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Cropping Pattern, Intensity and Diversity in Dhaka Region

N Parvin[1]*, A Khatun[1], M K Quais[1] and M Nasim[1]

ABSTRACT

Sustainable crop production in Bangladesh through improvement of cropping intensity and crop diversity in rice based cropping system is regarded as increasingly important in national issues. Planning of agricultural development largely depends on the authentic, reliable and comprehensive statistics of the existing cropping patterns, cropping intensity and crop diversity of a particular area, which will provide guideline to our policy makers, researchers, extensionists and development workers. The study was conducted over all 46 upazilas of Dhaka agricultural region in 2015 using pretested semi-structured questionnaire with a view to document the existing cropping patterns, cropping intensity and crop diversity in the region. From the present study, it was observed that about 48.27% net cropped area (NCA) is covered by exclusive rice cropping systems whereas deep water rice occupied about 16.57% of the regional NCA. The most dominant cropping pattern Boro−Fallow−T. Aman alone occupied about 22.59% of net cropped area (NCA) with its distribution over 32 upazilas out of 46. The second largest area was covered by single Boro cropping pattern, which was spread over 44 upazilas. Total number of cropping patterns was observed 164. The highest number of cropping pattern was identified 35 in Tangail sadar and Dhamrai upazila of Dhaka district and the lowest was seven in Bandar of Narayanganj and Palash of Narsingdi district. The lowest crop diversity index (CDI) was reported as 0.70 in Dhamrai followed by 0.72 in Monohardi of Narsingdi. The highest value of CDI was observed as 0.97 in Tangail sadar followed by 0.95 in Dhamrai of Dhaka and Bhuanpur of Tangail. The range of cropping intensity value was recorded 124-239%. The maximum CDI was observed in Saturia upazila of Manikganj district and minimum in Sreenagar upazila of Munsiganj district. The CDI value for Dhaka region was calculated 0.94 and the average cropping intensity at regional level was 191%.

Key words: Crop diversity index, land use, cropping intensity and deepwater ecosystem

INTRODUCTION

Agriculture is the science and practice of producing crops; and cropping pattern expresses the shares of various crops in the farmers' total cultivated area in an agricultural year. Cropping pattern is an important indicator of a farmer's decision making ability and also influences the consumption pattern as well as health and nutritional status of the people. Cropping pattern vary from region to region, country to country and culture to culture. Cropping systems of a region are decided by and large, by a number of soil and climatic parameters which determine overall agro-ecological setting for nourishment and appropriateness of a crop or set of crops for cultivation.

Bangladesh agriculture involves food production for over 162 million people from merely 8.75 million hectares of agricultural land (Salam *et al.,* 2014) and it is shrinking day by day. The overall land area increased in the recent past is due to reclamation of char lands .The annual loss of agricultural land is about 0.73% per annum due to construction of houses, roads and industrial infrastructure (BBS, 2014). Sustainable crop production in Bangladesh through improvement of cropping intensity in rice based cropping system is regarded as increasingly important in national issues such as food security, poverty alleviation and creation of job opportunity . The main challenge of the new millennium is to increase 50% yield per unit land area through manipulating the

[1]Rice Farming Systems Division, BRRI, Gazipur; *Corresponding author's E-mail: nargisrfs@gmail.com

limited land resource. In order to produce more food within a limited area, the most important options are i) to increase the cropping intensity by producing three or more crops over the same piece of land in a year and ii) to increase the production efficiency of the individual crop by using optimum management practices (Salam *et al.,* 2014).

To meet the challenges of a globalizing market in agriculture as well as the growing and changing needs of the population, many countries in South East Asia have undertaken crop diversification to enhance productivity and cultivate high value crop with positive outcome. Diversification is taking place either through area augmentation or by crop substitution. If carried out appropriately, diversification can be used as a tool to augment farm income, generate employment, alleviate poverty and conserve precious soil and water resources (Pingali and Rosegrant, 1995; Chand, 1996). It can be said that present cropping pattern and crop diversification is a contemporary issue in the field of agriculture, especially in the context of Bangladesh. Therefore, it claims a comprehensive study for the betterment of the agriculture of the country. From the literature, it is found that there are a number of studies were carried out in different countries regarding this issue. However, a very few studies on this aspect was carried out in Bangladesh. In this study, the cropping pattern survey was carried out in Dhaka region to search the better opportunities for improvement of cropping intensity in this region through the cropping pattern analysis. In this backdrop, the present study is an attempt to analyze to the present scenario of cropping pattern and diversification of Dhaka region in Bangladesh. The present study was designed with the following specific objectives to:

- Understand the existing cropping pattern scenario in Dhaka region
- Visualize the existing land use pattern at upazila and regional level
- Determine the crop diversity and cropping intensity at local and regional level.

