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Assam Flood and Financial Loss in Agricultural Production: A Study on Mitigation Strategy Adopted by the Farmers of Dhemaji District

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ABSTRACT

Background: Assam is considered as a flood prone state, as this natural disaster creates devastating situation almost every year. The study was conducted in Dhemaji district of Assam which is in the list of highly flood hazard index. The district was selected to know the impact of flood on financial loss for agricultural production and to study the mitigation strategy adopted by the flood affected farmers in the district.

Methods: For that a multistage random sampling technique was adopted to select flood affected farmers from the district. Financial loss for agricultural production due to flood was estimated by calculating financial loss for crop loss, agricultural asset loss and livestock loss for the study area. Flood situation and Non flood situation was compared while going for calculation of financial loss for crop due to flood. Henry Garret ranking technique was adopted to rank the problems face by the farmers.

Result: The result reflected that net return from crop production was recorded to be less (Group I 1032.44Rs/ha and Group II 3830.99 Rs/ha) in flood situation than the non-flood situation (Group I 7051.30 Rs/ha and Group II 8330.08 Rs/ha).Total financial loss due to crop loss, asset loss and livestock loss was found to be high for size group II farmers (Rs 39094.33) then the size group I (Rs 36643.40). Majority of the respondents (79.17 per cent) preferred migration as the best coping mechanism to protect them from flood loss.

Key words: Agricultural loss, Assam Flood, Mitigation strategy, Total financial loss.

INTRODUCTION

Floods are the second gravest disaster in the agricultural sector, responsible for a total loss of USD 21 billion of the crop and livestock production between the year 2008-18 in least develop countries (LDCs) and low to middle income countries (LMICs). Disaster takes lives, devastate rural livelihoods, destroy food and drive up hunger (FAO).

Assam is the state in the north-eastern region of India where two major rivers namely Brahmaputra and Barak flows through along with more than 50 nos. of tributaries which causes the flood devastation in the monsoon season. The flood prone area of the state as assessed by the Rastriya Barh Ayog (RBA) is 31.05 Lakh Hectares against the total area of state 78.523 Lakh Hectares *i.e.* about. 39.58% of the total land area of Assam. Flood prone area of Assam is four times the national mark of the flood prone area of the country (Govt. of Assam).

Dhemaji is Assam's most flood-affected district (Bordoloi and Muzzaddadi, 2015) approximately 98 per cent of the entire population in Dhemaji district lives in rural areas and is directly dependent on agriculture (Dhemaji District's Economy 2016). Dhemaji district which is earlier known as 'rice bowl' of Assam is now transformed into virtual desert due to sand deposition in after flood situation (Das, 2012). This condition reduces income to the farmers which come directly from rice cultivation. Decrease in farm productivity and farm income due to climatic disaster people adopt various diversified sources of income for livelihood generation (Oyakhilomen, 2016). For livelihood security, people sometimes decided to go for urban centres, where they find multiple sources of income. This study was carried out to know the impact of flood on financial loss for agricultural production and to know the mitigation strategies adopted by the flood affected farmers in Dhemaji district of Assam.

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MATERIALS AND METHODS

This study was conducted for the year 2021-22 at Assam Agricultural University. Dhemaji district of Assam was selected for collection of primary data.

Sampling technique

For collection of primary data, a multi stage random sampling technique was adopted. After the selection of district Dhemaji, two development blocks namely Dhemaji and Sisiborgaon of the district were selected among the five blocks as these two blocks were severely affected by last flash flood, 2020. From the selected blocks, three villages were selected randomly which are Lalung, Nilokhkonch and Amguri. The villages were selected based on occurrence of flood. A total of 40 farmers from each village were selected to get a sample of 120 respondents. Based on the area farmers were classified into two groups; Group I (below 1ha) and Group II (1 to 2ha).

The secondary data for the present study were collected from published and unpublished reports of Assam State Disaster Management Authority and Department of Agriculture, Assam.

Estimation of growth rates by exponential trend equation

In the study compound growth rate (CGR) analysis was used to estimate the growth in gross cropped area and net sown area affected for flood in Assam.

