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Crops diversification, adequate and nutritious food: A challenge for rural communities in Sunamganj District, Bangladesh

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Abstract: In Bangladesh's Sunamganj district, agricultural output forms a major part of the region's economic activity. The rural population's agriculture, food security, and nutrition are constantly threatened by natural disasters as Sunamganj district is located in a low-lying and flood-prone area of the country. The study explored crop diversity and how it relates to food security, livelihood improvement, and how farmers cope with their losses due to natural catastrophes. With the help of PRA (Participatory Rural Appraisal) techniques and secondary sources, the researchers obtained a better understanding of agricultural diversification in the study area. In this study, farmers, community members, experts, and government and non-governmental officials were interviewed. The qualitative data were collected through focus groups discussion, and key informant interviews. The study found that 46% of respondents opined that agriculture is the main occupation of the people, who are poor class people. 95.5% of people express that, people have seedbeds and homestead gardening, while 77.27% respond, people have land access. 63.64% of respondents took rice three times per day, and 36.36% took rice twice daily. The study estimated per capita calorie consumption ranges from 1600 to 2400 calories per day for adult women and 2000 to 3000 calories per day for adult men. Extensive infrastructural facilities can complement crop diversification as a socially beneficial policy, and financial and technological support. More than 90% of Boro crops 48 were damaged in Sunamganj by a flash flood in April 2017. Economically NRCs are higher-yielding crops than that HYV single Boro rice or other paddy or wheat. Farmers' experience and awareness about the production of vegetables in recent years is better than in the past because of the necessity of fulfilling family nutrition and earning money by selling surplus production. The findings of the present study may help the local-level government to adopt climate-smart agriculture to ensure food security.

1. Introduction

Bangladesh is a land of deltaic ecological territory that has developed due to changing continuous natural calamities (flood, flash flood, drought, heavy rainfall, waterlogging, cold wave, and hailstorm), posing devastating hazards to poor people and marginalized farmers and introducing a vulnerability into the population (Hossain et al. 2021, Mohiuddin et al. 2021, Hossain et al. 2019, Islam et al. 2020). Bangladesh is generally regarded as a vulnerable country concerning climate change, especially in haor areas because of its unique geographic location (Hossain et al. 2015, Rahaman et al. 2016, Hossain et

al. 2016, Abedin et al. 2019). Haors are large bowl-shaped floodplain depressions located in the northeastern region of Bangladesh covering 1.99 million ha (hectare) of the area and accommodating about 19.37 million people (CEGIS, 2012a, Mia, 2021). Haors with their unique hydro-ecological features, which transform into lakes in the wet season and are utilized for fishing activities (CEGIS, 2012a, Mia, 2021). It is a mono-cropped area, and in the dry season, the haor is being used for agriculture, mainly the cultivation of the boro rice crop (Himu et al. 2020, Hoq et al. 2021). Most of the Haor areas stay underwater for 6-7 months of a year, and a large area is a perennial wetland (Abedin et al. 2019, CEGIS 2012a, Mia, 2021, Himu et al. 2020, Hoq et al. 2021, Ali et al. 2018). There are almost 373 haors located in the districts of Sunamganj, Habiganj, Netrokona, Kishoreganj, Sylhet, Moulvibazar, and Brahmanbaria. These 373 haor cover 858,000 ha area which is around 43% of the total area of the Haor region (Mia 2021, Himu et al. 2020, Hoq et al. 2021, Ali et al. 2018, CEGIS 2012b). Among the haor area of these seven districts, Sunamganj has the largest haor area of 268,531 ha which is about 73% of the total area of the district (CEGIS 2012a, Mia 2021).

Sunamganj is a flood-prone locality in the haor basin and natural disasters or calamities have the potential to cause crop damage yearly (Abedin et al. 2019, CEGIS 2012a, Mia, 2021, Himu et al. 2020, Hoq et al. 2021, Ali et al. 2018). Haor/low land is completely submerged for almost six months of the year. It is critical to ensure that food grains are available for home consumption throughout the year in order to improve food security and the social safety net. The availability of food, particularly rice, for the consumption of marginalized and impoverished farmers throughout the year is critical in ensuring food security at the home level for these people (Himu et al. 2020, Hoq et al. 2021). As a result, Haor residents must contend with natural disasters to ensure their food security and meet their nutritional needs throughout the year (CEGIS 2012a, Mia, 2021, CEGIS 2012b). The hoar basin is low-lying and is subject to deep monsoon flooding supporting rich fisheries while drier winter yields a bumper rice crop. While flooding enhances floodplain fisheries, the early flash floods, unique to this region, caused due to a sudden surge of rainwater from adjacent Indian Hills, pose a high risk of damage to the standing winter rice crop just 2/3 weeks before harvesting. Flashflood has remained the major climate risk to thousands of rice farmers in the region over the years. Data reveal that rainfalls in Meghalaya, India, have increased in March-April, intensifying the severity of flash floods. Creating submergible dykes to delay or divert the entry of flashflood water into the crop fields is the only adaptation response from the government (CNRS 2014, Salehin et al. 2020). However, there are incidents of failure of dykes almost every year and consequent losses of winter rice, the only crop in this vast basin covering 97% of the total cropped area (Naeem et al. 2013, Ghosh et al. 2020). In 2003 over 80% of rice amounting to 0.6 million tons was completely damaged due to flash floods (CNRS 2014).

