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Competitive Research Grant

Sub-Project Completion Report

on

Agricultural Practices and Livelihood Patterns of Selected Tribal Communities in Bangladesh

Project Duration

July 2017toSeptember 2018

Department of Agricultural Economics and Policy
Faculty of Agricultural Economics and Business Studies
Sylhet Agricultural University, Sylhet-3100

Submitted to

Project Implementation Unit-BARC, NATP 2
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

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Acronyms

BBS	=	Bangladesh Bureau of Statistics
BCR	=	Benefit cost ratio
BDT	=	Taka of Bangladesh
C-L-H	=	Crop-Livestock-Homestead Enterprise
C-L-P	=	Crop-Livestock-Poultry
Co-PI	=	Co-Principal Investigator
C-P-H	=	Crop-Poultry-Homestead Enterprise
DAE	=	Department of Agricultural Extension
e.g.	=	exempli gratia (for example)
et al.	=	et alia (L.) and Other
etc.	=	et cetera (Other and so forth)
FGD	=	Focus Group Discussion
GM	=	Gross margin
GoB	=	Government of Bangladesh
GR	=	Gross return
ha	=	Hectare
HDI	=	Human Development Index
HDR	=	Human Development Report
HHs	=	Households
ICM	=	Integrated Crop Management
i.e.	=	id est (that is)
IPM	=	Integrated Pest Management
kcal	=	Kilocalorie
KII	=	Key Informant Interview
MPI	=	Multidimensional Poverty Index
NGO	=	Non-Governmental Organisation
No.	=	Number
NR	=	Net return
PCI	=	Problem Confrontation Index
PI	=	Principal Investigator
Tk.	=	Taka
US$	=	Dollar of the United States
viz.	=	videre licet (that is to say)
%	=	Percentage

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Executive Summary

The study was conducted to assess improvement of the livelihood of tribal farmers' through the use of agricultural technologies in Bangladesh. A total of 600 respondents were surveyed using multi-stage sampling technique from three districts of each Sylhet and Chittagong division. From Sylhet division, *Garo, Khasia*and*Manipuri*groups; and from Chittagong division, *Chakma, Marma*and*Tanchang* groups were interviewed. Information and data were collected from the respondents through questionnaire survey, key informant interviews (KII), focus group discussions (FGD), etc. The target of the key informant interviews (KII) and focus group discussions (FGD) was to get a rapid assessment of farmers' socioeconomic status and livelihood conditions, agricultural pattern and production practices, use of agricultural technologies, and constraints regarding agricultural production and agricultural technology use. For analyzing the data, a combination of descriptive (i.e., sum, average, percentages, ratios, etc. with the support of tables and figures), mathematical and statistical techniques were used. Descriptive statistics showed that average household size of the farmers was 6.0 (whereas 68.0% members were male and 32.0% were female) and 5.0 (whereas 65.0% members were male and 35.0% were female) in Sylhet and Chittagong divisions, respectively which was lower than the national average indicating to have an importance on household decision making activities.Most of the farmers were engaged in agriculture as well as other income generating activities. The most common farming practices were crop-livestock-poultry (C-L-P), crop-poultry-homestead enterprise (C-P-H) and crop-livestock-homestead enterprise (C-L-H). On an average, 84.8 and 82.7 percent of total cropped area of the farmers were under crop production in Sylhet and Chittagong divisions, respectively. Farmers had been given knowledge and training on organic farming, mixed cropping, assessment of climate change impact, improvement of soil quality, IPM and ICM Technology, livestock management, etc. Livelihood status of the farmers incorporating farmers' asset possession, activities and strategies, well-being, and external policies and institutions was improved by their agricultural production practices. Among all the agricultural enterprises, on an average, poultry rearing was the highest profitable business in Sylhet division (with BCR 2.08) and livestock rearing was the highest profitable business in Chittagong division (with BCR 2.06) for the farmers. The estimated crop productivity index value was 144.3 and 149.9 percent in Sylhet and Chittagong divisions which indicates that crop productivity was of moderately high range in the study areas. Average net change in inventory in Sylhet and Chittagong divisions was estimated at Tk. 16615 and Tk. 19125, respectively. Lower profitability in crop production and homestead farming had an influence on farmer to shift their concentration to comparatively higher profitable business of livestock and poultry production. Overall, 39.2, 26.6 and 34.2, and 38.8, 26.5 and 34.7 percent farmers in Sylhet and Chittagong divisions assured about increased, decreased and constant state of production practices using agricultural technologies, respectively like betel leaf and betel nut production, eel fish production (*MonopterusCuchia*, Eng. Name - Cuchia), agroforestry plantation, coffee tree cultivation, *jhum*cultivation, medicinal plants cultivation and rice cultivation (local). Educational level of household head, farm size, farm income, extension contact and farming experience had significant influence in explaining the variation in adopting agricultural technologies by the farmers. It was found that average annual income and expenditure of the farmers in Sylhet and Chittagong divisions was Tk. 92092 and Tk. 87459, and Tk. 111606 and Tk. 112451, respectively which were lower than the national average indicating an ample scope to increase the farmers' income thorough technology adoption. Food security indices indicated that average per capita daily calorie intake of the households was still below the national average level of 2122 kcal. The study revealed that poverty in terms of deprivation of health, education and living standards was decreased, and a remarkable improvement in farmers' socioeconomic status was found by using agricultural technologies. The study

recommended that training; motivation and extension services of government should be properly implemented to raise the awareness about modern agricultural technologies and its importance on agricultural production among the tribal groups.The study identified some promising technologies which are very important for sustainable livelihood for tribal communities which are betel leaf and betel nut production, eel fish (*MonopterusCuchia*, Eng. Name - Cuchia)production, agroforestry plantation, coffee tree, *jhum*, medicinal plants and rice cultivation (local). Also, initiative for scientific and technical training programs should be arranged by different government and non-government organizations to enrich the knowledge of the farmers on agricultural technology use.

CRG Sub-Project Completion Report (PCR)

A. Sub-project Description

1. Title of the CRG sub-project: Agricultural Practices and Livelihood Patterns of Selected Tribal Communities in Bangladesh
2. Implementing organization: Department of Agricultural Economics and Policy
   Faculty of Agricultural Economics and Business Studies
   Sylhet Agricultural University, Sylhet-3100
3. Name and full address with phone, cell and E-mail of PI/Co-PI (s):

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4. Sub-project budget (Tk):
   4.1 Total: Tk. 2500000.00
   4.2 Revised (if any): Not Applicable

5 Duration of the sub-project:
   5.1 Starting date (based on LoA signed): July 2017
   5.2 Ending date: 30 September 2018

6. Justification of undertaking the sub-project:

6.1 General background

Tribal people of Bangladesh are descendants of the original inhabitants of their land and are strikingly diverse in their culture, religion and patterns of social and economic organization. The exact number of ethnic minorities in Bangladesh is unknown. Officially the Bangladesh Government recognizes 27 ethnic minorities as the Small Ethnic Minority Cultural Institute Act of 2010. Different rights based organizations claimed that more than 45 ethnic minorities lived in Bangladesh before Independence in 1971 but ethnic minorities claimed that the exact number is closer to 2 million (Barman and Neo, 2014). There are about 35 smaller groups of Indigenous communities in Bangladesh covering about two

percent of the total population have been living in different pockets of the hilly zones and some plain lands of the country. The beauty of the hilly zones as well as the plain areas has been enhanced by the colorful culture and traditional practices of different ethnic groups, like the *Mandi* and *Hajong* in the northern part, the *Manipuri* and *Khasia* in the northeast (Sylhet), the *Chakma, Tripura, Marma, Rakhain, Mru, Tanchyanga, Murong* in the eastern and southeastern parts, and the *Santal*and *Rajbangshi* in the western part of the country.

In Bangladesh, the livelihood of rural people is dependent largely on agricultural activities but only the paddy production in small pieces of land is not sufficient to satisfy the need for survival of the small farmers. So they started thinking about the alternatives use of lands in order to get increased output from their small pieces of land and found a new way of using their scare resources in mixed nature. As the same piece of land use have effects on livelihood pattern largely in employment pattern, income, seasonality, social identity etc. The life style of each indigenous community is unique and related to the utilization of particular natural resource and particular type of work. Since tribal communities live in the close proximity with biodiversity rich landscapes, they have evolved local specific and novel livelihood strategies based on their indigenous knowledge. This knowledge was passed on through generations and it played an important role in conservation and sustainable use of biodiversity. By and large, they were depending on nature for their survival. Thus, there always existed an organic unity between human and their surrounding environments in the traditional societies. As a result, there existed an intricate relationship between their culture and nature.

Since last decade, the issues regarding livelihoods of tribal ethnic groups have been demanding increased attention by the government and international communities for their social, economic and cultural emancipation. They are the poorest group among the poor. Most of the tribal people are engaged with such income-generating activities which do not carry a high standard. In this region, most of the indigenous people earn their living through agricultural work and live just above or below the subsistence level. Here, tribal households generally used upland, plain land and homestead area for crop production. Upland and homestead area were mainly used for producing seasonal indigenous crops, vegetables, fruits and different forest trees. Though they earn their living through agricultural works, they have lack of knowledge about modern agricultural technologies. The other sources of household income of tribal people are livestock rearing, fish culture, selling of commodities and non-farm activities. It is possible for the tribal people of this region to improve the livelihood through integrated agricultural practices if they are provided with technical supports and modern technologies by the expert people.

6.2 Literatures related to present study

Toppo *et al.* (2016) examined the socioeconomic condition of tribal people and found that 60.94% households are involved in agricultural day labor activities. Around 22.14% household depend on their own cultivable land for production, 5.99% in various formal and non-formal service sectors, 2.34% of total sample HHs are involved in livestock rearing. About 2.86% tribal households were found involved with small business activities (Petty shop, tea stall). Among the *Mahali* and *Roabidas* tribal community have their own tradition occupation e.g. cobbler, bamboo material small cottage etc. Regarding average monthly income of the households, majority (50.26%) of the households are up to 4000.00 BDT (US$ 50) per month.

Jayasree *et al.* (2014) found that *Jhum* or shifting cultivation is the dominant land-use practice of northeastern region of India. *Jhum* cultivation systems are generally productive, making efficient use of resources, ensuring ecological sustainability and food security, thus providing a social safety net for local communities. The study revealed that the highest proportion (39.3%) of tribal farmers have low livelihood status followed by medium (36.4%) and high (24.3 %) livelihood status. Education, family size, number of family members involved in *Jhum,* area under *Jhum,* annual income, fallow period, livestock possession, material possession, and extension participation had positive significant relationships with the livelihood status of the study sample and thus, could be manipulated to improve the livelihood status of tribal people.

Prajapati *et al.* (2014) found that a large number of tribal communities are bereft of stable livelihood and thus they fall in the category of the vulnerable section of Indian society. The study showed that in case of tribal group, there was positively and significant association between the sustainable livelihood and seven criteria for agricultural modernization viz., extent of use of organic fertilizers, farming pattern, seed selection, available modern sources of energy equipment, extent of use of chemical fertilizers, use of plant protection measures and extent of use of improved dairy practices. While in case of non tribal group, all the 13 criteria of agricultural modernization studied were possessed positive and significant association with sustainable livelihood. It indicated the impact of the agricultural modernization on the extent of sustainable livelihood among the non-tribal respondents, while it was very low in tribal farmers.

Bappy (2012) reviewed the livelihood status and food security of indigenous people in Mymensingh district and found that most of the indigenous households of the study area were food insecure because of low income, low employment opportunity. The purchasing power of the ethnic households was in general poor. They had limited option and alternatives for income generation. Indigenous households' consumption behavior revealed that indigenous household members ate rice, fresh fish, meat, vegetables, potato, fruits, and spices more than the national average.

Faisal (2012) drawing upon qualitative evidence from the *Khasia* and *Garo* communities of Bangladesh, focused on the problems of older people of these tribal groups and explained some of the coping mechanisms used by the elders. Findings indicated that high status and support is extended to elders by family and community as part of tribal tradition and culture. Nonetheless, these elders still face problems that are largely a function of their age and economic and social circumstances. Lack of access to mainstream services is one of the major concerns among the older *Khasia* and *Garo* people. The tribal older people experience negligence, exclusion, and the violation of rights. Although the tribal older people have their own system to encounter problems, they are sensitive to the fact that their community does not always have the financial capacity to provide the required support.

Gigler (2009) identified poverty, inequality and human development of indigenous peoples in Bolivia where the data analysis revealed that eighteen municipalities suffer under extremely low human development of an HDI lower than 0.4 which compares to the levels of human development reached several Sub-Saharan countries such as Mali (0.391) or Ethiopia (0.389). It is particularly noteworthy that all the municipalities with either low and/or extremely low levels of human development are located in the western highlands and have a predominant indigenous population.

Saha and Azam (2004) studied on the indigenous hill-farming system and the status of *Khasia* tribes in Moulvibazar district of Bangladesh. Traditionally, Khasia tribes produce betel leaf supporting on naturally occurring tress. They studied that, *Khasia* peoples concerned about the forest and protecting trees for their livelihood. They sell betel leaf, collect fuel-wood and also consume the fruits from support trees. The paper stated that, sustainable production system is not only profitable but required betel leaf to the local market and also generate some export revenue for the country.

Nath *et al.* (2003) studied the socioeconomic conditions, hill farming practices and impacts on rural livelihood and forest conservation of the *Khasia* tribe in Sylhet district of Bangladesh. Noted that, survives of the *Khasia* people were centered on the hills and hill based resources. As their economy is basically forest based by using simple traditional technology they primarily depends on betel leaf based hill farming. It is their main sources of occupation. Besides providing earnings and employment opportunities, this type of farming also benefits in conservation of the forest and its floral diversity. In this study it is also stated that a flexible market for betel and the regulation of different tree age-classes can helps to make it a sustainable production system that assists in conserving biodiversity and can be adapted for use in a different place.

Kabir (2002) studied the participation of *Garo* youth in agricultural activities and revealed some problems as no adequate land for crop cultivation, no capital for crop cultivation, no contact with agricultural extension agencies, no training for modern vegetable cultivation and no update knowledge. In overall problem confrontation, above 75 percent of *Garo* youth had medium and non-fifth (14 percent) had problem confrontation.

Uddin *et al.* (2002) accomplished a study about the traditional farming system of *Garo* tribe in Netrokona district of Bangladesh. The study found that *Garo*tribe applied their indigenous knowledge on plain land and homestead management. They mainly adopted agro forestry farming technique for their early income and livelihoods. In case of forestland management they share their knowledge with forest department through participatory management. The study concluded that the indigenous knowledge of *Garo* tribes is helpful for the conservation of natural resources.

6.3 Justification of the study based on research gap

A few studies have been conducted on agricultural practices and livelihood of tribal farmers' in Bangladesh as tribal farmers live in remote areas. Therefore, research on agricultural practices of tribal people in this regions is critically important to know the situation of current agricultural practices among tribal people and their livelihood in order to provide them need based technical supports for modern agricultural practices to improve their living standard. This study will help to identify the present scenario of agricultural practices among tribal farmers' and its impact on farmers' livelihood as well as scrutinize the future potentiality in these neglected areas of Bangladesh.

