

# Crops and Cropping Systems in Dinajpur Region

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## ABSTRACT

The development of agricultural planning largely depends on the reliable and comprehensive statistics of the existing cropping patterns, cropping intensity and crop diversity of a particular area, which will provide a guideline to the policy makers, researchers, extensionists and development workers. A study was undertaken over all the upazilas of Dinajpur region during 2016 using pre-tested semi-structured questionnaire with a view to document of the existing cropping patterns, intensity and diversity for the region. The most important cropping pattern Boro-Fallow-T. Aman occupied about 41% of net cropped area (NCA) of the region with its distribution over all the upazilas. The second largest area, 9% of NCA, was covered by Wheat-Fallow-T. Aman, which was spread over 18 upazilas. A total of 112 cropping patterns were identified in the whole region. The highest number of cropping patterns was identified 30 in Boda upazila of Panchagarh district while the lowest was 11 in Kaharol upazila of Dinajpur district. The lowest crop diversity index (CDI) was reported 0.708 in Birampur followed by 0.753 in Ghoraghat of Dinajpur. The highest CDI was reported 0.955 in Ranisonkail followed by 0.952 in Baliadangi of Thakurgaon. The range of cropping intensity was recorded 206-249% whereas the maximum value was found for Khansama of Dinajpur and minimum for Boda of Panchagarh district. As a whole, CDI and cropping intensity for Dinajpur region were calculated 0.924 and 229% respectively, which indicates that the land use and crop diversification is not quite enough for the national demand.

**Key words:** Cropping patterns, land use, diversity, wheat, rice and cropping intensity

## INTRODUCTION

The agricultural sector plays a vital role in the economy of Bangladesh in terms of its contribution to GDP 15.59%, employment generation, livelihoods and poverty alleviation (BBS, 2015). Bangladesh has very fertile land for crop production though some natural calamities occur frequently. It has 30 agro-ecological zones (AEZ) in terms of different soil and climatic condition. That is why diversified cropping pattern exists in the country. A cropping pattern is defined as yearly sequences of crop production in a piece of land grown in the course of a year (Alam, 1994). The cropping patterns of a region are closely influenced by the geo-climatic, socio-economic, historical and political factors (Hossain, 1996). It is also dependent on physical, historical, social, institutional and economic factors as well as government policies (Agrawal and Kassam, 1976). The cropping pattern and the changes

therein depend on a large number of factors like climate, soil type, rainfall, agricultural technology, availability of irrigation facilities and other inputs, marketing and transport facilities and growth of agro-industries (Neena, 1998; Gadge, 2003; Rashid *et al.*, 2005). Rice-based cropping pattern shows dominancy in Bangladesh for the highest demand of rice as staple food and suitable condition for rice production (Shirazy *et al.*, 2016). Dinajpur agricultural region comprises three districts viz Dinajpur, Thakurgaon and Panchagarh. A unique character of this region is its extra-long winter season, which favors the successful production of numerous winter crops. Soils are mainly non-calcareous light-textured with less fertility. Occasional flash floods are prevailing in some specific locations. Short duration of rainy season and less availability of irrigation water are the limiting factors for production of diversified crops (FAO, 1988).

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Cultivable land is declining day by day so that escalating cropping intensity with more production and bringing the barren land under cultivation is the pre-requisite for sustainable food security of Bangladesh. Although the country is nearly self-sufficient in rice production, other foods such as vegetables, pulses, oil crops etc. are still deficit to a large extent. Even rice food security has not been achieved at the household level in many poor and extreme poor farm families (Shopan *et al.*, 2012). Therefore, crop diversification will increase cropping intensity, raising the productivity of land and labor, generate income and employment which in turn will eliminate food and nutritional insecurity and poverty of farming community of the Dinajpur region. From the above circumstances, the present study was undertaken for satisfying the following objectives to:

- Find out the existing cropping patterns scenario for Dinajpur region
- Understand the current land use pattern at upazila and regional level
- Visualize the cropping intensity and diversity at local and regional level.

## METHODOLOGY

Twenty-three upazilas of Dinajpur, Thakurgaon and Panchagarh districts under Dinajpur agricultural region were the locale of this study. Data were collected using double stage procedure. At initial stage, data were collected through pre-tested semi-structured questionnaire from 23 pre-assigned Sub-Assistant Agriculture Officers (SAAO) of each upazila during July 2016 at upazila level. SAAOs were purposively preselected by Agriculture Extension Officers (AEO), Additional Agriculture Officer (AAO) and Upazila Agriculture Officer (UAO) or altogether. Prior to data collection, the pre-tested questionnaire was explained along with proper guidelines to the AEOs or UAOs or both and handed over to them at each Deputy Director's office of Department of Agricultural