Flash floods and early flash floods are the main factors damaging agriculture production in Haor areas (Rahaman et al. 2016, Islam et al. 2021). Due to the early flash floods in April 2004, about 80% of Boro crops were destroyed. Almost every year, crops are damaged by flash floods and drainage congestion in about 25% of the total Boro cropped areas (Ali et al. 2018, CEGIS 2012b, Adger 2003). During 1973–1987, about 2.18 million tons (MT) of rice was damaged due to drought and 2.38MT due to flood. Drought affects annually about 2.32 Mha and 1.2 Mha of cropped land during the Kaharfi (summer) and Rabi (winter) seasons, respectively, in Bangladesh (Ali et al. 2018, CEGIS 2012b). In contrast, soil salinity, waterlogging, and acidification affect 3.05 Mha, 0.7 Mha, and 0.6 Mha of cropland, respectively, every year (BBS 2009). The Haor basin area is mono-cropped, and in the dry season, the haors are utilized for agriculture, mainly the cultivation of the Boro rice crop. Most Haor areas stay underwater for 6-7 months of a year, and a large area is a perennial wetland (Abedin et al.

2019). The total arable land in the Sunamganj district is 281644 hectares. Only the Boro crop is cultivated at 223082 hectares (79.21%) (BBS 2009). Besides mono-cropped, in the Sunamganj district, 96570 (34.29%) hectare is double cropping and 14161 (5.03%) hectare are triple cropping areas. Other rice varieties, including transplant Aman (69570 hectares; 24.7%) and AUS (6687 hectares; 2.37%) were cultivated across the Sunamganj district. Only 17.83% (50215.1 hectares out of a total of 281644-hectare arable land; land was cultivated by non-rice crops, mainly wheat (1452.36 hectares), maize (269.23 hectares), Jute (2630.55 hectares), potato (3927.3 hectares), sweet potato (1612.91 hectares), ground nut (2655.25 hectares), mustard/rape (4413.84 hectares), vegetable-winter (27009.45 hectares) and vegetable-summer (6244.16 hectares), (BBS 2009). The above information about land coverage by varieties (rice and non-rice crops) assumes a huge gap between rice and non-rice crop cultivation practice. Also, these signs indicate that rice varieties dominate impudently over other crop varieties (Abedin et al. 2019, Ali et al. 2018).

Most of the poor people of this area are eventually habituated to this calamity but have no sustainable coping mechanism to build their fortune plan to resolve the sudden hazards. Almost 6-7 months of the year Haors/low land are inundated by water (Chakma et al. 2021). Provisioning food gains for household consumption throughout the whole year is essential for enhancing food security and the social safety net. Availability of food, especially rice, for the consumption of marginalized and poor farmers throughout the year is very important to secure. There is no alternative way to produce more food for low-income families to meet their necessities around the whole year (Rahaman et al. 2016, Mia 2021). They can vigilantly run away from the crucial food insecurity in Haor areas. Some of the Haor and beel were covered by floodwater, which caused waterlogging over the cultivable land. The recession of water from the Haor takes much time, which delayed farmers preparing seedbeds and transplantation of seedlings into their cultivable land. Water stands for 6-7 months every year, which creates the widest waterlogging (Mia 2021, Hoq et al. 2021, Chakma et al. 2021). Flash flood water brings clay, alluvium, and sand into the Haor during the rainy season flood (Chakma et al. 2021). It deposits sediments that uplift the soil layer and silted up rivers, canals, beel, and Haor. Sometimes soil erosion of submerged embankments causes siltation. Food is a fundamental and constitutional right to humans, and the constitution bestows responsibility on the government to fulfill their basic needs (Hoque et al. 2021). Therefore, the study aimed to identify crop varieties of rice and non-rice crops that the farmers in the study areas cultivated. To know how the crop diversification in the study areas relates to food security and livelihood improvement of rural people and to assess the economic losses of crops by a flash flood and other disasters and how they recover.

