American Journal of Rural Development, 2015, Vol. 3, No. 3, 60-73
Available online at http://pubs.sciepub.com/ajrd/3/3/1

DOI:10.12691/ajrd-3-3-1

Disaster Risk Identification in Agriculture Sector: Farmer's Perceptions and Mitigation practices in Faridpur

AKM Abdul Ahad Biswas[1,*], Md. Mohidul Hasan[2], Md. Saifur Rahman[3], Md. Abdus Sattar[1], Md. Afjal Hossain[1], Md. Faisal[4]

[1]Department of Disaster Risk Management, Patuakhali Science and Technology University, Bangladesh
[2]Faculty of Disaster Management, Patuakhali Science and Technology University, Bangladesh
[3]Department of Geo-Information Science and Earth Observation, Patuakhali Science and Technology University, Bangladesh
[4]Department of Resource Management, Patuakhali Science and Technology University, Bangladesh
*Corresponding author: aahadpstu@yahoo.com

Received September 18, 2015; Revised September 29, 2015; Accepted October 09, 2015

Abstract Study on disaster risk identification in agriculture and farmer's perceptions and mitigation practices was lack on the perspective of Faridpur district of Bangladesh during this research. The purpose of this study was to have understanding of farmers' perception and mitigation practices towards disaster risk and climate change impacts adopted by the victim community at Faridpur district of Bangladesh. Primary data was collected through individual household interviews, field observation and secondary data was attained by accessing the relevant information from different media sources. Results showed that the agriculture sector of the study areas are potentially exposed by different risk factors phenomenon e.g. drought, flood, insect/pests attack, lack of quality seed etc. Study has discovered variations in risk perceptions which are influenced by several socio-economic factors like age, gender, livelihood, level of education and socio-economic conditions etc. Recurring phenomenon of hazards and increasing threats to agriculture provided the farmers diversified opportunities to make their livelihood more sustainable. They are more aware about their risks and what they could do to reduce their exposure on the impacts of future disaster risks. Farmers have adopted different mitigation strategies e.g. changing cropping pattern, use of resistant/tolerant variety, good management practice, integrated pest management practices, use of hybrid variety etc. Risks assessment and utilization of such risk assessment results will be helpful to develop the most efficient farmer's friendly risk management plan. Which will be benefited the country to establish climate smart disaster risk management in agriculture sector.

Keywords: *agriculture, farmers, mitigation, perceptions and risk assessment*

Cite This Article: AKM Abdul Ahad Biswas, Md. Mohidul Hasan, Md. Saifur Rahman, Md. Abdus Sattar, Md. Afjal Hossain, and Md. Faisal, "Disaster Risk Identification in Agriculture Sector: Farmer's Perceptions and Mitigation practices in Faridpur." *American Journal of Rural Development*, vol. 3, no. 3 (2015): 60-73. doi: 10.12691/ajrd-3-3-1.

1. Introduction

Risk results from the interaction of physically defined hazards with the properties of the exposed systems, i.e. sensitivity or vulnerability. In risk assessment, the focus is on individuals and social groups and understanding the probabilistic of the triggering event [26]. These interactions mean that different people are exposed in different ways to stresses and threats. Or more simply, who is vulnerable? To what? Risk equals the probability of climate hazard multiplied by a given system's vulnerability. Although measurement of risk is clearly important, quantification does not always tell the whole story, and not all risks are quantifiable [1]. According to UNISDR, risk is the combination of the probability of a hazardous event and its consequences which result from interaction(s) between natural or man-made hazard(s), vulnerability, exposure and capacity [70]. It is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying risk factors. Risk assessment is an approach to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability. ISO 31000 defines risk assessment as a process made up of processes: risk identification, risk analysis, and risk evaluation. Risk identification is process that is used to find, recognize, and describe the risks that could affect the achievement of objectives [70]. Over the last two decades there has been a growing realization that disaster management is most effective at the community level where specific local needs, resources, and capacities are met [57,58]. In risk assessment, the focus is on individuals and social groups and understanding the probabilistic of the triggering event

[26,66]. Several studies have been revealed the positive outcomes of community based approaches for disaster management worldwide [59,60,61]. This present study focused on farmer's risk and vulnerability analysis by understanding, planning for and adapting to a changing climate that individual agriculture farmer can take advantage of opportunities to reduce risks associated with climate-induced stresses [64]. Agriculture is the dominant economic activity in Bangladesh. Its role is vital in enhancing productivity, profitability and employment in the rural areas for improving the livelihood security status of the poor [53,54,55]. As the largest private enterprise, agriculture (crops, livestock, fisheries and forestry) contributes about 21% of the GDP, sustains the livelihood of about 52% of the labor force [56] and remains a major supplier of raw materials for agro-based industries. Agriculture is also a social sector concerned with issues like food and nutritional security, income generation and poverty reduction [47]. Agriculture sector is one of the threatened sectors due to the continuous threat of natural and manmade disasters and climate change and this sector will be remarkably affected due to climate change impacts resulting different climatic hazards/ disasters [62,63]. Many scholars in the world have studied the behaviors of farmers in coping with agriculture risks and their strategies adopted and farmers' risk management measures and its affects and farmers' financial risk management as well as informal risk-sharing mechanisms among family and friends [67,68,69]. This study explores the in detail assessment of the disaster risks at community level in agriculture-crop, horticulture, livestock and fisheries emphasizing the perception of the rural farmers; the people make sure that rest can have secured livelihood and ensured food and nutrition for their existence. Keeping in mind the importance of risk perception of agriculture farmers on the livelihood security to reduce disaster risk following research was carried out aiming with the following objectives- a) To identify and assess disaster risks in agricultural sector, b) To assess farmer's perception on disaster risks in agriculture and c) To find out probable mitigation and adaptation options

2. Materials and Methods

2.1. Description of the Study Area

2.1.1. Area, Location and Demography

The Faridpur district is bounded on the north by Manikganj, Dhaka and Rajbari zilas, on the east by Madaripur, Dhaka and Munshiganj districts, on the south by Gopalganj and Madaripur districts and on the west by Rajbari, Magura and Narail districts. It lies between 23º 17' and 23 º 40' north latitude and between 89 º 29' and 90 º 11' east longitudes; consist of 8 upazila, 79 unions (Sub Sub-District) and 1,859 villages; 2,052.86 sq.km (792.00 sq. miles) areas. Annual average temperature is maximum 35.8°C and minimum 12.6°C; annual rainfall is 1546 mm. Agro ecological zone is12 which is Low Ganges River Floodplain area. Main rivers are Padma, Old Kumar, Arial Khan, Gorai, Chandana, Bhubanshwar and Lohartek [6].

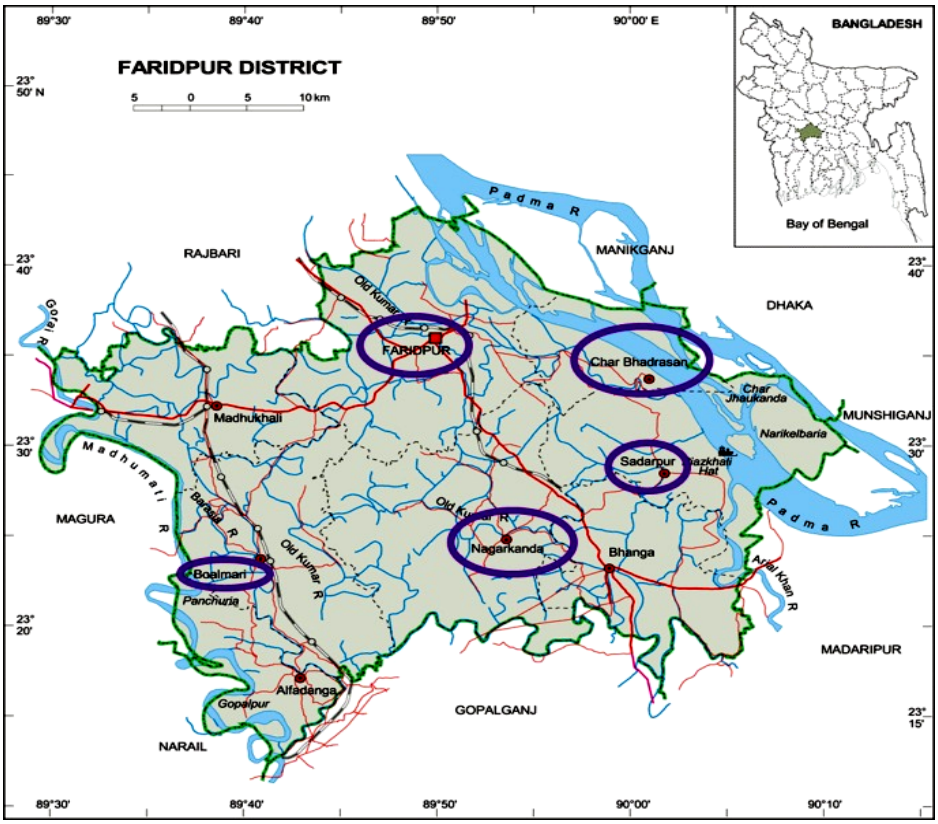

Figure 1. Five study areas- Faridpur Sadar, Boalmari, Char Bhaddrasan, Sadarpur and Nagarkanda of Faridpur District are shown in blue circles [28]

This study was conducted at five upazila's (Figure 1) namely Faridpur Sadar (20 respondents); Char Bhadrasan (19 respondents); Boalmari (30 respondents); Sadarpur (20 respondents), Nagarknada (11 respondents) under Faridpur district from 1st to 15th July, 2015. Faridpur Sadar upazila occupies an area of 412.86 sq.km. It is located

between 23º 29´ and 23º 34´ north latitudes and between 89º 43´ and 89º 56´ east longitudes. Char Bhadrasan upazila occupies an area of 154.65 sq. km. It is located between 23º 33´ and 23º 40´ north latitudes and between 89º 53´ and 90º07´ east longitudes. Boalmari upazila occupies an area of 271.73 sq. km. It is located between 23º 17´ and 23º 32´ north latitudes and between 89º 36´ and 89º 48´ east longitudes. Sadarpur upazila occupies an area of 261.29 sq.km. It is located between 23º24´ and 23º34´ north latitudes and between 89º57´ and 90º11´east longitudes. Nagarknada upazila occupies an area of 192.20 sq. km. It is located between 23º19´ and 23º24´ north latitudes and between 89º43´ and 89º56´ east longitudes [6].