Extension (DAE) during monthly meeting for the sake of accurate data collection. The filled questionnaires were collected by the scientists of RFS Division, checked and analyzed to find the inconsistencies of the supplied data before validation workshop. All the inconsistencies among the information were documented. The collected data along with documented inconsistencies were discussed in district level workshop for necessary correction and validation. The second stage of data collection was daylong data validation workshop at district level. The workshop dates were 1 September for Dinajpur; 4 October for Panchagarh; and 6 October 2016 for Thakurgaon. Four field-workers i.e. one SAPPO and three SAAOs experienced and engaged in crop-based data documentation, all officers from all upazilas viz UAOs, AEOs, AAEOs, DD (DAE), DD (Horticulture), DD of Seed Certification Agency, DTO and ADDs, one representative from Agricultural Training Institute (ATI) and scientists of BRRRI regional station, Rangpur participated in the data validation workshop. The number of participants of validation workshop ranged from 43 to 98 in each district. All the participants were divided into three to four groups for data validation. Each group was facilitated by two RFSD scientists to finalize and validate the data and authenticated data were captured. Crop diversity index was calculated by using the following equation described by Kshirsagar *et al.* (1997).

$$CDI_i = 1 - \sum_{j=0}^n \left( \frac{a_{ij}}{A_i} \right)^2$$

Where,  $CDI_i$  = Crop Diversity Index

$a_{ij}$  = Area planted to the  $j^{\text{th}}$  crop in the  $i^{\text{th}}$  location

$A_i$  = Total area planted under all crops

The index is zero for a land area growing only one crop. It approaches unity as the level of diversity increases. Compilation and processing of collected data were done using Micro Soft Excel programme. Descriptive statistics were used to facilitate the presentation of the findings.

## RESULTS AND DISCUSSION

### Land use

Net cropped area of Dinajpur agricultural region is 527,440 (Table 1). The cropping intensity (CI) of the region is 229% which is much higher than the national average. Crops occupied the particular land for round the year were considered under annual crops. The major annual crops reported in the region were sugarcane, banana, papaya, betel leaf, ginger and turmeric. The annual crops area in different upazilas ranged from 30 to 1,700 ha. The annual crops area accounted for only 1.79% of the net cropped area (NCA) in the region. At a glance, the region possesses 1.25% single cropped area (SCA), 64.66% double cropped area (DCA), 31.68% triple cropped area (TCA) and a very little amount (0.04%) of quadruple cropped area (QCA) which exists only in Bochaganj and Hakimpur upazila. The DCA had the major share of NCA in all the upazilas of Dinajpur, Thakurgaon and Panchagarh district except Khansama of Dinajpur district, Baliadangi and Haripur of Thakurgaon district where triple cropped area is the dominant one (Table 1). The area which could not be defined under SCA, DCA, TCA or QCA was considered as others whose coverage is less than 1% of the NCA.

### Cropping patterns of Dinajpur

In total 112 cropping patterns were observed in Dinajpur region of which only four cropping patterns with exclusive rice crop covers over 41% of the NCA. There were 32 cropping patterns with exclusive non-rice crop covering about 5% of the NCA. Rest of the NCA i.e. around 54% areas is covered by 74 rice non-rice cropping patterns (Appendix 1).

### Rice and non-rice crops at a glance

In Dinajpur region, 41.40% of NCA was covered by exclusively rice-based cropping patterns (Table 2). The highest area coverage (40.92%) was recorded by double rice, Boro-Fallow-T. Aman cropping pattern which was found in all the upazilas. Altogether, single and triple rice based pattern occupied less than 1% of NCA. Triple rice based pattern Boro-Aus-T. Aman

was reported in seven upazilas while single rice pattern was reported only in five upazilas.

In the current investigation, 32 cropping patterns were identified that were free from rice. Among these 32 patterns first 18 have been arranged in descending order in Table 3. The rest 14 patterns with negligible area coverage (Table 7) are arranged with other patterns of different categories. Aggregate of the 32 patterns have had approximately 5% of NCA. In critical comparison it is clear that exclusive rice area is about nine folds of exclusive non-rice area. Among these 32 patterns, year-round vegetable production system has the highest area coverage that practiced on or around the homestead area. Appropriate cropping patterns may facilitate maximum possible land use as well as efficient use of other scarce resources in a sustainable manner. Diversified cropping pattern may be an option for the farmers as a coping strategy against risks (Mandal and Bezbaruah, 2013). Typology of different cropping systems is the base for the managers of these systems to intensify production (Shriar, 2000).

### Non-rice cereal crops

Thirty-five cropping patterns are holding different non-rice cereal crops (Table 4). Among them wheat, with the largest area, is leading 14 patterns cultivated on 111,220 hectares that is equivalent to 21.08% of NCA. Maize holds the second position in non-rice cereal crop cultivation in Dinajpur region. There are 23 cropping patterns for maize, which in-together occupy 19.28% of NCA. In the documentation of non-rice cereal cropping systems wheat reported widest spreading e.g. Wheat-Jute-T. Aman is distributed over 20 upazilas out of 23. Overall, the aggregate area of the non-rice rice-cereal cropping system stands for 37.23% of the NCA in Dinajpur region. In Bangladesh there is a vast market of maize seeds for feed industries. Loam and sandy-loam soil of the comparative dry area is very suitable for maize cultivation. Wheat cultivation with its better yield in this region is specially favoured by long winter season that is normally unavailable in southern parts of the country. Light textured soil with