METHODOLOGY

Forty-six upazilas of Dhaka, Gazipur, Narsingdi, Manikganj, Munsiganj, Narayanganj and Tangail districts under Dhaka 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 46 pre-assigned Sub-Assistant Agriculture Officers (SAAO) of each upazila during July 2015 at upazila level. SAAOs were purposively selected by Agriculture Extension Officers (AEO), Additional Agriculture Officer (AAO) and Upazila Agriculture Officer (UAO). 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. The filled questionnaires were collected by the scientists of Rice Farming Systems 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 to for necessary correction and validation. Second stage of data collection was daylong data validation workshop at district level. The workshop held on the 27 August in Munsijganj; 7 September in Gazipur; 17 September in Manikganj; 21 September in Narsingdi; 5 October in Dhaka 3 November in Tangail; and 25 November 2015 in Narayanganj district. 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), Deputy Director of Seed Certification Agency, District Training Officer and Additional Deputy Directors, one representative from Agricultural Training Institute (ATI) participated in the data validation workshop. The number participants of validation workshop ranged from 46 to 104 in each district. All the participants were divided into three to four groups for data validation.

Each group was facilitated by two 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).

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

Where, CDI_i = Crop Diversity Index
a_{ij} =Area planted to the j^{th} crop in the i^{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 the collected data were done using Microsoft Excel programme. Descriptive statistics were used to facilitate the presentation of the findings.

RESULTS AND DISCUSSION

Land use

Table 1 presents the status of agricultural land utilization in Dhaka region. The net cropped area of the region is 653,670 hectares. Crops occupied the particular land for round the year were considered under annual crops. The major annual crops reported in the region were pineapple, sugarcane, banana papaya, betel leaf, ginger and turmeric. The annual cropped area in different upazilas ranged from 10 to 11,000 ha. The annual cropped area accounted only 5.21% of the net cropped area (NCA) in the region. At a glance, the region possesses 21.25% single cropped area (SCA), 55.37% double cropped area (DCA), 17.23% triple cropped area (TCA) and 0.04% quadruple cropped area (QCA). The SCA had the major share of NCA in Raipur upazila of Narsingdi district, Sreepur and Kaliganj upazilas of Gazipur district; Sreenagar upazila of Munsiganj district; Nawabganj and Savar upazilas of Dhaka district, Rupganj and Sonargaon upazila of Narayanganj district followed by corresponding double cropped area (DCA). Most of the upazilas were dominated by DCA (Table 1). The area which could not defined under SCA, DCA, TCA or QCA was considered as others whose coverage is less than 1% of the NCA.

Cropping patterns of Dhaka

In total, 164 cropping patterns were observed in Dhaka region of which eight cropping patterns with exclusive rice crop covers 48% of the NCA. There were 59 cropping patterns with exclusive non-rice crop covering about 16% of the NCA. Rest of the NCA i.e. around 25% area is covered by 97 rice - non-rice cropping patterns (Appendix 1).

Rice and non-rice crops at a glance

Table 2 presents eight cropping patterns where rice is the only crop round the year. It comprises 48.27% of the NCA in the region. Among them single, double and triple rice areas represent 18.88%, 29.20% and 0.19%, respectively. It reflects the unparallel dominance of rice in the cropping systems in Dhaka region. In case of individual pattern Boro−Fallow−T. Aman has the highest coverage (22.59%) and was recorded in 32 upazilas out of 46. The second dominant pattern as single Boro area occupied 16.74% of NCA which was distributed in most of the upazilas i.e. 44 upazilas. Boro−B.Aman covered 6.12% area with its considerable existence in 24 upazilas.

In the current investigation, 59 cropping patterns were identified that was free from rice. Among the 59 patterns first 47 have been arranged in descending order in Table 3. The rest 12 patterns with negligible area coverage can be found in Table 8 where they are arranged with other patterns of different categories. Aggregate of the 59 patterns have had approximately 16% of NCA. In critical comparison is clear that exclusive rice area is about three folds of exclusive non-rice area. In Dhaka region crop diversity is much wider than that of other regions like Sylhet and Chittagong where exclusive rice area covers 37 folds and 23 folds, respectively, of exclusive non-rice area (Muttaleb *et al*., 2017; Shahidullah *et al*., 2017). Appropriate cropping patterns may facilitate maximum possible land utilization as well as efficient use of other scarce resources

