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ADOPTION IMPACT OF IMPROVED COWPEA VARIETY IN SELECTED AREAS OF CHATTOGRAM DISTRICT OF BANGLADESH

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ABSTRACT

The study was carried out in 13 villages under three Upazila's namely Hathazari, Fatikchari and Satkania of Chattogram District, Bangladesh during 2017-18 covering 210 farmers in the selected locations. Results revealed that the rate of adoption of cowpea (BARI Cowpea-1) was found to be higher (71%) than that of the local and mixed varieties. The highest number of the respondents came to know about BARI Cowpea-1 from DAE (58.6%) followed by seed dealers (31.7%), research stations (19.0%) and NGO's (17.0%). The average yield of BARI Cowpea-1 was recorded at 0.613/ha irrespective to all locations; which indicated that the productivity of this variety has been declined due to perhaps mixed cultivation practices with the local variety, lack of knowledge on modern production technologies, lack of irrigation water during the dry seasons and not using the recommended dose of manures and fertilizers. Thus the adoption rate of individual production technology of BARI Cowpea-1 was found unsatisfactory. But it still might project promises; if the farmers could be acquainted, trained and put in practice with the modern production technologies. The respondents had agreed upon significant positive socio-economic impacts of cowpea cultivation on their livelihoods; so it's needed to motivate farmers to follow the recommended production technologies for gaining higher yield from this variety or alternatively needs to develop and release new varieties for this region.

Contribution/Originality: This study is one of very few studies which have investigated the adoption status of a BARI released cowpea variety, BARI Cowpea-1 and its specific production technologies at field level and the factors influencing adoption/ non-adoption for developing new cowpea varieties for the region.

1. INTRODUCTION

The Cowpea (*Vigna unguiculata*) is an annual herbaceous legume belongs to the genus *Vigna* (Hasskarl; IPNI). As tolerant to sandy soil and drought conditions (Márcia *et al.*, 2017) it has been an important crop in the semiarid regions across Africa and Asia. It requires very few inputs, as the plant's root nodules are able to fix atmospheric nitrogen, which makes it a valuable crop for resource-deficient farmers (Padulosil and Ng, 1997; Sudhir and Rana, 2016) and well-suited for intercropping with other crops. The whole vegetative part of the plant is used as animal fodder, with its use as cattle feed likely responsible for its name (Ayana *et al.*, 2013).

Commercially cultivated cowpeas are known by a few handfuls of names in different geographical regions likely black-eyed pea, southern pea, yard long, catjang and Crowder pea (Carlos, 2004). They were domesticated in Africa and are one of the oldest crops to be cultivated. Its second domestication occurred in Asia followed by spreading into Europe and the Americas. The crop is mainly grown for its seeds as the edible part, which is highly rich in protein, though the leaves and immature seed pods can also be consumed (Aliyu and Wachap, 2014). The seeds are usually of many edible forms to consume such as cooked and made into stews and curries, or ground into flour or paste (Salifou *et al*., 2017). A 1997 estimate suggests that cowpeas are cultivated on 12.5 million hectares (31 million acres), have a worldwide production of 3 million tones and are consumed by 200 million people on a daily basis (Singh *et al*., 1997).

As cowpea hasn't yet achieved its position as one of the highest ranked pulse crops worldwide and has been being produced in zone based limited areas; though it possess a high socioeconomic and nutritional value (Carlos, 2004) it worth intensive adoption researches. There are several socioeconomic, financial and environmental factors; those could influence the adoption rate of improved varieties of Cowpea developed by research institutes (Moussa *et al*., 2011; Sabo *et al*., 2014). Results of previous studies shows that the adoption rate of improved varieties of cowpea is determined by several factors like demographic aspects of the farm households, their production environments, typical adoption attitudes, amount of pesticides needed, the incidence of insect pest and diseases, drought related problems, degrading soil fertility, dwindling farm land, low yields and so on (Mbavai *et al*., 2015; Patricia *et al*., 2016; Sobda *et al*., 2018; Esther, 2019).

In Bangladesh cowpea, commonly known as "Felon", has been one of the most popular and most frequently cultivated pulse crops in greater Chattogram, Vola and Feni regions of Bangladesh. Some other areas are also involved in cowpea production in comparatively small scales. According to BBS (2018) the total area and production of other pulses like *Gari Kalai*, *Khesari*, *Maskhali*, *Mung*, *Motor*, *Masur*, *Arhar*, *Gram* were estimated at 363,182.5 ha and 473497 mt. respectively; of which cowpea contributed with notable number; which brings a total area of 32,000 hectors under cowpea production; the recorded amount of production is 35,000 tons in total.