**Table 1. Land use of different upazilas in Dinajpur region (area in hectare), 2014-15.**

Upazila	Area of upazila	Annual crop	SCA	DCA	TCA	QCA	Other	NCA	C.I. (%)
01 Birampur	21283	50	200	14450	2760	0	140	17600	214
02 Birganj	41312	300	0	17510	13110	0	130	31050	241
03 Biral	35358	120	150	15700	14060	0	190	30220	246
04 Bochaganj	22489	530	40	11730	7450	200	180	20130	236
05 Chirirbandar	31285	360	0	18370	4910	0	120	23760	219
06 Dinajpur	35447	1200	0	14590	11510	0	150	27450	238
07 Phulbari	22851	50	20	13800	4730	0	150	18750	225
08 Ghoraghat	14874	65	50	10245	1490	0	110	11960	212
09 Hakimpur	9993	30	0	6110	2015	10	115	8280	225
10 Kaharol	20555	600	0	13400	3800	0	100	17900	218
11 Khansama	17972	320	150	6710	7915	0	125	15220	249
12 Nawabganj	31754	360	190	22450	2800	0	160	25960	209
13 Parbatipur	39510	160	0	23440	4800	0	160	28560	216
14 Atwari	21002	400	30	11680	4070	0	120	16300	222
15 Boda	34998	340	250	20750	1980	0	120	23440	206
16 Debiganj	30905	690	1450	14690	7210	0	150	24190	221
17 Panchagarh	33844	640	1950	18360	3420	0	170	24540	203
18 Tetulia	18909	240	450	6720	6180	0	150	13740	240
19 Baliadangi	28425	80	1100	11120	11250	0	130	23680	243
20 Haripur	20115	160	240	8470	8680	0	110	17660	247
21 Pirganj	35414	550	300	19470	9190	0	140	29650	228
22 Ranisonkail	28748	300	30	12270	11450	0	150	24200	246
23 Thakurgaon	68375	1700	40	29030	22320	0	110	53200	239
Dinajpur region	-	9245	6640	341065	167100	210	3180	527440	229

**Table 2. Cropping patterns with exclusive rice in Dinajpur region, 2014-15.**

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Boro-Fallow-T. Aman	215850	40.92	23
02 Boro-Aus-T. Aman	1575	0.30	7
03 Boro-Fallow-Fallow	650	0.12	3
04 Fallow-Fallow-T. Aman	300	0.06	2
Total	218375	41.40	

low water-holding capacity as well as less availability of irrigation water is driving forces that discourage the farmers for modern Boro cultivation. During the harvesting period of wheat, the crop is privileged by clear sun-shine and low humidity. All these are the factors this area is dominated by wheat-based cropping systems (FAO, 1988).

### Pulses and oil-seed crops

There were 34 cropping patterns of pulse and oil-seed crops where eight patterns had been led by mustard alone (Table 5). Mustard is the most important among all the oil-seed

crops in the region. The total share of pulses and oil-seed crops is 8.16% of NCA whereas mustard absolutely occupies about 5%. Along with its widest coverage Mustard-Boro-T. Aman pattern was reported from 21 upazilas out of 23. On the other hand, the total pulse crops occupied only around 1% of NCA where mungbean was dominant.

### Vegetables and spices crops

Fifty-two cropping patterns have been arranged in descending order according to area coverage in Table 6. Potato and other vegetables of Rabi, Kharif-I and Kharif-II; spices viz chilli, onion,

**Table 3. Cropping patterns with exclusive non-rice in Dinajpur region, 2014-15.**

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Vegetab-Vegetab-Vegetab	5070	0.96	18
02 Wheat-Fallow-Fallow	3250	0.62	3
03 Wheat-Maize-Fallow	3050	0.58	3
04 Wheat-Maize-Vegetab	2000	0.38	2
05 Maize-Vegetab-Fallow	1700	0.32	3
06 Potato-Maize-Fallow	1600	0.30	1
07 Wheat-Vegetab-Vegetab	1400	0.27	2
08 Groundnut-Fallow-Fallow	1330	0.25	2
09 Onion-Vegetab-Vegetab	850	0.16	8
10 Garlic-Vegetab-Vegetab	710	0.13	7
11 Vegetab-Jute-Fallow	520	0.10	2
12 Vegetab-Fallow-Fallow	470	0.09	2
13 Vegetab-Fallow-Blackgram	405	0.08	5
14 Potato-Maize-Vegetab	350	0.07	1
15 Vegetab-Vegetab-Fallow	310	0.06	3
16 Chilli-Fallow-Fallow	240	0.05	3
17 Potato-Jute-Fallow	200	0.04	1
18 Chilli-Vegetab-Fallow	160	0.03	3
19-32 Other 14 patterns (in table 7)	980	0.19	
Total	24595	4.66	