7. Sub-project goal: Improvement of the livelihood of Tribal farmers' through the use of agricultural technologies in Bangladesh

8. Sub-project objective (s):

i) To identify the socioeconomic profile and livelihood pattern of tribal farmers' of Sylhetand Chittagong divisions;
ii) To know the agricultural practices of tribal farmers' and
iii) To explore the potentiality of the use of agricultural technologies to improve the livelihood of tribal farmers'.

9. Implementing location (s): Sylhet and Chittagong divisions.

10. Methodology in brief:

10.1 Survey of study areas, sample size and ethnic groups

Field survey method was conducted with the corresponding producers and different actors those who were involved with agricultural production, technology, inputs, labour utilization, distribution and consumption level. A total of 600 respondents were surveyed using multi-stage sampling technique. Three districts were selected from each of Sylhet and Chittagong division purposively as study areas which were: Sunamganj, Moulvibazar and Sylhet from Sylhet division and Rangamati, Bandarban and

Table 1: Number of farm households selected for interview by tribal communities

Sylhet division					
Districts		Tribal communities			Total
		Garo	*Khasia*	*Manipuri*	
Sunamganj	SunamganjSadar	30	10	10	50
	Chatak	30	10	10	50
Moulvibazar	Kulaura	3	28	19	50
	Baralekha	5	22	23	50
Sylhet	SylhetSadar	3	2	45	50
	Jaintapur	4	43	3	50
Total		75	115	110	300
Chittagong division					
Districts		Tribal communities			Total
		Chakma	*Marma*	*Tanchang*	
Rangamati	Kawkhali	30	10	10	50
	RangamatiSadar	30	10	10	50
Bandarban	BandarbanSadar	30	10	10	50
	Rowangchari	30	10	10	50
Khagrachari	KhagrachariSadar	30	10	10	50
	Mahalchari	30	10	10	50
Total		180	60	60	300
Grand total					600

Khagrachari from Chittagong division (Map 1). Two upazilas from each district (i.e., Sunamgan jSadar and Chatak from Sunamganj, Kulaura and Baralekha from Moulvibazar, and Sylhet Sadar and Jaintapur from Sylhet; and Kawkhali and Rangamati Sadar from Rangamati, Bandarban Sadar and Rowangchari from Bandarban, and Khagrachari Sadar and Mahalchari in Khagrachari) were selected based on the availability of the ethnic groups. From Sylhet division, *Garo, Khasia*and *Manipuri* groups; and from Chittagong division, *Chakma, Marma* and *Tanchang* groups were interviewed (Table 1). Higher priority was given to select the sampled villages considering the agricultural practices areas. All selected respondents were interviewed.

10.1.1 Basic information on agricultural practices of the tribal groups in Sylhet division

The main livelihood activities of *Garo* are agricultural practices in the plain land, homestead and in the forestland. They follow plough cultivation in plain land for transplanting rice. But they managed their homesteads and forest land as agroforestry system namely agrosilvi pastoral system and agrisilvi cultural system respectively. *Garo* community managed their plain land and homestead since time immemorial. But they managed the forestland from 1990 associated with forest department of Bangladesh. They cultivate rice in the plain land and different vegetable, spices, timber, etc. in their home garden. Except salt and oil, they produced most of their daily necessities. They collected fodder, fuel wood, timber, medicinal drugs and agricultural implements from the forest (Dwivedi, 1993).

Khasi are one of the major ethnic communities of north east Bangladesh, depending on tree crop farming practices for their earnings and livelihood. It is developed by local farmers through generation after generation of their communication with nature and natural resources for food fuel, fodder, resin and shelter. It is a local method of farming tree crops using own dependence locally available materials without massive external/global materials. The general aspect of indigenous cultivation is the existence of spatial and temporal heterogeneity frequently with mix plant age arrangement, intercropping, multi-cropping, host-pathogen interactions and practice of easy instruments to till and harvest the crop.Khasia regions have always been eco-friendly due to their rich traditional practice and prosperous biomass. The farming land is fertilized by organic manure, which derives from forest biomass and livestock (Majumder, 2017).

10.1.2 Basic information on agricultural practices of the tribal groups in Chittagong division

For centuries, *Chakma* community has been practicing *Jhum* cultivation and this term has also been adopted in fishing, hunting and harvesting of forest products. *Jhum* cultivation and forest are still central role player to this traditional society as its primary sources of food, shelter, medicine and other products and services. However, according to expansion of modernization, the farmers have recently shifted the importance from shifting or *Jhum* cultivation to permanent cultivation (Chakma and Ando, 2008).

Jhum cultivation is also the primary agricultural pursuit of *Marma* community. They also supplement their food requirement by gathering tree leaves, roots, and tubers from hill forests. Small-scale homestead gardening is also common among them. Other important economic activities of *Marma* include basketry, brewing and wage labor. Weaving is a very common activity of *Marma* women. Their

economic activities and production system were geared to their subsistence. Recently they became involved in trade and commerce. Produces of the *Marma* people are sold mostly through middlemen. Some *Marma* families now operate small retail stores (Khan and Rashid, 2006).

10.2 Preparation of the questionnaire and data collection

The questionnaire was developed in accordance with the objectives of the research and before finalizing the questionnaire, the draft one was pre-tested. Validity and reliability of the questionnaire was also ensured. Data were collected by the Scientific Assistant and Enumerator(s) along with direct observation of PI and Co-PI. Information and data were collected from the respondents by using structured questionnaire, semi structured interview schedule, etc. Secondary information having relevance with this research were also collected from different handouts, reports, published and unpublished documents of the Government of Bangladesh (GoB) and its different organizations and agencies. Data were collected from different expertise on food safety, nutrition and environmental authorities participating for the agricultural development in Bangladesh through participants and non-participant observations, key informant interviews (KII), focus group discussions (FGD), cluster based survey, in-depth interviews and case studies.

The aim of the key informant interviews (KII) and focus group discussions (FGD) was to get a rapid assessment of farmers' socioeconomic status and livelihood conditions, agricultural pattern and production practices, use of agricultural technologies, and constraints regarding agricultural production and agricultural technology use. The topics included the following specific issues:

- Socioeconomic status and livelihood conditions
    - Current land holdings (both agricultural and homestead)
    - Agricultural production practices followed by the farmers
    - The most profitable enterprise for production in the study areas
    - Farmers' engagement with farm and non-farm activities
    - Extension contact and training programs attendance
- Agricultural pattern and production practices
    - The major farming system in the study areas
    - Subsistence and commercial crop production
    - Reasons/motivations for farmers' current agricultural production practices
- Use of agricultural technologies
    - Types of agricultural technologies used
    - Factors influencing farmers' decision to adopt agricultural technologies
    - The impact of using technologies on agricultural production and farmers' livelihood
- Constraints regarding agricultural production and agricultural technology use
    - Major challenges facing by the farmers in agricultural production and use of agricultural technologies

Plate 1: Personal interviews, KIIs and FGDs

Map 1: Map of Bangladesh indicating the selected study areas

Legend: ★ Study areas

10.3 Farmers' training

Farmers' training was the one of the most suitable methods for technology dissemination to raise the productivity. Farmers made themselves skilled about technology through participation in the training program. Training program was arranged in the research period for the selected tribal farmers under the project beneficiaries to achieve project goals as well as other farmers of similar environment. A number of 180 participants joined in the training program. For better achievement, training program was arranged in 4 groups, each group consisting of 45 farmers.

Plate 2: Provision of training programs

10.4 Data analysis

For analyzing the data, a combination of descriptive (i.e., sum, average, percentages, ratios, etc. with the support of tables and figures), mathematical and statistical techniques were used to achieve the objectives and to get the meaningful result.

Livelihood component framework

Livelihood component framework was constructed to measure the impact of production practices on farmers' asset possession, activities and strategies, well-being, and external policies and institutions (Uddin and Dhar, 2017).

Profitability analysis

Profitability of different agricultural enterprises under most common farming systems was measured in terms of gross return, gross margin, net return and benefit cost ratio (undiscounted).

Gross return was calculated by multiplying the total volume of output of an enterprise by the average price in the harvesting period (Dillon and Hardaker, 1993). The equation was as follows:

$$GR = X_{mp}P_{mp} + X_{bp}P_{bp}$$

Where,

X_{mp} = Yield of main product per unit area;

P_{mp} = Price of main product;

X_{bp} = Yield of by-product per unit area; and

P_{bp} = Price of by-product.

Gross margin was calculated by the difference between gross return and total variable cost. The following equation was used to calculate GM:

$$GM = GR - \Sigma C_v$$

Where,

GR = Gross return per unit area; and

ΣC_v = Total variable cost per unit area.

Net return was calculated by deducting all costs (variable and fixed) from the gross return. The following algebraic form of NR was used for estimation:

$$NR = GR - \Sigma C_v - \Sigma C_f$$

Where,

GR = Gross return per unit area;

ΣC_v = Total variable cost per unit area; and

ΣC_f = Total fixed cost per unit area.

Benefit cost ratio (BCR) is a relative measure which is used to compare the return per unit of cost. BCR was estimated as a ratio of gross return to gross cost. The formula used for calculating BCR (undiscounted) was as follows:

$$BCR = GR \div GC$$

Where,

GR = Gross return per unit area; and

GC = Gross cost per unit area (i.e., $\Sigma C_v + \Sigma C_f$).

The Enyedi's index of crop productivity measurement

The Enyedi's index was used to measure the crop productivity in the study areas compared to the entire regions (Uddin *et al.*, 2016). For calculation, the following formula was used:

$$\text{Crop productivity} = (YT_n \div Y_nT) \times 100$$

Where,

Y = Production of the respective crop in the unit area;

Y_n= Total production of the crop in the entire region;

T = Cultivated unit area under the respective crop; and

T_n= Cultivated area in the entire region under the respective crop.

Net change in inventory of livestock

Inventory change of livestock was estimated as the difference between the inventory totals for the last reporting period and the current reporting period.Net change in inventory was calculated by deducting the sum of opening stock and bought from the sum of closing stock, consumed/gifted, sold and died (Ahmed, 2015). The formula used was as follows:

$$\text{Net change in inventory} = (\text{Closing stock} + \text{Consumed/gifted} + \text{Sold} + \text{Died}) - (\text{Opening stock} + \text{Bought})$$

Logistic regression model

In order to investigate the extent of influence of the determinants on the decision making status of adopting agricultural technologies, logistic regression analysis (logit model) was used. Logistic regression predicts the probability of an outcome that can only have two values (i.e., a dichotomy). The prediction is based on the use of one or several predictors (numerical and categorical). A linear regression is not appropriate for predicting the value of a binary variable for two reasons: i) a linear regression predicts values outside the acceptable range (i.e., predicting probabilities outside the range 0 to 1); and ii) since the dichotomous experiments can only have one of two possible values for each experiment, the residuals will not be normally distributed about the predicted line. On the other hand, a logistic regression produces a logistic curve, which is limited to values between 0 and 1. The curve in logistic regression is constructed using the natural logarithm of the 'odds' of the target variable, rather than the probability. Moreover, the predictors do not have to be normally distributed or have equal variance in each group (Gujarati, 2003).

In the present study, the following logit model was used to identify the level of influence of the factors influencing adoption of agricultural technologies by the farmers:

$$Z_i = \ln [P_i \div (1 - P_i)] = \beta_0 + \beta_1 Q_1 + \beta_2 Q_2 + \beta_3 Q_3 + \beta_4 Q_4 + \beta_5 Q_5 + \beta_6 Q_6 + \beta_7 Q_7 + \beta_8 Q_8 + U_i$$

Where,

P_i is the probability of adoption and non-adoption of agricultural technologies;

$P_i = 1$ indicates adoption and $P_i = 0$ indicates non-adoption.

Dependent variable:

Z_i= Probability of adoption of agricultural technologies.

Independent variables:

Q_1 = Household size (no.);

Q_2 = Educational level of household head (years of schooling);

Q_3 = Age of household head (years);

Q_4 = Farm size (ha);

Q_5 = Farm income (Tk.);

Q_6 = Non-farm income (Tk.);

Q_7 = Extension contact ($P_i = 1$ indicates having extension contact and $P_i = 0$ indicates having no extension contact);

Q_8 = Farming experience (years of farming);

β_0 = Intercept;

β_1 to β_8 = Regression coefficients of the dependent variables; and

U_i = Error term.

The marginal probabilities of the key determinants of adopting agricultural technologies by the farmers were estimated based on expressions derived from the marginal effect of the logit model which was estimated as:

$$dZ/dQ = \beta_i \{P_i (1 - P_i)\}$$

Where,

β_i = Estimated logit regression coefficient with respect to the i^{th}factor; and

P_i = Estimated probability of farmers' adoption status.

Marginal effects are computed differently for discrete (i.e., categorical) and continuous variables. With binary independent variables, marginal effects measure discrete change, i.e., how do predicted probabilities change as the binary independent variable changes from 0 to 1. Marginal effects for continuous variables measure the instantaneous rate of change (defined shortly). They are popular in some disciplines (e.g., Economics) because they often provide a good approximation to the amount of change in Z that will be produced by one unit change in Q_k. But then again, they often do not (Dhar and Uddin, 2017).

Measurement of food security

To identify the food security status of the selected households, two stages of analyses were done. At first a food security index (Z) was constructed and food security status of each household was determined based on the food security line using the recommended daily calorie intake (Babatunde*et al.,* 2007). Households whose daily per capita calorie intake amounted up to 2122 kcal were regarded as

food secure and those below 2122 kcal were regarded as food insecure. The mathematical representations were as follows:

$$Z_i = Y_i \div R$$

Where,

Z_i= Food security index for i^{th} households (1 = food secure households and 0 = food insecure households, i.e., $Z_i = 1$ for $Y_i \geq R$; and $Z_i = 0$ for $Y_i < R$);

Y_i = Daily per capita calorie intake of i^{th} households;

R = Daily per capita calorie required for i^{th} households; and

i = 1, 2, 3, ……., 200.

Based on the household food security index (Z), food shortfall/surplus index (P) and the head count ratio (H) were calculated. Food shortfall/surplus index was calculated as:

$$P = \frac{1}{M}\sum_{i=1}^{m} G_i$$

Where,

P = Food shortfall/surplus index;

M = Number of food secure households (for food surplus index) or food insecure households (for food shortfall index); and

G_i= Per capita calorie intake deficiency (or surplus) faced by i^{th} households where, $G_i = [(Y_i - R) \div R]$.

The head count ratio (H) measures the percentages of the households that are food secure or insecure which were defined as:

$$H = M \div N$$

Where,

H = Head count ratio;

M = Number of households that are food secure (for food surplus index) or food insecure (for food shortfall index); and

N = Number of sample households.

Multidimensional poverty index

The multidimensional poverty index (MPI) was designed to measure the intensity of poverty of the farming community (HDR, 2015). It comprises three equally weighted poverty dimensions; health, education and living standards. The health dimension is measured by the two equally weighted indicators, nutrition and child mortality. Education is captured by the two equally weighted indicators, years of schooling and child enrolment. Living standards are measured by the six equally weighted indicators; cooking fuel, sanitation, water, electricity, floor and assets. The following formula was used to appraise the intensity of poverty (Uddin and Dhar, 2017):

$$\text{Intensity of poverty} = [\{\Sigma\, c(k)\} \div \Sigma\, q] \times 100$$

Where,

c = Households deprived of the indicators;

k = Weighted score of the indicators; and

q = Average household size in each area.