Compound growth rates (CGR) was computed by fitting the exponential function.

The exponential functional form is

$$Y_t = ab^t \qquad \text{Or,}$$

$$\log yt = \log a + t \log b$$

Compound growth rate (CGR) was computed as,

$$CGR = (\text{antilog } 'b'\text{-}1) \times 100$$

Where,

y = time series data on gross cropped area affected/net sown area affected.

b= regression coefficient.

t= time period in year.

Measure of variation by coefficient of variation

In order to measure the variation in flood affected gross cropped area and net shown area the coefficient of variation (CV) was estimated using the following formula

$$CV = \frac{(\text{Standard deviation})}{\text{Mean}} \times 100$$

Economics of cost and return

Economics of cost and return of rice cultivation was calculated for both flood and non- flood situation. Flood and Non-flood situation was considered to calculate the total difference in crop production and income from that sector (Mandal, 2014).

Total variable cost (TC) = Sum of all the variable cost

Gross return = Total production × Price

Net income = Gross return - Total variable cost

Agricultural loss assessment

Agricultural loss was calculated by using the damage and loss assessment methodology given by Food and Agricultural Organisation (FAO) in the year 2012 (Femi, 2020) with appropriate modification required for the study.

Crop loss (Rs/ha) = Net income from crop (Non flood situation) - Net income from crop (Flood situation)

Agricultural assets loss= Cost of replacement of totally destroyed assets × No of totally destroyed assets + Cost of repair of partially destroyed assets × No of partially destroyed assets

Livestock loss = Unit value × No of livestock loss

Total financial loss = Crop loss + Assets loss + Livestock loss

Agenais *et al.* (2013) also classified flood damage to agriculture with some parameters which were also considered for this study to calculate flood damage.

Henry Garret ranking technique

Henry Garret technique was used to rank the problems faced by the farmers due to flood in the study area**.**

$$\text{Percentage position} = \frac{100(Rij - 0.5)}{Ni}$$

Where,

Rij = 1st, 2nd, 3rd, 4th, 5th and 6th ranks.

Nj = Total rank given by 120 respondents = 6.

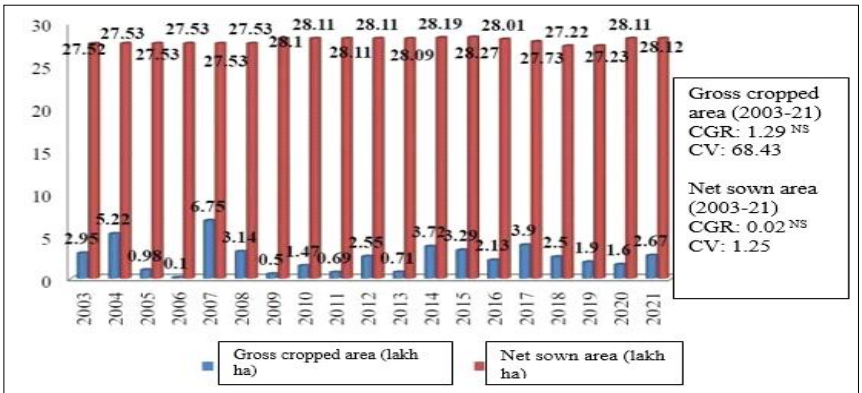
RESULTS AND DISCUSSION

Gross cropped area and net sown area affected by flood in Assam (2003-2021)

Fig 1 shows the Gross cropped area and Net sown area affected by flood in Assam from 2003 to 2021. It revealed that, the biggest flood incidence occurred in 2007, with 6.75 lakh ha of gross cropped area sand 27.53 lakh ha of net sown areas affected by the flood. The compound growth rate for gross cropped area affected by flood was recorded as 1.29 per cent while the rate was0.02 per cent for net sown area. Both the values were found statistically non-significant. The coefficient of variation of flood affect was high in gross cropped area (68.43 per cent) as compared to net sown area (1.25 per cent) for the entire period.