**Table 4. Non-rice cereal crops under different cropping systems in Dinajpur region, 2014-15.**

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Wheat-Fallow-T. Aman	46660	8.84	18
02 Maize-Fallow-T. Aman	45980	8.71	18
03 Potato-Maize-T. Aman	26330	4.99	18
04 Wheat-Jute-T. Aman	23960	4.54	20
05 Wheat-Maize-T. Aman	11520	2.18	7
06 Wheat-Aus-T. Aman	9990	1.89	13
07 Wheat-Mungbean-T. Aman	6280	1.19	14
08 Mustard-Maize-T. Aman	3590	0.68	10
09 Wheat-Fallow-Fallow	3250	0.62	3
10 Wheat-Maize-Fallow	3050	0.58	3
11 Wheat-Vegetab-T. Aman	2920	0.55	8
12 Wheat-Maize-Vegetab	2000	0.38	2
13 Maize-Maize-T. Aman	1700	0.32	1
14 Maize-Vegetab-Fallow	1700	0.32	3
15 Potato-Maize-Fallow	1600	0.30	1
16 Wheat-Vegetab-Vegetab	1400	0.27	2
17 Maize-Boro-T. Aman	1200	0.23	1
18 Vegetab-Maize-T. Aman	1020	0.19	6
19 Maize-Jute-T. Aman	440	0.08	2
20 Potato-Maize-Vegetab	350	0.07	1
21 Maize-Aus-Fallow	300	0.06	2
22 Maize-Vegetab-T. Aman	300	0.06	2
23 Maize-Aus-T. Aman	250	0.05	1
24 Millet( <i>kaon</i> )-Fallow-T. Aman	10	0.00	1
25-35 Other 11 patterns (in table 7)	665	0.13	-
Total non-rice cereal crops	196465	37.23	

**Table 5. Cropping patterns with pulses and oil-seed crops in Dinajpur region, 2014-15.**

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Mustard-Boro-T. Aman	18720	3.55	21
02 Wheat-Mungbean-T. Aman	6280	1.19	14
03 Groundnut-Fallow-T. Aman	3700	0.70	5
04 Mustard-Maize-T. Aman	3590	0.68	10
05 Potato-Groundnut-T. Aman	2700	0.51	3
06 Sesame-Fallow-T. Aman	2010	0.38	2
07 Mustard-Boro-Fallow	1490	0.28	3
08 Groundnut-Fallow-Fallow	1330	0.25	2
09 Fallow-Sesame-T. Aman	700	0.13	1
10 Vegetab-Fallow-Blackgram	405	0.08	5
11 Mustard-Jute-T. Aman	380	0.07	3
12 Mustard-Fallow-T. Aman	360	0.07	2
13 Groundnut-Jute-T. Aman	300	0.06	1
14 Vegetab-Groundnut-T. Aman	300	0.06	1
15 Mustard-Aus-T. Aman	160	0.03	2
16-34 Other 19 patterns (in Table 7)	630	0.12	-
Total pulses and oil-seed crops	43055	8.16	

garlic are included in this list. Here, potato based pattern is the most contributing cropping pattern that covers more than 12% of NCA. In addition, Potato-Boro-T. Aman and Potato-Maize- T. Aman pattern occupies the largest area than the other patterns. In total the area for vegetables and spices covered one-fifth of NCA in the Dinajpur region

#### **Sporadic and distinct cropping patterns**

There are some cropping patterns, which are extremely location-specific, however, with a large area coverage. These are Maize-Maize-T. Aman, Maize-Boro-T. Aman (Table 4) and Potato-Maize-Fallow (Table 6). Maize-Maize-T. Aman is grown on 1,700 hectares of land in Birol upazila of Dinajpur district. The Maize-Boro-T. Aman is limited to Dinajpur sadar upazila covering 1,200 hectares of area. Potato-Maize-Fallow is limited to only Ranisonkail upazila of Thakurgaon district with area coverage of 1,600 hectares.

#### **Rare cropping patterns**

In the present investigation, 40 cropping patterns have been identified as rare cropping patterns with negligible area coverage with seldom existence (Table 7). These are location specific system and are limited in one or two or

in some cases three upazilas of the region. Total area coverage of the 40 patterns is far below than 1% of NCA. Among them, top three patterns viz Chilli-Vegetab-T. Aman (150 ha), Maize-Jute-Fallow (150 ha) and Vegetab-Jute-T. Aman (150 ha) were recorded separately in one upazila of the region. The smallest area was recorded for Maize-Sesame-T. Aman cropping patterns whose coverage was five hectares for each (Table 7).

#### **Most dominant cropping pattern**

Boro-Fallow-T. Aman was the most dominant cropping pattern in Dinajpur region. It covers 40.91% of NCA in the region and is available in all upazilas of the region (Table 8). The highest area under this cropping was recorded 20,800 hectares in Parbatipur upazila which represents 9.64% of the total Boro-Fallow-T. Aman area of the region. In consideration of individual upazila Birampur has allocated the highest area and it is over 80% of its NCA for this pattern alone. Atwari upazila had the lowest area coverage for this pattern, which was 14.11% of NCA and 1.07% of the pattern in that region. In the country-wide compilation of data it was observed that Boro-F- T. Aman was the most dominant