2.1.2. Socio-economic Status of Faridpur District

Urban population is 1, 95,247; rural population is 16, 41,869; total household is 4,20,174; average household size is 4.51; population density is 2413/sq. km. Literacy is 49% [6]. Main sources of income is Agriculture 58.60%, others sources are laborer, industry, business, transport and communication, service, construction etc [5]. The entire household suffered from income deficits - less income than the requirement of expenditure. Main Crops are paddy, jute, peanut, wheat, oilseed, pulse, turmeric, onion, garlic and coriander etc. Main fruits are mango, jackfruit, black berry, palm, coconut, papaya, banana, guava etc [6].

2.2. Research Design

A combination of quantitative and qualitative research methods were used because they compliment to each other. It therefore adopted an exploratory approach through employing in-depth semi-structured individual interviews to explore the development of farmer's perception on Hazards and Vulnerability in agriculture sector. Quantitative research was used to address questions that were predominantly based on the objectives of the study. Examples include aspects surrounding disaster risk management, risk assessment and response and recovery as well as community participation and involvement within twenty villages of 100 individuals of Faridpur district. In addition, this approach was used to collect sensitive data, such as gender roles, income and assets (i.e. livelihoods). Farmers were selected randomly.

2.3. Methods of Data Collection

The method guarantees that different demographics of people are interviewed. The survey was careful to ensure that the people who participated volunteered and were not forced to be interviewed. Primary data was collected through questionnaire survey, in-depth interview during household visit of this study area and field observation. Additional information as secondary data was pertaining to the study was attained by accessing the relevant information from media such as journal articles, books, other research thesis and the use of recorded data, through Union Parishad (Local Government administrative office), Upazila Parishad (Sub-district Government administrative office), study areas and from various organizations working with this issue. The collected data was analyzed though computer by SPSS software.

3. Results and Discussion

3.1. Socioeconomic Conditions

Farmer's socioeconomic status and life style demonstrate their economic achievements, livelihood sustainability and development. This study has been observed the above problems of agriculture farmers in the Faridpur district of Bangladesh. Table 1 showed that among 100 farmers there were 56 % male and 44 % female; 40% were 31 to 45 years old; 31% were above 46 years and 29% were 15-30 years old. Study showed that the middle aged farmer's (40%) provided valuable information regarding existing risk and reduction measures and mitigation strategies regarding agriculture practices. Levels of education of respondents were 99% for higher secondary and their occupation was agriculture production. 75% farmers have the family size of 4 to 6 members. Researchers reported that the ability of farming households to cope with disasters is also significantly impacted by family members' experiences and their economic context at the village level [65]. In one research [77] factors affecting crop diversification were analyzed and reported that size of land holding, age of respondent, education level of respondent, farming experience of respondent, off farm income of respondent etc are the main factor of crop diversification.

Table 1. Socio-demographic condition of the local farmers

Parameters		Percent
Location and respondent percentage	Faridpur Sadar	20.0
	Char Bhaddrasan	19.0
	Boalmari	30.0
	Sadarpur	20.0
	Nagar kanda	11.0
Gender percentage	Male	56.0
	Female	44.0
Age group (year) percentage	15-30	29.0
	31-45	40.0
	Above 46	31.0
Level of Education percentage	Up to SSC Pass	99.0
	HSC pass	1.0
Occupation percentage	Farmer/house wife	99.0
	Others	1.0

Source: Surveyed data.

3.2. Farming Systems

Research data in Table 2 revealed farming systems of respondent agriculture farmers. Regarding total cultivable lands of respondent famers 46% owned bellow 50 decimal, 32% above 101 decimal and 22% from 51 to 100 decimal cultivable lands. Considering homestead area- 45% farmers have up to 10 decimal and this is found highest number of respondent's farmers. From other scientist's [33] research it was concluded that Bangladesh is a land scarce country where per capita cultivated land is only 12.5 decimals. On average landless farmers owned up to 0.22 acre land where family size is 4.8; marginal farmers owned 0.47 acres where family size is 5.1, small 1.63 acres where family size is 4.9 and medium 3.42 acres where family size is 5.7. The net amount of area in crop farming of the country was found declining because of land-loss from river and coastal erosions and agricultural

land being used for urbanization [74] concluded by other researcher.

Table 2. Farming systems of respondent agriculture farmers

Parameters		Per cent
Total cultivable land	up to 50 decimal	46.0
	51 to 100 decimal	22.0
	101 above decimal	32.0
Homestead area	up to 10 decimal	45.0
	11 to 20 decimal	32.0
	above 20 decimal	23.0
No. of family members	up to 3	13.0
	4 to 6	75.0
	Above 6	12.0
Decision making gender	Male	31.0
	Female	6.0
	Both	63.0
No. of livestock	Below 5	39.0
	6 to 10	37.0
	Above 10	24.0
Yearly income (Tk.)	Up to 1 lac (1285 US Dollar)	80.0
	1(1285 US Dollar) to 2 lac (2570 US Dollar)	16.0
	Above 2 lac (2570 US Dollar)	4.0

Source: Surveyed data.

In case of playing role in decision making (Table 2) for their agriculture related problems and implementation of any developing activities 63% case contribute both male and female, 31% only male and 6% case only female. Number of livestock of the respondent including animal and birds was below 5 for 39%, 6 to 10 was 37% and above 10 was 24%. In the study area 80% respondent's annual income was above 1285 US Dollar, 16% 1285 US Dollar to 2570 US Dollar and 4% was above 2570 US Dollar. Study showed that besides crop agriculture, the livestock productions also contribute a great role in livelihood security and helps farmers in various disaster risk reduction. Previous researcher [19] suggested on risk mitigation techniques in agriculture and presented that the most commonly applied risk management strategy is diversification and risk-averse farmers particularly diversify their crop and livestock productions. By doing so, loss in one sector is relatively covered by productivity of the other sectors. From the previous research it was found [9] that farmer's generally rare livestock and poultry in their house for the cash income and generally they sell these in order to meet household financial needs during disaster and when they have no income.

3.3. Cropping Patterns and Risks Faced

The attitude towards risk has an important influence on the cropping pattern choice of the farmers. A diversified cropping pattern is suggested as an important strategy to cope with risk and uncertainty associated with agriculture due to unpredictable change in climate [41]. Studies revealed three types of mix types cropping patterns in the study area- Pattern-A: Rice-Wheat-Lentil-Onion-Sugarcane-Potato-Egg plant–Mustard-Mix Vegetables-Jute; Pattern-B: Fallow-Rice-Wheat-Lentil-Sugarcane-Potato-Egg plant-Jute and Pattern-C: Fallow-Rice-Wheat-Onion-Sugarcane-Potato-Egg plant-Chilly-Mix Veg.-Jute (Figure 2). Rice, wheat, lentil, sugarcane, potato, eggplant and jute are common in three types of cropping pattern. Researcher's [10] suggested diversification of crops as a risk reduction tool and inclusion of several species in a crop production plan can have the advantage of buffering low price in a specific crop. Farmers try to minimize risk from various sources in their own way, often by adjusting the cropping pattern and/or cropping season [48].

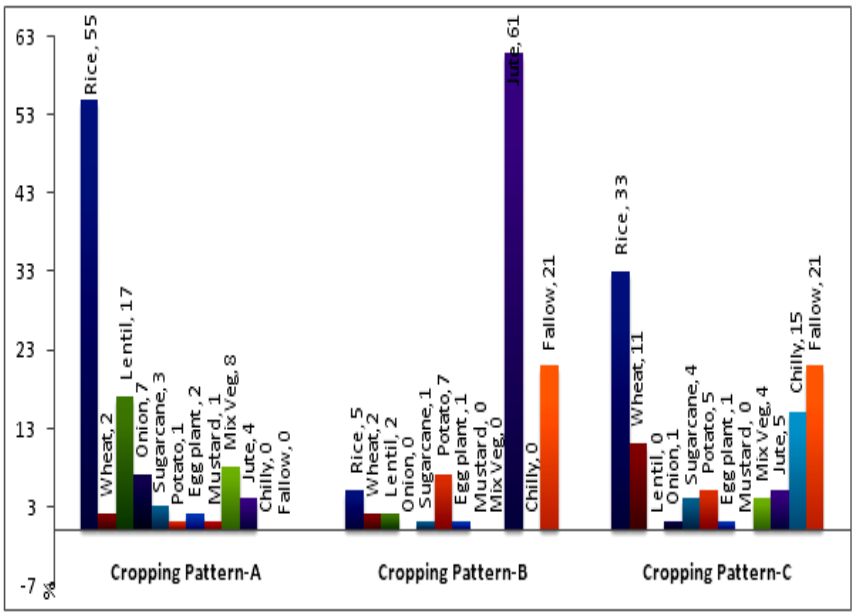

Figure 2. Percentage of respondent engaged with cropping patterns (Source: Surveyed data)