District-wise flood hazard index from 1985 to 2015

District wise flood hazard index from 1985 to 2015 was represented in the Table 1. Out of the 35 districts in Assam 17 districts were worst flooded during the entire period which includes- Morigaon, Dhemaji, Darrang, Sivasagar, Nalbari, Charaideo, Sonitpur, Biswanath, Dhubri, South Salamara, Kamrup, Jorhat, Lakhimpur, Barpeta and Dibrugarh, Golaghat and Hailakandi. It was also observed from the Flood Hazard Atlas for Assam (1998- 2015) that six districts



Source: Economic Survey of Assam, various issues, NS indicates non-significant.

Fig 1: Crop area and vet crop area affected by flood in Assam (2003-2021).

Table 1: District-wise Flood Hazard Index (1998-2015).

District	District area (hectares)	Total Flood inundated area(Hectares)	Per cent flood (hectares)	Flood hazard index
Kamrup	97840	56912	58	20
Sivsagar	156097	91619	59	19
Jorhat	283860	123037	43	19
Darrang	155598	65734	42	19
SouthSalmara	68159	30612	45	19
Dhuburi	202844	87199	43	17
Biswanath	298111	116347	39	17
Sonitpur	229614	71378	31	17
Charaideo	106559	46969	44	17
Hailakandi	132616	33998	26	16
Dibrugarh	337508	126954	38	17
Golaghat	353521	104066	29	15
Lakhimpur	289770	144780	50	22
Morigaon	149300	105160	70	22
Barpeta	213851	145341	68	20
Nalbari	110586	56293	51	20
Dhemaji	252527	115304	46	20
Nagaon	254479	144289	57	19
Hojai	145523	62968	43	17
Karimganj	183381	58914	32	16
Goalpara	201311	73006	36	16
Bongaigaon	110160	32586	30	16
South kamrup	208903	69873	33	16
Cachar	41073	6680	16	15
East kamrup	377431	101141	27	15
Kamrup(metro)	61632	17649	29	15
Baksa	158637	25972	16	16
Tinsukia	384494	72346	19	16
Udalguri	197518	38488	19	16
Chirang	188189	9737	5	15
Dimahasao	486293	162	0	15
Karbianglong	730613	38565	5	15
Kokrajhar	258923	24919	10	15
West Karbianglong	312144	14920	5	15

Source-Flood Hazard Atlas for Assam State (1998-2015), September 2016.

(Kamrup, Lakhimpur, Morigaon, Barpeta, Nalbari and Dhemaji) recorded flood hazard index of 20 and above as per the record.

Population affected and crop area affected in highly flood hazard districts of Assam from 2018- 2022

Table 2 represented the record of population and crop area affected in highly flood hazard districts of Assam from 2018-2022. Six districts (Kamrup, Lakhimpur, Morigaon, Barpeta, Nalbari and Dhemaji), of 20 and above flood hazard index were considered for the purpose. From the records of all these six districts, highest numbers of population (797809 nos) was affected in the year 2020 whereas, highest crop area affected (59308 ha) was observed for the year 2019. It was observed from the Table that percentage of population affected and crop area affected was found to be highest in Barpeta district and lowest record was observed for Kamrup district. For Dhemaji district percentage of population affected was less as compared to other districts throughout the years, but the district was recorded for highest crop area affected (35.57 per cent) among all these flood hazard districts in the year 2018.

Cost and return of rice cultivation for different farm sizes under non flood situation (Rs/ha)

It was observed from the Table 3 that Cost of cultivation of rice for Size group I (Rs. 34684.70) and size Group II (Rs. 34629.92) were almost equal in non-flood situation. Similarly, the cost incurred for seed, fertilizer, FYM, labour charges and machine labour was more or less same for both the size groups of farmers. The gross return and net return for both the farms represented that Size Group II recorded (Rs. 42600.00 and Rs. 8330.08) more gross and net return as compared to size Group I (Rs. 41736.00 and Rs. 7051.30). With increase sizes of farms Gross return and Net return increases.