Considering the Emerging popularity, scopes and opportunities, Bangladesh Agricultural Research Institute has invented two distinct varieties of cowpea; BARI Cowpea- 1, BARI Cowpea-2. The germplasm of Cowpea- 1 was collected from Chittagong region through primary, secondary and multi spot trial basis selection. The main traits of BARI Cowpea- 1 includes light green erected leaves and stem, lifetime 125-135 days, ash coloured skin with blackish stripes, weight of 100 seed is 90-95 grams, yield 1.1- 1.4 tons per hectare, protein content 25-30% (Khrishi, 2016). In the other hand BARI Cowpea-2 was originated from some variety lines of IITA invented pulse crops. The performances of the lines regarding yielding capacity, resistance to pest and disease, lifetime etc. were closely observed analysed. The variety was developed and identified as a high yielding variety through primary secondary and multi spots trials. In 1996 the National Seed Board (NSB) certified and released this variety as BARI Cowpea- 2 for commercial production. The main features of this variety includes comparatively dark greenish leaves and stems, lifetime 120-30 days, skin is of ash colour, weight of 100 seeds is 100-120 grams; 75-80 grams without peel, yield 1.5 kg per hector (Khrishi, 2016). Since BARI Cowpea-1 was developed and released for commercial production in 1993, it was preferably introduced in Chattogram region rather than BARI Cowpea-2 for its specific features suited better in this region. In 2017, as an endeavor of the Department of Economics, Regional Agricultural Research Station, Hathazari , Chattogram, an adoption study was carried out on BARI Cowpea-1 for assessing the status of adoption and socioeconomic impact of this technology (variety) on farmer's household income. It was imperative to know the status of the technology (BARI Cowpea-1) considering circumstances at field level and factors effecting adoption and non-adoption. The other associating organizations also have shown interests and cooperated executing the study successfully. The DAE high officials had projected highly positive responses about this new study during the "Research-extension Review Workshop" at planner's session on 27 April 2017 at RARS, Hathazari, Chattogram. Their assistance was a very good mean for disseminating the technologies at field level.

Simultaneously, the govt. would also be benefited by the achievement. Keeping this in mind, the study had been undertaken with the following specific objectives: (i) to document socioeconomic and contextual information of the cowpea growers; (ii) to evaluate the status of adoption of BARI Cowpea-1 and its production technologies; and (iii) to identify the factors responsible for adoption and non-adoption of BARI Cowpea-1. (iv) to derive policy recommendations.

2. METHODOLOGY

2.1. Selection of Specific Study Areas

The study was covered in 13 villages under three Upazilas (administrative unit) in Chattogram District. The specific locations were selected based on intensity of cowpea cultivation. In consultation with respective Upazila's Agriculture Officer's (UAO) and Sub-Assistant Agricultural Officer's (SAAO). Multi-stage sampling technique was followed for selecting the specific study areas. The study areas (villages) namely were: Alipur, Alampur, Mirer khil, Poschim Dewan nagar, Enaetpur, Purbo Dholoi, Poschim Dholoi, Gardianpara under Hathazari Upazila's (8), Raushangiri, Sadeknagar, shomitipara, Doulotpur in Fatikchari Upazila's (4) and Afjalnagar in Satkania Upazila (1).

2.2. Sampling Techniques and Sample Size

Determination of sample size was very important for the study to make sure the proper representation of the areas. Keeping this in mind and considering the time and resources, a total of 210 sample farmers were selected for the study. Of them, the highest number of sample size (150) was taken from Hathazari Upazila due to coverage of more villages, 30 from Fatikchari and 30 from Satkania Upazilas. Proportionate random sampling technique was followed for the study. Before selecting the sample size, a list of cowpea growers was taken into count and then the sample size selected proportionately (63.4% to 77.3%) irrespective to all locations. Out of the total sample size, the adopter of BARI cowpea-1 was 150 and non-adopter was 60.

2.3. Data Collection Procedures

Mainly primary and secondary data were used in the study. Focus group discussion, key informant interviews and survey questionnaires were used for data collection. The secondary data were collected from books and BBS reports. The primary data were collected by the Scientific Officer, Scientific Assistants, Sub-assistant Agricultural Officers and the researcher himself as well; using pre-texted semi-structured interview schedule. The data collection period was from January to April, 2018.