Report from the research at Barisal district [72] of Bangladesh showed that, wheat needs comparatively less irrigation than Boro rice. Moreover, mungbean, mustard, lentil and grass pea produce reasonability good yield in rain fed condition. About 20- 25 % land becomes suitable for seeding wheat by first week of December. T. Wheat is a more profitable Rabi crop than other crops like grass pea, mustard, lentil. Farmers have earned the highest gross return from the Wheat –*Aus* rice -T. Aman rice pattern. Higher benefit was achieved from the pattern Wheat –*Aus* rice -T. Aman rice because of less production cost and high price of wheat grain, though three cereals crops could

exhaust soil nutrient so that Mungbean-Aus rice – T. Aman pattern may be alternate option to sustain soil health as well as productivity. As the medium low land and low land area [6], for Faridpur district of Bangladesh FAO researcher [73] suggested 10 (ten) types of cropping patterns e.g. medium low land: Potato - Boro - T.Aman; Wheat - T.Aman – Pulses; Oilseed - Boro - T.Aman; Boro - T.Aman – Mustard; Tomato - Aus – Vegetable and low land: Potato - Boro- B.Aman; Boro - T.Aman – Fallow; Kaon - T.Aman – Fallow; Wheat - Boro - T.Aman and Jute - T.Aman – Fallow. The impact of extreme hazards in Bangladesh and changes in cropping pattern along with a forecast of area to be distributed among various crops in 2029-30 was analyzed [74]. He has concluded that the net crop area for the year 2029-30 was estimated at 7,430,000 hector excluding a significant loss from coastal erosion. The distribution of total crop area among various crops since 1970s along with a forecasting for the year 2029-30 was analyzed and was observed that the cereal crops (rice, wheat, maize, etc.) occupied more than 80% of total crop area during 1970 to 2007, which would not vary remarkably in 2029-30. The share of area under rice decreased during 1970s and 1990s, and increased thereafter. On the contrary, the shares of areas under pulses, oilseeds and spices increased during 1970s and 1990s, and decreased thereafter. However, the area under rice was estimated a relative decrease in 2029-30, which was estimated an increase for pulses and oilseeds. On the other hand, the cropping intensity increased from 154 to 177 during 1980-01 to 2005-06 [75], which was estimated to reach at 184 in 2029-30. Also recent tendency of lower rice consumption and its impacts on encouraging crop diversification in future was analyzed [74] and proposed a re-distribution of cropping patterns considering probable crop failure, water crisis and change in food habit in Bangladesh. An incentive policy for diversified crops farming and their intensification in all crop seasons was suggested.

Researcher's [49] provide four conclusions from cropping patterns adopted by small and marginal farmers: (a) they allocate larger proportion of their cultivated land to high value crops like vegetables and fruits; (b) they are seem to have comparative advantage in growing vegetables than fruits because of quick returns in the former; (c) they allocate larger proportion of rice and wheat than other farmers; (d) they allocate lower proportion of land to pulses and oilseeds. The analysis of data from the Figure 2 also showed approximately same result and revealed that in case of cropping pattern- A, highest 55% farmers are rice cultivar and 17% are Lentil cultivars-lower portion than rice. Rests are spices and vegetables cultivars. In case of cropping pattern- B, highest 61% farmers are Jute cultivar and 21% are no cultivars, rests 18% are spices and vegetables cultivars. In case of cropping pattern- C, highest 33% farmers are rice cultivar, 21% are no cultivars, 15% are Chilly cultivars and rests are vegetable and spices cultivars. From the Figure 2 we observed that cultivation of rice in the cropping pattern-A is 55%, whereas in the cropping pattern-B and C in 05% and 33%. During the study 300% cropping intensity were found in some areas of Faridpur district. The fall in rice price together with the increase in cultivation cost e.g. fertilizer cost, seed cost, wages of farm labor turned rice cultivation is non-remunerative. In the cropping pattern-C, the respondent farmer's showed more interest in cultivating Jute as a cash crop. Similarly in the cropping pattern-A farmers are more interested in producing different types of spices as cash crop. Farmers commented that to earn as much money as possible at the minimum cost and in the shortest time possible to avoid impacts of climate induced hazards and disaster are the major causes of change in cropping pattern. This study also indicate that spread of high-yielding varieties of crops, use of pesticides and fertilizers, substitution of men by machines, shortage of skilled workers etc have influenced in changing cultivation practices and crop pattern. These results are reinforced by an earlier study and presented that profit is the main significant factor of change in cropping pattern [42]. However, underlying all these has been the people's attitude to agriculture. For the older generation agriculture was a way of life; while for the present generation it is a commercial activity due to adopt with climate change and to reduce disaster risk. Farmers are more aware then previous on DRR and CCA. In one research discussion paper [27] commented that at the previous time monetary income was not the decisive factor for cropping decisions. That time people cultivated their land only for family consumption. But the situation has now changed; in the present scenario, cultivation is mainly for income and profit generation. Farmers therefore take special care to select crops and crop varieties with better yields and tend them carefully, to obtain better yields.

Table 3. Correlation (r) among the risk factors of different cropping patterns

Parameters	Cropping Pattern		
	AxB	AxC	BxC
Risks faced in	1	1	1
Type of risks faced in	0.96	0.75	0.86
How much risks for	0.92	0.55	0.82
Mitigation of risks by famers	0.95	0.69	0.88
All Factors	0.95	0.70	0.87

Source: Surveyed Data.

A choice of correct combinations of crops or cropping patterns can be used as a useful tool to minimize the possible devastations and damages from droughts and floods [48]. Table 3 showed the correlation between different cropping patterns according to the respondent's perceptions. Linier correlations between cropping patterns revealed that correlation of cropping pattern AxB, AxC and BxC are strongly positive-95%, 70% and 87% sequentially i.e. in case of impact of all risk factor's on cropping patterns- A, B and C will be approximately same.

3.4. Cropping Systems and Risk Assessment

Table 4. Risks faced in (%) different cropping patterns

Parameters	Factors	Percent in Pattern		
		A	B	C
Risks faced in	Yes	98.0	79.0	60.0
	No	2.0	21.0	40.0

Source: Surveyed Data.

Table 4 showed the risks faced in different cropping patterns according to the respondent's perceptions. Respondent are practicing the cropping pattern-A of 98%, B of 79% and C of 60% experienced so many risks to

produce their crop. All three linier correlations showed perfectly positive results i.e. 1. This proved that adopted cropping patterns practiced by local farmers were not the location specific innovative mechanisms of sustainable adaptation but were alternative options. Previous researcher [21] commented that farmer's are increasingly changing their livelihoods as alternative options -not as appropriate innovative options and which results no sustainable change in agriculture but almost compensation based adaptation practice. Innovative adaptation practices are almost absent in locality.

Scientist [34] has represented how selected correct crops mix and cropping pattern has been adopted by the farmers to cope with risk of crop loss due to drought. The farmers were growing those crops which are highly drought-resistant. The farmers in the areas with scarcity of water put a larger area under mustard because of its lower use of water. They also adopted a mixed cropping system which allowed them to follow a flexible production schedule in terms of their responses to varying rainfall patterns. A large number of crops and their combinations are used to take care of climatic risk.

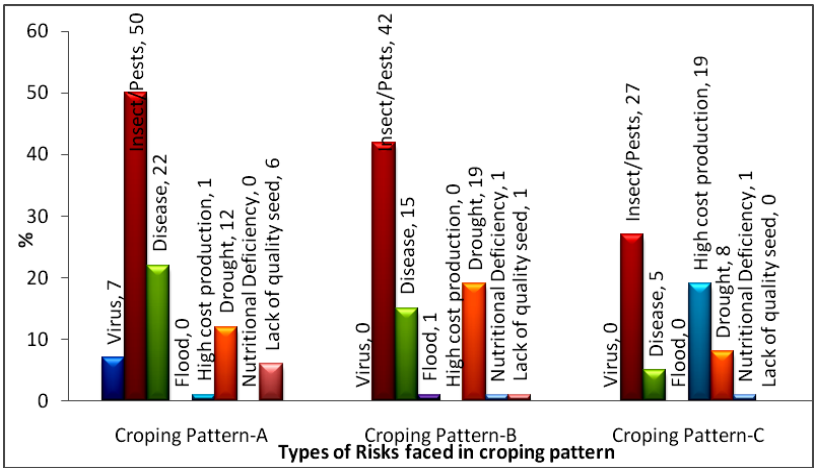

Figure 3. Types of risks faced in different cropping patterns (%) (Source: Surveyed data)

Figure 3 revealed that for the cropping pattern-A, farmers faced every year insect infestation (50%), different pathogenic disease infection (22%) and recurring disastrous phenomena, increasing frequency and intensity of different types of disaster like draught, flood etc. Farmers of pattern-B of 79% faced many risks to produce their crop-42% faced insect attack, 15 % different pathogenic disease infection, 19% faced drought and other types of disaster (Figure 3). Farmers under the pattern-C type of cropping pattern asked faced different risks in the agriculture practices and of 27% identified insects/pests as the risk factors and high production cost for 19% were risks to produce third crops in a year (Figure 3). In a previous research [4] commented on the analysis of elements at risk that rice, vegetable, livestock and poultry production are faced flood, flash flood, drought and heavy rainfall hazards as well. Researchers [79] commented that higher or lower than optimum temperature situations, crops tend to respond negatively, resulting in a drop in yield. Excessive rain fall may cause damage younger plants and yield declines due to water logging and increased pest infestations. Draught, inundation can also hinder field operations. The extent of crop damage depends on the duration of precipitation and flooding, crop developmental stage, and air and soil temperatures. The distribution and proliferation of pests are determined to a large extent by climate. Pests are any organism or microorganism- weeds, insects, and pathogens that harm or kill crops and reduce the value of crops before and after harvest. Most analyses concur that in a changing climate, pests may become even more active than they are currently, thus posing the threat of greater economic losses to farmers [79]. Adoptions of management practices are the most appropriate strategies to reduce these risks for growing crops were suggested by researchers [76]. Figure 4 demonstrated that of 100 respondents, 40% farmers of Cropping Pattern-A claimed that they were affected by agriculture risks moderately, 32% affected by strongly and asked for rapid possible solution. From Pattern-B, 43% famers claimed that they are affected by agriculture risks moderately, 24% affected by strongly. From Pattern-C, 46% famers claimed that they are affected by agriculture risks moderately, 8% affected by strongly.