Problem confrontation index

Problems related to input, output, using agricultural technologies and technical issues were categorized using problem confrontation index (PCI). The researchers identified 07 major problems faced by the farmers in the study areas. An overall score of the problems were computed by adding their scores of the problems in all the selected problems. Each farmer was asked to indicate the extent of difficulty caused by each of the problems by checking any of the four responses such as 'frequently', 'occasionally', 'rarely' and 'not at all' and weights were assigned to these responses as 3, 2, 1 and 0, respectively. The scores of PCI for each selected problem were computed through using the subsequent formula (Dhar *et al.*, 2018):

$$PCI = (P_{frequently} \times 3) + (P_{occasionally} \times 2) + (P_{rarely} \times 1) + (P_{not\ at\ all} \times 0)$$

Where,

$P_{frequently}$= Number of responses indicating the problem occurred frequently;

$P_{occasionally}$= Number of responses indicating the problem occurred occasionally;

P_{rarely} = Number of responses indicating the problem occurred rarely; and

$P_{not\ at\ all}$ = Number of responses indicating no problem at all.

The problems were ranked according their PCI score which denoted their severity in using agricultural technologies.

11. Results and discussion:

11.1 Socioeconomic characteristics of the selected farmers

Table 2 represents the basic information of the selected farmers in the research areas. It is found that average household size of the farmers was 6.0 (whereas 68.0% members were male and 32.0% were female) and 5.0 (whereas 65.0% members were male and 35.0% were female) in Sylhet and Chittagong divisions, respectively which was lower than the national average of 50.1% male and 49.9% female (BBS, 2015) indicating to have an importance on household decision making activities. It was found that farm size of the farmers was 0.44 and 0.52 ha in Sylhet and Chittagong divisions, respectively. Average dependency ratio of the farmers in Sylhet division (1.2) was comparatively higher than of the farmers in Chittagong division (1.0).The percentages of male and female respondents in Sylhet and Chittagong divisionswere 56.0and 44.0 percent, and 62.0 and 38.0 percent, respectively. Average age of the male members of farm households was found as 57.0 years and 56.0 years, and average age of the female members of farm households was found as 49.0 years in both Sylhet and Chittagong divisions, respectively.Though 25.6 and 27.2 percent farmers' family members in Sylhet and Chittagong divisions, respectively could put sign only, majority of them (49.6 and 53.4 percent in Sylhet and Chittagong divisions, respectively) were illiterate.

Table 2: Basic information about the selected farmers

Particulars		Study areas	
		Sylhet	Chittagong
Average household size (no.)		6.0 (male: 68.0%; female: 32.0%)	5.0 (male: 65.0%; female: 35.0%)
Average farm size (ha)		0.44	0.52
Average dependency ratio (no.)		1.2	1.0
Average sex distribution of the farmers (% of farmers)	Male	56.0	62.0
	Female	44.0	38.0
Average age of the household members (years)	Male	57.0	56.0
	Female	49.0	49.0
Literacy rate of the household members (% of respondents)	Illiterate	49.6	53.4
	Sign only	25.6	27.2
	Primary and above	24.8	19.4
Occupational status of the household members (% of respondents)	Agriculture only	38.8	32.5
	Agriculture and others	61.2	67.5
Farming systems practiced (% of farmers)	Subsistence (for own consumption only)	36.0	32.6
	Commercial (both for own consumption and selling in the market)	64.0	67.4

Source: Field survey, 2018.

Table 3: Snapshot of tribal groups' comparison on basic information

Particulars		Study areas					
		Sylhet			Chittagong		
		Garo	*Khasia*	*Manipuri*	*Chakma*	*Marma*	*Tanchang*
Average household size (no.)		5.0 (male: 59.0%; female: 41.0%)	6.0 (male: 70.0%; female: 30.0%)	6.0 (male: 65.0%; female: 35.0%)	5.0 (male: 69.0%; female: 31.0%)	7.0 (male: 61.0%; female: 39.0%)	4.0 (male: 63.0%; female: 37.0%)
Average farm size (ha)		c	0.48	0.43	0.53	0.52	0.51
Average dependency ratio (no.)		1.0	1.2	1.4	1.0	1.2	1.0
Average sex distribution of the farmers (% of farmers)	Male	55.0	59.0	57.0	60.0	65.0	67.0
	Female	45.0	41.0	43.0	40.0	35.0	33.0
Average age of the household members (years)	Male	58.0	63.0	49.0	62.0	54.0	53.0
	Female	49.0	52.0	45.0	54.0	48.0	46.0
Literacy rate of the household members (% of respondents)	Illiterate	48.7	43.7	45.2	56.1	51.6	53.3
	Sign only	24.9	30.5	29.4	27.6	32.1	22.9
	Primary and above	26.4	25.8	25.4	16.3	16.3	23.8
Occupational status of the household members (% of respondents)	Agriculture only	39.5	37.6	38.0	33.0	30.8	32.5
	Agriculture and others	60.5	62.4	62.0	67.0	69.2	67.5
Farming systems practiced (% of farmers)	Subsistence (for own consumption only)	35.2	37.9	38.3	31.9	33.4	31.6
	Commercial (both for own consumption and selling in the market)	64.8	62.1	61.7	68.1	66.6	68.4

Source: Field survey, 2018.

Most of the farmers were engaged in agriculture as well as other income generating activities like labour selling, service, small business, etc. (61.2 and 67.5percent farmers in Sylhet and Chittagong divisions, respectively). It is also found that in Sylhet and Chittagong divisions, 64.0 and 67.4 percent farmers, respectively produced agricultural commodities commercially in the research areas (Table 1).Table 3depicts that the household size of *Marma* group was the highest (7.0) compared to the other groups. *Chakma* group's farm size was relatively higher (0.53 ha) in Chittagong division, and *Khasia* group's farm size was relatively higher (0.48 ha) in Sylhet division. Among all the tribal groups, the dependency ratio was highest in case of *Manipuri* group which was 1.4. In all groups, majority of the farmers surveyed were male which was more than fifty percent, and most of the farmers were illiterate. The tendency of tribal group's engagement in agricultural activities was highest in Sylhet district compared to Chittagong district. The scenario was similar in case of farming systems practiced also (Table 3).

11.2 Production practices in the study areas

A number of production practices were found in the study areas that involved agricultural enterprises like crop, livestock, poultry and homestead enterprise. The most common farming practices were crop-livestock-poultry (C-L-P), crop-poultry-homestead enterprise (C-P-H) and crop-livestock-homestead enterprise (C-L-H).

Table 4: Production practices in the study areas

Farming practices	Study areas			
	Sylhet		Chittagong	
	No. of farmers	% of farmers	No. of farmers	% of farmers
Crop-livestock-poultry (C-L-P)	110	36.7	95	31.7
Crop-poultry-homestead enterprise (C-P-H)	56	18.7	72	24.0
Crop-livestock-homestead enterprise (C-L-H)	134	44.6	133	44.3
Total	300	100.0	300	100.0

Source: Field survey, 2018.

Table 5: Snapshot of tribal groups' comparison on production practices (% of farmers)

Farming practices	Study areas					
	Sylhet			Chittagong		
	Garo	*Khasia*	*Manipuri*	*Chakma*	*Marma*	*Tanchang*
Crop-livestock-poultry (C-L-P)	32.8	40.5	36.0	29.7	32.4	31.0
Crop-poultry-homestead enterprise (C-P-H)	17.9	16.7	19.5	26.5	25.7	29.2
Crop-livestock-homestead enterprise (C-L-H)	49.3	42.8	44.5	43.8	41.9	39.8
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field survey, 2018.

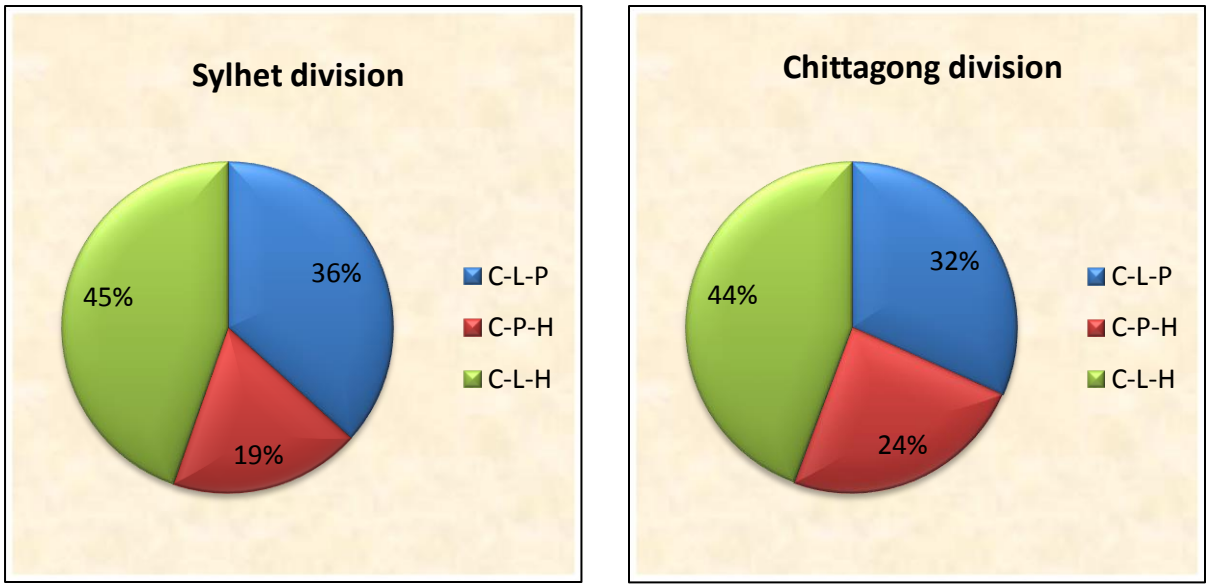

Figure 1: Production practices in the study areas

It is evident from Table 4 and Figure 1 that majority of the farmers were engaged in C-L-H farming system (44.6 and 44.3 percent farmers in Sylhet and Chittagong divisions, respectively) which was followed by C-L-P and C-P-H farming systems (36.7 and 31.7, and 18.7 and 24.0 percent farmers in Sylhet and Chittagong divisions, respectively). It was also experienced that C-L-P was mostly practiced by *Khasia* group (40.5% farmers), C-P-H by *Tanchang* group (29.2% farmers) and C-L-H by *Garo* group (49.3% farmers) (Table 5).

11.3 Area under agricultural production

It is evident from Table 6 that 84.1 and 86.5 percent of total cropped area of the farmers were under crop production (i.e., cereals crops, vegetables, spices and pulses), and 15.9 and 13.5 percent were under homestead enterprise (i.e., fruits and agroforestry) in Sylhet and Chittagong divisions, respectively. On an average, each household belonged14 poultry birds (i.e., hen, pigeon and duck), and 7 small (i.e., goat and pig) and large (i.e., cow, ox and calf) livestock animals in Sylhet division, and 15 poultry birds and 5 small and large livestock animals in Chittagong division. Uddin (2016) also found the similar result in *haor* areas of Bangladesh where the author stated that on an average, *haor* residents had 14 poultry birds, and 6 small and large animals. From the group comparison (Table 7), it is seen that Khasia tribe occupied the highest amount of cultivated area in Sylhet division (0.48 ha) whereas Chakma tribe occupied the highest amount of cultivated area in Chittagong division (0.48 ha).

Table 6: Area under agricultural enterprises

Enterprises		Cultivated area (ha)	% of total cropped area	No./ household
Sylhet division (tribal groups: *Garo, Khasia* and *Manipuri*)				
Crop (cereals crops, vegetables, spices and pulses)		0.37	84.1	-
Homestead enterprise (fruits and agroforestry)		0.07	15.9	-
Total cropped area		0.44	100.0	-
Livestock	Poultry (hen, pigeon and duck)	-	-	14
	Small and large animals (cow, ox, calf, goat and pig)	-	-	7
Chittagong division (tribal groups: *Chakma, Marma* and*Tanchang*)				
Crop (cereals crops, vegetables, spices and pulses)		0.45	86.5	-
Homestead enterprise (fruits and agroforestry)		0.07	13.5	-
Total cropped area		0.52	100.0	-
Livestock	Poultry (hen, pigeon and duck)	-	-	15
	Small and large animals (cow, ox, calf, goat and pig)	-	-	5

Source: Field survey, 2018.

Table 7: Snapshot of tribal groups' comparison on area under agricultural enterprises

Enterprises		Cultivated area (ha)	% of total cropped area	No./ household	Cultivated area (ha)	% of total cropped area	No./ household	Cultivated area (ha)	% of total cropped area	No./ household
Sylhet division										
Tribal groups		*Garo*			*Khasia*			*Manipuri*		
Crop (cereals crops, vegetables, spices and pulses)		0.34	82.9	-	0.37	77.1	-	0.40	93.0	
Homestead enterprise (fruits and agroforestry)		0.07	17.1	-	0.11	22.9	-	0.03	7.0	-
Total cropped area		0.41	100.0	-	0.48	100.0	-	0.43	100.0	-
Livestock	Poultry (hen, pigeon and duck)	-	-	13	-	-	18	-	-	12
	Small and large animals (cow, ox, calf, goat and pig)	-	-	11	-	-	5	-	-	6
Chittagong division										
Tribal groups		*Chakma*			*Marma*			*Tanchang*		
Crop (cereals crops, vegetables, spices and pulses)		0.49	92.5	-	0.42	80.8	-	0.44	86.3	-
Homestead enterprise (fruits and agroforestry)		0.04	7.5	-	0.10	19.2	-	0.07	13.7	-
Total cropped area		0.53	100.0	-	0.52	100.0	-	0.51	100.0	-
Livestock	Poultry (hen, pigeon and duck)	-	-	10	-	-	16	-	-	18
	Small and large animals (cow, ox, calf, goat and pig)	-	-	4	-	-	6	-	-	6

Source: Field survey, 2018.

11.4 Sources of farmers' knowledge and purposes of training provided

Generally, the farmers of Sylhet and Chittagong divisions gathered knowledge about agricultural production practices from different government and non-government organizations. Farmers of the study areas had been given knowledge and training on different issues of agricultural production. The major training provisions given on tribal groups of Sylhet divisionincluded organic farming, preparation of compost and vermicompost, impact of climate change assessment, soil quality improvement, development of cottage industry, mixed cropping, livestock management, etc. The major training provisions given on tribal groups of Chittagong divisionincluded pig farming, impact of climate change assessment, livestock management organic farming, preparation of compost and vermicompost, mixed cropping, etc. (Table 8).