2.4. Analytical Techniques

Descriptive statistical methods i.e. average, percentages and mean differences were used in the study. In order to estimate the factors responsible for adoption and non-adoption of BARI cowpea-1, the Probit model was used.

2.5. Probit Model

In order to ascertain the adoption of technology, the following empirical Probit model was applied. Since the dependent variable is dichotomous, Ordinary Least Square (OLS) method was not suitable. Therefore, MLE method was followed to run the probit model using STATA software. The empirical probit model was as follows:

$$Ai = \alpha + \beta iXi + \ldots\ldots..+ Ui$$

Where,

Ai = Adopter of BARI cowpea-1 (Adoption of the variety= 1; Otherwise = 0).

α = Intercept.

Xi = Explanatory variables.

βi = Coefficients of respective variables.

Ui = Error term

The adoption impact of the variety is likely to be influenced by different explanatory variables. The variables are:

X^1 = Ln income from cowpea (tk/ha).

X^2 = Age.

X^3 = Education (Year of schooling).

X^4 = Family size.

X^5 = Ln area of cowpea cultivation.

X^6 = Having knowledge of the production technology of cowpea (score).

X^7 = Yield of cowpea.

X^8 = Risk bearing capacity (score).

X^9 = Willingness (score).

X^{10} = Economic aspiration.

X^{11} = Mass media exposure (score).

X^{12} = Research contact of the farmers (score).

X^{13} =Extension contact of the farmers (score).

The analytical results of the model are shown in the next section.

3. RESULTS AND DISCUSSION

3.1. Socioeconomic Profile of the Respondents

It is shown in Table 1 that the average age of the respondents was found to be 47.75 years irrespective to all locations which implied that all the respondents were able and willing to adopt new agricultural technologies due to belonging in young age range. Duram (1997); Marenya and Barrett (2007) argued that young producers are more open to the adoption of new practices. Mamun *et al.* (2019) claimed that the probability of adoption of new technologies decreases when farmer's age increases. In the case of education of the respondents, the average year of schooling was found to be 6.1 years in all locations. Mamun *et al.* (2019) viewed that the possibility of adoption of new technology is higher when the level of education increases. The major occupation of the respondents was agriculture (98.2%) irrespective to locations; which was the highest in Fatikchari (100%) followed by Hathazari (98%) and Sathkania (96.6%). Occupations of the respondents might have influenced adopting new technologies. The secondary occupation was reported to be business (21.07%) and private job (5.97%) in all locations. The average household size was 6.4 persons per family which was higher than that of the national average household size (5.0) (BBS, 2018). The family type might have influenced the decision making for adopting new technologies as more than 73.07% respondents belonged to single families and the rest to joint families.

Table-1. Socioeconomic profile of the respondents.

Si. No.	Particulars	Locations			
		Hathazari	Fatikchari	Sathkania	All
1	Age of the respondent (years)	45.4	44.2	53.6	47.75
2	Education (average years of schooling)	6.4	6.8	5.1	6.10
3	Main occupation (%):				
	- Agriculture	98.0	100.0	96.6	98.20
	- Business	13.3	23.3	26.6	21.08
	- Private job	4.6	3.3	10.0	5.98
	- Day Labor	1.3	-	-	1.30
4	Household size (Person/family):				
	- Male	3.1	3.2	3.4	3.24
	-Female	3	3.1	3.4	3.17
5	Family types (%):				
	- Single	62.6	76.6	80.0	73.07
	- Joint	37.3	23.3	20.0	26.87

Source: Field survey, 2018.

3.2. Contextual Information of BARI Cowpea-1 Growers

Table 2 shows that the average size of cultivable land of the farmers was 0.731 ha either in homestead areas or in other places irrespective to locations. The average area under cowpea cultivation was reported to be 0.15 ha in all locations which was the highest in Sathkania areas (0.174 ha) followed by Hathazari (0.152 ha) and Fatikchari (0.146 ha). The mean differences of cowpea cultivation areas were varied significantly at 1% level of probability among the locations (F=5.2131). The average duration (years) of total cowpea cultivation was found to be 14.20 in all locations which was the highest in Sathkania (18.63) followed by Hathazari (13.38) and Fatikchari (10.06). The average seed rate followed by the farmers was 31.37 Kg/ha which was lower than the recommended rate (45 kg/ha) (Khrishi, 2016). The farmers were able to sale the product at an average price of Tk 63.99/Kg. Irrespective to locations. The highest 41.54% farmers cultivated cowpea in medium low lands, 40.42% in medium high lands, 17.11% in high lands and 3.33% in sloppy lands. The highest 65.32% of the respondents reported that the soil type for cowpea cultivation was sandy-loam as recommended.