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

	Upazila	Area of upazila	Annual crop	SCA	DCA	TCA	QCA	Other	NCA	C.I. (%)
01	Dhamrai	30740	100	500	15580	5910	0	110	22200	224
02	Dohar	12169	30	3040	2130	770	0	160	6130	161
03	Keraniganj	16697	530	1200	4530	2900	0	170	9330	213
04	Nawabganj	24481	20	6830	6520	2840	0	110	16320	175
05	Savar	28013	60	6400	4230	3310	0	160	14160	178
06	Gazipur sadar	43363	2000	4900	8665	3170	0	165	18900	180
07	Kapasia	35698	3500	5700	9150	1140	0	110	19600	159
08	Kaliakair	31114	690	5285	5520	1680	0	165	13340	167
09	Kaliganj	2153	360	6950	3870	1150	0	130	12460	150
10	Sreepur	46294	970	10940	7890	1110	0	160	21070	148
11	Daulatpur	21031	40	2830	9340	1930	0	100	14240	193
12	Ghior	14601	520	1130	6820	1780	0	120	10370	201
13	Harirampur	24542	90	4590	7890	1600	0	110	14280	178
14	Manikgnj sadar	21515	320	230	12790	3770	0	110	17220	219
15	Saturia	14009	160	350	4670	4150	0	130	9460	239
16	Shibalaya	19910	100	1900	5000	4500	0	100	11600	222
17	Singair	21765	1120	470	7560	6950	0	120	16220	233
18	Gazaria	13092	40	2820	3170	0	0	110	6140	153
19	Lohajang	13012	10	3230	4790	150	0	120	8300	162
20	sadar	20719	30	920	9450	570	0	130	11100	197
21	Sreenagar	19239	30	9300	3000	0	0	100	12430	124
22	Serajdikhan	18000	30	1200	9550	2800	0	150	13730	212
23	Tungibari	15002	50	200	9320	350	0	180	10100	201
24	Araihazar	18335	20	3350	8400	1460	0	140	13370	186
25	Bandar	5439	30	2120	950	300	0	80	3480	146
26	Nrayangnj sadar	10080	20	300	2710	550	0	40	3620	206
27	Rupganj	17908	100	6540	3470	100	0	90	10300	136
28	Sonargaon	17166	10	6470	2370	0	0	60	8910	127
29	Belabo	11800	250	500	4850	3050	0	100	8750	227
30	Monohardi	19260	1500	400	8400	1360	0	140	11800	195
31	Narsingdi sadar	21344	240	6000	4000	1360	0	140	11740	158
32	Palash	9013	430	800	3010	600	0	90	4930	187
33	Raipur	31255	10	12000	8670	2010	0	110	22800	156
34	Shibpur	20586	420	900	9290	1460	0	150	12220	201
35	Basail	15626	50	1600	6260	4750	0	190	12850	224
36	Bhuanpur	21638	300	3300	7750	4640	0	110	16100	207
37	Delduar	18400	150	0	9820	2900	0	130	13000	221
38	Dhanbari	13020	500	530	8900	1300	20	150	11400	203
39	Ghatail	45171	4500	1300	20930	2650	0	170	29550	189
40	Gopalpur	19337	10	1625	9645	3345	100	85	14810	213
41	Kalihati	30100	260	3600	11100	5560	80	160	20760	209
42	Madhupur	37047	11000	100	11590	1370	0	140	24200	160
43	Mirzapur	37400	740	3035	17740	5220	0	155	26890	205
44	Nagarpur	26720	560	70	14280	6400	0	150	21460	227
45	Shakhipur	43000	1500	500	15300	4535	0	115	21950	212
46	Tangail sadar	30197	680	2980	11070	5150	50	150	20080	208
	Dhaka region	-	34080	138935	361940	112600	250	5865	653670	191

Table 2. Cropping patterns with exclusive rice in Dhaka region, 3014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Boro−Fallow−T. Aman	147820	22.61	32
02	Boro−Fallow−Fallow	109530	16.76	44
03	Boro−B.Aman	40050	6.13	24
04	Fallow−Fallow−T. Aman	9650	1.48	5
05	Boro−Sesbania−Fallow	4410	0.67	7
06	Boro−Sesbania−T. Aman	2440	0.37	6
07	Boro−Aus−T. Aman	1215	0.19	7
08	Boro−Aus−Fallow	780	0.12	6
	Total	315895	48.33	

in a sustainable manner. Diversified cropping pattern may be 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).

Deep water rice ecosystem

Deep water is a special type of ecosystem in the country. In context of Dhaka region this ecosystem represents a large portion. The cropping patterns under deep water ecosystem are listed in the Table 4. Among the listed 20 patterns Boro−B.Aman cropping pattern covers the highest area coverage of 40,050 hectares which represents 6.12% of the region's NCA. This pattern is distributed over 24 upazilas out of 46. The second highest Mustard-Boro-B. Aman cropping pattern covers 26,600 hectares and distributed over 21 upazilas. The first two patterns jointly covered 10.18% NCA which is more than three-fifths of total deep-water irce area in the region. The water level of this ecosystem ranges between 150 and 400 cm, and water usually remains 3-4 months. Special rice varieties known as 'floating rice' are planted in these areas. In the past, Bangladesh had a land coverage of 3 million hectares for deepwater rice (Jackson *et al.*, 1972). In course of time the continuous effort on modern agriculture shifted DWR area mainly to modern Boro. Now, the area under deep water rice in Bangladesh is reduced to 0.4 million hectares (Nasim *et al.*, 2017). Though this cropping system is less productive than other modern cropping systems, the specific fragile ecosystem still struggling because of no other alternatives.