Table 8: Sources of farmers' knowledge and issues on training provided

Divisions	Tribal groups	Institutions	Average duration (days)	Purposes/technologies
Sylhet	*Garo*	DAE and local NGOs	03	Preparation of compost and vermicompost, promoting safe drinking water, impact of climate change assessment, pig farming
	Khasia	Local NGOs	07	Organic farming, using cowdung instead of synthetic fertilizer, soil quality improvement, development of cottage industry
	Manipuri	DAE	02	Improvement of soil quality, using IPM and ICM technology, mixed cropping, livestock management
Chittagong	*Chakma*	Local NGOs	03	Pig farming, organic farming, livestock management
	Marma	DAE	05	Impact of climate change assessment, soil quality improvement, mixed cropping
	Tanchang	Local NGOs	07	Organic farming, Preparation of compost and vermicompost, IPM and ICM technology

Source: Field survey, 2018.

11.5 Impact of agricultural practices on farmers' livelihood

Farmers' engagement with different agricultural production practices had a great impact on their livelihood which was represented by livelihood component framework in Tables 9 and 10. The positive and negative impacts of the farming practices were overviewed on the basis of farmers' asset possession, activities and strategies, well-being, and external policies and institutions.

In Sylhet division, it is observed that land use efficiency was increased in case of 25.0 percent farmers, and income for purchasing assets and agricultural inputs was increased for 42.5 percent farmers in terms of asset possession. Financial solvency of the farmers also increased. On the other hand, 55.0 percent farmers experienced increasing ecological imbalance and decreasing environmental condition. Farmers' livelihood activities and strategies were greatly influenced by their farming practices. It is seen that 56.0 percent farmers stated about increased cropping intensity in the study areas which allowed them to grow more crops in a year. Additional income from farming activities had been increased accordingly. Production risk was decreased according to 32.5 percent farmers. But 20.0 percent farmers opined that their involvement with other income generating activities was decreased to some extent. Most of the farmers discoursed about improved food security condition (62.5% farmers) and sustainable livelihood provision (62.0% farmers). Risk and uncertainties associated with production practices caused limited and unpredictable cash earnings which were experienced by 77.5% farmers. Also, market access of the people was increased in the study areas (Table 9).

In terms of asset possession in Chittagong division, it is observed that in case of 49.5 percent farmers, their knowledge were enhanced through training and field visit and self managerial capability was increased for 35.5 percent farmers. On the other hand, 47.5 percent farmers experienced reduced environmental quality and soil fertility due to more use of chemical fertilizer and pesticides, etc. From the view point of farmers' activities and strategies, 51.6 percent farmers stated about increased cropping intensity in the study areas. According to 47.3 percent farmers, the rate of child enrollment and adult education were increased. 36.0 percent farmers opined about Diversification in work and wage labour use that resulted in additional income from farming activities. But 24.7 percent farmers said that farmers' involvement in other income generating activities was reduced consequently. Most of the farmers discoursed about improved food availability and food security condition (65.0% farmers) and sustainable livelihood provision (60.0% farmers). Women empowerment was experienced by 37.0% farmers but 40.0% farmers stated about lack of capacity building of groups. Also, farmers' market access and control was increased in the study areas (Table 10).

Table 9: Livelihood component framework for Sylhet division

Impacts on	Outcomes/responses			
	Positive effects	% of farmers	Negative effects	% of farmers
Impact of agricultural practices on farmers' asset possession				
Human capital	Income used for educational purposes	36.0	-	-
Physical assets	Income used to buy food, modern agricultural equipment, housing construction, etc.	42.5	-	-
Financial assets	Increased savings and cash at hand, reduced borrowing tendency of capital	39.5	-	-
Natural capital	Increased land use efficiency	25.0	Reduced environmental quality, increased ecological imbalance due to over extraction of underground water, more use of chemical fertilizer and pesticides, etc.	55.0
Social capital	Reduced dowry system, increased training facilities, etc.	34.0	Conflicts within community	47.0
Impact of agricultural practices on farmers' activities and strategies				
Farming, schooling and other activities	Increased cropping intensity	56.0	Reduced involvement in other income generating activities	20.0
	Increased child enrollment	45.3		
	Work can be shared within household	23.5		
	Further reducing tradeoff with other works	21.0		
Strategies for selecting activities: - Diversify - Minimize risk - Maintain liquidity	Contributes to diversification	29.5	-	-
	Less production risk	32.5		
	Additional income	41.0		
Impact of agricultural practices on farmers' well being				
Cash	Earnings can be significant	45.0	Limited and unpredictable	77.5
Food security	Helps to ensure households' food security	62.5	-	-
Sustainability of livelihood	Contributes to livelihood sustainability	62.0	Some earn distrust	17.5
Empowerment	Increased empowerment, especially of women	35.0	Lack of capacity building of groups	32.0
Reduced vulnerability	Cannot rely on unpredictable earnings	29.5	-	-
Impact of agricultural practices on farmers' external policies and institutions				
Market access	Gain access to market	78.5	-	-
	Control access of members	46.0		

Source: Field survey, 2018.

Table 10: Livelihood component framework for Chittagong division

Impacts on	Outcomes/responses			
	Positive effects	% of farmers	Negative effects	% of farmers
Impact of agricultural practices on farmers' asset possession				
Human capital	Enhanced knowledge through training and field visit	49.5	-	-
Physical assets	Income used to buy food, modern agricultural equipment, housing construction, etc.	35.3	-	-
Financial assets	Increased cash at hand and liquid assets, reduced tendency of receiving donation	41.7	-	-
Natural capital	Increased alternative land use decisions and water use efficiency	18.5	Reduced environmental quality and soil fertility due to more use of chemical fertilizer and pesticides, etc.	47.5
Social capital	Increased self managerial capability, social access, etc.	35.5	Lower involvement tendency in social groups	58.7
Impact of agricultural practices on farmers' activities and strategies				
Farming, schooling and other activities	Increased cropping intensity	51.6	Reduced involvement in other income generating activities	24.7
	Increased child enrollment and adult education	47.3		
	Work can be shared within household	30.0		
	Further reducing tradeoff with other works	25.0		
Strategies for selecting activities: - Diversify - Minimize risk - Maintain liquidity	Diversification in work and wage labour use	36.0	-	-
	Less production risk	34.0		
	Additional money income	52.7		
Impact of agricultural practices on farmers' well being				
Cash	Increased savings and investment	40.5	Limited and unpredictable	80.0
Food security	Ensured food availability and food security of the households	65.0	-	-
Sustainability of livelihood	Contributes to livelihood sustainability	60.0	-	-
Empowerment	Increased empowerment, especially of women	37.0	Lack of capacity building of groups	40.0
Reduced vulnerability	Cannot rely on unpredictable earnings	30.5	-	-
Impact of agricultural practices on farmers' external policies and institutions				
Market access	Gain access to market	65.3	-	-
	Control access of members	36.5		

Source: Field survey, 2018.

Table 11: Snapshot of tribal groups' comparison on livelihood component framework (% of farmers)

Impacts of agricultural practices	Positive effects						Negative effects					
	Sylhet			Chittagong			Sylhet			Chittagong		
	Garo	*Khasia*	*Manipuri*	*Chakma*	*Marma*	*Tanchang*	*Garo*	*Khasia*	*Manipuri*	*Chakma*	*Marma*	*Tanchang*
i. Farmers' asset possession	37.5	34.2	36.7	43.7	40.3	43.5	51.6	47.3	58.2	50.4	54.2	57.3
ii. Farmers' activities and strategies	38.3	39.7	41.0	34.8	31.5	35.2	18.4	17.3	21.7	26.8	22.7	27.4
iii. Farmers' well being	51.0	47.5	49.8	55.0	59.7	51.0	47.5	60.0	47.5	65.2	52.0	61.8
iv. Farmers' external policies and institutions	62.9	57.2	59.7	47.3	42.6	45.6	-	-	-	-	-	-

Source: Field survey, 2018.

The comparative scenario shows that in case of impact of agricultural practices on farmers' asset possession, highest 43.7% farmers of *Chakma* group stated about positive effects and highest 58.2% farmers of *Manipuri* group stated about negative effects; in case of impact of agricultural practices on farmers' activities and strategies, highest 41.0% farmers of *Manipuri* group stated about positive effects and highest 27.4% farmers of *Tanchang* group stated about negative effects; in case of impact of agricultural practices on farmers' well-being, highest 59.7% farmers of *Marma* group stated about positive effects and highest 60.0% farmers of *Khasia* group stated about negative effects; and in case of impact of agricultural practices on farmers' external policies and institutions, highest 62.9% farmers of *Garo* group stated about positive effects and no farmers stated about negative effects (Table 11).

11.6 Profitability of agricultural enterprises

The study attempted to evaluate the profitability of agricultural enterprises (i.e., crop, livestock, poultry and homestead enterprise) under most common agricultural production practices. For calculating total production cost, variable and fixed costs were taken into consideration. The components of variable cost were: i) human labour; ii) power tiller; iii) seeds/seedlings; iv) feed; v) fertilizers; vi) insecticides; vii) artificial insemination; viii) vitamin and medicine; ix) irrigation; and x) maintenance. Fixed cost items for different agricultural enterprises were as follows: i) lease value of land; ii) housing cost; and iii) interest on operating capital. The cost items differed in accordance with each farming practice.

11.6.1 Profitability of crop production

Profitability of crop production in Sylhet and Chittagong divisions under C-L-P, C-P-H and C-L-H farming systems are represented in Table 12. It is observed that total cost of crop production was Tk. 45441, Tk. 40233 and Tk. 52809; and Tk. 43051, Tk. 40406 and Tk. 52257 per hectare in C-L-P, C-P-H and C-L-H farming systems in Sylhet and Chittagong divisions, respectively. Net return from crop production was higher in C-L-P farming system (Tk. 4544 and Tk. 6998 per ha) compared to C-P-H (Tk. 805 and Tk. 1694 per ha) and C-L-H farming systems (Tk. 3169 and Tk. 1650 per ha) in Sylhet and Chittagong divisions, respectively. The BCR was higher in C-L-P farming system (i.e., 1.10 and 1.16) in both Sylhet and

Chittagong divisions, respectively. The lower BCR motivated the tribal farmers to shift their concentration to livestock and poultry farming which can be seen in the upcoming sections.

Table 12: Crop profitability under common farming systems (Tk. /ha)

Cost items		Study areas					
		Sylhet			Chittagong		
		C-L-P	C-P-H	C-L-H	C-L-P	C-P-H	C-L-H
Cost of crop production							
Variable costs	Human labour	13652	11235	18647	12485	11654	18220
	Power tiller	3458	4940	4940	3625	4873	4871
	Seed/seedlings	1258	1245	3520	1324	1325	3745
	Fertilizers	6754	2159	4529	6248	2144	4610
	Insecticides	2015	1986	2560	2314	1873	1424
	Irrigation	9880	9880	9880	8867	9899	9755
i. Total variable cost		37017	31445	44076	34863	31768	42625
Fixed costs	Rental charge	4586	4475	5120	4621	4593	5011
	Depreciation cost	1247	1874	1582	1127	1821	1637
	Interest on operating capital	2591	2439	2031	2440	2224	2984
ii. Total fixed cost		8424	8788	8733	8188	8638	9632
iii. Total cost (i + ii)		45441	40233	52809	43051	40406	52257
Return from crop production							
iv. Gross return		49985	41038	55978	50049	42100	53907
v. Gross margin (iv - i)		12968	9593	11902	15186	10332	11282
vi. Net return (iv - iii)		4544	805	3169	6998	1694	1650
vii. BCR (iv ÷ iii)		1.10	1.02	1.06	1.16	1.04	1.03

Source: Authors' estimation, 2018.

NB:C-L-P= Crop-Livestock-Poultry, C-P-H=Crop- Poultry-Homestead Enterprise, C-L-H=Crop-Livestock-Homestead Enterprise

11.6.2 Profitability of livestock rearing

Table 13 represents profitability of livestock rearing in Sylhet and Chittagong divisionsunder C-L-P and C-L-H farming systems. It is seen that total cost of livestock rearing per animal per year was Tk. 6096 and Tk. 5945, and Tk. 5741 and Tk. 5524 under C-L-P and C-L-H farming systems in Sylhet and Chittagong divisions, respectively. Net return from livestock rearing in C-L-P farming system was much higher than in C-L-H farming system (Tk. 6828 and Tk. 6520, and Tk. 5626 and Tk. 5662 per animal per year in C-L-P and C-L-H farming systems in Sylhet and Chittagong divisions, respectively). The BCR was found as 2.12 and 2.10, and 1.98 and 2.02 under C-L-P and C-L-H farming systems in Sylhet and Chittagong divisions, respectively indicating C-L-P farming system more profitable compared to C-L-H farming system.

Table 13: Profitability of livestock rearing under most common farming systems (Tk./animal/year)

Cost items		Study areas			
		Sylhet		Chittagong	
		C-L-P	C-L-H	C-L-P	C-L-H
Cost of livestock rearing					
Variable costs	Human labour	1250	1158	1294	1029
	Feed	365	401	376	482
	Artificial insemination	256	269	215	271
	Vitamin and medicine	495	365	509	304
	Maintenance	1200	1069	1149	1000
i. Total variable cost		3566	3262	3543	3086
Fixed costs	Rental charge	1254	1248	1173	1195
	Housing cost	569	589	519	627
	Depreciation cost	457	414	462	400
	Interest on operating capital	250	228	248	216
ii. Total fixed cost		2530	2479	2402	2438
iii. Total cost (i + ii)		6096	5741	5945	5524
Return from livestock rearing					
iv. Gross return		12924	11367	12465	11186
v. Gross margin (iv - i)		9358	8105	8922	8100
vi. Net return (iv - iii)		6828	5626	6520	5662
vii. BCR (iv ÷ iii)		2.12	1.98	2.10	2.02

Source: Authors' estimation, 2018.

NB:C-L-P= Crop-Livestock-Poultry and C-P-H=Crop- Livestock -Homestead Enterprise

11.6.3 Profitability of poultry rearing

Profitability of poultry rearing under C-L-P and C-P-H farming systems in Sylhet and Chittagong divisions is depicted in Table 14. It is found that net return from poultry rearing in C-L-P farming system was comparatively higher than C-P-H farming system (Tk. 277 and Tk. 268, and Tk. 159 and Tk. 159 per bird per year in Sylhet and Chittagong divisions) where the total cost was Tk. 243 and Tk. 247, and Tk. 249 and Tk. 253 per bird per year in Sylhet and Chittagong divisions, respectively. The BCR of poultry rearing was higher in C-L-P farming system (i.e., 2.13 and 2.09) in respect of C-P-H farming system (i.e., 2.03 and 1.63)in Sylhet and Chittagong divisions, respectively.

Table 14: Profitability of poultry rearing under most common farming systems (Tk./bird/year)

Cost items		Study areas			
		Sylhet		Chittagong	
		C-L-P	C-P-H	C-L-P	C-P-H
Cost of poultry rearing					
Variable costs	Human labour	42	40	45	42
	Feed	110	122	105	125
	Vitamin and medicine	30	28	35	30
	Maintenance	10	11	12	10
i. Total variable cost		192	201	197	207
Fixed costs	Rental charge	8	8	9	8
	Housing cost	12	11	10	12
	Depreciation cost	15	12	17	12
	Interest on operating capital	16	17	14	14
ii. Total fixed cost		51	48	50	46
iii. Total cost (i + ii)		243	249	247	253
Return from poultry rearing					
iv. Gross return		520	408	515	412
v. Gross margin (iv - i)		328	207	318	205
vi. Net return (iv - iii)		277	159	268	159
vii. BCR (iv ÷ iii)		2.13	2.03	2.09	1.63

Source: Authors' estimation, 2018.