Table-2. Contextual information of cowpea growers.

Si. No.	Particulars	Locations			
		Hathazari	Fatikchari	Sathkania	All
1	Average cultivable land per household (ha)	0.82	0.97	0.39	0.73
2	Average plot size under BARI Cowpea-1 (ha)	0.15	0.14	0.17	0.15
3	Experience of cowpea cultivation (years)	13.38	10.6	18.63	14.20
4	Seed used of BARI Cowpea-1 (kg/ ha)	35.7	21.22	37.19	31.37
5	Market Price (tk./kg)	64.11	64.2	63.66	63.99
6	Types of land for cowpea cultivation (%):				
	- High land	31.33	-	20	25.67
	- Medium high land	44.66	16.6	60	40.42
	-Medium low land	18	83.3	23.33	41.54
	- Sloppy land	6.66	-	3.33	5.00
7	Types of soil (%):				
	- Loam	26.66	10.0	66.66	34.44
	- Sandy-loam	72.66	73.3	50.0	65.32
	- Clay-loam	-	16.6	-	16.60

Source: Field survey, 2018.

3.3 Respondent's Awareness about BARI Cowpea- 1

Table 3 shows that about 65.5% farmers were found to be acquainted with BARI Cowpea while 34.4 % were not. The highest percentage of acquaintance (90%) was found in Fatikchari and the least was in Satkania (46.6%).The respondent farmers came to know about BARI Cowpea-1 from different sources such as BARI, DAE, local sources and NGOs. The highest percentages of the respondents got information about BARI Cowpea-1 from DAE (58.63%) followed by the Dealer Shops (31.77%), research Stations (19%) and NGOs (17%) Table 4.

Table-3. Respondent's awareness about BARI Cowpea- 1.

Si. No.	Locations	Acquainted (%)	Not acquainted (%)	Total
1	Hathazari	60.00	40.00	100.00
2	Fatikchari	90.00	10.00	100.00
3	Sathkania	46.66	53.34	100.00
	All	65.55	34.45	100.00

Source: Field survey, 2018.

Table-4. Sources of information about BARI Cowpea-1.

Si. No.	Locations	In % of respondents by source			
		BARI	DAE	NGO	Dealer Shop
1	Hathazari	56.6	76.6	16.0	25.0
2	Fatikchari	30.0	66.0	11.3	37.3
3	Sathkania	20.4	33.3	26.4	33.0
	All	19.00	58.63	17.90	31.77

Source: Field survey, 2018.

3.4 Extent of Adoption of BARI Cowpea-1

As shown in Table 5 BARI Cowpea-1 had more acceptances (71.97%) than the local one (16.73%) ; where Fatikchari was the highest (80%) in BARI Cowpea-1 cultivation followed by Hathazari(73.2%) and Satkania (62.7%). It was the highest in Hathazari (24.9%) followed by Fatikchari (13.8%) and Sathkania (11.5%) for the local variety. About 11.33% farmers reportedly used mixed varieties irrespective of all locations Table 5.

Table-5. Rate of adoption of BARI Cowpea-1 in 2018 by locations.

Si. No.	Cowpea varieties	% of respondents (Rate of adoption)			
		Hathazari	Fatikchari	Sathkania	All
1	BARI Cowpea-1	73.2	80.0	62.7	71.97
2	Local Varieties	24.9	13.8	11.5	16.73
3	Mixed (BARI Cowpea-1+Local)	12.4	13.1	8.5	11.33

Source: Field survey, 2018.

3.5. Knowledge of Modern Technologies for Cowpea Production

Table 6 shows that only 23.31% of the cowpea farmers claimed that they had ideas on modern technologies of BARI Cowpea production where the highest percentages 33.3% were both in Hathazari and Fatikchari. But in Satkania it was comparatively much lower (3.3%). Only 7.31% farmers reportedly received training on BARI Cowpea production in the last three years irrespective of locations. The highest 78.44% of the farmers managed to have BARI Cowpea seed from their own collection, 17.1% from local markets, 12.22% from neighbors and relatives and 3.3% from BADC and research stations Table 6.

Table-6. Responses regarding BARI Cowpea production technology and seed sources.