Vegetables and spices crops

Seventy-six cropping patterns have been arranged in descending order according to area coverage in Table 5. Potato, sweet potato, vegetables of Rabi, Kharif-I and Kharif-II; spices viz chilli, onion, garlic are included in this list. A row is included at the end of the Table 5 representing an aggregate of 19 patterns of vegetables and spices, which is elaborately presented in the Table 8 with other patterns of different categories. The most contributing cropping pattern is year-round vegetables covering 3.98% of NCA, which distributed over 36 upazilas. Potato−B.Aman was the second dominant cropping pattern which possessed 19,960 ha covering 3.05% of NCA and recorded in 15 upazilas. Potao−Sesbania is the third dominant pattern exists in 13 upazilas. Among the vegetables potato alone is leading in 20 cropping patterns covering 49,550 hectares of land, which is equivalent to 7.57% of NCA. For availability of irrigation water in dry season, supply of modern varieties of various crops, skilled technology transfer system, knowledge on modern crop management practices, high market value of fresh vegetables, good communication and marketing facilities enhanced the extensive production of various types of vegetables in Dhaka region (FAO, 1988). Vegetables like *Colocasia esculenta*, okra (*Abelmoschus esculentus*), amaranth (*Amaranthus* spp.), brinjal (*Solanum melongena*), cucurbits, etc are grown in medium upland adjacent to rice fields during rainy season and potato, sweet gourd, cole crops, leafy vegetables etc are grown during winter season in Tripura (Das *et.al.*, 2015).

Table 3. Cropping patterns of non-rice exclusive in Dhaka region, 2014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Vegetab−Vegetab−Vegetab	26050	3.99	36
02	Potato−Sesbania	10220	1.56	13
03	Vegetab−Vegetab−Fallow	8750	1.34	17
04	Vegetab−Fallow−Fallow	6980	1.07	9
05	Potato−Jute−Fallow	4360	0.67	15
06	Groundnut−Fallow−Fallow	3620	0.55	8
07	Fallow−Fallow−Blackgram	3415	0.52	10
08	Maize−Maize−Fallow	3280	0.50	3
09	Maize−Jute−Fallow	2790	0.43	6
10	Maize−Fallow−Fallow	2265	0.35	6
11	Vegetab−Jute−Fallow	2170	0.33	10
12	Sesame−Fallow−Blackgram	1850	0.28	4
13	Maize−Vegetab−Fallow	1700	0.26	5
14	Wheat−Jute−Fallow	1560	0.24	10
15	Chilli−Fallow−Fallow	1490	0.23	6
16	S.Potato−Fallow−Fallow	1430	0.22	9
17	Potato−Sesame−Fallow	1390	0.21	8
18	Grasspea−Sesbania−Fallow	1350	0.21	2
19	Onion−Jute−Fallow	1350	0.21	11
20	S.Potato−Jute−Fallow	1230	0.19	7
21	Vegetab−Maize−Fallow	1170	0.18	3
22	Grasspea−Fallow−Fallow	1060	0.16	3
23	Chilli−Jute−Fallow	1050	0.16	11
24	Lentil−Jute−Fallow	1040	0.16	8
25	Maize−Sesbania−Fallow	1000	0.15	1
26	Grasspea−Sesame−Fallow	920	0.14	6
27	Onion−Vegtab−Vegetab	800	0.12	9
28	Vegetab−Fallow−Blackgram	790	0.12	4
29	Maize−Sesame−Fallow	690	0.11	2
30	Blackgram−Jute−Fallow	660	0.10	2
31	Potato−Maize−Fallow	610	0.09	4
32	Coriander−Vegetab−Fallow	580	0.09	3
33	Chilli−Vegetab−Fallow	570	0.09	7
34	Mustard−Jute−Fallow	560	0.09	4
35	Garlic−Jute−Fallow	530	0.08	9
36	Grasspea−Jute−Fallow	420	0.06	3
37	Coriander−Fallow−Fallow	390	0.06	6
38	Lentil−Sesame−Fallow	355	0.05	3
39	Pea−Vegetab−Fallow	350	0.05	1
40	Coriander−Jute−Fallow	330	0.05	6
41	Potato−Chilli−Fallow	330	0.05	3
42	Lentil−Vegetab−Vegetab	320	0.05	4
43	Potato−Groundnut	170	0.03	1
44	Garlic−Fallow−Fallow	150	0.02	3
45	Maize−Fallow−Blackgram	150	0.02	1
46	Garlic−Vegetab−Vegetab	135	0.02	5
47	Wheat−Chilli−Fallow	110	0.02	1
48-59	Other 12 patterns (in Table 8)	575	0.09	-
	Total area for exclusive non-rice	103065	15.77	