NB:C-L-P= Crop-Livestock-Poultry and C-P-H=Crop- Livestock -Homestead Enterprise

11.6.4 Profitability of homestead enterprise

Table 15 shows profitability of homestead enterprise in C-L-H and C-P-H farming systems in Sylhet and Chittagong divisions. It is apparent that total cost of homestead enterprise was Tk. 51640 and Tk. 49706, and Tk. 47874 and Tk. 48960 per ha under C-L-H and C-P-H farming systems in Sylhet and Chittagong divisions, respectively. Net return under C-L-H farming system (i.e., Tk. 4131 and Tk. 7013) was relatively higher with regard to C-P-H farming system (i.e., Tk. 1915 and Tk. 4786)in Sylhet and Chittagong divisions, respectively. The BCR of homestead enterprise under C-L-H and C-P-H farming systems was 1.08 and 1.14, and 1.04 and 1.10 in Sylhet and Chittagong divisions, respectively.

Table 15: Profitability of homestead enterprise (Tk./ha)

Cost items		Study areas			
		Sylhet		Chittagong	
		C-L-H	C-P-H	C-L-H	C-P-H
Cost of homestead enterprise					
Variable costs	Human labour	14578	12457	15672	13525
	Seed/seedlings	4852	4820	4732	4750
	Fertilizers	6485	5861	6490	5900
	Insecticides	1254	1342	1359	1437
	Irrigation	4940	4940	1744	4830
	Maintenance	8475	7425	8500	7500
i. Total variable cost		40584	36845	38497	37942
Fixed costs	Lease value	8215	8450	8514	8362
	Interest on operating capital	2841	2579	2695	2656
ii. Total fixed cost		11056	11029	11209	11018
iii. Total cost (i + ii)		51640	47874	49706	48960
Return from homestead enterprise					
iv. Gross return		55771	49789	56719	53746
v. Gross margin (iv - i)		15187	12944	18222	15804
vi. Net return (iv - iii)		4131	1915	7013	4786
vii. BCR (iv ÷ iii)		1.08	1.04	1.14	1.10

Source: Authors' estimation, 2018.

NB: C-L-P= Crop-Livestock-Poultry and C-P-H=Crop- Livestock -Homestead Enterprise

Average profitability scenario of the farmers in Sylhet and Chittagong divisionsis depicted in Figure 2. It is clearly represented that among all the agricultural enterprises, on an average, poultry rearing was the highest profitable business in Sylhet division (with BCR 2.08) and livestock rearing was the highest profitable business in Chittagong division (with BCR 2.06) for the farmers. As crop production and homestead farming were not as profitable as livestock and poultry rearing, farmers gradually shifted their concentration to livestock and poultry production.

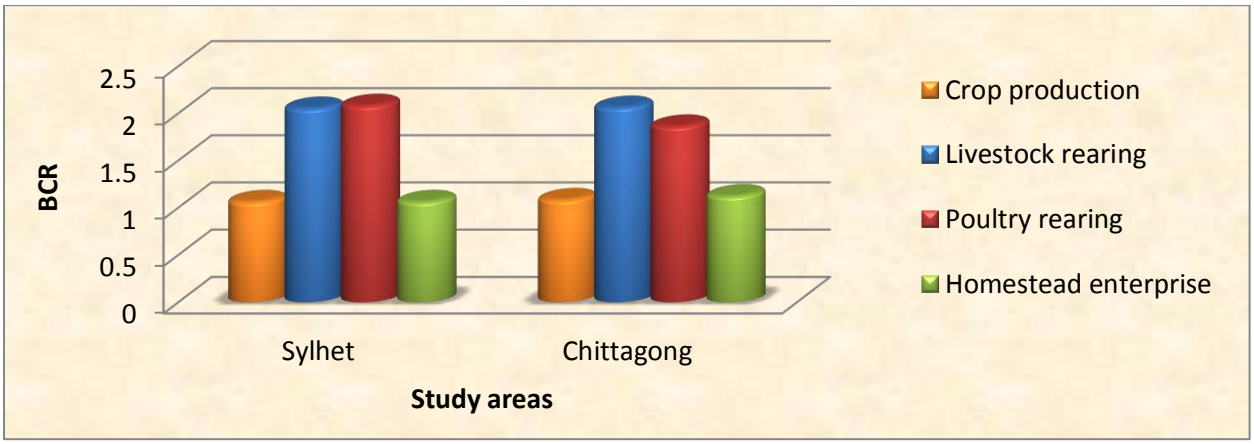

Figure 2: Average profitability scenario in the study areas

11.6.5 Snapshot of tribal groups' comparison on profitability of agricultural enterprises

In case of crop production, the BCR was highest as 1.18 for *Chakma* and *Tanchang* groups in C-L-P, 1.04 for *Chakma* and *Marma* groups in C-P-H and 1.06 for *Manipuri* group in C-L-H. In terms of livestock rearing, the BCR was highest as 2.14 for *Khasia* group in C-L-P and 2.04 for *Tanchang* group in C-L-H. In stare of poultry rearing, the BCR was highest as 2.14 for *Manipuri* group in C-L-P and 2.06 for *Khasia* group in C-P-H. Lastly, in case of homestead enterprise, the BCR was highest as 1.14 for *Marma* and *Tanchang* groups inC-L-H and 1.13 for *Chakma* group in C-P-H (Table 16).

Table 16: Snapshot of tribal groups' comparison on BCR of agricultural enterprises

Agricultural enterprises	Farming systems	Study areas					
		Sylhet			Chittagong		
		Garo	*Khasia*	*Manipuri*	*Chakma*	*Marma*	*Tanchang*
Crop production	C-L-P	1.08	1.10	1.11	1.18	1.17	1.18
	C-P-H	1.02	1.02	1.00	1.04	1.04	1.03
	C-L-H	1.03	1.03	1.06	1.03	1.05	1.04
Livestock rearing	C-L-P	2.09	2.14	2.10	2.10	2.10	2.09
	C-L-H	1.94	2.00	1.98	2.01	1.99	2.04
Poultry rearing	C-L-P	2.13	2.12	2.14	2.09	2.05	2.10
	C-P-H	2.04	2.06	1.99	1.65	1.64	1.69
Homestead enterprise	C-L-H	1.13	1.08	1.11	1.12	1.14	1.14
	C-P-H	1.01	1.06	1.04	1.13	1.09	1.10

Source: Authors' estimation, 2018.

NB: C-L-P = Crop-Livestock-Poultry, C-P-H= Crop- Poultry- Homestead Enterprise, C-L-H= Crop-Livestock-Homestead Enterprise

11.7 Measurement of crop productivity

Using Enyedi's crop productivity index, the average crop productivity in Sylhet and Chittagong divisionswas estimated in comparison with the crop production in the entire region which is represented by Table 17. It is seen that per hectare crop production of the farmers was 14.15and 14.58 tonin Sylhet and Chittagong divisions, respectively. Total cultivated area and crop production in the entire region of Sylhet and Chittagong division were found at 4856 and 5620 ha, and 103482.54 and 105127.92ton per ha, respectively. The estimated crop productivity index value was 144.3 and 149.9 percent in Sylhet and Chittagong divisions which indicates that crop productivity was of moderately high range in the study areas.

Table 17: Enyedi's crop productivity index (in average)

Particulars	Study areas	
	Sylhet (tribal groups: *Garo, Khasia* and *Manipuri*)	Chittagong (tribal groups: *Chakma, Marma* and*Tanchang*)
Production (ton/ha)	14.15	14.58
Total production in the entire region (ton)	103482.54	105127.92
Cultivated area (ha)	0.46	0.52
Total cultivated area in the entire region (ha)	4856	5620
Crop productivity (%)	144.3	149.9

Source: Authors' estimation, 2018.

Note: Information on total cultivated area and production in the entire region were collected from BBS, 2015 and DAE, 2018.

11.8 Net change in inventory of livestock

Net change in inventory of livestock was calculated by deducting the sum of opening stock and bought from the sum of closing stock, consumed/gifted, sold and died. From Table 18 it is seen that inventory change in case of goat was the highest among all livestock enterprises (Tk. 4850 and Tk. 5700 in Sylhet and Chittagong divisions, respectively). Average net change in inventory in Sylhet and Chittagong divisionswas estimated at Tk. 16615 and Tk. 19125, respectively. In comparison, net change in inventory was the highest in case of *Khasia* group in Sylhet division (Tk. 17169) and in case of *Marma* group in Chittagong division which was Tk. 19383 (Table 19). The findings are quite similar with Ahmed (2015) where the author found that net change in inventory was Tk. 12223.3 on an average in *char* areas of northern Bangladesh.

Table 18: Net change in inventory of livestock

Animals	Opening stock		Bought		Died		Sold		Consumed/ Gifted		Closing stock		Inventory change
	1		2		3		4		5		6		7=(6+5+4+3)-(1+2)
	No.	Value (Tk.)	No.	Value (Tk.)	No.	Value (Tk.)	No.	Value (Tk.)	No.	Value (Tk.)	No.	Value (Tk.)	Value (Tk.)
Sylhet division													
Cow	1.63	30250	1.15	28560	-	-	1.26	35250	-	-	2.19	28250	4690
Ox	0.89	19980	0.92	20465	-	-	0.88	22480	-	-	2.10	21085	3120
Calf	0.65	12560	0.56	12480	-	-	-	-	-	-	1.89	27490	2450
Goat	1.12	10780	1.10	12457	0.26	6580	-	-	-	-	2.14	18162	1505
Pig	1.02	30980	0.69	24589	0.58	14520	-	-	-	-	1.56	45899	4850
Net change in inventory													16615
Chittagong division													
Cow	1.54	32455	1.35	27450	-	-	1.35	37465	-	-	2.56	25455	3015
Ox	0.93	17370	0.81	21955	-	-	1.00	20100	-	-	1.75	22150	2925
Calf	0.58	12490	0.69	13500	-	-	-	-	-	-	1.50	30490	4500
Goat	1.26	10470	1.02	13200	0.35	7200	-	-	-	-	2.35	19455	2985
Pig	1.05	31720	0.73	20535	0.41	13250	-	-	-	-	2.21	44705	5700
Net change in inventory													19125

Source: Authors' estimation, 2017-18.

Table 19: Snapshot of tribal groups' comparison on net change in inventory of livestock

Inventory change for animals	Study areas					
	Sylhet			Chittagong		
	Garo	*Khasia*	*Manipuri*	*Chakma*	*Marma*	*Tanchang*
Cow	4583	4890	4761	2964	3075	3170
Ox	3254	3043	3164	2970	2955	2806
Calf	2149	2844	2553	4663	4420	4580
Goat	1650	1507	1449	2570	3247	2862
Pig	4711	4885	4710	6120	5686	5805
Net change in inventory	16347	17169	16637	19287	19383	19223

Source: Authors' estimation, 2017-18.

11.9 Impact of using agricultural technologies on production practices

It is found from the study that the tribal farmers in the research areas practice agricultural technologies like betel leaf and betel nut production, eel fish (*Monopterus Cuchia*, Eng. Name - Cuchia) production, agroforestry plantation, coffee tree, *jhum*, medicinal plants and rice cultivation (local). To appraise the impact of using these agricultural technologies on production practices in Sylhet and Chittagong divisions, the researchers made discussion with the farmers about their perception on the change of their agricultural practices before and after using the technologies. Following the discussion,

13(thirteen) issues were selected for this research. Each farmer of the study areas was asked to indicate his/her opinion regarding the level of improvement in their agricultural production practices. The percentages of farmers sharing their opinions on the selected issues are represented in Table 20. It is seen that most of the farmers experienced increase in weed control, use of irrigation water, and growth and productivity of crops (59.6, 54.5, 54.4 and 54.0, and 55.0, 51.7, 59.0 and 55.6percent farmers in Sylhet and Chittagong divisions, respectively). Some of them stated about decreased labour use, time consumption and tillage operation (59.2, 58.4 and 39.7, and 54.0, 57.5 and 40.2percent farmers in Sylhet and Chittagong divisions, respectively). On the other hand, 59.5, 40.8 and 38.8, and 53.9, 37.3 and 42.2percent farmers in Sylhet and Chittagong divisions opined about constant aspects of pest management, expenditure in production and grain quality, respectively. Overall, 39.2, 26.6 and 34.2, and 38.8, 26.5 and 34.7percent farmers in Sylhet and Chittagong divisions assured about increased, decreased and constant state of production practices, respectively (Figure 3).

Table 20: Extent of change in production practices after using agricultural technologies

Items	Study areas					
	Sylhet (tribal groups: *Garo, Khasia*and *Manipuri*)			Chittagong (tribal groups: *Chakma, Marma*and*Tanchang*)		
	Increased	Decreased	Constant	Increased	Decreased	Constant
Labour use	8.5	59.2	32.3	9.2	54.0	36.8
Expenditure in production	41.2	18.0	40.8	43.1	19.6	37.3
Complexity in practice	49.6	12.0	38.4	47.5	15.0	37.5
Time consumption	16.2	58.4	25.4	19.6	57.5	22.9
Need of intensive care	40.4	22.8	36.8	37.5	26.0	36.5
Growth of crops	54.4	16.4	29.2	59.0	18.0	23.0
Productivity of enterprises	54.0	19.2	26.8	55.6	17.0	27.4
Tillage operation	28.6	39.7	31.7	21.9	40.2	37.9
Use of irrigation water	54.5	16.0	29.5	51.7	15.8	32.5
Weed control	59.6	19.6	20.8	55.0	17.6	27.4
Land under cultivation	41.0	24.5	34.5	43.8	20.9	35.3
Pest management	25.5	15.0	59.5	27.6	18.5	53.9
Grain quality	36.4	24.8	38.8	32.8	25.0	42.2

Source: Field survey, 2017-18.