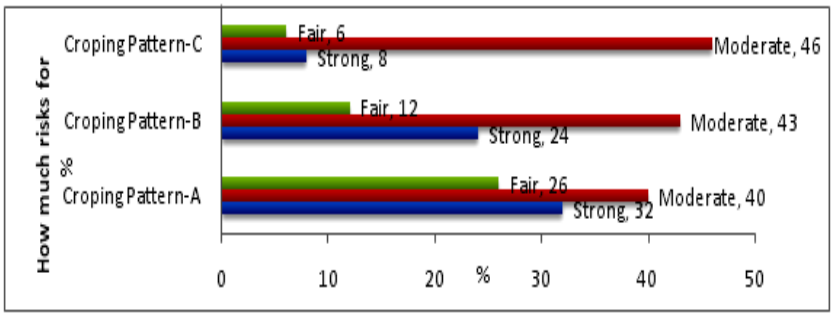

Figure 4. Amount of risks faced in different cropping patterns (%) (Source: Surveyed data)

3.5. Cropping Patterns and Risk Mitigation

Regarding the possible solution against the identified risks in agriculture sector, 47% farmers were agreed to strengthen good management practice during crop cultivation, 31% farmers wanted to have training on integrated pest management, 15% use the tolerant/resistant variety and only 5 % suggested to use hybrid variety to mitigate the disaster risk (Figure 5) belonging to the Cropping Pattern-A. Farmers of Cropping pattern-B commented to strengthen good management practice (41%) during crop cultivation, 18% farmers wanted to get training on integrated pest management, 19% use the tolerant/resistant variety-could be able to overcome the situation and only 21 % were not aware about climate change adaptation, mitigation and disaster risk reduction practices. To overcome these risky situation proper management practice (32%), use of resistant/tolerant variety (19%) and participation in the IPM training (7%) to protect pest/insects could be helpful for reducing risks (Figure 5) commented by farmers of Cropping pattern-C.

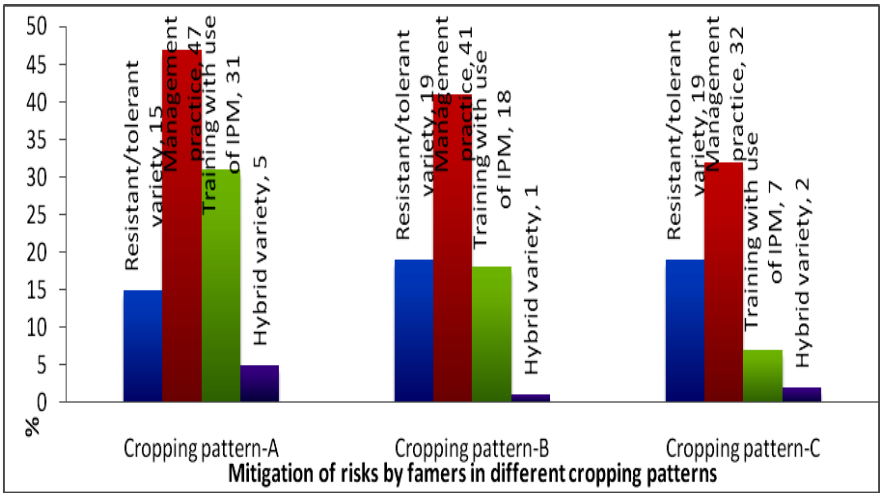

Figure 5. Mitigation of risks by famers in different cropping patterns (%)

From the above discussion it can be concluded that the farmers are exposed in vulnerable condition and expressed to have appropriate measures to reduce the vulnerabilities. Above results reinforced by earlier studies [35] and they reported that the inherent problems in the agricultural sector are lack of finances, poor irrigation infrastructure; high cost of fertilizer, quality seed, lack of credit, insect and disease problem etc. Farmers who are living on agriculture and fish production they suffer a lot during dry season as drought, wet season flood, cyclone, inundation, flash flood is observed which destroyed livestock, cattle, paddy, trees and crops, and flood water swept away many crops [30]. FAO [18] suggested and emphasis on appropriate crop variety selection, good quality seed, timely planting or sowing, line sowing, appropriate fertilizer management, irrigation and drainage, weeding and IPM as the examples of technologies, practices and approaches as important good agronomic practices for building resilient livelihoods for the farmer's community. Researcher also commented that timely planting, timely irrigation, timely weeding and timely harvesting constituting non-monetary good agronomic practices essential to adapt to increase the productivity, yield and profit suggested by other researcher [29,43]. Establishment of 'Field school' as demonstration plot and center for rice seed or seedling; extensive promotion work for farmers to adopt non-monitory adaptations measures [43], providing credit facilities with soft loan [38] could be helpful to promote the adoption of good agronomic practices.

3.6. Risks and vegetable production

Vegetables production is one of the most widespread activities in homestead-based food production system. Previous research [46] found that homesteads are the resources. Poor farmers get about 50% percent [46] of their food and cash from homestead-based food production system likely to growing vegetables and fruits, rearing livestock, poultry and fishes and rising different varieties of trees and plants around the household that provide major share of livelihood especially for the poor farmers. Table 5 showed that among the vegetable production farmers 80% were told that they faced different risks in vegetable production. From the Figure 6 it was revealed that 51% farmers told about insect or pest infestation was the main risk factor where pathogenic disease was only 20%. In case of level of risk 34% faced strongly, 24% fairly and 22% moderately that could be reduced by adopting disaster resistance variety (42%), good management practice (22%) and training on agricultural improved technology like integrated pest management (15%).

Table 5. Farmer's perception on risks faced in (%) vegetable and wood tree production

Parameters	Factors	Vegetables production (%)	Forest/Wood tree production (%)
Risks faced in	Yes	80.0	59.0
	No	20.0	41.0

Source: Surveyed data.

The risk of crop losses from pest and disease are an important vulnerability for agricultural producers [14,20]. Other researcher [44] commented that a combination of pest and insects control techniques in a particular cropping system includes cultural practices, crop rotation, use of resistant varieties and chemical treatment only when there is a real need. The problems in homestead agriculture production identified and including lack of impute, money and knowledge [25]. Research [91] commented that insect

pest is one of the major causes for low production of those crops in Bangladesh and suggested to develop and use of eco-friendly, sustainable, socio-economic acceptable Integrated Pest Management packages and other good agronomic practices, which not only boost up the production of fruits, vegetables and flowers in Bangladesh but also ensure the quality of those crops [44,79,91].

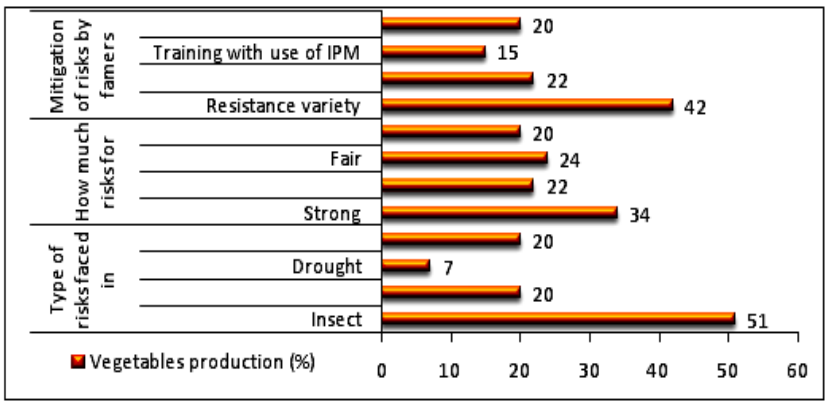

Figure 6. Risks identification, analysis and mitigation on vegetable production

3.7. Risks and Wood Tree Production

A minimum of 25 % forest cover is suggested for a healthy environment, whereas the current forest cover in Bangladesh is assumed less than 10% [24]. In the study area the resource poor farmers have their own program for household forestation -wood tree plantation and told that 59% (Table 5) faced different types of risks where insect infestation was 21%, lack of knowledge 16%, disease problem 6%, drought 5% and rests of the farmers faced flood, lack of quality seed, dwarf and cattle pest problems (Figure 7). Amount of risks faced 59% farmers where moderate 19%, strong and fair 30%. Proper management practices in right time (38%) and use of resistant variety (10%) were suggested by the farmers to overcome this situation (Figure 7).

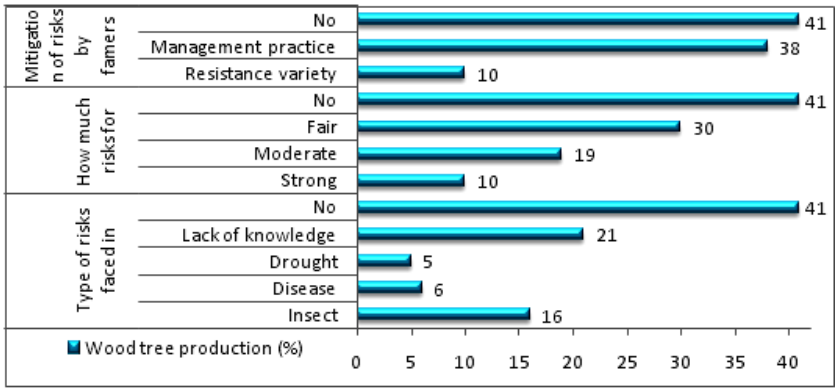

Figure 7. Risks identification, analysis and mitigation on wood tree production

The problems in homestead agroforestry were identified by other researchers including inappropriate technical knowhow, lack of knowledge on diverse variety [23], inadequate improved variety, and limited access in finance [93]. Suggestions are recommendations were plantation of multipurpose tree species to meet the demand for timber, fuel wood, fruit, fodder etc; women should be encouraged in homestead forestry than it could be better managed, since women are always available at home and seeds and seedlings should be collected form horticultural forest extension nurseries [93].