Table 4. Cropping patterns under deep water rice ecosystem in Dhaka region, 2014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Boro−B.Aman	40050	6.13	24
02	Mustard−Boro−B.Aman	26600	4.07	21
03	Potato−B.Aman	19960	3.05	15
04	Onion−B.Aman	5230	0.80	8
05	Blackgram−B.Aman	3090	0.47	8
06	Grasspea−B.Aman	2970	0.45	11
07	Maize−B.Aman	1920	0.29	7
08	Vegetab−B.Aman	1690	0.26	6
09	Mustard−B.Aman	1340	0.20	4
10	Chilli−B.Aman	820	0.13	6
11	Mustard−Sesame+B.Aman	800	0.12	2
12	Wheat−B.Aman	690	0.11	7
13	Garlic−B.Aman	640	0.10	5
14	Sesame+B.Aman−Blackgram	600	0.09	1
15	Coriander−B.Aman	550	0.08	6
16	Groundnut−B.Aman	420	0.06	4
17	Lentil−B.Aman	330	0.05	5
18	Grasspea−B.Aus+B.Aman	300	0.05	1
19	Potato+Maize−B.Aman	300	0.05	1
20	Fallow−Sesame+B.Aman	200	0.03	2
21	Pea−B.Aman	170	0.03	4
22-24	Other three patterns (in Table 8)	280	0.04	
	Total deep-water rice	108950	16.67	

Oil-seed crops

Mustard is the most important one among the oil-seed crops in Dhaka region. There are 32 cropping patterns for oil-seeds among which 15 patterns had been led by mustard alone (Tables 6 and 8). The total share of oil-seed cropping patterns is 17.71% of NCA in the region whereas mustard absolutely occupies 16.11%. The second prevailing sesame covers over 1%. The most dominant Mustard−Boro−Fallow pattern is distributed over 31 upazilas out of 46.

Pulse crops

Thirty-four cropping patterns are holding different pulse crops (Tables 7 and 8). Among them blackgram is covering the largest area whereas pea is cultivated in the smallest area. Twelve cropping patterns of blackgram jointly cover 2.42% of NCA. Grasspea (*Lathyrus sativus*) holds the second position in pulse crop cultivation in Dhaka region. There are nine cropping patterns for grasspea, which in-together occupy about 1% of NCA. In the documentation of pulse cropping systems grasspea has the widest spreading in the region. The third ranking pattern Grasspea−B. Aman is available in 11 upazilas. Finally the aggregate area of the pulse cropping system stands for 4.26% of the NCA in Dhaka region. The rapid increase in human population creates additional pressure on natural resources at above optimal levels of their inherent potential, which resulted the loss of biodiversity, serious soil erosion leading to depletion of plant nutrient, gradual degradation and decline in productivity and carrying capacity (FAO, 1988).

Sporadic and distinct cropping patterns

Some cropping patterns are extremely location-specific, however, with a large area coverage. These are Maize−Maize−Fallow (Table 3) and Vegetable−Boro−Fallow (Table 5). The Maize−Maize−Fallow is grown in Ghior (430 ha), Saturia (1,700 ha) and Singair (1,150 ha) upazila in Manikganj district. Vegetable−Boro−Fallow is limited to only Dhamrai upazila (1,590 ha)

Table 5. Area for vegetables and spices under different cropping patterns in Dhaka region, 2014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Vegetab−Vegetab−Vegetab	26050	3.98	36
02	Potato−B.Aman	19960	3.05	15
03	Potato−Sesbania	10220	1.56	13
04	Vegetab−Vegetab−Fallow	8750	1.34	17
05	Vegetab−Fallow−Fallow	6980	1.07	9
06	Onion−B.Aman	5230	0.80	8
07	Potato−Jute−Fallow	4360	0.67	15
08	Potato−Boro−Fallow	4050	0.62	5
09	Potato−Jute−T. Aman	3360	0.51	14
10	Potato−Boro−T. Aman	3090	0.47	11
11	Vegetab−Boro−Fallow	2590	0.40	2
12	Boro−Vegetab(Float/Norm)	2360	0.36	5
13	Vegetab−Jute−Fallow	2170	0.33	10
14	Maize−Vegetab−Fallow	1700	0.26	5
15	Vegetab−B.Aman	1690	0.26	6
16	Vegetab−Vegetab−T. Aman	1660	0.25	6
17	Chilli−Fallow−Fallow	1490	0.23	6
18	S.Potato−Fallow−Fallow	1430	0.22	9
19	Potato−Sesame−Fallow	1390	0.21	8
20	Onion−Jute−Fallow	1350	0.21	11
21	S.Potato−Jute−Fallow	1230	0.19	7
22	Boro−Vegetab−T. Aman	1200	0.18	1
23	Vegetab−Maize−Fallow	1170	0.18	3
24	Vegetab−Jute−T. Aman	1120	0.17	7
25	Chilli−Jute−Fallow	1050	0.16	11
26	Chilli−B.Aman	820	0.13	6
27	Vegetab−Boro−T. Aman	820	0.13	5
28	Onion−Vegtab−Vegetab	800	0.12	9
29	Vegetab−Fallow−Blackgram	790	0.12	4
30	Fallow−Vegetab−T. Aman	720	0.11	1
31	Vegetab−Aus−T. Aman	680	0.10	3
32	Garlic−B.Aman	640	0.10	5
33	Potato−Maize−Fallow	610	0.09	4
34	Coriander−Vegetab−Fallow	580	0.09	3
35	Chilli−Vegetab−Fallow	570	0.09	7
36	Coriander−B.Aman	550	0.08	6
37	Garlic−Jute−Fallow	530	0.08	9
38	Onion−Jute−T. Aman	530	0.08	5
39	Potato−Vegetab−T. Aman	440	0.07	5
40	Chilli−Fallow−T. Aman	400	0.06	2
41	Potato−Fallow−T. Aman	400	0.06	1
42	Potato−Maize−T. Aman	400	0.06	2
43	Coriander−Fallow−Fallow	390	0.06	6
44	Vegetab−Fallow−T. Aman	360	0.06	4
45	Pea−Vegetab−Fallow	350	0.05	1
46	Coriander−Jute−Fallow	330	0.05	6
47	Potato−Chilli−Fallow	330	0.05	3
48	Lentil−Vegetab−Vegetab	320	0.05	4
49	Potato+Maize−B.Aman	300	0.05	1
50	Potato−Sesame−Aus	200	0.03	1
51	Potato−Groundnut	170	0.03	1
52	Chilli−Vegetab−T. Aman	150	0.02	1
53	Garlic−Fallow−Fallow	150	0.02	3
54	Garlic−Vegetab−Vegetab	135	0.02	5
55	Garlic−Jute−T. Aman	110	0.02	4
56	Potato−Aus−Fallow	110	0.02	2
57	Wheat−Chilli−Fallow	110	0.02	1
58-76	Other 19 patterns (in Table 8)	1030	0.16	-
	Total vegetab. and spices	130475	19.94	

