ecosystem based approaches			
19	Agricultural forestation/buffer agriculture			
20	Integrated pest management			
21	Use of natural pest protector			
22	Use of pheromone trap/yellow board/adhesive chart			

Selected Characteristics of the Farmers Attitude

A host of factors that come into play in advancing climate smart agriculture by the farming community. Six features have been selected to describe the characteristics profile of the respondent farmers shown in Table 3. The mean age of the farmers was found around 37 years and the majority (49.37 percent) of them are middle aged. All of the respondents were educated, they can provide signatures and have a primary to higher secondary level of education. The average family size is high (4.98), compared to the national average of 4.06 (HIES, 2016). Majority of the respondents belong to medium to large farm size category. The average farm size of the respondent farmers was 0.73 ha which was higher than that of the national average of 0.51 ha or 1.24 acres per farmer (BBS, 2015). It was found that 68.12% respondent are credit borrowers from banks and other MFIs or financial institutions while 13.75% respondent is non-credit borrower and rest of the 18.13% respondents are saving depositors. This observation revealed that farmers have access to financial services from MFIs and Banks. The result showed that 56.88% respondent farmers had received short duration (1 to 3 days) training on agricultural cultivation, production, packaging and marketing related issues. The training is mainly provided by DAE and NGO like BRAC, Asha, Proshika, SDI etc.

Farmers Attitude towards CSA Practicing for Food Production

Farmers' attitude towards climate smart agriculture practice is the main focus of this study. Five statements were made to measure the extent of farmers' attitude towards CSA practices as presented in Fig. 1 and table 4. The observation showed that 90.60%, 5% and 4.38% farmers had favorable, non-favorable and no observation towards climate smart agriculture practices, respectively. This finding shows a close similarity with Mohan and Helen, 2014 observations.

Table 3: Salient characteristics of farmers' attitude towards CSA (n=160)

Characteristics	Measuring Unit	Possible Range (observed range)	Respondents				
			Categories	No.	%	Mean	SD
Age	Year	18-53	Young (18-35)	47	29.38	37.36	8.13
			Middle aged (36-50)	79	49.37		
			Old (above 50)	34	21.25		
Educational qualification	Year of schooling	0-14	Illiterate (can sign)	38	23.76	7.12	5.89
			Primary (1–5)	45	28.12		
			Secondary (6–10)	53	33.12		
			Higher secondary (above 10)	24	15.00		
Family size	Number	4–10	Small (up to 4)	28	17.50	4.98	1.57
			Medium (5-6)	93	58.12		
			Large (above 6)	39	24.38		
Farm size	Decimal	50-150	Small (below 50)	56	35.00	0.73	0.53
			Medium (51-100)	96	60.00		
			Large (above 100)	8	5.00		
Microcredit recipient	Group member	Borrower/ Non borrower	Savings member	29	18.13	7.88	6.98
			Credit borrower	109	68.12		
			Credit non borrower	22	13.75		
Agricultural training received	Day(s)	0-5	No training exposure (0)	60	37.50	1.55	1.23
			Low training exposure (1-3)	91	56.88		
			High training exposure (above 4)	9	5.62		

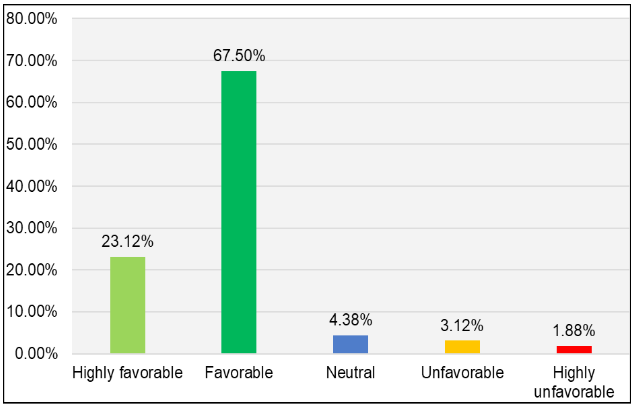

Fig. 1: Graphical Representation of Farmers Attitude toward CSA

Table 4: Numerical Representation of Farmers Attitude toward CSA (n=160)

Categories	Respondent	
	Number	Percent
Highly unfavorable	3	1.88
Unfavorable	5	3.12
Neutral	7	4.38
Favorable	108	67.50
Highly favorable	37	23.12
Total	**160**	**100**

They observed that the majority of the organic farmers (86.67%) had a favorable attitude towards organic farming practices followed by a more favorable (10%) and less favorable (3.33%) attitude. The favorable attitude towards climate smart agriculture might be due to the fact that the farmers' belief this practice will be a profitable activity for more income.