**Table 6. Cropping patterns with vegetables and spices crops in Dinajpur region, 2014-15.**

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Potato-Boro-T. Aman	26590	5.04	16
02 Potato-Maize-T. Aman	26330	4.99	18
03 Chilli-Fallow-T. Aman	7560	1.43	10
04 Vegetab-Vegetab-Vegetab	5070	0.96	18
05 Vegetab-Fallow-T. Aman	4460	0.85	8
06 Potato-Jute-T. Aman	3515	0.67	7
07 Wheat-Vegetab-T. Aman	2920	0.55	8
08 Potato-Groundnut-T. Aman	2700	0.51	3
09 Vegetab-Vegetab-T. Aman	2650	0.50	8
10 Potato-Vegetab-T. Aman	2460	0.47	8
11 Potato-Aus-T. Aman	2020	0.38	4
12 Wheat-Maize-Vegetab	2000	0.38	2
13 Maize-Vegetab-Fallow	1700	0.32	3
14 Potato-Maize-Fallow	1600	0.30	1
15 Potato-Fallow-T. Aman	1440	0.27	4
16 Wheat-Vegetab-Vegetab	1400	0.27	2
17 Vegetab-Maize-T. Aman	1020	0.19	6
18 Garlic-Jute-T. Aman	980	0.19	8
19 Onion-Vegetab-Vegetab	850	0.16	8
20 Onion-Jute-T. Aman	740	0.14	6
21 Garlic-Vegetab-Vegetab	710	0.13	7
22 Chilli-Jute-T. Aman	670	0.13	5
23 Garlic-Fallow-T. Aman	570	0.11	6
24 Onion-Fallow-T. Aman	560	0.11	5
25 Vegetab-Jute-Fallow	520	0.10	2
26 Potato-Boro-Fallow	500	0.09	1
27 Potato-Onion-T. Aman	500	0.09	1
28 Vegetab-Fallow-Fallow	470	0.09	2
29 Vegetab-Fallow-Blackgram	405	0.08	5
30 Garlic-Aus-T. Aman	350	0.07	3
31 Potato-Maize-Vegetab	350	0.07	1
32 Onion-Aus-T. Aman	300	0.06	2
33 Chilli-Fallow-Fallow	240	0.05	3
34 Potato-Jute-Fallow	200	0.04	1
35 Chilli-Vegetab-Fallow	160	0.03	3
36-52 Other 17 patterns (in Table 7)	1030	0.20	
Total veg and spices crops	105540	20.01	

cropping pattern in Bangladesh covering 2.31 million ha (27% of NCA in the country) with its distribution in 426 upazilas of 63 districts (Nasim *et al.*, 2017).

### Second dominant cropping pattern

The second dominant cropping pattern in Dinajpur region is Wheat-Fallow-T. Aman. It belongs to 8.84% of NCA of the region

and spread out over 18 upazilas (Table 9). Thakurgaon sadar upazila hold the highest area (7,500 ha) under this cropping pattern with 16% share of the region alone. Regarding NCA percentage Pirganj upazila occupied over 22% of NCA, which was the highest of that region. The four upazila namely Debiganj, Nawabganj, Parbatipur and Hakimpur shared very little area as less than 1% of NCA.

**Table 7. Rare cropping patterns covering non-significant area in Dinajpur region, 2014-15.**

	Cropping pattern	Area (ha)	% of NCA	Freq.	Upazila
01	Chilli-Vegetab-T. Aman	150	0.03	1	Dinajpur
02	Maize-Jute-Fallow	150	0.03	1	Tetulia
03	Vegetab-Jute-T. Aman	150	0.03	1	Boda
04	W.Melon-Fallow-Fallow	140	0.03	3	Bochaganj+Boda+Debiganj
05	Onion-Maize-T. Aman	130	0.02	2	Debiganj+Baliadangi
06	S.Potato-Vegetab-Fallow	120	0.02	2	Parbatipur+Chirirbandar
07	S.Potato-Fallow-T. Aman	110	0.02	3	Pirganj+Debiganj+Ghoraghat
08	Maize-Fallow-Fallow	100	0.02	1	Debiganj
09	Onion-Jute-Fallow	90	0.02	1	Khansama
10	Fallow-Fallow-Blackgram	80	0.02	3	Phulbari+Tetulia+Haripur
11	Wheat-Sesame-T. Aman	80	0.02	3	Atwari+Ranisonkail+Thakurgaon
12	Chilli-Aus-T. Aman	70	0.01	1	Pirganj
13	Maize-Aus-Blackgram	70	0.01	1	Chirirbandar
14	Wheat-Jute-Fallow	60	0.01	1	Khansama
15	Coriander-Fallow-Fallow	50	0.01	1	Tetulia
16	Mustard-Mung-T. Aman	50	0.01	1	Atwari
17	Potato-Mungbean-T. Aman	50	0.01	1	Panchagarh
18	Coriander-Vegetab-Fallow	40	0.01	1	Debiganj
19	Mungbean-Aus-T. Aman	40	0.01	1	Birganj
20	Potato-Chilli-Fallow	40	0.01	1	Tetulia
21	Lentil-Jute-T. Aman	35	0.01	3	Ranisonkail+Parbatipur+Hakimpur
22	Blackgram-Jute-T. Aman	30	0.01	1	Boda
23	Lentil-Vegetab-Vegetab	30	0.01	2	Tetulia+Bochaganj
24	Mustard-Sesame-T. Aman	30	0.01	1	Boda
25	S.Potato-Fallow-Fallow	30	0.01	1	Ranisonkail
26	S.Potato-Jute-T. Aman	30	0.01	1	Boda
27	Wheat-Chilli-Fallow	30	0.01	1	Thakurgaon
28	Coriander-Fallow-T. Aman	20	0.00	2	Pirganj+Boda
29	Coriander-Jute-T. Aman	20	0.00	2	Nawabganj+Parbatipur
30	Groundnut-F-Blackgram	20	0.00	1	Debiganj
31	Lentil-Aus-T. Aman	20	0.00	1	Pirganj
32	Lentil-Fallow-T. Aman	20	0.00	2	Dinajpur+Hakimpur
33	Lentil-Vegetab-T. Aman	20	0.00	1	Boda
34	Wheat-Aus-Blackgram	20	0.00	1	Ghoraghat
35	Chickpea-Aus-T. Aman	10	0.00	1	Pirganj
36	Lentil-Maize-T. Aman	10	0.00	1	Haripur
37	Millet( <i>kaon</i> )-F-T. Aman	10	0.00	1	Boda
38	Potato+Maize-Veg-T. Aman	10	0.00	1	Hakimpur
39	Vegetab-Aus-Blackgram	10	0.00	1	Hakimpur
40	Maize-Sesame-T. Aman	5	0.00	1	Ghoraghat
	Total	2180	0.41		