3.8. Risks and Social Forestations

In the study area field observation showed that not always necessary that the farmer grows trees for fruit, fuel wood or timber (36%), but very often they (64%) are interested in growing trees to provide shade for the agricultural crops; as storm wind shelters; soil conservation; to use wasteland; to protect bank erosion or to protect soil degradation and also for economic motive. According to the FAO, community forestry has three core elements: provision of fuel and other goods essential to meet basic needs at the rural household and community level; provision of food and the environmental stability necessary for continued food production and generation of income and employment in the rural community [17]. On the other hand, due to improper tree plantation, a large number of deaths were caused by fallen homestead tree trunks during SIDR [2]. FAO Policy brief [16] commented that when forests are appropriately planned and managed, can withstand and protect against natural disasters of varying degrees and types.

Table 6. Risks faced in (%) social forestation and fruit culture

Parameters	Factors	Social forestation (%)	Fruit cultivation (%)
Risks faced in	Yes	57.0	76.0
	No	43.0	24.0

Source: Surveyed data.

Respondent farmers have their own forestation program on their own land and in the homestead area. Table 6 showed that among 100 farmers 57% have experienced the production related risks in social forestation. They claimed that they faced the risks (Figure 8) like insect/pest infestations (28%) and destroyed their plantation and drought (10%) was another risk for lack of irrigation in winter season. 34% faced the moderate risks, 15% fair and 8% strong which could be mitigated by proper management (29%) practices and taking risk reduction action plan for preventive measures like fertilization and cleaning management.

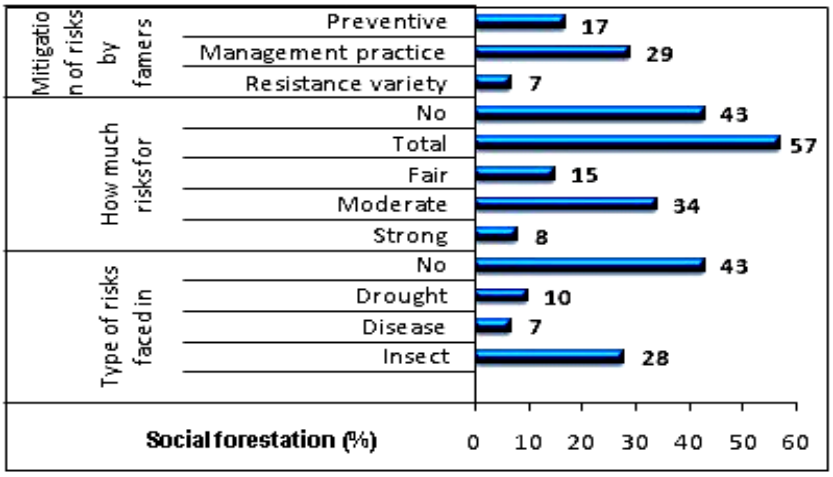

Figure 8. Risks identification, analysis and mitigation on social forestation (Source: Surveyed data)

Above findings are supported by other research [46] and stated that lack of irrigation facility had been identified by the respondent of the selected area as a severe constraint to the progress of homestead-based agriculture production system. Researchers recommended the measures against insects and pests are use of popular cultivar; training on improved management practices [92]; women should be encouraged in forestation activities than it could be better managed, and seeds and seedlings should be collected form horticultural forest extension nurseries [93].

3.9. Risks and Fruit Cultivation

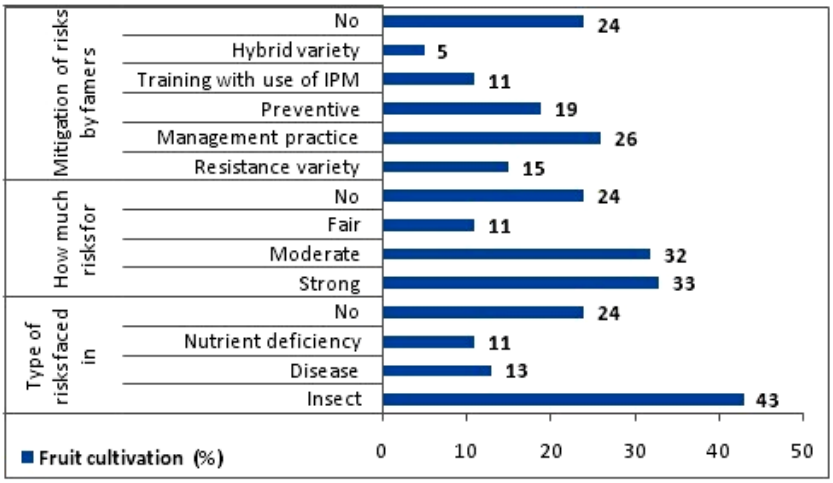

Figure 9. Risks identification, analysis and mitigation on fruit cultivation (Source: Surveyed data)

Damage by pest and disease and traditional methods of farming are the two most perceived sources of production risk commented from the research [14] on economic analysis of risks in fruit and vegetable farming. Considering fruit culture 76% farmers (Table 6) were claimed to face some risks (Figure 9) where insect/pest attack 43%, pathogenic or parasitic disease 13% and lack of nutrient 11%. The levels of risks were strongly 33%, moderately 32% and fairly 11% respectively. Suggestions from the farmers (Figure 9) were proper management practice 26%, preventive measure 19%, use of resistance variety 15% and modern hybrid variety 5% could be mitigate and reduce the risks they face. Discussion with farmers it was revealed that they are interested in fruit culture because it helps them to use the fellow homestead area (33%); to use wasteland (22%); to protect bank erosion (9%) or to protect soil degradation (9%), reduce food and nutritional insecurity (10%) and makes them in financially solvent (17%) which reduce the disaster risks they face. Research [3] revealed that unavailability of quality seed of improved variety; drought and high temperature; lack of sufficient irrigation water; lack of proper knowledge in preparing compost; lack of finance are the limitations for vegetables, fruit and wood plant production i.e. homestead gardening. From the research [91] findings it was suggested to develop and use of eco-friendly, sustainable, socio-economic acceptable Integrated

Pest Management packages and other good agronomic practices to overcome the situations.

To determine the problems in IPM practices and probable suggestions for overcoming those problems research [80] was carried out and suggested by the researchers and respondents were- i) establishment of more IPM field school, ii) arrangement of farmers practical training, iii) introduction of IPM practices into the school/college academic course, iv) increase the farmers' awareness on environment pollution and v) to ensure proper supervision of extension worker. As the important examples of technologies, practices and approaches to build resilient livelihoods for the farmer's community need to emphasis on appropriate crop variety selection, good quality seed, timely planting or sowing, line sowing, appropriate fertilizer management, irrigation and drainage, weeding and integrated pest management [18,43]; non-monetary good agronomic practices [29]; providing credit facilities with soft loan [38]; establishment of 'Field school' as demonstration plot and center for crop seed or seedling; extensive promotion work for farmers to adopt [43] non-monitory adaptations measures; location specific packages of technologies moving towards "prescription farming" [32] could be helpful to promote the adaptation of good agronomic practices to increase the productivity, yield and profit.

3.10. Risks and Poultry Rearing

Table 7. Risks faced (%) in poultry and Cattle rearing and fish culture

Parameters	Factors	Poultry rearing (%)	Cattle rearing (%)	Fish culture (%)
Risks faced in	Yes	79.0	75.0	44.0
	No	21.0	25.0	56.0

Source: Surveyed data.

Development organization considered poultry as a potential activity for income generation among the landless, particularly destitute women, many of whom owned a few chicken [37]. In the rural area every farmer's more or less rear poultry in their homestead area. During study 79% famers were found facing risks in poultry rearing (Table 7). Among the farmers 57% were faced different viral and bacterial disease especially fowl cholera, Newcastle disease, fowl pox etc. Also infestation of insect or external and internal parasite (18%) namely worm, mouse, tick, lice etc were found. Level of risk was- 34% strong, 23% fare and 22% moderate (Figure 10). Farmers who faced different diseases (57%) and parasitic infestation (18%) risks strongly (34%) or moderately (22%), they asked for diseases resistant and country adopted resistant poultry variety (39%) and suggested to take preventive measurement (32%) and should be follow the vaccination programs in right time (Figure 10).

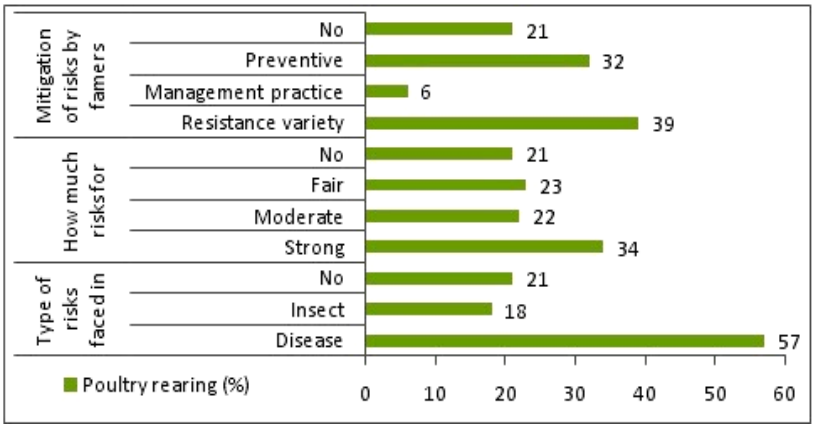

Figure 10. Risks identification, analysis and mitigation on poultry rearing (Source: Surveyed data)

Major problems identified by different research in village poultry rearing in Bangladesh were high mortality and low productivity [50]; scarcity of feed and nutrition; lack of locally adapted breed, improper vaccination and hygienic management and lack of knowledge of modern management systems [15,81]; mismanagement, predation, and lack in modern medicine, traditional medicaments [82]. Despite the many problems involved in keeping poultry, almost all poor households, including the landless, own poultry, because it is an excellent tool for poverty alleviation. Use of locally available indigenous feed resources, ethno-veterinary medicine, educating farmers, good management practices [81,82], improved poultry housing, care of chicks, improved on disease prevention and control -particularly New Castle diseases and coccidiosis [84] can be viable options to improve village chicken in rural areas suggested by researchers.