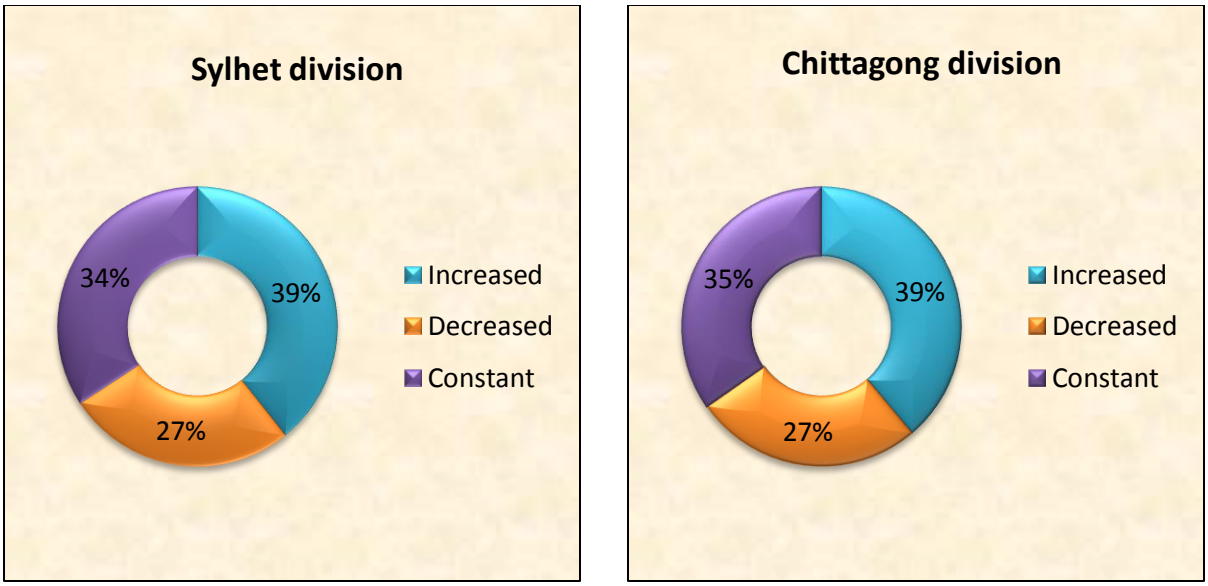

Figure 3: Average perceptions of the farmers regarding the extent of change in production practices after using agricultural technologies

11.10 Factors determining farmers' decision to adopt agricultural technologies

In the logit model, the dependent variable Z represented the probability of a dummy variable taking the value of 1 if the farmer had adopted agricultural technologies and 0 if the farmer had not. Eight (08) independent variables (Q_1 to Q_8) were included in the model that were related to each farmer's characteristics namely household size, educational level of household head, age of household head, farm size, farm income, non-farm income, extension contact and farming experience.

11.10.1 Interpretation of logit model along with regression coefficients

Five (05) out of eight (08) independent variables included in the model were found significant in explaining the variation in adopting agricultural technologies by the farmers. These variables were educational level of household head, farm size, farm income, extension contact and farming experience of the farmers in the research areas (Table 21).

Therefore the estimated equation was as follows:

$$Z_i = 2.178 + 0.005Q_1 + 1.131Q_2 - 1.137Q_3 + 1.127Q_4 + 1.129Q_5 - 0.022Q_6 + 0.087Q_7 + 0.023Q_8$$

Table 21: Estimates of logistic regression of determinants adopting agricultural technologies

Variables	Coefficient (β)	Standard Error	z	P>|z|	95% confidence interval	
Constant	2.178	1.588	1.37	0.170	-0.936	5.291
Household size (Q_1)	0.005	0.002	2.70	0.379	-0.009	-0.001
Educational level of household head (Q_2)	1.131**	0.435	2.60	0.031	-1.984	-0.278
Age of household head (Q_3)	-1.137	0.436	-1.01	0.209	0.023	1.992
Farm size (Q_4)	1.127*	0.435	2.59	0.083	0.273	1.980
Farm income (Q_5)	1.129*	0.435	2.59	0.070	0.275	1.982
Non-farm income (Q_6)	-0.022	0.021	-1.06	0.291	-0.062	0.019
Extension contact (Q_7)	0.087***	0.100	0.87	0.004	-0.109	0.284
Farming experience (Q_8)	0.023*	0.072	0.32	0.086	-0.119	0.164

Source: Authors' estimation, 2018.

Note: ***, ** and * indicate significant at 1%, 5% and 10% probability level, respectively.

Household size

Household size had a positive value of coefficient which was 0.005, and it meant that the farmers with a larger household size than others have a higher probability of adopting agricultural technologies than other farmers.

Educational level of household head

The coefficient of educational level of household head had a positive value which was 1.131 and statistically significant at 5% level of probability. The result implied that the farmers whose educational status is higher than other farmers have a significantly higher probability of adopting agricultural technologies.

Age of household head

The result shows that age of household head had a negative value of coefficient which was 1.137. It demonstrated that the farmers who are senior in age have a lower probability of adopting agricultural technologies than other farmers.

Farm size

The value of coefficient of farm size was positive and it was 1.127 which was statistically significant at 10% probability level. The result indicated that the farmers having a larger farm size encompass a significantly higher probability of adopting agricultural technologies than other farmers.

Farm income

Farm income had a positive value of coefficient which was 1.129, and it was statistically significant at 10% probability level implying that the farmers earning a higher money income from farming activities comprise a significantly higher probability of adopting agricultural technologies.

Non-farm income

The result shows that non-farm income had a negative value of coefficient which was 0.022. It indicated that the farmers earning a higher money income from non-farming activities embrace a significantly lower probability of adopting agricultural technologies than other farmers.

Extension contact

The coefficient of extension contact had a positive value which was 0.087 and statistically significant at 1% level of probability. The result meant that the farmers having extension contact comprise a significantly higher probability of adopting agricultural technologies compared to the farmers who do not have extension contact.

Farming experience

Farming experience had a positive value of coefficient which was 0.023, and it was statistically significant at 10% probability level implying that the farmers whose farming experience are higher compared to other farmers have a significantly higher probability of adopting agricultural technologies.

11.10.2 Interpretation of logit model according to marginal effects

Marginal effects were computed to get a good approximation to the amount of change in Z that will be produced by one unit change in Q_k. Marginal effects were computed differently for discrete (i.e., categorical) and continuous variables to measure the discrete change, i.e., how predicted probabilities were changed as the binary independent variable changed from 0 to 1, i.e., for a categorical variable Q_k,

$$\text{Marginal Effect } (dZ/dQ_k) = P\ (Z = 1 \mid Q, Q_k = 1) - P\ (Z = 1 \mid Q, Q_k = 0)$$

Marginal effects for continuous variables measured the instantaneous rate of change (Table 22).

Table 22: Estimates of marginal effect of determinants adopting agricultural technologies

Variables	dZ/dQ	Standard Error	z	P>|z|	95% confidence interval		Q
Household size (Q_1)	0.001	0.001	2.69	0.107	-0.002	-0.000	5
Educational level of household head (Q_2)	0.281**	0.108	2.61	0.039	-0.492	-0.070	3
Age of household head (Q_3)	-0.283	0.108	-2.62	0.239	0.071	0.494	37
Farm size (Q_4)	0.280*	0.108	2.60	0.092	0.069	0.491	5.043
Farm income (Q_5)	0.280*	0.108	2.60	0.061	0.069	0.492	51196
Non-farm income (Q_6)	-0.005	0.005	-1.06	0.291	-0.015	0.005	38580
Extension contact (Q_7)	0.023***	0.025	0.87	0.005	-0.027	0.070	0.804
Farming experience (Q_8)	0.006*	0.018	0.32	0.053	-0.029	0.041	3

Source: Author's estimation, 2015-16.

Note: ***, ** and * indicate significant at 1%, 5% and 10% probability level, respectively.

Household size

The result of marginal effect shows that household size had a positive value of dZ/dQ and it was 0.001. It indicated that if household size is increased by 1 unit, the probability of adopting agricultural technologies will be increased by 0.001 times.

Educational level of household head

Educational level of household head had a positive value of dZ/dQ which was 0.281 and it was statistically significant at 5% probability level. It meant that if educational level of household head is increased by 1 unit, the probability of adopting agricultural technologies will be increased by 0.281 times. The reason was that farmers could gain better knowledge about agricultural technologies which could insist them to adopt the modern technologies.

Age of household head

The result of marginal effect shows that age of household head had a negative value of dZ/dQ and it was 0.283. It implied that if the age of household head is increased by 1 unit, the probability of adopting agricultural technologies will be decreased by 0.283 times.

Farm size

The result of marginal effect shows that farm size had a positive value of dZ/dQ and it was 0.280, which was statistically significant at 10% level of probability. It demonstrated that if farm size is increased by 1 unit, the probability of adopting agricultural technologies will be increased by 0.280 times. The reason was that with a large farm size, farmers became eager to apply new agricultural technologies in a noticeable amount of cropland keeping practicing conventional agricultural technologies in other cropland.

Farm income

Farm income had a positive value of dZ/dQ which was 0.280 and it was statistically significant at 10% level of probability. It indicated that if farm income is increased by 1 unit, the probability of adopting agricultural technologies will be increased by 0.280 times. The reason was that farmers intended to adopt new agricultural technologies with an expectation of more money income from agricultural production.

Non-farm income

Non-farm income had a negative value of dZ/dQ and it was 0.005. It meant that if non-farm income is increased by 1 unit, the probability of adopting agricultural technologies will be decreased by 0.005 times.

Extension contact

The result of marginal effect shows that extension contact had a positive value of dZ/dQ and it was 0.023, which was statistically significant at 1% level of probability. It implied that the probability of adopting agricultural technologies for those farmers who have extension contact is 0.023 times higher compared to those farmers who do not have extension contact. The reason was that farmers got influenced and motivated by the extension agents to adopt modern agricultural technologies.

Farming experience

The result of marginal effect shows that farming experience had a positive value of dZ/dQ which was 0.006, and it was statistically significant at 10% probability level. It meant that if extension contact is increased by 1 unit, the probability of adopting agricultural technologieswill be increased by 0.006 times. The reason was that farmers having existing knowledge and training on new agricultural technologieswere aware about its pros and cons which provoked them to adopt the technologies.

11.11 Average annual income of the agricultural technology using farmers

The money income earned by the farmers from different sources in Sylhet and Chittagong divisionsis depicted in Table 23 and Figure 4. Mainly, there were two sources of money income in the study areas namely: farm income and non-farm income. Farm income included income from crop, livestock, poultry and homestead enterprises. Non-farm income included income from small business, wage labour, shop keeping, van/rickshaw pulling and other sources.

It was found that average annual income of the farmers in Sylhet and Chittagong divisionswas Tk. 92092 and Tk. 87459, respectively. In case of farmers in Sylhet division, 59.4 percent income (i.e., Tk. 54727) was from farming activities and 40.6 percent (i.e., Tk. 37365) was from non-farming activities where these were 54.5 percent (i.e., Tk. 47665) and 45.5 percent (i.e., Tk. 39794) in terms of farmersin Chittagong division, respectively. The national average annual income is Tk. 191340 (HIES, 2016) which is almost double than the findings which indicates that there is an ample scope to increase the farmers' income thorough technology adoption. The study also represented that *Khasia* group's annual income (Tk. 92362) was the highest among others in Sylhet division whereas; *Chakma* group's annual income (Tk. 87933) was the highest among others in Chittagong division (Table 24).

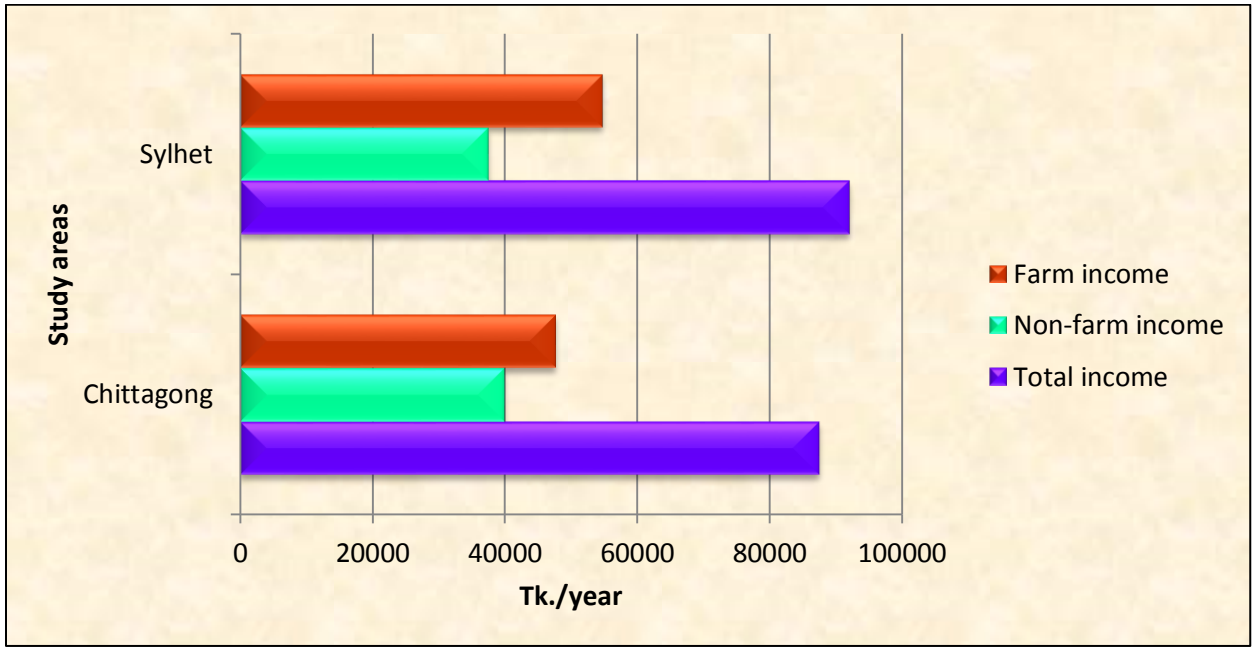

Figure 4: Average annual income of the agricultural technology using farmers

Table23: Average annual income of the agricultural technology using farmers

Sources of income		Study areas			
		Sylhet		Chittagong	
		Tk./year	% of total income	Tk./year	% of total income
Farm income	Crop	30569 (55.8)[a]	59.4	26629 (55.9)[a]	54.5
	Livestock	12357 (22.6)[a]		9749 (20.5)[a]	
	Poultry	2551 (4.7)[a]		3017 (6.2)[a]	
	Homestead	8000 (14.6)[a]		7420 (15.6)[a]	
	Others	1250 (2.3)[a]		850 (1.8)[a]	
Total farm income		54727 (100.0)[a]		47665 (100.0)[a]	
Non-farm income	Small business	12575 (33.7)[b]	40.6	11972 (30.1)[b]	45.5
	Wage labour	8119 (21.7)[b]		10041 (25.2)[b]	
	Shopkeeping	8790 (23.5)[b]		7990 (20.1)[b]	
	Van/rickshaw pulling	5044 (13.5)[b]		6796 (17.1)[b]	
	Others	2837 (7.6)[b]		2995 (7.5)[b]	
Total non-farm income		37365 (100.0)[b]		39794 (100.0)[b]	
Total income		92092	100.0	87459	100.0

Source: Field survey, 2018.

Note: a. Figures in the parentheses indicate percentages of total farm income; and

b. Figures in the parentheses indicate percentages of total non-farm income.

Table 24: Snapshot of tribal groups' comparison on average annual income

Sources of income	Study areas					
	Sylhet			Chittagong		
	Garo	*Khasia*	*Manipuri*	*Chakma*	*Marma*	*Tanchang*
Farm income	51467	57014	53749	47680	48317	46670
Non-farm income	38472	35348	36997	40253	37146	38141
Total income	89939	92362	90746	87933	85463	84811

Source: Field survey, 2018.

11.12 Average annual expenditure of the agricultural technology using farmers

Average annual expenditure of the farmers in Sylhet and Chittagong divisionsis revealed in Table 25 and Figure 5. The major sectors of farmers' expenditure identified were food, clothes, health services, house repairing, education, electricity/fuel, transportation, festivals and miscellaneous items. The highest portion of the farmers' expenditure included food consumption (49.2 and 48.9 percent in Sylhet and Chittagong divisions, respectively) followed by expenditure on miscellaneous items and festivals (18.6 and 18.3 percent, and 12.8 and 13.0 percent in Sylhet and Chittagong divisions, respectively). The study observed that tribal communities spent a noticeable amount of money on a diverse range of tribal festivals.It is found from Table 25 that the average annual expenditure of the farmers in Sylhet and Chittagong divisionswas Tk. 111606 and Tk. 112451, respectively.