Table 6. Area coverage for oil-seed crops under different cropping patterns in Dhaka region, 2014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Mustard−Boro−Fallow	51300	7.84	31
02	Mustard−Boro−B.Aman	26600	4.06	21
03	Mustard−Boro−T. Aman	22400	3.42	26
04	Groundnut−Fallow−Fallow	3620	0.55	8
05	Sesame−Fallow−Blackgram	1850	0.28	4
06	Potato−Sesame−Fallow	1390	0.21	8
07	Mustard−B.Aman	1340	0.20	4
08	Mustard−Boro−Jute	1100	0.17	5
09	Grasspea−Sesame−Fallow	920	0.14	6
10	Mustard−Sesame+B.Aman	800	0.12	2
11	Mustard−Boro−Sesbania	700	0.11	2
12	Maize−Sesame−Fallow	690	0.11	2
13	Sesame+B.Aman−Blackgram	600	0.09	1
14	Mustard−Jute−Fallow	560	0.09	4
15	Groundnut−B.Aman	420	0.06	4
16	Lentil−Sesame−Fallow	355	0.05	3
17	Mustard−Boro−Jute−T. Aman	240	0.04	4
18	Mustard−Jute−T. Aman	220	0.03	3
19	Fallow−Sesame+B.Aman	200	0.03	2
20	Potato−Sesame−Aus	200	0.03	1
21	Potato−Groundnut	170	0.03	1
22-32	Other 11 patterns (in Table 8)	490	0.07	
	Total oil-seed crops	116165	17.77	

in Dhaka and Singair (1,000 ha) upazila in Manikganj district.

Rare cropping patterns

In the present investigation, 45 cropping patterns have been identified as rare cropping patterns with a negligible area coverage with seldom existence (Table 8). These are location specific system and are limited in one or two upazilas of the region. Total area coverage of the 45 patterns is only 0.35% of NCA. Among these the top nine patterns are holding the same area i.e. 100 ha for each. The smallest area was recorded for Millet (*cheena*)−Fallow−Fallow cropping pattern whose coverage was only 5 hectares (Table 7) and is available only in Mirzapur upazila of Tangail district.

Most dominant cropping pattern

Boro−Fallow−T. Aman was the most dominant cropping pattern in Dhaka region. It covers 22.59% of NCA in the region and is available in 32 upazilas out of 46 (Table 9). The highest area under this cropping was recorded 18,000 hectares in Ghatail upazila of Tangail district, which represents 12.18% of the total Boro−Fallow−T. Aman area of the region. In consideration of individual upazila Dhanbari stands on the sixth position for area coverage of the pattern, however, this upazila has allocated highest area and it is 79.16% of its NCA for this pattern alone. Keraniganj and Dohar upazila of Dhaka district and Narayanganj sadar upazila had a negligible area coverage for this pattern. In the country-wide compilation of data it was observed that Boro−F−T. Aman was the most dominant 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 Dhaka region is the single Boro. It belongs to 16.74% NCA of the region and spread out over most of the upazilas i.e. 44 upazilas (Table 10).