2. Methodology

2.1 Location of the study area

In this study, 4 Upazilas (Tahirpur, Bishwamabapur, Sunamganj Sadar, Jamalganj), 7 unions (South Sreepur, Tahirpur Sadar, South Badhaghat, Solukabad, Fatepur, Jahangir Nagar, Beheli) and 15 villages (Anandanagar, Latifpur, Manikkhila, Ratanshree, Gorkathi, Paschim Majhertek, Rotargawn, Majhertek, Jiragtahirpur, Nurujpur, Krishnapur, Krishanagar, Rajapur) were chosen (**See Figure 1**). Because only single Boro crops cultivated low lands or a deeper part of Haor areas around the Sunamganj district, some highlands adjacent to the Meghalaya Mountain and Lesley affected by the flash flood were cultivated by other rice non-rice crops. Land criteria created opportunities for farmers and rural people to initiate diversified crop cultivation practices in these study areas (Himu et al. 2020).

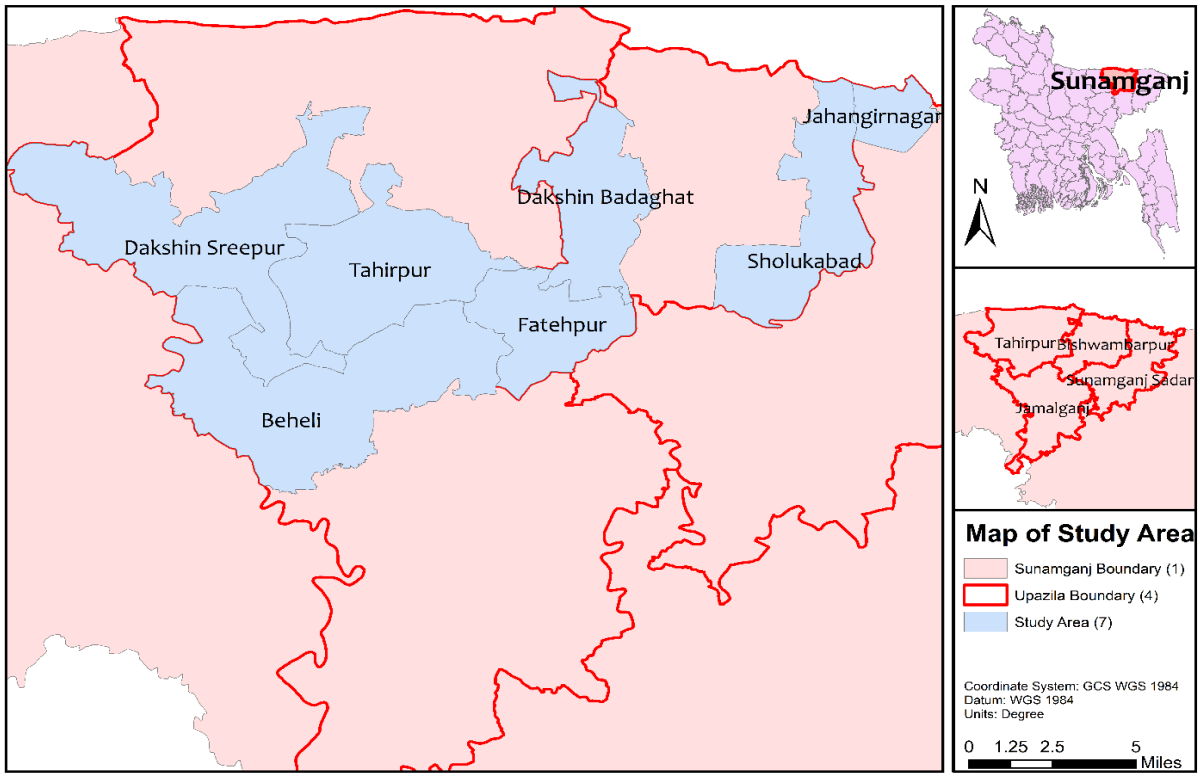

Figure 1. Location map of the study area

2.2 Data Collection Techniques

In the study area, total population is 222480 farm holdings. There are 143525 owning holdings among the agriculture households, 68641 owners cum tenant, and 110998 tenant holdings. First of all, a preliminary visit was made to select the sample sites. We selected the respondents for this study, considering farm size and land tenure pattern. Farmers are classified into four classes according to the size of the farm, for details are below the **Table 1.**

Table 1. Farmer classification based on farm size (Quasem, 2011)

Sl.	Farmer classification	Farm size (acres)
1	Landless farmers	Upto 0.5
2	Marginal farmers,	0.51 to 1.0
3	Small farmers,	1.01 to 2.5
4	Medium farmers and	2.51 to 5.0
5	Large farmers.	5.01 and above

Furthermore, the land tenure patterns are divided into four classes, and these are 1) pure tenant, 2) own land only, 3) mixed tenant (own land plus land share in), and 4) mixed tenant (own land plus lease out).