Relationship between Farmers Characteristics and their Attitude towards CSA

Relationship between the selected characteristics of the respondent farmers and their attitude towards climate smart agriculture is presented in table 5. It is observed that, the level of education, cultivable land size, extension services & media contact, agricultural training and farming experience shows significant positive attitude towards climate smart agriculture. However, the other characteristics like age, organizational participation and annual income do not show any significant positive attitude towards CSA. Oluwasusi, (2014) found similar results regarding perception and attitude of farmers towards organic agricultural practices. Adebayo and Oladele, (2013) showed that farming

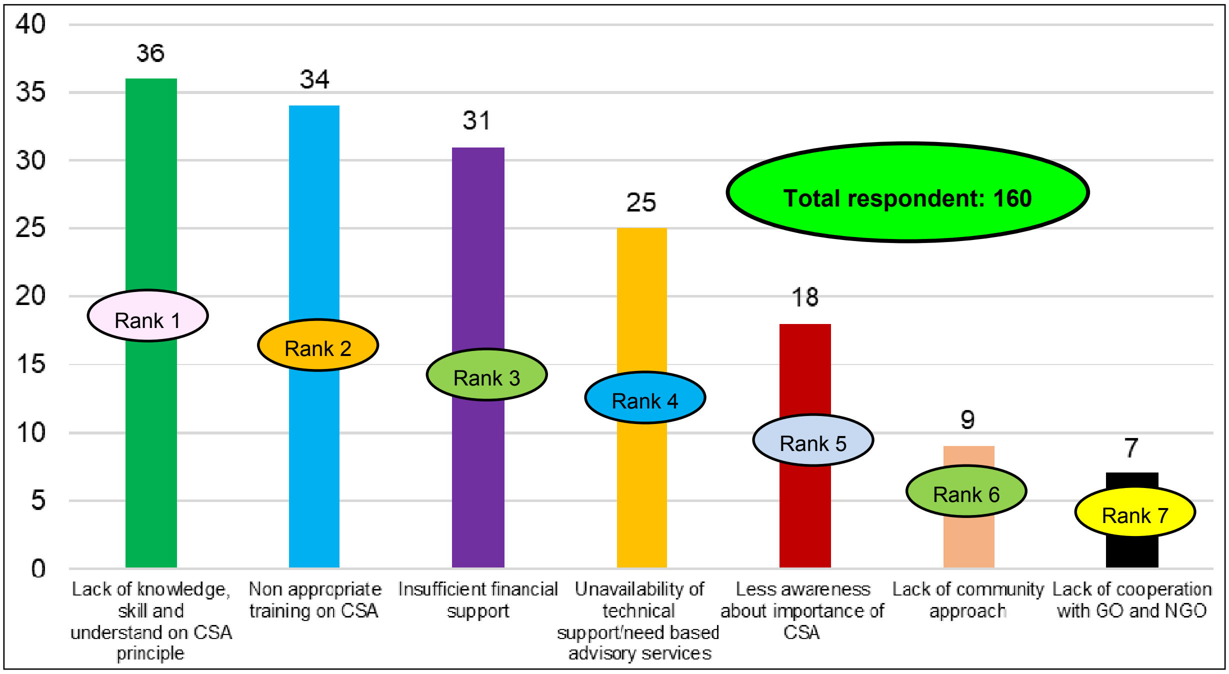

Fig. 2: Constraints and Challenges to Adoption of CSA to Food Production

experience, farm size, household size, organization membership and frequency of extension contacts had significantly positive relationships with attitude towards organic farming practices.