Si. No.	Particulars	In % of respondents who answered 'Yes'			
		Hathazari	Fatikchari	Sathkania	All
1	Known to modern technology of Cowpea cultivation	33.3	33.33	3.33	23.32
2	Received training on Cowpea production	11.33	-	3.33	7.33
3	Source of seeds of BARI Cowpea-1:				
	- Owned	78.66	66.66	90.00	78.44
	- Research station	-	-	3.33	3.33
	- BADC	-	3.33	-	3.33
	- Local market	18.00	13.33	20.00	17.10
	- Relatives	6.66	20.00	10.00	12.22

Source: Field survey, 2018.

3.6. Rate of Adoption of Individual Production Technologies of Cowpea

The rate of adoption of individual cowpea production technologies varied among the locations. None of the individual modern cultivation practices were fully adopted. Most of them were adopted partially; might be due to unawareness or ignorance. The rate of adoption of individual production technologies were shown in Table 7. In case of *land preparation*, 98.4% farmers used tractors or power tillers irrespective to locations. On an average the farmers ploughed the land 2.15 times during land preparation whereas the recommended plough intensity was 3-4 times (Khrishi, 2016). Most of the farmers (93.06%) used traditional method of sowing (Broadcast) followed by line sowing (9.5%). Only 14.63% of the farmers treated seeds with chemicals or by other means before sowing. Most of the farmers were sown the seed in the month of December (40.83%) Table 7.

Cent percent of the farmers didn't use recommended doses of manures and fertilizers. In the case of chemical fertilizer, farmers used 6.38Kg Urea, 7.15Kg TSP, 2.86K MoP and 0.34Kg Zypsum per hector of land. The amount of fertilizers used in field preparation was found to be lower than that of recommended dose of 25kg, 45kg, 25 kg and 5kg respectively (Khrishi, 2016). The average *planting distance* was maintained as 20 cm x 19 cm which was different than that of recommended distance of 35 cm × 10 cm (Khrishi, 2016).

Table-7. Extent of individual production technology adopted by the cowpea growers.

Si. No.	Individual technology	Study location			
		Hathazari	Fatikchari	Sathkania	All
1	Land preparation using tractor (In % of respondents)	98.6	100	96.6	98.4
2	Number of Ploughs (on average)	2.12	2.13	2.20	2.15
3	Seed sowing method (In % of respondents)				
	- Relay Method	3.3	6.33	3.13	3.21
	- Broadcasting	82.6	100.0	96.6	93.6
	- Line sowing	18.6	6.6	3.3	9.5
4	Treating seed before sowing. (In % of respondents)	7.3	30.0	6.6	14.63
5	Manure used before planting (kg/ha)	220.1	-	128.76	174.43
6	Fertilizer used before planting (kg/ha)		-		
	- Urea	6.70	-	6.06	6.38
	- TSP	12.6	-	1.7	7.15
	- MoP	3.93	-	1.8	2.86
	- Zypsum	0.58	-	0.1	0.34
7	Maintained plant distance (cm)				
	- Plant to plant	15	24	18	19
	- Line to line	20	24	16	20
8	Sowing time (In % of respondents):				
	- October	5.33	40.0	33.3	22.66
	- November	20.0	56.6	13.3	29.96
	- December	62.6	3.3	56.6	40.83
	- January	14.6	-	23.3	18.95
	- February	1.3	-	13.3	7.3
	- March	0.6	-	-	0.6
9	Irrigation in dry season (In % of respondents)	30.0	3.3	3.3	12.2
10	Irrigation method:				
	- Flood Irrigation	-	-	-	-
	- Line irrigation	30	3.3	3.3	12.2
	- Split water irrigation	-	-	-	-
	- Rain fed Irrigation	-	-	-	-
11	Number of irrigations (on average)	1.37	1.0	2.0	1.4
12	Major Pests:				
	- Aphid	32.66	10.0	36.6	26.42
	- Red Spot	20.0	3.3	60.0	27.76
	- Beetles	2.0	-	20.0	11.0
13	Pesticide use (In % of respondents)	46.6	10.0	76.66	44.42
15	Followed appropriate harvesting time (% of respondents)	91.33	96.6	100	95.97
16	Number of harvest	4.38	5.7	4.7	4.92
17	Harvesting time followed				
	- Mid March	17.33	13.13	30.0	20.15
	- Last week of March	35.33	70.0	60.0	55.11
	- First week of April	42.66	53.3	23.3	39.75
18	Preservation of seed after harvest (In % of respondents)	88.0	66.6	90.0	81.53
19	Amount of preserved seed per year (Kg)(In average)	9.07	5.5	8.1	7.55
20	Type of container used for preservation(In % of respondents):				
	- Sac	4.6	-	36.6	14.83
	- Drum	68.66	3.3	23.3	39.52
	- Pitcher	11.33	26.6	40.0	24.87
	- Others (Plastic Pot)	10.0	23.3	23.3	15.53
21	Use medicine for preservation of seed(In % of respondents)	24	6.6	3.3	11.3
22	Medicine used for Preservation:				
	- Chaye (Ash)	6.66	3.3	-	4.95
	- Nimpata	14.6	3.3	3.33	7.07
	- Biskatali	1.3	-	-	1.3
	- Karpor	0.6	-	-	0.6

Source: Field survey, 2018.