3.11. Risks and Cattle Rearing

Dairy farming generates more regular cash income, while dairy production, processing and marketing generate more employment per unit value added than do crops [31]. Dairying is also considered a strong tool to develop a village micro economy of Bangladesh [39] in order to improve rural livelihoods and to alleviate rural poverty. During study 75% famers were found facing risks in cattle rearing (Table 7).

Research revealed that cattle attacked by disease infestation like anthrax (50%), 21% by insect, external and internal parasite like worm, liver fluke, tick, mites, lice etc in the study area. Level of risk was- fair 35%, moderate 33% and strong 7% that can solve by adopted suitable/resistance cattle variety (24%) and appropriate preventive measurement by vaccination (24%); need hybrid variety (14%) and good hygienic management (11%) could overcome the above mention risks (Figure 11) commented by respondent's. Previous scientist reported from their research that diseases and parasite infestation, lack of vaccine [22], lack in livestock feed, green grass, improved breed, knowledge of scientific feeding and poor manure management are the most important constraints to rural cattle production [86]. Other researches [36,51,52]

commented that scarcity of feed and nutrition; lack of locally adapted breed and proper vaccination and hygienic management and lack of knowledge of modern management systems are the major constraints for small holder cattle and dairy farming in Bangladesh. Suggested possible solutions by the researchers are to practice integrated rice/forage production, cultivation of legume forages and feed storage, to transfer developed technologies to rural farmers, short training courses for farmers to appreciate the importance of improved manure management, hygienic management for diseases prevention and control, veterinary services etc [86]; the development of cooperative milk marketing system for betterment of the rural dairy farmers [87]; technical training in dairy feeding, health risks to humans for dairy keeping, and milk preservation; regular and consistent delivery of health services including veterinary and marketing services and strong and deliberate information asymmetry aimed to increase profit margins of the milk marketing [88].

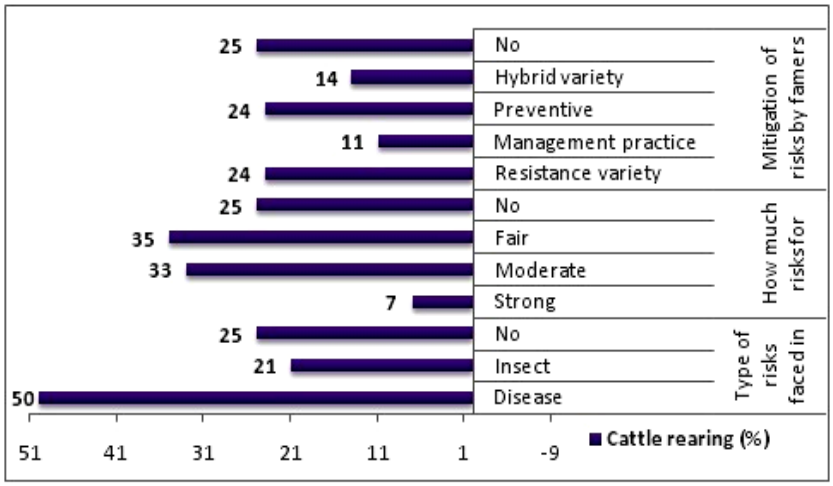

Figure 11. Risks identification, analysis and mitigation on Cattle rearing (Source: Surveyed data)

3.12. Risks and Fish Culture

Aquaculture is widely considered to have the potential to reduce poverty and enhance food security [8,45]. Among the respondent farmers no one found to have supplementary livelihood as fish culture or they don't have own experience of fish farming. Changes in the farming practices in the neighbor fish farmers and land scarcity encouraged them not to culture fish. From the neighbor farmers they came to know the risks faced the fish farmers. Among 100 farmers, 44% faced risks (Table 7) like drought (31%), fish disease (7%) and flood 5%. Level of risk was- strong 23% and moderate 19% that could be solved through good management practice, suggested by 39% (Figure 12) farmers. Researchers commented that extremely high levels of landlessness and lack in knowledge of improved management practices and diseases control in Bangladesh [7,85] limit the ability of the most resource-poor households to participate in small-scale aquaculture. Other problems are mentioned [89] low growth and high mortality of prawn larvae, scarcity of snail in natural sources for feeding, high and uprising price of supplementary feeds and floods. Suggested possible solutions by the farmers and researchers [89] are use of alternate feed sources and further research for development.

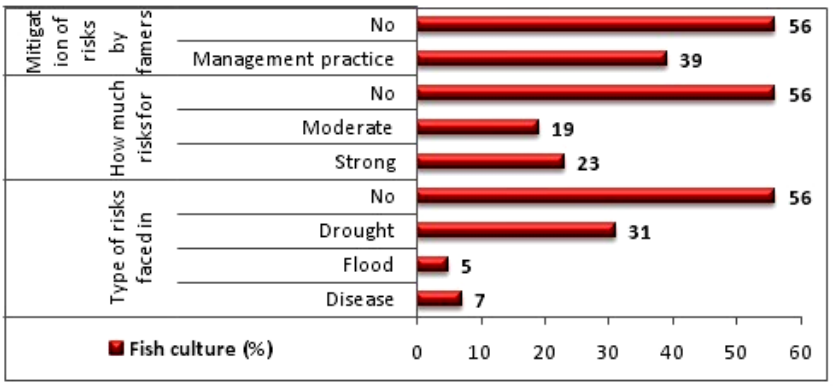

Figure 12. Risks identification, analysis and mitigation on fish culture (Source: Surveyed data)

4. Conclusions

The purpose of the study was to have understanding of farmers' perception and mitigation strategies towards disaster risk and climate change impacts and adopted mitigation strategies by the victim community of Faridpur district of Bangladesh. The agriculture sector of the study area is potentially exposed by different primary and secondary risk factors phenomena, such as drought, flood, insect/pests attack, different disease infestation, nutritional deficiency and lack of quality seed etc revealed in the analysis. The variations in risk perception also influenced

by several factors like age, gender, livelihood, level of education and socio-economic conditions etc. Present research revealed three types of cropping patterns as adopted by the agriculture farmers to cope with climate change and risk impact. Recurring phenomenon of hazards and increasing threats to agriculture production provide the farmers diversified opportunities to make their livelihood more sustainable. Farmers are more aware about their risk and what they could do to reduce their exposure on the impacts of future disaster risks. To ensure their food and nutritional security, farmers adopted different mitigation strategies like integrated farming system, changing cropping pattern, use of resistant/tolerant variety, good management practice, integrated pest management practices, use of hybrid variety, appropriate diseases prevention and hygienic measures etc. Future extensive field based research in these regards will fulfill the required information to get the most efficient small farmers friendly risk management plan which will be benefited the country to establish climate smart disaster risk management in agriculture sector.

Statement of Competing Interests

The authors have no competing interests.

References

[1] Adger, N. W., "Social Vulnerability to Climate Change and Extremes in Coastal Vietnam." *World Development*, 27(2): 249-69. 1999.

[2] Ahmed, A.U., Lessons to learn from Bangladesh cyclone. *DIPECHO network report.* Centre for Global Change, Dhaka, Bangladesh. 2008.

[3] Ali, M.Y., Rahman, M. A., Quayyum, M. A., and Islam, M. B., Improved adaptive capacity to climate change for sustainable livelihoods in the agricultural sectors – The case of High Barind Tract: BARI-FAO collaborative program. BARI, Gazipur-1701, Bangladesh, 2007.

[4] Bahauddin, K. M. and Uddin, M. H., Community Based Risk Assessment and Adaptation to Climate Change in Dharam Wetland under Sunamganj District. *J. Environ. Sci. & Nat. Res.*, 5(2): 161-166, 2012.

[5] Banglapedia, *National Encyclopedia of Bangladesh*, Asiatic Society of Bangladesh, Dhaka. 2015.

[6] BBS. *Statistical Year Book of Bangladesh.* Bangladesh Bureau of Statistics, Bangladesh, Dhaka. 2013.

[7] Belton, B., Haque, M.M. and Little, D.C., Does size matter? Reassessing the relationship between aquaculture and poverty in Bangladesh. *J.l of Deve. Studies*, 2012. 48(7):904-22.

[8] Belton, B. and Little, D.C., Immanent and interventionist inland Asian aquaculture development and its outcomes. *Development Policy Review*. 2011. 29(4):459-84.

[9] Biswas, A.K.M.A.A., Sattar, M.A., Zaman, A.K.M.M, Osman, M.S., Jahan, R., Flood Risk and Its Reduction Strategies Practiced by Women. *J. Patuakhali Sci. and Tech. Univ*. 2014. 5 (2):147-164.

[10] Blade, S. F. and Slinkard, A. E., "New Crop Development: The Canadian Experience" in J Janick and A Whipkey (eds), *Trends in New Crops and New Uses*. ASHS Press. 2002.