The tools used for gathering information were as follows:

(1) Semi-structured questionnaire survey- A preliminary questionnaire was given to randomly selected respondents in the study villages. The respondents were asked further questions based on their responses. Participatory Rural Appraisal (PRA) methods were applied to draw information.

(2) Focus Group Discussion (FGD) - Focus group discussions were arranged in familiar places where people usually gather to rest, gossiping places, and tea stalls. This method helped avoid personal opinions and assess the common collective perspective. During the field survey, 6 FGDs were conducted in 6 villages and each group consisted of 10-12 people.

(3) Key Informant Interview (KII)- Discussed with the local elite person, the village head of the community, Head teacher of the local high, the political leader, and the religious leader about collected data to do a qualitative evaluation. This evaluation helped better to understand the socio-economic condition of hoar and nutrition and food security. During my fieldwork, five key informant interviews were conducted with DD-DAE, DFO, DLO, and SAAAO and UP chairman of Fatepur UP of Bishwamabarpur Upazila

2.3 Data analysis

After completing the data collection process, the acquired data were entered into the SPSS (v. 16.0) spreadsheet. Analyze data in the MS Spreadsheet in specific instances to avoid complications and ensure that the data was handled simply throughout the analysis.

3. Results and Discussion

3.1 Socioeconomic condition

3.1.1 Households and Family Composition

Twenty-two respondents consist of 134 family members, 50% male, and 50% female. There are 9% boys and 5% girl's children under age five years respectively. The percentage of boys and girls of 5=<15 years are 15 and 19 respectively. Among the family members, only 22.36% (37 persons; 31 males and 6 females) are directly or indirectly involved in earning. Among the family earning members, 84.21% are male, and 15.79% are female. On the contrary, only capable earning members of these 22 respondents are being male 23.88%, and female 4.48%. The study shows that family members are directly dependent on 27.61% of earning members, which is a huge gap between male and female earning capabilities in the rural areas of Sunamganj district, especially in the study areas.

3.1.2 Household's Occupation

Sunamganj is a low land and is a resource-dependent community; the main sources of earning are agriculture, labor, and fishing (Femconsult 2014, Rapsomanikis, 2015). Out of 22 respondents, agriculture is the main source of earning for 10 respondents (45.5%), followed by agriculture labor 18.2% (4 respondents), day labor 13.6% (3 respondents), fishing 9.1% (2 respondents), and 4.5% (1 respondent for each) for fish business, small trade and handicraft respectively. This study revealed that of those whose main occupation is agriculture, 18.2%, have no second occupation, but 9.1% are involved in other occupations, and 9.1% and 4.5% are involved in seasonal fishing and fishing as secondary occupations, respectively. Those whose main occupation is day labor have a second occupation; 9.1% and 4.5% are involved in the seasonal fishery and agricultural activities, respectively. 18.2% are engaged in the seasonal fishery as a secondary occupation. Of those whose main occupation is agriculture labor, 4.5% of respondents are respectively involved in day labor and agriculture labor as a secondary occupation, those whose main occupation is fishing. The present study also revealed that 45.5% of respondents have no third occupation. Also, 9.1%-day laborers have no third occupation, but 4.5% are involved in agriculture labor as a third occupation. 9.1% of agriculture labor is engaged in agriculture activities, and day labor is the third occupation.

3.1.3 Population Class of Respondents

Well-being illustrates community people's actual phenomenon of how well they operate and maintain their earning mechanism, food security, health, water and sanitation, children's education, recreation, assets, livelihoods, and other activities. To know the respondents' well-being in the study areas, we collected information from 22 respondents in the study areas by dividing the population into four classes: rich, medium, poor, and ultra-poor. **Figure 2,** shows that 40.91% are low-income families followed by medium type (36.36%), ultra-poor (18.18%), and only 4.55% are rich class respectively in the study areas.