Majority of the farmers adopted the right *time of sowing* seed (40.83% in December). *Irrigation in dry season* is also an important factor for higher yield of cowpea. Only 12.2% farmers provided irrigation into their cowpea field through pump or carrying bucket and they did not know the exact time of irrigation for cowpea cultivation. The cent percent farmers followed line irrigation method and the irrigation operations were conducted 1.4 times on an average in a total period of one season Table 7. *Insect pest and disease management* is inevitable for producing quality cowpea and for getting higher market prices. Reportedly aphids (26.42%), red spot (27.76%) and beetles (11%) were the major problems. More than 44.42% of farmers used pesticides in consultation with DAE people or pesticides dealers for controlling insect-pest and diseases. But they didn't follow the recommended dose for pest and disease management due to unawareness and lack of training in this regard Table 7. Most of the respondents (95.97%) followed the appropriate time of harvesting and they had done the harvesting 4.92 times on an average in the period of seasonal time. Most of the farmers (81.53%) collected and preserved the seed for next season of an amount of 7.55kg on an average. Various types of containers had been used for the preservation process; among them drum was the most popular one (39.52%). Only 11% farmers used preservatives in the process Table 7.

3.7. Yield of BARI Cowpea-1 as Compared to Local Varieties

As Shown in Table 8 though the yield of BARI Cowpea -1 (413.57Kg/ha) was considerably higher than the local one (299.33 Kg/ha) but it was much lower as compared to the yield (1,200 Kg/ha) recommended in Krishi Projukti Hatboi, (Part 1) pointedly because of ignorance of the farmers, lack of knowledge or not following the modern production technologies, lack of irrigation water in the dry season, not using the recommended dose of manures and fertilizers and on. In case of BARI Cowpea-1 the highest yield was found in Fatikchari (612.72 Kg/ha) followed by Sathkania (340.03 Kg/ha) and Hathazari (287.97 Kg/ha); for the local one it was the highest in Fatikchari (440.77 Kg/ha) as well followed by Hathazari (248.44Kg/ha) and Sathkania (208.88 Kg/ha) Table 8.

Table-8. Yield of BARI Cowpea varieties per household in locations, 2018.

Si. No.	Cowpea varieties	Average yield (kg/hh)			
		Hathazari	Fatikchari	Sathkania	All
1	BARI Cowpea-1	287.97	612.72	340.03	413.57
2	Local Varieties	248.44	440.77	208.88	299.33

Source: Field survey, 2018.

3.8. Socioeconomic Impact of Cowpea Cultivation

As shown in Table 9 the respondents had agreed upon significant socio-economic impacts of cowpea cultivation in their livelihood. Considering all areas, on average 91.52% of the respondents reported their family income to be increased by cowpea cultivation; for nutritional nourishment it is 94.86% respondents who agreed and for proper utilization of fallow land it is 94.2%. About 85% respondents reported that their social reputation has been uplifted , 92.85% found cowpea cultivation more profitable than other pulse crops and 93.31% farmers reported that their soil fertility had increased Table 9.

Table-9. Socioeconomic impact of cowpea cultivation.

Si. No.	Impact indicators	Respondent's reaction (%)			
		Hathazari	Fatikchari	Sathkania	All
1	Family income has raised	91.3	86.6	96.66	91.52
2	Nutritional nourishment has been ensured.	98.0	86.6	100.0	94.86
3	Proper utilization of fallow lands.	96.0	86.6	100.0	94.2
4	Social reputation has been increased.	92.0	66.6	96.66	85.0
5	Cowpea is much more profitable as compared to other pulse crops.	98.6	83.3	96.66	92.85
6	Soil fertility has been increased	100.0	86.6	93.33	93.31

Source: Field survey, 2018.