Cost and return of rice cultivation for different farm sizes under flood situation (Rs/ha)

Table 4 shows the cost and return cultivation of rice for different farm sizes under flood situation (Rs/ha). It was observed that the cost of cultivation of rice for the size Group I was higher (Rs. 32315.56) than size Group II (Rs. 30129.01). As the yield was less for the farmers under flood situation so the gross return was also found less for both the groups (Rs. 33348.00 and Rs. 33960.00) as compared to non-flood situation. Ultimately the net return was recorded to be less for both the groups in flood situation than the non-flood situation.

Damage of agricultural assets per farm for the year 2021-22

Table 5 and Table 6 represented the partially damage agricultural assets and totally damage agricultural assets per farm for the year 2021-22. It was observed that the total financial loss due to partially damage asset loss for Group II (Rs. 1060.67) farmers were high as compared to Group I (Rs. 1006.74) farmers. The partially damage assets were power sprayer, weeder and plough. On the other hand, totally

Table 2: Population affected (P.A) and crop area (C.A) affected in highly flood hazard districts of Assam from 2018- 2022.

District	Barpeta		Dhemaji		Kamrup		Lakhimpur		Morigaon		Nalbari		Total	
Parameters	P.A	C.A (ha)	P.A	C.A (ha)	P.A	C.A (ha)	P.A	C.A (ha)	P.A	C.A (ha)	P.A	C.A (ha)	P.A	C.A (ha)
2018	28754	47	6152	163	0	0	26534	138.3	0	0	970	110	62410	458.30
	(46.07)	(10.26)	(9.86)	(35.57)	(0.00)	(0.00)	(42.52)	(30.18)	(0.00)	(0.00)	(1.55)	(24.00)	(100)	(100)
2019	352592	22912	32025	1975	5250	920	3183	0	69592	33491	120	10	462762	59308.00
	(76.19)	(38.68)	(6.92)	(3.33)	(1.13)	(1.55)	(0.69)	(0.00)	(15.04)	(56.47)	(0.03)	(0.02)	(100)	(100)
2020	486709	21930	71697	2948	7470	444.4	28857	711.3	98804	10771	104272	2369.3	797809	39174.00
	(61.01)	(55.98)	(8.99)	(7.53)	(0.94)	(1.13)	(3.62)	(1.82)	(12.38)	(27.50)	(13.07)	(6.05)	(100)	(100)
2021	6326	1217.2	33192	2636.41	1807	1720.73	108327	6477.3	10888	4299.5	110671	796.5	271211	17147.6
	(2.33)	(7.10)	(12.24)	(15.37)	(0.67)	(10.33)	(39.94)	(37.77)	(4.01)	(25.07)	(40.81)	(4.64)	(100)	(100)
2022	400502	16418	97733	6510	42566	649.2	94096	1948	123369	9376.5	2380	139	760646	35040.70
	(52.65)	(46.85)	(12.85)	(18.58)	(5.60)	(1.85)	(12.27)	(5.56)	(16.22)	(26.76)	(0.31)	(0.40)	(100)	(100)

Table 3: Cost and Return of rice cultivation for different farm sizes under non flood situation (Rs/ha).

Units	Cost of cultivation under non flood situation (Rs/ha)		
	Group I (`)	Group II (`)	All Farm (`)
Seed	1609.38	1602.02	1608.62
Fertilizer	1450.53	1453.30	1451.81
FYM	1250.00	1233.00	1241.30
Labour costs	26165.11	26121.30	26142.68
Machine labour	4209.70	4220.30	4204.38
Total variable cost	34684.70	34629.92	34648.79
Yield (q/ha)	34.78	35.50	35.15
Gross return	41736.00	42600.00	42181.00
Net return	7051.30	8330.08	7532.21

Table 4: Cost and Return of rice cultivation fordifferent farm sizes under flood situation (Rs/ha).