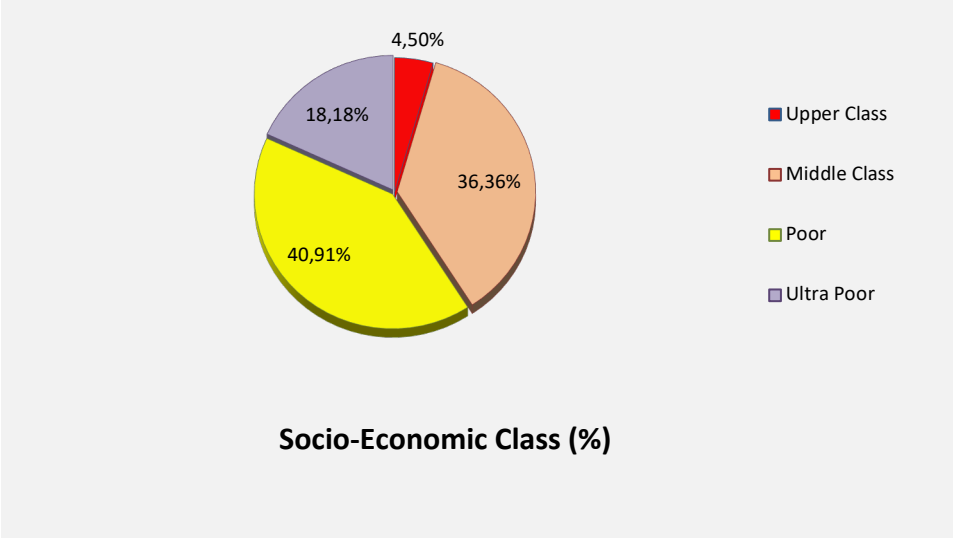

Figure 2. Respondent Socio-economic class

3.1.4. Homestead Gardening

The study revealed that 95.5% of respondents have seedbeds and homestead gardening land. This means that almost everyone has access to seedbeds and homestead gardening involved in agricultural activities. Still, those not directly involved in agriculture production have homestead gardening, and this percentage is very low. Medium farmers possess a maximum of 33.3% seedbeds and homestead gardening, followed by 28.6% to small farmers, 19% to marginal farmers, and 19% to large farmers, respectively. Only 22.7% have pit crops farming in the study area, and 77.3% do not garden pit crops. Among the pit crop cultivation, 38.8% belong to the middle and poor class population, 19% to the ultra-poor class, and only 4.5% of rich farmers are involved in pit crop gardening (**Table 2**).

Table 2. Information on seed beds and homestead gardening in the study areas

Farmer's classification	Do you have a bed crop?			
	Yes		No	
	Count	Column Total N %	Count	Column Total N %
Marginal farmer	4	19.0%	1	100.0%
Small farmer	6	28.6%	0	0.0%
Medium farmer	7	33.3%	0	0.0%
Large farmer	4	19.0%	0	0.0%

3.1.5 Access to Land

The study found that 22 respondents possessed 43.43 acres of land. Among this, 43.42% were land followed by 20.87% mortgage/lease out (give mortgage or lease to others), 19.34% leased in (took a lease from others), 12.59% share in the land (took share from others; sharecroppers), 3.09% fallow land and 0.69% Khas land respectively. **Table 3 and Figure-2** represent that 77.27% of respondents have their land (including seedbed, bed crops, and pit crops), 40.91% have shared land, 36.36% have mortgaged or shared out the land, and 36.36% have leased land, 22.73% of respondents have fallow land, and 4.55% have Khas land respectively.

Table 3. Land possession information of respondents

Land in possession	Having land (%)		Land in acre	Percentage (%)
	Yes	No		
Own land	77.27	22.73	18.86	43.42
Mortgage/share out	36.36	63.64	9.06	20.87
Share in land	40.91	59.09	5.47	12.59
Lease land	36.36	63.64	8.40	19.34
Khas land	4.55	95.45	0.30	0.69
Fallow land	22.73	77.27	1.34	3.09
Total land			43.43	100.00

3.1.6. Food Consumption

Table 4, shows that 63.64% of respondents took rice three times per day, and 36.36% took rice twice daily. Besides this, 63.64% took Chapat or Ruti taken once per day those were taken rice twice per day. Among the 22 respondents, 36.36% did not take Chapati or Ruti. In fish consumption, 31.8% of households ate three times per week, and 13.6% ate once per day and twice per week, respectively. 81.82% of respondents did not take meat during the last seven days, and only 4.51% of households ate meat once per week. 31.82% of households took vegetables two times per day, 13.64% took vegetables three times per day, and 27.27% took four times per week, the next food item after rice to intake the most calories. 13.64%, 86.82%, and 73% of households did not take a pulse, milk, and fruits during the last seven days, but 27.27% HHs took a beating once per day, and 31.82% HHs took a pulse three times per week. Only 9% and 4.5% HHs took milk and fruits 3 and 2 times per week, respectively.