Table 5: Relationship between the selected characteristics and their attitude towards climate smart agriculture (n=160)

Variable	Selected characteristics of farmers	Correlation coefficient (r)
Attitude towards climate smart agriculture	Age	0.005
	Level of education	0.171*
	Family size	0.015
	Cultivable land size	0.129*
	Organizational participation	0.078
	Annual income	0.077
	Extension services and media contact	0.384**
	Agriculture training received	0.212*
	Farming experience/ Scientific orientation	0.212*

** Significant at 0.05 level of probability and ** Significant at 0.01 level of probability.*

It was revealed from table 5 that there was a negative and non-significant relationship between age and attitude of farmers towards climate smart agriculture. From this finding, it can be inferred that as the age of the farmers increases, a favorable attitude towards ICT tools decreases. But the relationship between the two variables was found non-significant. Age may have negatively influenced the utilization of CSA practices due to lack of skill in utilization of those tools. It is evident that there is a positive and significant relationship between education and farmers' attitude towards climate smart agriculture and also positive and significant relationship between cultivable land size and the attitude of farmers towards climate smart agriculture. The farmer who has more cultivable land shows a positive attitude towards CSA. It could be that the more cultivable land gives a strong financial backup for practicing new technologies. It is also evident that there is a positive and significant relationship between training and attitude of farmers towards climate smart agriculture. From this finding, it can be summarized that the technical know-how can make a favorable attitude towards CSA. It is also evident from table 5 that there is a positive and significant relationship between extension contact and attitude of farmers towards climate smart agriculture. From this finding, it can be concluded that continuous technical supervision and monitoring plays a crucial role for technology adoption. There is a positive and significant relationship between scientific orientation and attitude of farmers towards climate smart agriculture. From this finding, it can be concluded that demonstration of good agricultural practices plays a pivotal role for technology acceptance.

Constraints and Challenges Faced by the Farmers in Practicing CSA

Seven constraints which hindered the farmers in practicing climate smart agriculture were ranked according to the order are presented in Fig. 2 and table 6. It was observed that the highest constraint was lack of knowledge and understanding on the principles of climate smart agriculture. It was revealed that 22.50% farmers have no knowledge on the basic principle of climate smart agriculture for vegetable and rice production. Moreover, they do not know proper soil, water, fertilizer, pesticide, residue and postharvest loss management techniques.

Table 6: Ranked order of the constraints and challenges faced by the farmers towards climate smart agriculture (n=160)

Sl. No.	Constraints	Respondent Number	Rank Order
1	Lack of knowledge, skill and understand on the principle of CSA	36	1
2	Insufficient training on CSA	34	2
3	Insufficient financial support	31	3
4	Unavailability of technical support/need based advisory support	25	4
5	Less awareness about importance of climate smart agriculture	18	5
6	Lack of community approach	9	6
7	Lack of cooperation of GO and NGO	7	7
Total		160	

It was found that 21.25% farmers faced constraints of insufficient training on CSA which rank second. The study revealed that insufficient training means less introduction of CSA technologies and practices with farmers which is obviously needed for rice and vegetable production. Farmers expressed their attitude that they need training especially on use of submergence resistant and high yielding varieties, use of short duration and high value crops, use of solar power irrigation, use of salinity resistant varieties, soil management, soil test, crop cultivars, crop rotation, mix cropping, mulching, pest management system, procedure of making organic pesticides and pesticide residue and withdrawal date of pesticides. Farmers also expressed that they did not have enough ideas on safe food regulations. It is evident from table 6 that insufficient financial support is another major constraint for adoption of CSA which rank three. The study found that 19.38% respondents have problems with sufficient finance for applying CSA practices. It was observed that the constraints and challenges like unavailability of need based technical support, less importance given by the farmers on CSA, lack of community approach and low cooperation from government and non-government organization remain rank 4,5,6 and 7 respectively.

CONCLUSION

Most of the respondent farmers have a favorable attitude towards CSA for vegetable and rice production. Lack of skill and understanding of the principles of CSA were the highest constraints faced by the farmers followed by insufficient training, inadequate financial services, unavailability of need based technical provision found the other constraints to adoption of climate smart agricultural techniques and practices to food production. The proper ways should be taken to overcome the problems. Farmer's level of education, farm size, agricultural training and farming experience of the respondent showed significant positive attitude towards climate smart agricultural practices. So, these characteristics should be taken into consideration.

It is therefore recommended that the department of agricultural extension (DAE) can take necessary policy and research initiatives on CSA. It also recommended to ensure incentive for technology adoption, appropriate extension services and availability of necessary inputs with a reasonable cost on climate smart agricultural technologies

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