Table 7. Area coverage for pulse crops under different cropping systems in Dhaka region, 2014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Boro−Fallow−Blackgram	3955	0.60	9
02	Fallow−Fallow−Blackgram	3415	0.52	10
03	Blackgram−B.Aman	3090	0.47	8
04	Grasspea−B.Aman	2970	0.45	11
05	Sesame−Fallow−Blackgram	1850	0.28	4
06	Grasspea−Sesbania−Fallow	1350	0.21	2
07	Grasspea−Jute−T. Aman	1150	0.18	2
08	Lentil−Jute−T. Aman	1120	0.17	4
09	Grasspea−Fallow−Fallow	1060	0.16	3
10	Lentil−Jute−Fallow	1040	0.16	8
11	Grasspea−Sesame−Fallow	920	0.14	6
12	Blackgram−Aus−T. Aman	850	0.13	2
13	Vegetab−Fallow−Blackgram	790	0.12	4
14	Blackgram−Jute−Fallow	660	0.10	2
15	Sesame+B.Aman−Blackgram	600	0.09	1
16	Grasspea−Jute−Fallow	420	0.06	3
17	Lentil−Sesame−Fallow	355	0.05	3
18	Blackgram−Jute−T. Aman	350	0.05	2
19	Pea−Vegetab−Fallow	350	0.05	1
20	Lentil−B.Aman	330	0.05	5
21	Lentil−Vegetab−Vegetab	320	0.05	4
22	Grasspea−B.Aus+B.Aman	300	0.05	1
23	Pea−B.Aman	170	0.03	4
24	Maize−Fallow−Blackgram	150	0.02	1
25-34	Other 10 patterns (in Table 8)	570	0.09	
	Total pulse crops	28135	4.30	

Sreenagar upazila of Munsiganj district holding the highest is (9,300 ha) under this single Boro cropping. This upazila alone contribute 8.49% share of single Boro cropping area in the region. This upazila has allotted its largest share (74.82%) of NCA. Sonargaon upazila of Narayanganj has maintained the 8th position for single Boro area coverage (5,400 ha) in the region. However, this area represents 60.61% of its own NCA. This pattern is frequent and concurrently experienced by early flash flood in April and cold injury at reproductive stage. Diversified cropping pattern may be resort for the farmer as a coping strategy with flood related risk (Mandal and Bezbaruah, 2013) but scope of diversification is limited due to environmental and climatic condition (FAO, 1988). In the country-wide compilation of data it was observed that the single Boro was the second dominant cropping pattern in Bangladesh covering 1.14 million ha (13% of NCA in the country) with its distribution in 342 upazilas of 59 districts (Nasim *et al*., 2017).

Third dominant cropping pattern

Mustard−Boro-Fallow cropping pattern holds the third largest area coverage 51,300 hectares in Dhaka region. This area is an equivalent to 7.84% of NCA in the region. This pattern Mustard−Boro-Fallow is widely distributed over 31 upazilas. Manikganj sadar upazila has an area of 6,100 ha for this pattern which stands for 11.89% of the total area under this pattern in the region (Table 11). Ghior upazila of Manikganj district ranks in third position for Mustard−Boro-Fallow, however, this upazila has allotted the largest share (41.44%) of NCA.

Fourth dominant cropping pattern

Fourth dominant cropping pattern Boro−B. Aman has occupied 40,050 hectares representing 6.12% share of NCA in Dhaka region (Table 12).