Table 4. Food consumption among the respondent at the study area

Type of Food	No.	Percentage
Rice	3/D	63.64
	2/D	36.36
Chapati	1/D	63.6
Fish	1/D	13.6
Consumption	2/W	13.6
Total	3/W	31.8
Meat	0	81.82
Vegetable	2/D	31.82
	4/W	27.27
Pulse/Dal	0	13.64
	1/D	27.27
	3/W	18.18
	4/W	13.64
Milk/Powder	0	86.36
milk	3/W	9.091
Fruits	0	73
Sugar/Gur	0	50

3.1.7. Per capita calories consumption

The total number of calories needed per day may vary depending on various factors, such as the person's age, sex, height weight, and level of physical activities he performed. Calories consumption also needs to lose maintain or gain weight. **Figure 3 exhibits** that estimate range from 1600 to 2400 calories per day for adult women and 2000 to 3000 calories per day for adult men. Also, it depends on the age-sex group. For children and adolescents, reference height and weight vary. The reference man is 5 feet 10 inches tall and weighs 154 pounds for adults. The reference woman is 5 feet 4 inches tall and weighs 126 pounds. Estimated needs for young children range from 1000 to 2000 calories per day, and the range for older children and adolescents varies substantially from 1400 to 3200 calories per day; it also noted that boys generally need higher calories than girls.

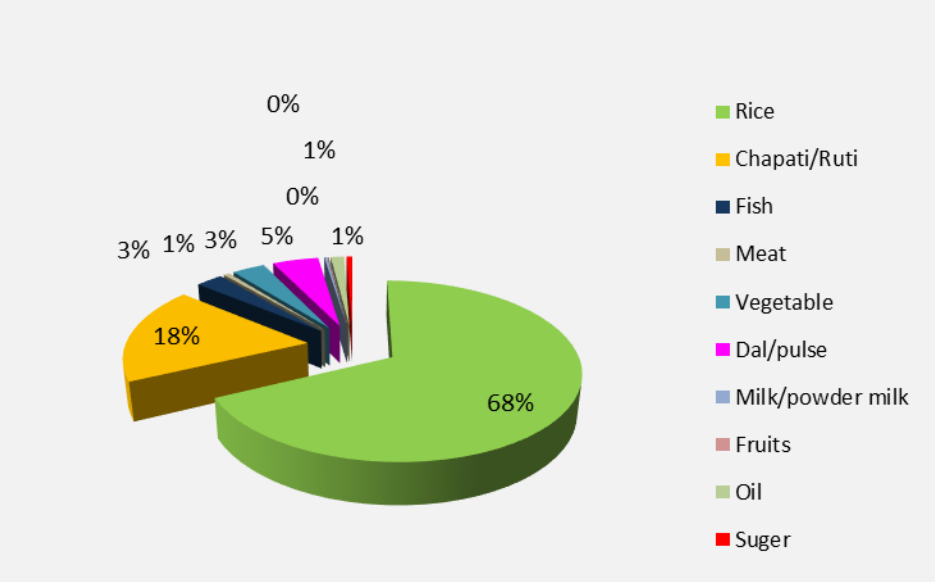

Figure 3. HHs calories consumption

3.2 Crops diversification

Rice is the main food crop in the country (Islam et al. 2016). In the middle of the 1980s, rice acquired 4th place in the world for its huge production due to utilizing high-yielding varieties of seeds, fertilizer, and irrigation. Crop diversification is believed to be a widely prescribed means of agriculture and rural development. It offers comparatively high returns from crops by minimizing price and yield risk created by climatic variability and price volatility of agricultural produce. Again, it also provides higher labor productivity, optimizing resource use, and utilizing the land efficiently. Extensive infrastructural facilities can complement crop diversification as a socially beneficial policy, financial and technological support, etc., especially for the localized micro (labor-intensive) enterprises engaged in 40 processing, storing, grading, and packaging activities. The crop diversification program started in the early 1990s was not successful in Bangladesh (Akanda, 2008). Earlier governmental policies and research supported intensifying rice farming or diversified crops considered water available and abundant.