**Third dominant cropping pattern**

Maize-Fallow-T. Aman cropping pattern holds the third largest area coverage 45,980 hectares in Dinajpur region. This area is an equivalent to 8.71% of NCA in the region. This pattern is distributed over 18 upazilas as same as Wheat-Fallow-T. Aman cropping pattern. Birol upazila has an area of 5,800 ha which stands for 12.61% of the total area under this pattern in the region

(Table 10). Ranisonkail has the lowest area compared to other upazila and it is just 20 ha.

**Fourth dominant cropping pattern**

Fourth dominant cropping pattern Potato-Boro-T. Aman has occupied 26,590 hectares representing 5.04% share of NCA in Dinajpur region (Table 11). This pattern is distributed over 16 upazilas where Dinajpur sadar ranked



**Table 8. Distribution of the most dominant Boro–Fallow–T. Aman cropping pattern in Dinajpur region, 2014-15.**

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Parbatipur	20800	72.83	9.64
02	Thakurgaon	17500	32.84	8.11
03	Chirirbandar	17100	71.97	7.92
04	Nawabganj	15900	61.23	7.37
05	Birampur	14200	80.66	6.58
06	Phulbari	11500	61.33	5.33
07	Boda	11000	46.92	5.10
08	Debiganj	11000	45.46	5.10
09	Dinajpur	10400	37.86	4.82
10	Pirganj	9800	33.05	4.54
11	Ghoraghat	8700	72.71	4.03
12	Birol	8200	27.13	3.80
13	Birganj	8000	25.76	3.71
14	Bochaganj	7800	38.75	3.61
15	Haripur	6750	38.21	3.13
16	Baliadangi	6600	27.87	3.06
17	Hakimpur	6000	72.41	2.78
18	Khansama	5100	33.49	2.36
19	Panchagarh	4900	19.96	2.27
20	Kaharol	4700	26.20	2.18
21	Ranisonkail	4400	18.17	2.04
22	Tetulia	3200	23.29	1.48
23	Atwari	2300	14.11	1.07
	Dinajpur region	215850	40.91	100.00

**Table 9. Distribution of the 2<sup>nd</sup> dominant Wheat–Fallow–T. Aman cropping pattern in Dinajpur region, 2014-15.**

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Thakurgaon	7500	14.07	16.07
02	Pirganj	6600	22.26	14.14
03	Ranisonkail	5000	20.64	10.72
04	Birganj	4850	15.62	10.39
05	Baliadangi	3700	15.63	7.93
06	Kaharol	3150	17.56	6.75
07	Boda	3100	13.22	6.64
08	Atwari	3000	18.4	6.43
09	Tetulia	3000	21.83	6.43
10	Birol	1700	5.63	3.64
11	Bochaganj	1600	7.95	3.43
12	Haripur	1600	9.06	3.43
13	Chirirbandar	1000	4.21	2.14
14	Dinajpur sadar	400	1.52	0.86
15	Debiganj	200	0.85	0.43
16	Nawabganj	120	0.47	0.26
17	Parbatipur	100	0.35	0.21
18	Hakimpur	40	0.48	0.09
	Dinajpur region	46660	8.84	100.00

in top position. This upazila has 4,530 ha area which is only 16.49% of upazila NCA. Birganj upazila ranked in second position with 4,500 ha area for this pattern, while Pirganj holds the lowest position with just 500 hectares area. In the country-wide data compilation it was observed that Potato-Boro-T. Aman was the 8<sup>th</sup> dominant cropping pattern in Bangladesh covering 1.80 lac ha (2.11% of NCA in the country) with its distribution in 115 upazilas of 33 districts (Nasim *et al.*, 2017).

#### Fifth dominant cropping pattern

Fifth dominant cropping pattern Potato-Maize-T. Aman had been covering 26,330 hectares representing 4.99% share of NCA in Dinajpur region (Table 12). This pattern is distributed over 18 upazilas where Thakurgaon sadar ranked in top position. This upazila had 6,500 ha area for Potato-Maize-T. Aman pattern which is only 12.2% of upazila NCA and 24.69% contributor for the region. Birampur and Debiganj occupied the lowest area, which was only 100 ha for each upazila under this cropping pattern.