Units	Cost of cultivation under flood situation(Rs/ha)		
	Group I (`)	Group II (`)	All Farm (`)
Seed	1044.31	1065.71	1055.25
Fertilizer	1034.52	1031.40	1032.93
FYM	423.63	1029.50	733.63
Labour costs	23324.10	23754.00	23544.30
Machine labour	6489.00	3248.40	3327.82
Total variable cost	32315.56	30129.01	29693.96
Yield (q/ha)	27.79	28.30	27.56
Gross return	33348.00	33960.00	33072.00
Net return	1032.44	3830.99	3378.04

Table 5: Partially damage agricultural assets per farm for the year 2021-22.

Farm size	Power sprayer		Weeder		Plough		Total loss(`)
	Partially damage (No.)	Average repairing (Rs)	Partially damage (No.)	Average repairing (Rs)	Partially damage (No.)	Average repairing (Rs)	
Group I	1	356.77	1.41	305.30	1.21	181.40	1006.74
Group II	1	328.18	1.59	318.29	1.24	182.59	1060.67

Table 6: Totally damage agricultural assets per farm for the year 2021-22.

Farm size	Cattle shed		Power sprayer		Total loss (`)
	Total damage (No.)	Average replacement cost (`)	Total damage (No.)	Average replacement cost (`)	
Group I	1	1961.98	1	1938.79	3900.77
Group II	1	1963.24	1	1930.00	3893.24

damage assets created a financial loss of Rs. 3900.77 for size Group I farm and Rs. 3893.24 for size Group II farms. The totally damage assets were cattle sheds and power sprayers *etc.* Farmers were facing loss of different agricultural assets due to flood which resulted monetary loss at the final.

Livestock loss due to flood for the year 2021-22

Livestock loss for size Group I and II were recorded in the Table 7. Financial loss for livestock loss was found highest for loss of cow by the sample farmers. It was observed that the total financial loss faced by the farmers in the size Group I due to loss of livestock was Rs. 30006.50 while for size group II farmers it was Rs 29592.00. So for both the size groups livestock loss created a huge financial loss to the farmers.

Per farm financial loss for crop loss, asset loss and livestock loss due to flood in the year 2021-22

Table 8 represented the total per farm financial loss face by the farmers for crop loss, asset loss and livestock loss due to flood. The result represented that size Group II farmers

Table7: Livestock loss due to flood for the year 2021-22.

Livestock particulars	Av. Number	Unit Value (`)	Total loss (`)	Per cent
Group I farmers				
Cow	1	17000	17000.00	56.65
Goat	2.17	2250	4882.50	16.27
Pig	1.45	5400	7830.00	26.09
Poultry	5.88	50	294.00	0.98
Total	10.5	24700	30006.50	100
Group II farmers				
Cow	1	17000	17000.00	57.45
Goat	2.13	2250	4792.50	16.20
Pig	1.39	5400	7506.00	25.36
Poultry	5.87	50	293.50	0.99
Total	10.39	24700	29592.00	100

Table 8: Per farm financial loss for crop loss, asset loss and livestock loss due to flood in the year 2021-22.

Farm size	Crop loss (`)	Asset loss (`)	Livestock loss (`)	Total loss (`)
Group I	1729.29(4.72)	4907.51(13.39)	30006.50(81.88)	36643.40(100)
Group II	4548.42(11.63)	4953.91(12.67)	29592.00(75.69)	39094.33(100)

Table 9: Contribution of different sectors to the household income to mitigate the income loss from winter rice due to flood.

Farm size	Horticulture sector (Rs)	Animal husbandry sector (Rs)	Agricultural sector (Autumnrice+summerrice) (Rs)	Service sector (Rs)	Household income (excluding winter rice) (Rs)
Group I	25313.95(22.52)	23398.84(20.81)	21300.00(18.95)	43093.02(38.33)	112427.91(100)
Group II	25833.33(21.29)	23444.44(19.32)	29230.00(24.09)	42722.22(35.21)	121313.33(100)

were facing more loss due to flood with a record of total financial loss of Rs 39094.33 for all the three enterprises. While, the loss was Rs. 36643.40 for size Group I farmers which was found less than the other groups. It was also reflected that livestock loss contributed highest to the total financial loss faced by the farmers for the flood.