3.2.1 Choice of rice variety

Non-rice crops mean crops except rice crops. Generally, it includes wheat, maize, tuber crops, oilseeds (edible), spices and condiments, vegetables, and fruits. In the Sunamganj district, non-rice crops were not cultivated on a large scale or in remarkable land areas. The following table-14 shows a brief picture of non-rice cultivation. The wheat crop was estimated to cultivate at 181 acres with a yield

per acre of 0.76 MT per acre with a total estimated production of 455 metric tons in 2014-2015. Maize was estimated to cultivate in Sunamganj at 30 acres with 0.25 MT per acre yield. The total production of maize was estimated at 75 metric tons in 2014-2015. Oilseeds (edible), total pulses, vegetables (winter), and vegetables (summer) were estimated to cultivate at 3471 acres, 3471 acres, 139 acres, 6469 acres, and 1851 acres of land, respectively. The yields per acre were estimated for oil seeds (edible), total pulses, vegetable (winter), and vegetable (summer) as 0.71 MT, 0.39 MT, 4.82 MT, and 1.87 MT with total production as 2459 MT, 54 MT, 31148 MT and 3457 MT (BBS 2009). The study found that only 6.7% (1.9 acres) of land was cultivated by Potato as a non-rice crop by two farmers out of 22 farmers (9.1%). The following **Table 5** shows that only 21.69% of total respondents' farmer's lands were cultivated by 40.91% of interviewed farmers in 2015-2016. But in 2016-2017, it was 18.99% out of the total 28.22 acres, which was 2.7% less than the previous year. This happened due to a flash flood in April 2017 in Sunamganj that flash flood also inundated and damaged high land, especially in Bishwamabarpur Upazila, which was prominently known as a vegetable's cultivation area.

Table 5. Rice Yield at the study area

Crops		2013-2014			2014-2015		
		Area acre	Yield/acre (kg.)	Production MT	Area '000'acre	Yield/acre (kg.)	Production MT
Rice	Variety	1	2	3	1	2	3
AUS	Local	1530	769	1176	1502	769	1155
	HYV	6093	1106	6739	9678	1079	10440
AUS total		7623	938	7915	11180	924	11595
Aman	Broadcast	33	636	21	38	657	25
	Transplant local	53108	660	35049	52399	702	36771
	Hybrid	74077	1186	87875	77382	952	73656
Aman Total		127218	966	122945	129819	770	110452
BORO	Local	28240	736	20798	24822	750	18623
	HYV	384062	1431	549786	393749	1463	576146
	Hybrid	48020	1647	79083	57619	1754	101086
BORO total		460322	1411	649667	476190	1461	695855
Total all rice		595163	3315	780527	617189	3155	817902
	Wheat	181	742	134	598	761	455
	Maize	0	0	0	30	2500	75
	Total pulses	190	484	92	139	388	54
	Oil seeds (edible)	1649	510	841	3471	708	2459
	Spices & condiments	771	0	899	933	0	1456
	Vegetable (winter)	3197	2283	7937	6469	4815	31148
	Vegetable (summer)	2458	2624	6451	1851	1868	3457

3.2.2 Cultivation practice

Despite modern agriculture technology developed, traditional agriculture method is also practiced in the Haor region of Sunamganj district due to a lack of financial capacity and agriculture equipment, materials, and proper knowledge of operating modern agriculture technology among the poor farmers. Local rural farmers also sometimes practiced mixed methods (modern plus traditional methods) to minimize cultivation costs. The study found that some of the respondents followed a mixed approach in such a way that, firstly they followed the modern agriculture method in land preparation

by using a power tiller and then followed the traditional method in transplanting, wedding, utilization of fertilizers, pest management, irrigation and even harvesting period. Also, some farmers followed modern agriculture technology in pest management and irrigation. The study found that in vegetable cultivation, 54.55% of farmers used modern technology, followed by 36.36% traditional and 9.1% mixed methods of cultivation for 2015-2016. For the case of Boro paddy, a maximum of 81.82% of farmers now practiced modern agricultural technology and 27.27% still follow traditional and mixed methods in rice cultivation practices in the study areas. This was also found in AUS paddy cultivation in 2015-2016. But utilization of modern technology increased in 2016-2017 for Boro crops at 90.91% and AUS crops at 36.36%. The mixed method remained unchanged as in the previous year. Farmers pinioned that we could not make up our agricultural costs by the market price of our total yields of crops. Though technology increased agricultural production costs, it also increased productivity. Recurrent flash floods hampered Boro crops yielding and reducing farmers' financial capacity and morale.