#### Crop diversity and cropping intensity

Higher number of available crops under cultivation in an area dictates its higher diversity. Number of cropping patterns is also a gross indicator of crop diversity. A total of 110 cropping patterns were identified in the whole area of Dinajpur region under this investigation. The highest number of cropping patterns was identified 30 in Boda upazila and that was 26 in Khansama; and 25 in Dinajpur sadar, Debiganj, Tetulia (Table 13). The lowest number of cropping patterns was identified 11 in Kaharol followed by 15 in Birampur. Higher number of cropping patterns is generally related to higher level of diversity indices for cropping pattern. The highest diversity index for cropping pattern was recorded 0.883 in Ranisonkail followed by 0.874 in Panchagarh. The lowest value of diversity index for cropping pattern was found 0.343 in Birampur upazila that was followed by 0.451 in Parbatipur upazila. The highest CDI was reported 0.955 in Ranisonkail followed by 0.952 in Baliadangi. The lowest value of CDI was observed 0.708 in Birampur followed by 0.753 in Ghoraghat upazila. The range of cropping intensity values was recorded 206-249%. The maximum value

**Table 10. Distribution of the 3<sup>rd</sup> dominant Maize-Fallow-T. Aman cropping patterns in Dinajpur region, 2014-15.**

Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01 Birol	5800	19.19	12.61
02 Nowabganj	5500	21.18	11.96
03 Panchagarh	5500	22.41	11.96
04 Kaharol	5400	30.10	11.74
05 Birganj	4300	13.85	9.35
06 Dinajpur	3000	10.92	6.52
07 Atwari	2500	15.33	5.44
08 Thakurgaon	2400	4.50	5.22
09 Phulbari	2200	11.73	4.78
10 Bochaganj	2000	9.93	4.35
11 Parbatipur	1900	6.65	4.13
12 Boda	1550	6.61	3.37
13 Debiganj	1500	6.20	3.26
14 Khansama	1300	8.54	2.83
15 Ghoraghat	800	6.72	1.73
16 Birampur	200	1.14	0.43
17 Chirirbandar	110	0.47	0.24
18 Ranisonkail	20	0.08	0.04
Dinajpur region	45980	8.71	100.00

**Table 11. Distribution of the 4<sup>th</sup> dominant Potato–Boro–T. Aman cropping pattern in Dinajpur region, 2014-15.**

Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01 Dinajpur	4530	16.49	17.04
02 Birganj	4500	14.49	16.92
03 Parbatipur	3300	11.55	12.41
04 Thakurgaon	3200	6.00	12.03
05 Birol	1800	5.96	6.77
06 Bochaganj	1300	6.46	4.89
07 Birampur	1200	6.82	4.51
08 Phulbari	1000	5.33	3.76
09 Debiganj	1000	4.13	3.76
10 Hakimpur	800	9.65	3.01
11 Ranisonkail	800	3.30	3.01
12 Khansama	760	4.99	2.86
13 Chirirbandar	700	2.95	2.63
14 Ghoraghat	600	5.01	2.26
15 Nawabganj	600	2.34	2.26
16 Pirganj	500	1.72	1.88
Dinajpur region	26590	5.04	100.00

**Table 12. Distribution of the 5<sup>th</sup> dominant Potato–Maize–T. Aman cropping patterns in Dinajpur region, 2014-15.**

Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01 Thakurgaon	6500	12.20	24.69
02 Birganj	3550	11.43	13.48
03 Birol	3000	9.93	11.39
04 Haripur	2500	14.15	9.49
05 Khansama	2300	15.10	8.74
06 Kaharol	2100	11.71	7.98
07 Baliadangi	1550	6.55	5.89
08 Pirganj	1000	3.37	3.80
09 Dinajpur	600	2.18	2.28
10 Phulbari	600	3.20	2.28
11 Ghoraghat	600	5.01	2.28
12 Chirirbandar	500	2.14	1.90
13 Parbatipur	500	1.76	1.90
14 Nawabganj	380	1.48	1.44
15 Atwari	300	1.89	1.14
16 Hakimpur	150	1.82	0.57
17 Birampur	100	0.57	0.40
18 Debiganj	100	0.43	0.40
Dinajpur region	26330	4.99	100.00

was for Khansama upazila of Dinajpur district and minimum for Boda upazila of Panchagarh district. As a whole, crop diversity index (CDI) for Dinajpur region was calculated 0.924. In a simultaneous study, the investigators identified 316 cropping patterns for whole Bangladesh; where the CDI value was 0.952 at national level and the national average of cropping intensity

was 200% (Nasim *et al.*, 2017). Diversification of crops helps risk reduction as diversification allows a producer to balance low price in one or two crops with reasonable prices in the other. (Blade and Slinkard, 2002). The farmers of Kerala diversified their cropping pattern to minimize risk from due to crop failures and price fluctuations (Mahesh, 1999).

**Table 13. Crop diversity and cropping intensity in Dinajpur region, 2014-15.**

Upazila	No. of identified pattern	No. of crop	Diversity index for cropping pattern	Crop diversity index (CDI)	C.I. (%)
01 Birampur	15	14	0.343	0.708	214
02 Birganj	19	16	0.849	0.941	241
03 Birol	16	15	0.856	0.947	246
04 Bochaganj	17	14	0.811	0.927	236
05 Chirirbandar	22	16	0.473	0.777	219
06 Dinajpur	25	16	0.809	0.925	238
07 Phulbari	19	15	0.600	0.837	225
08 Ghoraghat	17	19	0.458	0.753	212
09 Hakimpur	20	19	0.456	0.774	225
10 Kaharol	11	13	0.794	0.909	218
11 Khansama	26	15	0.831	0.937	249
12 Nawabganj	18	18	0.578	0.803	209
13 Parbatipur	16	16	0.451	0.760	216
14 Atwari	20	19	0.852	0.935	222
15 Boda	30	22	0.746	0.879	206
16 Debiganj	25	21	0.863	0.902	221
17 Panchagarh	20	19	0.874	0.938	203
18 Tetulia	25	19	0.855	0.941	240
19 Baliadangi	18	14	0.859	0.952	243
20 Haripur	18	15	0.792	0.931	247
21 Pirganj	22	18	0.811	0.922	228
22 Ranisonkail	24	18	0.883	0.955	246
23 Thakurgaon	19	16	0.839	0.938	239
Dinajpur region	112	25	0.807	0.924	229