3.9. Causes of Non-Adoption of BARI Cowpea-1 Cultivation

The highest 76.66% (in Hathazari) of farmers reported that the seed of BARI Cowpea-1 was not available in the local shops Table 10; whereas 87.33% of them mentioned about not knowing about the sources. Even 90.66% (in Hathazari) farmers reported that they did not get sufficient seeds of BARI Cowpea-1 varieties from the Agricultural Research Centers situated in the region. About 63.32% admitted not to know the right cultivation method and 47.08% reported not to get desired yield. The other causes for non-adoption of BARI cowpea varieties are mentioned in Table 10.

Table-10. Causes of non-adoption of BARI Cowpea cultivation in the selected locations.

Si. No.	Causes of non-adoption of BARI Cowpea	In % of respondents			
		Hathazari n=150	Fatikchari n=30	Satkania n=30	All n=210
1	Unavailability of seed of BARI Cowpea-1	76.66	20	63.3	53.32
2	Sources are unknown	87.33	26.6	80	64.64
3	Not meeting the demands of the farmers by the research centers	90.66	26.6	73.33	63.53
4	The genetic purity of BARI Cowpea-1 varieties was not confirmed in the local markets	-	-	-	-
5	Unknowing the right cultivation method	90.0	23.3	76.66	63.32
6	Unknowing the pest and diseases management.	-	-	-	-
7	Obtained low yield	51.33	26.6	63.33	47.08
8	Proper preservation techniques are unknown	58.66	26.6	63.33	66.33
9	Unavailability of laborers in harvesting time.	63.33	26.6	60	49.97
10	Haven't received any training on cultivations of BARI Cowpea-1	87.33	23.3	73.33	61.32

Source: Field survey, 2018.

3.10. Farmer's Responses to the Support Needed from BARI and DAE

On an average 69.76% of the respondents made demands for high quality seeds of BARI Cowpea varieties. Another need mentioned by the farmers was training on modern technologies. Providing power spray machines, proper treatment of the pest and diseases particularly for BARI Cowpea were also demanded by the respondent farmers Table 11.

Table-11. Farmer's responses to the support need from BARI and DAE.

Si. No.	Problem/Constraints	In % of farmers respondents			
		Hathazari n=150	Fatikchari n=30	Satkania n=30	All n=210
1	Supply of high quality seed of BARI Cowpea-1	86	73.3	50	69.76
2	Training on modern technology	76.66	93.3	83.3	84.42
3	Proper treatment for pests and diseases	19.33	-	26.6	22.96
4	Judicious use of fertilizer & pesticide	50	16.6	40	35.53
5	Provide credit facilities	14.66	3.3	83.33	33.76
6	Provide irrigation facilities	25.33	-	76.66	50.99

Source: Field survey, 2018.

3.11. Farmer's Reactions on Extension of BARI Cowpea-1 at Farm Level

Ensuring quality seeds, conducting farmer's meetings at village level, broadcasting through mass media, providing modern training and monitoring and follow-up could help to extend the adoption of BARI Cowpea-1 at farm level as reported by the respondent farmers in the study areas Table 12.

Table-12. Farmer's reaction to expand of BARI Cowpea varieties at farmer level.

Si. No.	Farmers reactions	In % of farmers respondents			
		Hathazari n=150	Fatikchari n=30	Sathkania n=30	All n=210
1	Ensure quality seeds at farm level	40.6	50.0	53.33	47.99
2	Conduct farmer meeting at village level	14.6	23.3	70.0	35.98
3	Broadcast BARI Cowpea (1+2) in mass media	14.6	10.0	30.0	18.22
4	Provide modern training on BARI Cowpea	35.3	63.3	66.66	55.09
5	Need regular field visit & monitoring	8.0	10.0	36.6	54.6
6	Provide irrigation facilities	6.0	-	80.0	43.0

Source: Field survey, 2018.

3.12. Factors Influencing Adoption of Improved Cowpea Variety (BARI Cowpea-1)

In order to assess the contribution of various factors effecting the adoption of BARI Cowpea-1 at farm level, a regression equation was applied with 2 dependent variables (0 and 1) and 13 independent variables, mentioned in the methodology section. The results of the analysis are presented in "Table 13" and "Table 14".The price of cowpea was a significant determinant for decision to adopt this technology.

Table-13. Probit regression coefficient of extent of adoption of BARI Cowpea-1.