Table 25: Average annual expenditure of the agricultural technology usingfarmers

Particulars	Study areas			
	Sylhet (tribal groups: *Garo, Khasia*and *Manipuri*)		Chittagong (tribal groups: *Chakma, Marma*and*Tanchang*)	
	Tk./year	% of total expenditure	Tk./year	% of total expenditure
Food	54908	49.2	54965	48.9
Clothes	7041	6.3	7005	6.3
Health services	2696	2.4	2812	2.5
House repairing	3084	2.8	3195	2.8
Education	3155	2.8	3078	2.7
Electricity/fuel	3206	2.9	3330	3.0
Transportation	2468	2.2	2805	2.5
Festivals	14281	12.8	14637	13.0
Miscellaneous	20767	18.6	20624	18.3
Total expenditure	111606	100.0	112451	100.0

Source: Authors' estimation, 2018.

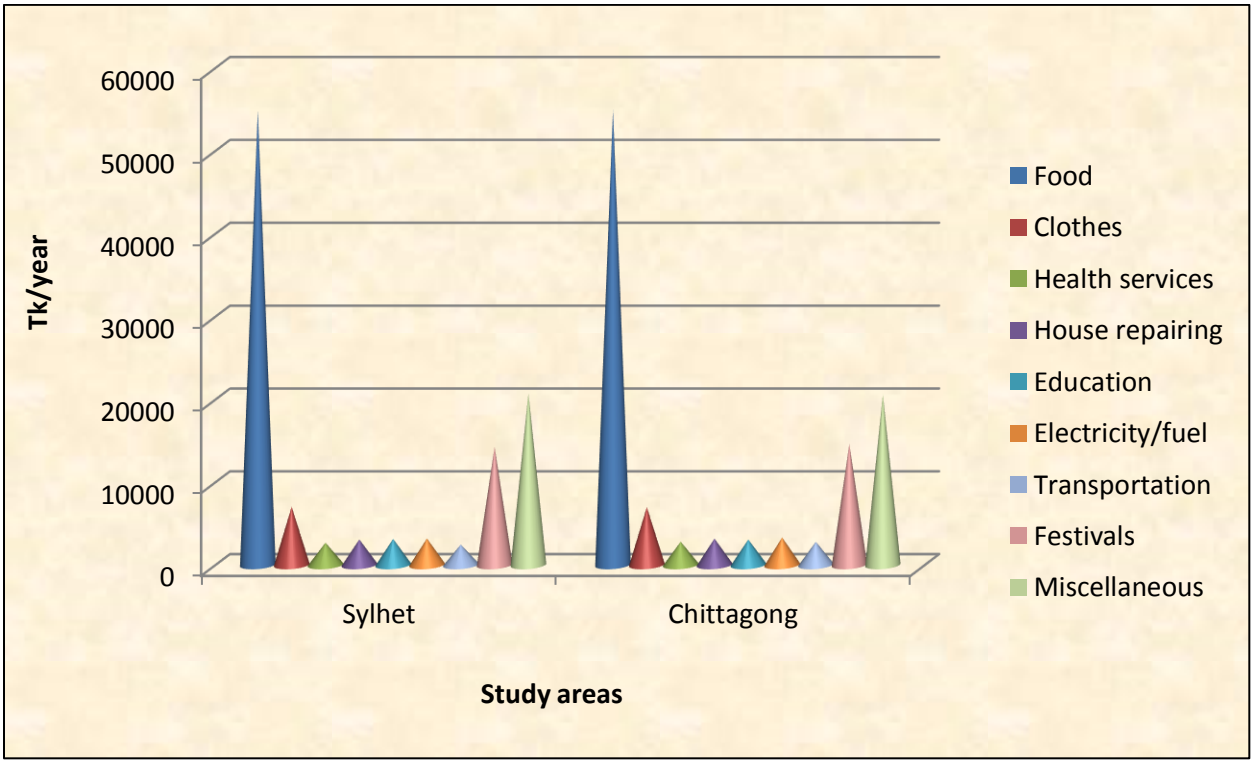

Figure 5: Average annual expenditure of the agricultural technology using farmers

11.13 Food security status of the agricultural technology using households

Food security status of the agricultural technology using households was estimated from the viewpoint of three perspectives, such as, availability of safe and nutritious food, access to food and utilization of food. It is evident from Table 26 that food security index value for food secure households was 1.09 and 1.03; and for food insecure households was 0.43 and 0.50 in Sylhet and Chittagong divisions, respectively. Based on the recommended daily calorie intake of 2122 kcal, it was observed that 71.7 and 65.0 percent households were food secure; and remaining 28.3 and 35.0 percent households were food insecure in Sylhet and Chittagong divisions, respectively. Average calorie intake of food secure households was 2017.4 and 1984.2 kcal per day which was 1788.4 and 1940.1 kcal in case of food insecure households in Sylhet and Chittagong divisions, respectively but these were still lower than the national average level (i.e., 2122 kcal) for both food secure and insecure households. The value of food surplus index in share of food secure households was 0.21 and 0.16, respectively which indicated that households of both categories had superfluous food for crisis period, where the value of food shortfall index for food insecure households was -0.16 and -0.20in Sylhet and Chittagong divisions, respectively indicating a situation of food shortage and no surplus food at the dilemma period for households of both categories (Table 26).

Table 26: Food security indices of the farm households

Study areas	Food security indices	Index values	
		Food secure households	Food insecure households
Sylhet (tribal groups: *Garo, Khasia*and *Manipuri*)	Food security index (Z)	1.09	0.43
	Head count index (H)	71.7	28.3
	Per capita daily calorie availability	2017.4	1788.4
	Food shortfall/surplus index (P)	0.21	-0.16
Chittagong (tribal groups: *Chakma, Marma*and*Tanchang*)	Food security index (Z)	1.03	0.50
	Head count index (H)	65.0	35.0
	Per capita daily calorie availability	1984.2	1910.1
	Food shortfall/surplus index (P)	0.16	-0.20

Source: Authors' estimation, 2018.

11.14 Impact of agricultural technology use on farmers' livelihood

Multidimensional poverty index (MPI) was used to demonstrate the impact of usingagricultural technologies on farmers' livelihood condition in terms of appraising poverty circumstances. Poverty has traditionally been measured in one dimension, usually income or consumption. In this analysis, a basket of goods and services was considered as the minimum requirement to live a non-impoverished life. People who did not have an income sufficient to cover that basket were deemed as poor (HDR, 2015).

The MPI combined two key pieces of information to measure acute poverty: the incidence of poverty or the proportion of people (within a given population) who experienced multiple deprivations, and the intensity of their deprivation - the average proportion of (weighted) deprivations they experienced. Both the incidence and the intensity of these deprivations were highly relevant pieces of information for

poverty measurement. To start with, the proportion of poor people was a necessary measure to know how many poor were people in the research as a proportion of the sample included.

The MPI was composed of three dimensions (health, education and living standard) made up of ten indicators (two for health, two for education and six for living standards). Associated with each indicator, there was a minimum level of satisfaction named 'DeprivationCut-off'. The indicators were selected after a thorough consultation process. During this process, the ideal choice of indicators was reconciled with what was actually possible in terms of data availability and cross-area comparison. The ten indicators finally selected were the only set of indicators that could be used to compare focal and control farmers' poverty situation in the research areas.

Education

Two indicators were used by the MPI inside the education dimension: one pointed out at completed years of schooling of household members and the other at whether children were attending school. Years of schooling acted as a proxy for the level of knowledge and understanding of household members. Both years of schooling and school attendance were imperfect proxies. They did not capture the quality of schooling, the level of knowledge attained or skills but both were robust indicators, widely available and provided the closest feasible approximation to levels of education for household members.

In terms of deprivation cut-offs for this dimension, the MPI required that at least one person in the household had completed five yearsof schooling and all children of school-agewere attending class I to class VIII of school. Because of the nature of the MPI indicators, someone living in a household where there was at least one member with five years of schooling was considered privileged. Analogously, someone living in a household where there was at least one child not attending school was considered deprived in this indicator. People living in households with no school-aged children were considered privileged in school attendance. Hence the incidence of deprivation in this indicator reflected the demographic structure of the educational attainments of the households in the research areas.

Health

Two health indicators were used in The MPI that, although related, depart significantly from standard health indicators. The first indicator looked at nutrition of household members. The nutritional indicator used for children as well as adult related to being underweight as per age (i.e., weight-for-age). Adults or children who are malnourished are susceptible to other health disorders; they are less able to learn and to concentrate and may not perform as well at work. The second indicator used data on child mortality. In the MPI, each household member was considered to be deprived if there had been at least one observed child death in the household.

Living standards

The MPI considered six indicators for standards of living. It included three standard indicators related to health and living standards which were: access to clean drinking water, access to improved sanitation and the use of clean cooking fuel. It also included two other indicators that were: access to electricity and flooring material. All of these indicators provided some rudimentary indication of the quality of housing for the household. The final indicator covered the ownership of some consumer goods, each of

which had a literature surrounding them: radio, television, telephone, bicycle, motorbike, car, truck, refrigerator, etc.

Water

A person was considered to have access to clean drinking water if the water source was any of the following types: tube well, protected well, public tap, pump and protected rainwater which could be accessed within a distance of 10 minutes' walk (roundtrip). If it failed to satisfy these conditions, the household was considered deprived in access to water.

Table 27: Dimensions, indicators, thresholds and weights inside the MPI

Dimensions	Indicators	Thresholds	Weights
Education	Years of schooling	Deprived if no household member had completed five years of schooling	1/6
	School attendance	Deprived if any school-aged child was not attending school from class I to class VIII	1/6
Health	Child mortality	Deprived if any child had died in the family	1/6
	Nutrition	Deprived if any adult or child was malnourished	1/6
Living standard	Electricity	Deprived if any household had no electricity	1/18
	Drinking water	Deprived if any household did not have access to clean drinking water	1/18
	Sanitation	Deprived if any household lacked adequate sanitation or if latrine was shared	1/18
	Flooring	Deprived if any household had a dirty, sand or dung floor	1/18
	Cooking fuel	Deprived if any household had to cook with wood, charcoal or cowdung	1/18
	Asset ownership	Deprived if any household did not own more than one of radio, television, mobile, bicycle, motorcycle or refrigerator; and did not own a car or tractor	1/18

Source: Adapted from Santos *et al.* (2011).

Improved sanitation

A person was considered to have access to improved sanitation if the household had some type of flush toilet or latrine, ventilated improved pit or composting toilet, conditioned that they were not shared. If the household did not satisfy these conditions, it was considered deprived in sanitation.

Electricity

A person was considered to be deprived here if he/she did not have access to electricity.

Flooring

Flooring material made of dirt, sand or dung was counted as deprivation in flooring.

Cooking fuel

A person was considered deprived in cooking fuel if the household cooked with cowdung, charcoal or wood.

Assets

If a household did not own more than one radio, television, mobile, bicycle, motorbike or refrigerator, and did not own a car or tractor, each person in it was considered deprived.

It is reflected from Tables 28 and 29 that the percentage of deprived households in Sylhet and Chittagong divisionswas 45.7 and 45.3 percent; and the percentage of privileged households was 75.4 and 54.2 percent, respectively. The households were deprived or privileged of all the indicators of a single dimension or at a combination of the indicators across dimensions.

Table 28: Multidimensional poverty index to measure poverty intensity in Sylhet division

Indicators	Tribal groups						Weights
	Garo		*Khasia*		*Manipuri*		
	Average household size						
	5 (N = 100)		6 (N = 100)		6 (N = 100)		
	No. of households deprived (√) or privileged (×) based on the indicators						
	√	×	√	×	√	×	
Education							
No one has completed five years of schooling	64/100	36/100	58/100	42/100	60/100	40/100	1/6
At least one school-age child not enrolled in school	58/100	42/100	52/100	48/100	54/100	46/100	1/6
Health							
At least one member is malnourished	42/100	58/100	52/100	48/100	47/100	53/100	1/6
One or more children have been died	0/100	100/100	0/100	100/100	0/100	100/100	1/6
Living standards							
No electricity	36/100	64/100	34/100	66/100	38/100	62/100	1/18
No access to clean drinking water	24/100	76/100	24/100	76/100	22/100	78/100	1/18
No access to adequate sanitation	28/100	72/100	32/100	68/100	33/100	67/100	1/18
House having dirty floor	44/100	56/100	46/100	54/100	45/100	55/100	1/18
Household uses dirty cooking fuel (i.e., cowdung, firewood or charcoal)	100/100	0/100	100/100	0/100	100/100	0/100	1/18
Household has no car and owns at best one bicycle, motorcycle, radio, refrigerator, mobile or television	100/100	0/100	100/100	0/100	100/100	0/100	1/18
Score of the households	0.458	0.542	0.457	0.543	0.456	0.544	-
Intensity of poverty (%)	Deprived households				Privileged households		
	45.7				54.3		

Source: Authors' estimation, 2018.

Note: Score of deprived households in *Garo* group = (64/100 × 1/6) + (58/100 × 1/6) + (42/100 × 1/6) + (0/100 × 1/6) + (36/100 × 1/18) + (24/100 × 1/18) + (28/100 × 1/18) + (44/100 × 1/18) + (100/100 × 1/18) + (100/100 × 1/18) = 0.458
Score of privileged households in *Garo* group = (36/100 × 1/6) + (42/100 × 1/6) + (58/100 × 1/6) + (100/100 × 1/6) + (64/100 × 1/18) + (76/100 × 1/18) + (72/100 × 1/18) + (56/100 × 1/18) + (0/100 × 1/18) + (0/100 × 1/18) = 0.458

Score of deprived or privileged households of other groups is calculated accordingly.
Deprived households (%) = [{(0.458 × 5) + (0.457 × 6) + (0.456 × 6)} ÷ (5 + 6 + 6)] × 100 = 45.7%
Privileged households (%) = [{(0.542 × 5) + (0.543 × 6) + (0.544 × 6)} ÷ (5 + 6 + 6)] × 100 = 54.3%

Table 29: Multidimensional poverty index to measure poverty intensity in Chittagong division

Indicators	Study areas						Weights
	Chakma		*Marma*		*Tanchang*		
	Average household size						
	5 (N = 100)		7 (N = 100)		4 (N = 100)		
	No. of households deprived (√) or privileged (×) based on the indicators						
	√	×	√	×	√	×	
Education							
No one has completed five years of schooling	73/100	27/100	61/100	39/100	63/100	37/100	1/6
At least one school-age child not enrolled in school	52/100	48/100	50/100	50/100	51/100	49/100	1/6
Health							
At least one member is malnourished	35/100	65/100	47/100	53/100	45/100	55/100	1/6
One or more children have been died	0/100	100/100	0/100	100/100	0/100	100/100	1/6
Living standards							
No electricity	40/100	60/100	38/100	62/100	43/100	57/100	1/18
No access to clean drinking water	27/100	73/100	27/100	73/100	25/100	75/100	1/18
No access to adequate sanitation	22/100	78/100	30/100	70/100	30/100	70/100	1/18
House having dirty floor	45/100	55/100	44/100	56/100	42/100	58/100	1/18
Household uses dirty cooking fuel (i.e., cowdung, firewood or charcoal)	100/100	0/100	100/100	0/100	100/100	0/100	1/18
Household has no car and owns at best one bicycle, motorcycle, radio, refrigerator, mobile or television	100/100	0/100	100/100	0/100	100/100	0/100	1/18
Score of the households	0.452	0.548	0.452	0.548	0.454	0.546	-
Intensity of poverty (%)	Deprived households				Privileged households		
	45.3				54.7		

Source: Authors' estimation, 2018.