## CONCLUSION

The cropping intensity, diversity and land use of the Dinajpur region is little bit higher than the national average but it is not yet enough as we have a vast population and need a huge amount of food everyday. Exclusive rice area is about nine folds of exclusive non-rice area. Abundance of non-rice cereal crops is extraordinary characteristic of the region. Therefore, Dinajpur region can play a vital role through abundant crop production for maintaining the food security of the country. Based on the findings of the study, the following recommendations were made.

- Initiative to be taken to increase productivity of exclusive rice based cropping pattern. As rice is the synonym of the primary food security, the high yielding varieties of rice along with recommended crop management packages to be adopted.

- The upazilas having unique or exceptional cropping patterns with large area coverage might be studied in-depth to extrapolate to similar environments.
- Devotion might be invested so that a portion of double-rice area could be brought under Potato-Boro-T. Aman cropping system or other three cropping systems.
- Scope might be explored for the establishment of agro-based food and feed industry for the best use of potato as well as maize.

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**Appendix 1. List of cropping patterns in Dinajpur region, 2014-15.**

	Cropping pattern	Area (ha)	Cropping pattern	Area (ha)	
01	Boro-Fallow-T. Aman	215850	36	Garlic-Jute-T. Aman	980
02	Wheat-Fallow-T. Aman	46660	37	W.Melon-Fallow-T. Aman	970
03	Maize-Fallow-T. Aman	45980	38	Onion-Vegetab-Vegetab	850
04	Potato-Boro-T. Aman	26590	39	Onion-Jute-T. Aman	740
05	Potato-Maize-T. Aman	26330	40	Garlic-Vegetab-Vegetab	710
06	Wheat-Jute-T. Aman	23960	41	Fallow-Sesame-T. Aman	700
07	Mustard-Boro-T. Aman	18720	42	Chilli-Jute-T. Aman	670
08	Wheat-Maize-T. Aman	11520	43	Boro-Fallow-Fallow	650
09	Wheat-Aus-T. Aman	9990	44	Garlic-Fallow-T. Aman	570
10	Chilli-Fallow-T. Aman	7560	45	Onion-Fallow-T. Aman	560
11	Wheat-Mungbean-T. Aman	6280	46	Vegetab-Jute-Fallow	520
12	Vegetab-Vegetab-Vegetab	5070	47	Potato-Boro-Fallow	500
13	Vegetab-Fallow-T. Aman	4460	48	Potato-Onion-T. Aman	500
14	Groundnut-Fallow-T. Aman	3700	49	Vegetab-Fallow-Fallow	470
15	Mustard-Maize-T. Aman	3590	50	Maize-Jute-T. Aman	440
16	Potato-Jute-T. Aman	3515	51	Vegetab-Fallow-Blackgram	405
17	Wheat-Fallow-Fallow	3250	52	Mustard-Jute-T. Aman	380
18	Wheat-Maize-Fallow	3050	53	Mustard-Fallow-T. Aman	360
19	Wheat-Vegetab-T. Aman	2920	54	Garlic-Aus-T. Aman	350
20	Potato-Groundnut-T. Aman	2700	55	Potato-Maize-Vegetab	350
21	Vegetab-Vegetab-T. Aman	2650	56	Vegetab-Boro-T. Aman	310
22	Potato-Vegetab-T. Aman	2460	57	Vegetab-Vegetab-Fallow	310
23	Potato-Aus-T. Aman	2020	58	Fallow-Fallow-T. Aman	300
24	Sesame-Fallow-T. Aman	2010	59	Groundnut-Jute-T. Aman	300
25	Wheat-Maize-Vegetab	2000	60	Maize-Aus-Fallow	300
26	Maize-Maize-T. Aman	1700	61	Maize-Vegetab-T. Aman	300
27	Maize-Vegetab-Fallow	1700	62	Onion-Aus-T. Aman	300
28	Potato-Maize-Fallow	1600	63	Vegetab-Groundnut-T. Aman	300
29	Boro-Aus-T. Aman	1575	64	Maize-Aus-T. Aman	250
30	Mustard-Boro-Fallow	1490	65	Chilli-Fallow-Fallow	240
31	Potato-Fallow-T. Aman	1440	66	Vegetab-Aus-T. Aman	240
32	Wheat-Vegetab-Vegetab	1400	67	Potato-Jute-Fallow	200
33	Groundnut-Fallow-Fallow	1330	68	Vegetab-Boro-Aus-T. Aman	200
34	Maize-Boro-T. Aman	1200	69	Chilli-Vegetab-Fallow	160
35	Vegetab-Maize-T. Aman	1020	70	Mustard-Aus-T. Aman	160
			71-110	Other 40 patterns (Table 7)	2180