[11] Bloomer, J., *Homestead Aquaculture in Bangladesh: Current Status and Future Directions*. M.Sc. in Aquatic Resource Management Thesis of King's College London, Department of Geography. University of London. 2012.

[12] Brink, P. J. and Wood, M. J., *Advanced designs in nursing research.* 2nd edition. Thousand Oaks: Sage, p-337. 1998.

[13] Cresswell, S. 1994. *Research design: Qualitative and quantitative approach.* London: Sage. 1998.

[14] Fakayode, S. B., Rahji, M. A.Y. and Adeniyi, S. T., Economic Analysis of Riska in Fruit and Vegetable in Osun State, Nigeria. *Bangladesh J. Agril. Res*. 37(3): 473-491, September 2012.

[15] Fakhrul Islam, S. M. and Jabbar, M. A., Smallholder poultry model for poverty alleviation in Bangladesh: a review of evidence on impact. Live. Res. for Rural Deve. 17(112).

[16] FAO Policy brief, *Forests and natural disaster risk reduction in Asia and the Pacific. The Center for People and Forests and Food and Agriculture Organization. FAO and RECOFTC*, 2013.

[17] FAO., Community Forestry: Ten Years in Review. Rome. 1992. [Online]. Available: http://www.fao.org/docrep/u5610e/u5610e04.htm [Accessed July 20, 2015].

[18] FAO., Resilient Livelihoods – Disaster Risk Reduction for Food and Nutrition Security Framework Programme. 2013. [Online]. Available: http://www.fao.org/3/a-i3270e.pdf. [Accessed July 15, 2015].

[19] Gulseven, *Risk Mitigation Techniques in Agriculture. Aginsurance Project.* 2008. [Online]. Available: http://www.aginsuranceproject.com/index.php/agricultural-insurance/risk-mitigation-techniques-in-agriculture.html. [Accessed July 20, 2015].

[20] Hollander, A. D. *California Augmented Multisource Land cover Map. Information Center for the Environment, Univ. of California, California*. 2007. [Online]. Available: http://cain.ice.ucdavis.edu/caml. [Accessed July 20, 2015].

[21] Hossain, M.S. and Roy. K., Community Based Risk Assessment and Adaptation to Climate Change in the Coastal Wetlands of Bangladesh: A Case Study from Chenchuri Beel, Narail, Bangladesh. Proceedings of Int. Conf. on Environmental Aspects of Bangladesh, Japan, Sept. 2010.

[22] Imtiaz, M. A. and Rana, S., Problems faced by the small scale dairy owners in receiving veterinary services in selected areas of Chittagong. *Bangl. J. Vet. Med.* 2014. 12 (1): 63-65.

[23] Islam, M. S., Women in the Homestead Agroforestry-Contribution to Sustainable Development, *Journal of Natural Sciences Research.* Vol.5, No.1, 2015.

[24] Khalequzzaman, M.D. Flood mitigation through best management practices. *The Daily Star, Bangladesh*. 26th July, 2004. pp 5. [Online]. Available: http://www.thedailystar.net/2004/07/26/. [Accessed July 26, 2012].

[25] Marzan. L., Homestead food production practice and its impact on livelihood of rural women under coastal area (Patuakhali) in Bangladesh. *MS in Rural Sociology thesis*, Dept. of Rural Sociology, BAU, Bangladesh. 2009.

[26] Magombeyi, M.S. and Taigbenu, A.E., A crop yield risk analysis and mitigation of small-holder farmers at quaternary catchment level- Case study of B72A in Olifants river basin. School of Civil & Environmental Engineering Witwatersrand Univ., Zimbabwe. 2007.

[27] Mahesh, R., Causes and Consequences of Change in Cropping Pattern: A Location Specific Study, Dis.Paper-11, Kerala Research Program on Local Level Development, CDS, Thiruvananthapuram, India. 1999.

[28] Maps., Map of Bangladesh, Prime Minister Office Library. Gov. of the People's Republic of Bangladesh. 2015.

[29] Mitin, A., Documentation of Selected Adaptation Strategies to Climate Change in Rice Cultivation. *East Asia Rice Working Group*. Philippines. 2009.

[30] Nasreen, M., Hossain, K.M., Azad, M.A.K. Climate Change and Livelihood in Bangladesh: Experiences of people living in coastal regions. *Proce. of Int. Con. of Building Resilience*. 2013. Sri Lanka, 2013. [Online]. Available: http://www.buildresilience.org/2013/proceedings/files/papers/454.pdf, pp.1-25.. [Accessed July 28, 2015].

[31] Omore, A., Mulindo, J.C., Islam, S.M.F., Nurah, G., Khan, M.I., Staal, S.J. and Dugdill, B.T., *Employment Generation through Small–scale Dairy Marketing and Processing: Experiences from Kenya, Bangladesh and Ghana*. FAO, Rome, Italy. 2002.

[32] Papademetriou, M.K., Rice production in the Asia-Pacific Region: Issues and perspectives. *In 'Bridging the Rice Yield Gap in the Asia-Pacific Region'. FAO, UN, Bangkok, Thailand. RAP Publication 2000/16*. 2000.

[33] Quasem. M.A., Conversion of Agricultural Land to Non-agricultural Uses in Bangladesh: *Extent and Determinants. Bangladesh Development Studies.* Vol. XXXIV, March 2011, No. 1, 2011.

[34] Rathore, J.S., "Drought and Household Coping Strategies: A Case of Rajasthan", *Indian J. of Agri. Econ.* 2004. 59(4), pp 689-708.

[35] Razzaque,M. A. and Rafiquzzaman, S., Comparative Analysis of T. Aman Rice Cultivation under Different Management Practice in Coastal Area. *J Agric Rural Dev*. 2007. 5(1&2): 64-69.

[36] Saadullah M., Smallholder dairy production and marketing in Bangladesh', Edited by D. Rangnekar and W. Thorpe, *Proceedings of a South-South workshop held at National Dairy Development Board (NDDB) Anand, India,* 13-16 March 2001, pp. 7-21, 2002.

[37] Saleque, M.A., *Scaling-up: Critical factors in leadership, management, human resource development and institution building in going from pilot project to large scale implementation.* March 22-26, 1999, Tune, Denmark. 2000. Pp.15. [Online]. Available: http://www.husdyr.kvl.dk/htm/php/tune99/5-Saleque.htm. [Accessed July 10, 2015].

[38] Sarwar, M.G.M., *Impacts of Sea Level Rise on the Coastal Zone of Bangladesh.* Master's in Environmental Science thesis, Lund University, Sweden. 2005. [Online]. Available: https://static.weadapt.org/placemarks/files/225/golam_sarwar.pdf. [Accessed July 10, 2015].

[39] Shamsuddin, M., Alam, M.M., Hossein, M.S., Goodger,W.J., Bari,F.Y., Ahmed, T.U., Hossain, M.M. and Khan, A.H.M.S.I., Participatory rural appraisal to identify needs and prospects of market-oriented dairy industries in Bangladesh. *Trop. Ani. Health Prod*. 2007 39:567-581.

[40] Shamsuddin, M., Goodger, W.J., Hossein, M.S., Azizunnesa, Bennett, T. and Nordlund, K., A survey to identify economic opportunities for smallholder dairy farms in Bangladesh. *Trop Anim Health Prod* (2006) 38: 131-140.

[41] Shiyani, R. L. and Pandya, H. R., "Diversification of Agriculture in Gujarat: A Spatio-Temporal Analysis", *Indian J.l of Agric. Econ.* 1998. 53(4), pp 627-39.

[42] Shrestha, R. M., Factors Affecting the Cropping Patterns in Hills and Plains of the Central Development Region. *Nepal J. Sci. Tech.* 2009. 10:199-203.

[43] Siddiq, E.A., *Bridging the rice yield gap in India*. FAO, UN Regional Office for Asia and Pacific, Bangkok, Thailand. RAP Publication 2000/16. 2000.

[44] Sigvald, R., Risk Assessments for Pests and Diseases of Field Crops, especially forecasting and warning systems. *Reducing the Risks Associated with the Use of Plant Protection Products no 25. Sust. Agric*. Christine Jakobsson [ed], Uppsala: Baltic University Press, 1500. 2012. 185-201.

[45] Subasinghe,R.P., Arthur, J.R., Bartley,D.M., De Silva,S.S., Halwart,M., Hishamunda, N., Mohan, C.V. and Sorgeloos, P., eds., Farming the waters for people and food. *In Proceedings of the Global Conference on Aquaculture 2010, Thailand, 22-25 September, 2010,* 719–83. Rome: FAO; Bangkok: NACA.

[46] Sultana, Z., Economics of Homestead-Based Food Production System in Some Selected Areas of Gazipur District. *M. S. in Agricultural Economics (Production Economics) thesis, BAU, Bangladesh. 2013.* [Online]. Available: http://180.211.163.203:8080/xmlui/bitstream/handle/123456789/1140/AE-598%20JUNE-2013.pdf?sequence=1&isAllowed=y. [Accessed July 5, 2015].

[47] WAVE Foundation., Reports on Climatic Risks Assessment at Community Level in Agriculture, Lalmatia, Dhaka. 2010. [Online]. Website: www.wavefoundationbd.org. [Accessed July 5, 2015].

[48] Mandal. R., Cropping Patterns and Risk Management in the Flood Plains of Assam. *Economic and Political Weekly.* August, 2010. vol xlv No 33. [Online]. Available: http://www.researchgate.net/publication/259400050. [Accessed July 2, 2015].

[49] Birthal, P.S., Joshi, P.K. and Narayanan, A.V., *"Agricultural Diversification in India: Trends, contribution to growth and small farmer participation", ICRISAT, mimeo*. 2011.