11.15 Problems faced by the farmers related to agricultural technologies

Problem confrontation index (PCI) is a mathematically problem ranking index which is defined as a set of objects whose state must satisfy a number of problems or limitations. It represents the entities in a problem as a homogeneous collection of finite limitations over variables in a specific area. The farmers of the study areas were asked to give their opinion on 07 selected problems which were identified during data collection period and after computing the PCI scores, the problems were ranked according to their PCI score. The computed PCI score of the 07 problems ranged from 1386 to 1566 (against a possible range from 0 to 1800) which were arranged in rank order according to their PCI scores as shown in Table 30.

Table 30: Problem confrontation index including seven (07) selected problems

Identified problems	Extent of problem					
	Frequently (3)	Occasionally (2)	Rarely (1)	Not at all (0)	PCI	Rank order
Lack of good quality inputs	408	126	12	54	1488	4
High price of inputs	426	120	24	30	1542	3
Lack of transportation and storage facilities	354	102	120	24	1386	7
Lack of knowledge on agricultural technologies	426	120	48	6	1566	1
Lack of extension service	420	114	60	6	1548	2
Difficulties in maintenancelivelihoods	432	60	54	54	1470	5
Insufficient institutional credit	390	108	42	60	1428	6

Source: Authors' estimation, 2018.

Lack of good quality inputs

Lack of good quality inputs was one of the major problems faced by the farmers in the study areas. Precisely, availability of good quality seeds and fertilizers were infrequent to the farmers. According to the perceptions of the farmers, the PCI score of this problem stood 1488 which resulted in a rank of this problem as 4th.

High price of inputs

Majority of the farmers opined that the prices of the production inputs were very much higher for them to meet the production expense. The PCI score of this problem was 1542which was ranked as 3rd.

Lack of transportation and storage facilities

Transportation of products was not easy for the farmers in the study areas because of underdeveloped road communication system. A vast amount of products were being damaged because of this reason. Also, storage facility was weak and as a result, storing of products for future sale was reasonably uncertain. This problem was ranked as 7th with PCI score of 1386.

Lack of knowledge on agricultural technologies

The knowledge of the farmers on access and use of agricultural technologies was not immensely transparent. Lack of appropriate knowledge was a great knotty issue for the farmers. As stated by the farmers, this problem was ranked as 1st by means of PCI score of 1566.

Lack of extension service

A noticeable number of farmers in the research areas stated that they experienced lack of extension contact. The frequency of visit by the extension agents in the research areas was very limited. The problem was ranked as 2nd as per the PCI score of 1548 according to the farmers.

Maintenance is difficult

The maintenance of modern agricultural machineries was seemed to be difficult than conventional farming practice to some of the farmers. As stated by them, this problem was ranked as 5th by means of PCI score of 1470.

Insufficient institutional credit

Inadequate credit facility was another major problem faced by the farmers in the study areas. The credit lending process of different formal credit lending institutions was not transparent to them and as a result, they had to depend on different informal sources of credit like moneylenders, relatives, friends, etc. The PCI score of this problem was calculated at 1428, which was ranked as 6th problem along with the statements of the farmers.

12. Research highlights / findings

1. Agriculture plays a crucial role in overall economic development of agro-based developing countries like Bangladesh and its agriculture. Tribal people are lag behind the mainstream of economic development in this country. Sustainable agricultural development can help tribal agriculture to be modernized. The study aimed to assess the improvement of the livelihood of tribal farmers' by the means of increased income through the use of agricultural technologies in Bangladesh.
2. The study revealed that most of the tribal farmers were engaged in agriculture as well as other income generating activities where majority of them produced agricultural commodities commercially. The most common farming practices were crop-livestock-poultry (C-L-P), crop-poultry-homestead enterprise (C-P-H) and crop-livestock-homestead enterprise (C-L-H).
3. Farmers of the study areas gathered knowledge about agricultural production practices from different government and non-government organizations. The production practices tagged with the farmers had a great influence on their livelihood components. Majority of the farmers experienced positive impacts of farming systems practiced in the mirror of asset possession, activities and strategies, well being, and external policies and institutions.
4. It was evident from the study that almost all of the most common farming practices like C-L-P, C-P-H and C-L-H were more or less profitable that had a considerable impact on increasing the monetary income of the farmers. Crop productivity of the farmers using agricultural technologies was moderately high in response to the crop production in the entire region. Net change in inventory of livestock was satisfactory also. Lower profitability in crop production and homestead farming had an influence on farmer to shift their concentration to comparatively higher profitable business of livestock and poultry production. Specifically, the study found

livestock rearing as more profitable among all the tribal groups while poultry farming was profitable in C-L-P farming system only.

5. The study exposed that majority of the farmers avowed about enhanced state of production practices using agricultural technologies like betel leaf and betel nut production, ell fish production (*Monopterus Cuchia*, Eng. Name - Cuchia), agroforestry plantation, coffee tree cultivation, *Jhum* Cultivation, medicinal plants cultivation and rice cultivation (local).

6. It is also seen from the study that five out of eight independent variables had significant influence on adoption of agricultural technologies by the farmers found which were: educational level of household head, farm size, farm income, extension contact and farming experience of the farmers.

7. Per capita daily calorie intake by the farmers was still under the national level average which was a great issue of concern. The study also indicated that tribal farmers' poverty in terms of deprivation of health, education and living standards was decreased; and overall livelihood circumstances were improved after using the agricultural technologies.

8. Considering the findings of the study, some essential policy recommendations have been arisen which are: training, motivation and extension services of government should be properly implemented to raise the awareness about modern agricultural technologies and its importance on agricultural production among the tribal groups. Also, initiative for scientific and technical training programs should be arranged by different government and non-government organizations to enrich the knowledge of the farmers on agricultural technology use. Besides these, government should take necessary steps to ensure the good quality production inputs in the market and subsidize them to support the tribal farmers. In addition, the output price in the market should be monitored by the government so that farmers always get the rational price for their product. Moreover, farmers' access to institutional credit should be made transparent and easy by the respective authority.

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B. Implementation Position

1. Procurement:

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	
(a) Office equipment					
File Cabinet	1	20000	1	19800	
Executive Table	1	22000	1	21700	
Visitor Chair	2	8000	2	8000	
Computer Chair	1	4500	1	4400	
Computer Table	1	7000	1	6700	
Steel Almirah	1	26000	1	25900	
(b) Lab &field equipment	-	-	-	-	
(c) Other capital items					
Desktop Computer	1	60000	1	59500	
Labtop Computer	1	60000	1	65000	
Laser Printer (Black &White)	1	20000	1	19400	
UPS	1	10000	1	5800	
Scanner	1	10000	1	5300	
Portable Hard disk	1	10000	1	9600	
Digital Camera	1	25000	1	29500	

2. Establishment/renovation facilities:

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	
Repairing of equipment and Office Room (PI)	-	-	8000	8000	

3. Training/study tour/ seminar/workshop/conference organized:

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training	41	49	90	03 Days	
(b) Workshop	-	-	-	-	

C. Financial and physical progress

Fig in Tk

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	632061	632061	632061	0	100	
B. Field research/lab expenses and supplies	750000	750000	750000	0	100	
C. Operating expenses	259239	259239	259239	0	100	
D. Vehicle hire and fuel, oil & maintenance	262000	262000	262000	0	100	
E. Training/workshop/seminar etc.	132900	132900	132900	0	100	
F. Publications and printing	120000	*26585	25000	95000	20.83	
G. Miscellaneous	39200	39200	39200	0	100	
H. Capital expenses	304600	304600	304600	0	100	

- ***Tk. 26585 was received in this head out of Tk. 120000. Expenditure in this head was Tk. 25000 and remaining Tk. 1585 was sent back to PIU BARC by Check. Tk. 95000 for PCR was not disbursed.***

D. Achievement of Sub-project by objectives: (Tangible form)

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output(i.e. product obtained, visible, measurable)	Outcome(short term effect of the research)
To identify the socioeconomic profile and livelihood pattern of tribal farmers' of Sylhet and Chittagong regions	Survey of the study areas are completed with the respondents	Socioeconomic profile, agricultural practices and livelihood pattern of tribal farmers' are examined and presented	Effective strategies can be made based on the projects results to improve socioeconomic condition and livelihood pattern of tribal farmers'
To know the agricultural practices of tribal farmers'	Personal interviews, key informant interviews and focus group discussions, survey	Agricultural practices are documented with their methods and used materials	Existing agricultural practices of tribal people have been addressed in the projects and based on the results/information need based modern/ modified agricultural technologies can be transferred to the tribal people to improve their agricultural practices effectively
To explore the potentiality of the use of agricultural technologies to improve the livelihood of tribal farmers'	Meeting with tribal farmers, local elite, DAE, BARI and NGO personnel; and arrangement of group based training programmes	Potentiality of the use of agricultural technologies to improve the livelihood of tribal people are explored and tested	Tribal farmers can be motivated greatly use modern agricultural technologies in their existing agricultural practices to improve their livelihood through increased productivity.

E. Materials Development/Publication made under the Sub-project:

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer,*etc*.			
Journal publication	√		
Information development			
Other publications, if any (PCR)	√		
MS Thesis		√	Environmental income and inequality among tribal communities in Chittagong hill tracts

F. Technology/Knowledge generation/Policy Support (as applied):

i. Generation of technology (Commodity & Non-commodity)

List of farmers improved technologies –

- Betel leaf and Betel nut production
- Eel fish production (*MonopterusCuchia*, Eng. Name-Cuchia)
- Agroforestry plantation
- Coffee tree cultivation
- Jhum Cultivation
- Medicinal plants cultivation

ii. **Generation of new knowledge that help in developing more technology in future**

Livelihood status of tribal communities is now known through project activities. The information may be used for their livelihood development.

iii. Technology transferred that help increased agricultural productivity and farmers' income

Training on summer and winter vegetable production along with supplied seeds of modern varieties

iv. Policy Support

Tribal communities are under privileged. Based on the project results following policy supports are recommended:

- Training support to improve their skills.
- Technological support to improve their agricultural practices.
- Financial support to motivate poor tribal people to agricultural practices.
- Educational support to increase their awareness and to improve their livelihood.
- Special income generating project from the local government to improve their socioeconomic condition and livelihood.

G. Information regarding Desk and Field Monitoring

i) Desk Monitoring [description & output of consultation meeting, monitoring workshops/seminars etc.):

A workshop on "Progress Review of CRG Sub-projects, PIU-BARC, NATP-2 Project under AERS Division, BARC" was held on 05 March 2018 at the Conference room-1 of Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka. Dr. Paresh Chandra Golder, Member Director (P&E), BARC and Dr. Mian Syeed Hassan, Director (PIU-BARC), NATP-2 project was presented as Chief Guest and Special Guest, respectively in the inaugural session of the workshop. Dr. A.S. M. Anwarul Huq, Member-Director (AERS), BARC presided over the inaugural session. A total of 75participants including principal & co-principal investigators (PI & Co-PI) of 10 sub-projects, research management expert of PIU-BARC, scientists, professors, agriculture experts and delegates attended the workshop from different research organizations, universities and private sectors. Activities wise progress under the objectives of the respective sub-projects along with limitations was presented by PIs/Co-PIs in the technical sessions of the workshop. Two technical sessions were presided over by Professor Dr. Rezaul Karim Talukder, Advisor, MUCH, FAO/MoFood and Dr. Jahangir Alam Khan, Former Director General, BLRI, Dhaka. In discussion sessions the learned participants were participated actively by giving valuable comments/suggestions for further improvement. However, sub-project wise comments/suggestions made in the workshop by the distinguished participants are given below:

Comments:

- A comprehensive review of existing related research should be done carefully.
- Actual field based report must be accomplished and originality of the project should be reflected.
- Indicators of productivity and livelihood should be specified.
- Standard and scientific technique should be applied to design the sample size and sample frame.
- Changes in agricultural practices that persist to happen over the years should be visible in the report.

ii) Field Monitoring (time& No. of visit, Team visit and output):
Technical Division/ Unit, BARC, 22 to 23 February 2018
PIU-BARC, NATP-2, 7 April 2018

H. Lesson Learned/Challenges (if any)

I. Challenges (if any)

Some of the specific limitations of this study are as follows:

i) Limitation of time. The primary data and other necessary information need to be collected within a short period of time.
ii) Remote area. The study areas lack well road and telecommunication system.
iii) It is difficult to collect data from the ethnic groups because of linguistic and religious barriers.
iv) The agricultural practices in the hilly areas are not well developed.

Signature of the Principal Investigator
Date ……
Seal

Counter signature of the Head of the organization/authorized representative
Date ……..
Seal

Appendices

Appendices

Snapshots during the study

Training program for tribal farmers' of Jaintiapur upazila of Sylhet district

Distribution of vegetables seeds to the farmers

Group photograph after completion of farmers training

Training program for tribal farmers' of Kawkhali upazila of Rangamati district

Refreshment to the farmers participated in the training program

Focus Group Discussion with farmers at Jaitiapur Upazila

Focus Group Discussion with farmers at Sadar upazila of Sylhet District

Discussed with local leaders

Data collection from the farmers

Data collection from the farmers by PI

Income generating Activities

Local agricultural practices

Field visit with monitoring team of PIU, BARC

Group photo of PI, Co-PI and Enumerators (MS Students)

Local technologies practices

Local technologies practices

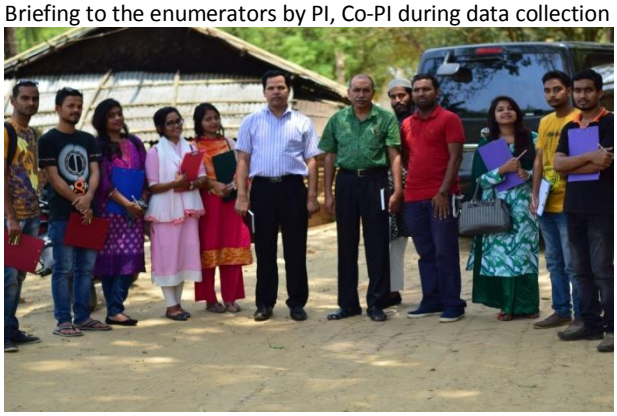
Local agricultural practices

Data collection from the farmers

Data collection from the farmers

Briefing to the enumerators by PI, Co-PI during data collection

Photo session with the participants during farmers training



Group photo of PI, Co-PI and enumerators with local Guides








Cultivation of different vegetables by the tribal farmers using the provided vegetables seeds