Independent variables	Probit coefficient	Std. Err.	Z	P-value
Constant	.61439	1.84813	0.33	0.740
Age	-.01025	.00784	-1.31	0.191
Education	-.00897	.03062	-0.29	0.769
Family size	.00538	.03945	0.14	0.891
Area of cowpea cultivation	2.8936	1.97315	1.47	0.143
Income from cowpea cultivation	.45431**	.09456	0.05	0.005
Knowledge on improve technology	-.00978***	.06260	3.23	0.001
Yield of Cowpea	.19757	.28613	0.69	0.490
Risk bearing capacity	.14797	.20173	0.73	0.463
Willingness	-.57436***	.14224	-4.04	0.000
Economic aspiration	.16202	.24536	0.66	0.509
Mass media exposure	-.52439**	.24556	-2.14	0.033
Research contact	.36255	.24956	1.45	0.146
Extension contact	.41449***	.22813	0.50	0.006
Model diagnosis:				
Log likelihood	-112.38453	-	-	-
Pseudo R^2	0.1403	-	-	-
LR chi-squared	36.69	-	-	0.000
Accuracy of prediction (%)	79.0%			
Number of observations	210			

Note: The variable of training dropped because of multi co linearity problem.
*** Significant at 1% level (P≤ 0.01); ** Significant at 5% level ((P≤ 0.05); * Significant at 10% level (P≤ 0.10).

The marginal effect of the relevant variable of income from cowpea cultivation, having knowledge on improve production technology, willingness, mass media exposure and extension contact were estimated at 0.454, .009, 0.574, -0.524 and 0.414 implying that a one per cent increase of the respective variable will increase the adoption of the technology significantly by 0.454, .009, 0.574, -0.524 and 0.414% respectively. For example, the marginal effect of the variable willingness to adopt this technology was estimated at 0.574 implying that a one per cent increases in the willingness will increase the adoption of those technology by 57% Table 14. The results of regression analysis revealed that the income from cowpea, knowledge on improved technologies, willingness, mass media exposure and extension contact has indeed helped in contributing adoption of this technology significantly. Out of these, family size, area of cowpea cultivation, yield, risk bearing capacity, economic aspiration and research contact can be seen as insignificant but positive indicator of formulation for adopting this technology in the region.

Table-14. Marginal effects after probit analysis.

Independent variables	dy/dx	Std. Err.	z	P-value	X
Age	-.00399	.00306	-1.31	0.191	46.281
Education	-.00349	.01194	-0.29	0.769	6.328
Family size	.00210	.01538	0.14	0.891	6.255
Area of cowpea cultivation	1.12793	.77065	1.46	0.143	.152
Income from cowpea cultivation	-.02940	.08364	-0.35	0.025	2.510
Knowledge on improve technology	.32838	.09561	3.43	0.001	.239
Yield of cowpea	.07701	.1116	0.69	0.490	4.935
Risk bearing capacity	.05767	.07864	0.73	0.463	2.25
Willingness	-.22388	.0554	-4.04	0.000	1.984
Economic aspiration	.06315	.09566	0.66	0.509	2.473
Mass media exposure	-.20440	.09573	-2.14	0.033	2.562
Research contact	.14293	.09846	1.45	0.147	.218
Extension contact	.04475	.08939	0.50	0.007	.635

Marginal effect after probit y = 0.5909 (*) dy/dx is for discrete change of dummy variable from 0 to 1
Note: The marginal effect is the average change probability when x increases by one unit. Since a probit is a non-linear model, that effect will differ from individual to individual.

4. CONCLUSION AND POLICY RECOMMENDATIONS

Though BARI Cowpea-1 possesses a great potential both in economic and food value aspects as a tropical pulse crop, but the yield is not yet at per; pointedly because of several reasons; firstly ignorance of the farmers, mixed cultivation with local varieties, lack of proper production knowledge or not following the modern production technologies, lack of irrigation facilities in the dry seasons, not using the recommended dose of manures and fertilizers and on. In-spite of these, the respondents had agreed on the significant rate of positive socio-economic impacts of cowpea cultivation in their livelihoods. BARI Cowpea-1 still projects promises if the farmers could be acquainted, trained and put in practice with the modern production technologies. To rid off of the constrains the following measures could be taken under consideration:

(i) Arranging more training on technical aspects of cowpea cultivation (production technology, improved varieties, management, marketing etc).
(ii) Conducting awareness campaigns (farmer's meetings, FGDs, TV and radio programs and other promotional activities).
(iii) Provision of irrigation facilities during the dry seasons.
(iv) Collection of germplasms from the localities and beyond and developing new improved/ hybrid/ high yielding varieties; particularly suitable for Chattogram region of Bangladesh.

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