3.2.3 Crops and economic loss by flash flood April 2017 in Sunamganj

The Flash flood 2017 of Sunamganj started on 29th March 2017 and continued up to 25th April 2017. Continuous rainfall in the Meghalaya Mountain and Sunamganj Haor area, downstream water rush, increased water level, and weak embankment construction damaged Boro crops around the Sunamganj district. More than 90% of Boro crops 48 were damaged in Sunamganj by a flash flood in April 2017. Not only damaged Boro crops, but also polluted water (due to increased ammonia in water and decreased pH of the water and other factors) and damaged fish (17th April to 18th April 2017) in some haors of Sunamganj district. 277188 farmers of all classes were directly and indirectly affected by a flash flood in April 2017 in the Sunamganj district. Among the affected farmers, 22690 from Sunamganj Sadar, 24668 from Tahirpur, 26610 from Jamalganj, and 12360 from Bishwamabarpur Upazila were affected and lost more than 90% of Boro crops. The total loss of Boro crops in my study areas (Tahirpur, Bishwambarpur, Jamalganj, and Sunamganj Sadar) was 210266 metric tons, and the economic loss is BDT 637.10 crore. The total Boro crops damage was 648121 metric tons worth BDT 1963.81 crore (CNRS 2014, Brouwer et al. 2007, Ahamed 2013). The study revealed that 11 farmers of 14 villages of 7 Union Parishad under 4 Upazilas cultivated various species of vegetables in the year 2015-2016 and earned BDT 802050 (83% of the total market price of the sold vegetables worth 964250 takas) by selling 36.36 metric tons of vegetables and non-rice crops nearby village, UP and Upazila markets. But a recent flash flood in April 2017 in Sunamgnaj reduced their earnings by damaging standing non-rice crops (vegetables and other non-rice crops). In the year 2016-2017, the farmers only earned 53% of the total market price of the sold vegetables and non-rice crops and 47% of non-rice crops were damaged by the recent flash flood of April 2017 in the study areas, which was a huge economic loss as well as physical labor to recover the present and future financial crisis and meeting up family nutrition and other expenses.

4. Food security against présent agriculture practice

Food security, directly and indirectly, depends on the family's farm and off-farm activities and the progressive increment of family per capita income. Food security may be hampered when per capita income decreases in the household. When a natural disaster such as à flash flood, drought, hail storm, and cold wave in the Sunamganj haor region occurs, it decreases total productivity, increases the unemployment rate, low wages, surplus labor in the labor market, shortage of food stock in the market and hike of food commodities. Mostly ultra-poor and poor faced severe food insecurity for a long period due to a lack of employment opportunities. Sometimes large and medium-class farmers also

faced problems with damage to crops by any natural calamity. The present practice of agriculture in the study areas observed that single Boro crops dominated most parts of arable land. Most of the people in Sunamganj depend on this Boro production. Only factors, such as high and medium high land, were cultivated by non-rice crops. Still, these crops did not significantly contribute to their demand or act as supporting antidotes of single Boro crops. In some places, vegetables, wheat, maize, groundnuts, sugar cane, watermelon, chilly, potato, tomato, oilseeds, onion, and garlic were cultivated, but the rate of farmers is very poor. Depending only on a single Boro crop may not ensure food security and insufficient and appropriate nutritious food. Lack of calorie consumption regularly decreases human working capacity, leading to low levels of income, low levels of income leading to low per capita income, and low per capita income leading to poverty. Poverty embedded households as a trap that insecure food security (BBS 2009).

Conclusion

The commencement of crop diversification in agriculture in Sunamganj has created opportunities for farmers to produce and consume a variety of crops such as vegetables, pulses, wheat, maize, potato, tomato, spices, oilseeds, fruits etc. Economically NRCs are higher-yielding crops than that HYV single Boro rice or other paddy or wheat. Farmers' experience and awareness about the production of vegetables in recent years is better than in the past because of the necessity of fulfilling family nutrition and earning money by selling surplus production. In Sunamganj, the transformation of crop varieties from local to HYV due to increased yielding like potato, tomato, beans, mustard, watermelon, onion, garlic, and green banana gives maximum yield when provided with irrigation, fertilization, and better management. There are relatively better performances of NRCs farmers than farmers of rice corps. Still, both are simultaneously affected by natural disasters like flash floods, hail storms, drought, and cold waves almost every year. These natural hazards decline their regular progressive trend of agriculture production, food security, and livelihoods. Cost-benefit analysis may also hinder the positive increment of crop diversification. Still, technological advancement, better-integrated irrigation system, easy access to agriculture credit, use of improved crop varieties, application of agronomic management practices, increased use of compost or chemical fertilizer, use of IPM, advanced early warning mechanism, proper utilization of land including fallow and homestead land and prioritizing small and marginal farmers and improved marketing system can enhance more crops diversification in Sunamganj district that will increase agricultural production and enhance food security.

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