Contribution of different sectors to the household income to mitigate the income loss from winter rice due to flood

Contribution of different sectors to the Household income to mitigate the income loss from winter rice was represented in the Table 9. It was found that service sector contribution was highest for both the size groups of farmers (Group I Rs. 43093.02 and Group II Rs. 42722.22) towards mitigating the financial loss faced by them. Along with the service sector horticulture, animal husbandry and autumn and summer rice contributed to mitigate financial loss faced by the sample farmers during the flood situation.

General coping activities practiced by sample farmers to mitigate the income loss due to flood

Table 10 highlights the general coping mechanisms followed by the respondents to mitigate the income loss due to flood. Majority of the respondents (79.17 per cent) preferred migration as the best coping mechanism to protect them from flood loss. Migration increases engagement in service sector for which contribution of that sector towards household income was high. The other notable coping activities performed by the sample farmers include, the livestock rearing (70.83 per cent), small village shops (54.17 per cent), weaving (48.33 per cent), local wine making (45.00 per cent) and working as casual labour (55.80 per cent). But in Bangladesh situation changing cropping pattern was remarkably adopted by the farmers to cope with agricultural loss as given by Choudhury *et al.* (2004). In both the states, Assam and Bangladesh flood havoc was mainly because of River Brahmaputra.

Risk management strategies adopted by farmers in flood affected areas

Table 11 represented the risk management strategies adopted by farmers in flood affected areas during the study period. The listed six risk management strategies were found to be adopted by the farmers of the study area to minimise risk created by flood. Among these strategies, adoption of flood tolerant variety was found to be adopted by the highest nos. of farmers in the study area followed by Livestock rearing in upland areas, staggered planting, Boro rice cultivation *etc.*

Table 10: General coping activities practiced by sample farmers to mitigate income loss due to flood.

Coping activities	Frequency* (%) Respondents (n=120)
Migration	95(79.17)
Livestock rearing	85(70.83)
Establishing small village shop within the village by male respondents	65(54.17)
Women took weaving as profession to support family	58(48.33)
Local wine making and selling by women respondents	54(45.00)
Women involved in casual labour work during crisis time	67(55.80)

Note: Figures in parenthesis indicates percent to total respondent, *multiple response.

Table 11: Risk management strategies adopted by farmers in flood affected areas.

Management strategies	No. of farmers	per cent total
Mixed cropping of rice	35	29.20
Staggered planting	42	35.00
Shifting to cultivation of summer rice, *Boro*	41	34.20
Asset disposal	37	30.80
Livestock rearing in upland areas	48	40.00
Off-farm migration	30	25.00
Adoption of flood tolerant varieties	52	43.30

The analysis of the study reflected that flood situation created a huge income loss to the farmers of the Dhemaji district. Winter rice was found to be highly affected by the flood and for that income from winter rice in flood situation was less than the non-flood situation. Along with the crop, asset loss and livestock loss also contributed a huge loss in financial term to the farmers of the Dhemaji district. The study also revealed that because of continuous income loss most of the farmers took migration as the best copping mechanism to protect themselves from the vagaries of flood.

CONCLUSION

The result of the study reflected that flood creates natural disaster and income loss to the farmers. After flood situation farmers need to take support of some other sectors to meet the financial need for running the family. This natural disaster creates unproductive situation to the winter rice for Dhemaji district. The continuous income loss faced by the farmers from crop and livestock activities along with the loss created for damage of farm implements due to flood were the main reasons to create interest to migrate from their own place to urban areas for livelihood generation. Service sector was the main sector to mitigate the financial loss faced by the sample farmers in the study area. For management of flood problem and to safeguard the income of the farmers' effective flood management strategies needs to be taken by the State and the Central Govt. which will reduce the migration from rural to urban and increase production of agricultural commodities in the district. With proper strategy adoption, production of the rice for the district can again be increase which may lead to sustainable agricultural development and income generation to the rural people staying at their own place.

Conflict of interest: None.

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