[50] Iqbql, K., Toufique, K,A., Hossain, M.H., Mis-targeting and Mis-using Microcredit in Livestock Development Projects in Bangladesh. *Bangladesh Deve. Stud.* XXXIV(3), 2011.

[51] Halder, S., R. and Barua, P., Dairy production, consumption and marketing in Bangladesh. Research & Evaluation Division, BRAC. September 2003

[52] Saadullah, M. and Hossain, M.M., Report on the quantification of locally available feed resources and feeding systems of animal in different regions of Bangladesh. BARC, Dhaka and BAU, Mymensingh, Bangladesh. 2000.

[53] Sen, B., Drivers of Escape and Descent: Changing Household Fortunes in Rural Bangladesh. *World Deve.* 31:513-534. 2003.

[54] Quddus, M.A., Roles of Agro-Industry in Bangladesh Economy: an Empirical Analysis of Linkages and Multipliers. *Bangladesh J. Agric. Econs*. XXXII:31-48. 2009.

[55] Alauddin, M., Identification of key sectors in the Bangladesh economy: A linkage analysis approach. *Applied Economics* 18:421-442. 1986.

[56] BBS, *Bangladesh Bureau of Statistics.* People's Republic of Bangladesh. Dhaka. 2008.

[57] ADPC, 'Workshop for South East Asia, *Proceedings of the workshop on institutionalizing CBDRM in government policy-making, planning and program implementation,* 10-13 May 2003, ADPC, Bangkok. 2003.

[58] Maskrey, A., Revisiting community-based disaster risk management. *Env. Hazards,* 10(1):42-52.

[59] Zhang, X., Yi, L., Zhao, D., Community-based disaster management: a review of progress in China. *Natural Hazards* 65:2215-2239. 2013.

[60] Zahari, R.K., Ariffin, R.N.R., Community-Based Disaster Management in Kuala Lumpur. *Procedia - Social and Behavioral Sci*. 85:493-501. 2013

[61] Chen, L.-c., Liu, Y.-c., Chan, K.-c., Integrated Community-Based Disaster Management Program in Taiwan: A Case Study of Shang-An Village. *Natural Hazards.* 37:209-223. 2006.

[62] NAPA., National Adaptation Programme of Action, MoEF. Final Report November.2005

[63] Ayanwuyi, E. Kuponiyi, F.A., Ogunlade, and Oyetoro, J., Farmers Perception of Impact of Climate Changes on Food Crop Production in Ogbomosho Agric. Zone of Oyo State, Nigeria, *Glob. J. of Human Soc. Sci.* 10(7): 33-39.2010

[64] Madu, I.A., Partial vulnerability of rural households to climate change in Nigeria: Implication for internal security. W. P.-2; May 2012. Univ. of Texas, USA:The Robert S. Strauss Center for Int. Security and Law.

[65] Zhang, H., Zhuang, T., and Zeng, W., 2012. Impact of Household Endowments on Response Capacity of Farming Households to Natural Disasters. Int. *J. Disaster Risk Sci.* 2012. 3(4):218–226.

[66] Lindell, M. K., and Hwang. S. N., Households' Perceived Personal Risk and Responses in a Multihazard Environment. *Risk Analysis* 28 (2): 539-56. 2008.

[67] Xu, F., Household Financial Risk Management. *J. of Agrotechnical Econ.* 6: 14-18. 2000.

[68] Chen, C. B. Empirical Study on the Informal Risk-Sharing of Farmers in China. *Issues of Agric. Econ.*6: 20-26. 2007

[69] Chen, F. B., Chen, C. B. and Ding. S. J., The Risk and Management Strategies of Drought for Farmers in Southern China. *Chinese Rural Economy* No. 6: 61-67. 2005

[70] UNISDR. *UNISDR Terminology on Disaster Risk Management.* Geneva, Switzerland. 2015. [Online Available at www.unisdr.org]. [Accessed July 2, 2015].

[71] Shahidullah, S. M., Talukder, M. S. A., Kabir, M. S., Khan, A. H., and NUR-E-ELAHI., 2006. Cropping Patterns in the South East Coastal Region of Bangladesh. *J Agric Rural Dev 4(1&2), 53-60, June 2006.*

[72] Kabir, M.J., and Islam, M. M., Study on Agronomically and Economically Dominant Cropping Patterns in Some Selected Areas of Barisal District. Bangladesh. *J. Agril. Res.* 37(1): 55-65, March 2012.

[73] Hoque M.E. Crop diversification in Bangladesh. *In: Crop Diversification in Asia-Pacific Region. FAO RAP Publication 2001/03. FAO, Thailand.* 2001. [Online]. Available: www.fao.org/docrep/003/x6906e/x6906e04.htm. [Accessed July 22, 2015].

[74] Akanda, A.I., Rethinking crop diversification under changing climate, hydrology and food habit in Bangladesh. *J. Ag. and Env. for Int. Dev.* 2010, 104 (1-2): 3-23.

[75] MOA, *Handbook of Agricultural Statistics.* Ministry of Agriculture, Dhaka. 2007.

[76] Metzel, J. and Ateng, B. Constraints to diversification in Bangladesh: A survey of farmers' views. *The Bangladesh Deve. Stud. XXI*(3):39-71. 1993.

[77] Ashfaq, M., Hassan. S., Naseer, M. Z., Baig, I. A. & Asma, J. Factors affecting farm diversification in rice-wheat. *Pak. J. Agri. Sci., 45*(3), 91-94. 2008.

[78] Rahman, S., Whether crop diversification is a desired strategy for agricultural growth in Bangladesh? *Food Policy*. 34(4), August 2009.

[79] Rosenzweig, C., Iglesias, A., Yang, X.B., Epstein, P.R., Chivian, E., Climate Change and U.S. Agriculture: The Impacts of Warming and Extreme Weather Events on Productivity, Plant Diseases and Pests. Published by: Center for health and global environment. Harvard Medical School. 2000. [Online]. Available: http://www.med.harvard.edu/chge. [Accessed July 12, 2015].

[80] Rahman, M. M., Problems and Suggestions for Farmers' Adoption of IPM Practices in Rice (*Oryza sativa* L) Cultivation. *Bangladesh J. Agril. Res.* 37(1): 121-128, March 2012.

[81] Mapiye, C., Mwale, M., Mupangwa, J. F., Chimonyo, M., Foti, R., and Mutenje, M. J., A Research Review of Village Chicken Production Constraints and Opportunities in Zimbabwe. *Asian-Aust. J. Anim. Sci*. 21(11). 2008.

[82] Selam, M. and Kelay, B., Causes of village chicken mortality and interventions by farmers in Ada'a District, Ethiopia. *Int. J. of Live. Prod.* 4(6):88-94, 2013.

[83] Rota, A., Brett, N, Nahar, J., Rahman, S.M.R., Ali,Y., Sarwar,A., Fattah, K.A., 2009. *The experience with mini-hatcheries technology in Bangladesh. IFAD and PKSF, Dhaka, Bangladesh.* [Online]. Available at: http://www.cop-ppld.net/fileadmin/user_upload/cop-ppld/items/Rice%20husk%20Mini-hatcheries.pdf [Accessed July 15, 2015].

[84] Kusina, J., Kusina, N.T., Mhlanga, J., A survey on village chicken losses: causes and solutions as perceived by farmers. In: *Alders, R.G., Spradbrow, P.B. (Eds.), Australian Centre for International Research (ACIAR) Proceedings No. 113 on SADC Planning Workshop on Newcastle disease control in village chickens.* pp. 148-155. 2001.

[85] Parvez,M.S., Azad,M.S., Rahman, and Jahan, K.M., 2014. Status and Practices of Shrimp Culture in South West Part of Bangladesh. *Aquaculture. Engormix.* [Online] Available: https://en.engormix.com/about_us/WhoAreWe.aspx [Accessed July 1, 2015].

[86] Akbar,M.A. and Jahiruddin,M., Utilizing indigenous resources in an integrated approach to improving livestock production while conserving the environment. Joint FAO/IAEA programme. IAEA-TECDOC-1640. 2010. [Online] Available: http://www-pub.iaea.org/books/IAEABooks/8271. Accessed July 1, 2015].

[87] Ghosh, A.K. and Maharjan, K. L. Milk Marketing Channels in Bangladesh: A Case Study of Three Villages from Three Districts. *J. of In. Deve. and Coop.,* 8 (2):87-101. 2002.

[88] Hall,D.C., Alam,M.G.S. and Raha,S.K., 2012. Improving dairy production in Bangladesh: Application of integrated agriculture and ecohealth concepts. *Int. J Anim. Pdn.*

[89] Galib,S. M., Mohsin, A.B.M., Chaki, N., Fahad, M.F.H., Haque, S.M.M., An overview of the traditional rice-prawn-fish farming in Kalia of Narail district. Bangladesh. *J. of Fish.* 1(1): 1-6, 2013.

[90] Practical Action. How people are adapting to climate change and fighting food insecurity. *Floating gardens, Practical Action, Warwickshire, UK.* 2014. [Online] Available: http://practicalaction.org/floating-gardens. [Accessed July 08, 2015].

[91] Alam, S.N., Insect pest management for quality horticulture crop production in Bangladesh. *Hortex Newsletter*. 11(2) April - June, 2011.

[92] Foysal,M.A., Hossain,M.L., Rubaiyat,A., Hasan, M.B., Economics of Homestead Forestry and Their Management Activities at Fatickchari Upazila of Chittagong District, Bangladesh. *Agriculture, Forestry and Fisheries.* 2(4). 2013.

[93] Hasan, M.K., Ahmed, M.M. and Miah, M.G., Agro-Economic Performance of Jackfruit-Pineapple Agroforestry System in Madhupur Tract. *J Agric Rural Dev*. 6(1&2):147-156. 2008.