Table 8. Rare cropping patterns covering non-significant area in Dhaka region, 2014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency	Upazila
01	Tobacco−Jute−Fallow	100	0.02	2	Daulatpur+Ghior
02	Vegetab−Aus−Blackgram	100	0.02	2	Saturia+Shibpur
03	Wheat−Vegetab−T. Aman	100	0.02	2	Madhupur+Nagarpur
04	Garlic−Fallow−T. Aman	100	0.02	1	Belabo
05	Grasspea−Boro−B.Aman	100	0.02	1	Dohar
06	Grasspea−Sesame+B.Aman	100	0.02	1	Singair
07	Maize−Aus−T. Aman	100	0.02	1	Dhamrai
08	Potato−Boro−Vegetab	100	0.02	1	Saturia
09	Wheat−Sesame−Fallow	100	0.02	1	Delduar
10	Coriander−Jute−T. Aman	90	0.01	1	Dhamrai
11	Mungbean−Fallow−T. Aman	80	0.01	3	Sreepur+Belabo+Shibpur
12	Mustard−Aus−T. Aman	80	0.01	1	Dhamrai
13	S.Potato−B.Aman	80	0.01	1	Araihazar
14	Tobacco−Fallow−Fallow	80	0.01	1	Daulatpur
15	Coriander−Fallow−T. Aman	70	0.01	1	Belabo
16	Wheat−Aus−T. Aman	65	0.01	4	Sreepur+Raipur+Araihazar
17	Mustard−Aus−Fallow	50	0.01	2	Dohar+Keraniganj
18	Wheat−Sesame−T. Aman	50	0.01	2	Kalihati+Tangail
19	Boro−Aus−Blackgram	50	0.01	1	Basail
20	Onion−Sesame−Fallow	50	0.01	1	Kalihati
21	Vegetab−Jute−Vegetab	50	0.01	1	Madhupur
22	Wheat−Aus−Fallow	50	0.01	1	Tangail
23	Grasspea−Boro−Fallow	40	0.01	2	Dhamrai+Keraniganj
24	S.Potato−Jute−T. Aman	40	0.01	2	Belabo+Kalihati
25	Chilli−Aus−Fallow	40	0.01	1	Tungibari
26	Onion−Maize−Fallow	40	0.01	1	Ghior
27	Potato−Maize−Vegetab	40	0.01	1	Ghior
28	Vegetab−Aus−Fallow	40	0.01	1	Keraniganj
29	Wheat−Jute−Blackgram	40	0.01	1	Singair
30	Lentil−Aus−Fallow	30	0.00	2	Dhamrai+Tungibari
31	Wheat−Vegetab−Vegetab	30	0.00	1	Singair
32	Wheat−Jute−Vegetab	20	0.00	2	Savar+Narsingdi
33	Lentil−Fallow−T. Aman	20	0.00	1	Kaliganj
34	Mustard−Fallow−T. Aman	20	0.00	1	Gazipur
35	Onion−Aus−Fallow	20	0.00	1	Lohajang
36	Wheat−Fallow−Fallow	20	0.00	1	Gopalpur
37	Grasspea−Fallow−T. Aman	10	0.00	1	Kaliganj
38	Groundnut−Jute−T. Aman	10	0.00	1	Belabo
39	Mustard−Boro−Aus−T. Aman	10	0.00	1	Tangail
40	Mustard−Sesame−T. Aman	10	0.00	1	Belabo
41	Potato−Sesame−T. Aman	10	0.00	1	Belabo
42	Potato+S.gourd−Aus−T. Aman	10	0.00	1	Gopalpur
43	Tobacco−Jute−T. Aman	10	0.00	1	Daulatpur
44	Wheat−Fallow−T. Aman	10	0.00	1	Sreepur
45	Millet (*cheena*)−Fallow−Fallow	5	0.00	1	Mirzapur
	Total	2270	0.35		-

Table 9. Distribution of the most dominant Boro−F−T. Aman cropping patterns in the region, 2014-15.

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Ghatail	18000	60.91	12.18
02	Shakhipur	14000	63.78	9.47
03	Madhupur	11500	45.73	7.78
04	Gopalpur	9400	63.26	6.36
05	Shibpur	8800	72.01	5.95
06	Dhanbari	8700	79.16	5.89
07	Monohardi	8400	71.19	5.68
08	Kapasia	8200	41.71	5.55
09	Sreeppur	6500	30.85	4.40
10	Kalihati	6500	31.31	4.40
11	Gazipur	6100	32.28	4.13
12	Raipur	5000	21.92	3.38
13	Mirzapur	4500	16.73	3.04
14	Belabo	4400	50.25	2.98
15	Bhuanpur	3900	24.53	2.64
16	Kaliakair	3800	28.48	2.57
17	Delduar	3500	26.66	2.37
18	Palash	3000	60.85	2.03
19	Kaliganj	2500	20.06	1.69
20	Narsingdi	1900	16.18	1.29
21	Rupganj	1800	17.48	1.22
22	Nagarpur	1800	8.39	1.22
23	Tangail	1700	8.47	1.15
24	Savar	1400	9.88	0.95
25	Dhamrai	530	2.38	0.36
26	Saturia	530	5.60	0.36
27	Bsail	500	3.89	0.34
28	Manikganj	450	2.61	0.30
29	Araihazar	300	2.24	0.20
30	Keranjganj	100	1.07	0.07
31	Narayanganj	100	2.76	0.07
32	Dohar	10	0.16	0.01
	Dhaka region	147820	22.59	100.00

This pattern is distributed over 24 upazilas where Mirzapur upazila of Tangail district ranked in top position. This upazila has 6,000 ha area for Boro−B. Aman which is only 22.31% of upazila NCA. Nagarpur upazila of the same district ranks in third position with 5,500 ha area for this pattern, however, this upazila has allotted the biggest share (25.63%) of its NCA.

Fifth dominant cropping pattern

Fifth dominant cropping pattern Mustard−Boro−B.Aman has occupied 26,600 hectares representing 4.06% share of NCA in Dhaka region (Table 13). This pattern is distributed over 21 upazilas where Shibalaya upazila of Manikganj district ranked in top position. This upazila has 4,300 ha area Mustard−Boro−B. Aman, which is 37.07% of upazila NCA and it is 16.17% of the total patern area in the region. The second ranking upazila is Singair of Manikganj district where area coverage for this pattern is 23.41% of upazila NCA and it is 14.29% of total pattern area in the region.

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 164 cropping patterns were identified in the whole

Table 10. Distribution of the second dominant Boro−F−F cropping pattern in Dhaka region, 2014-15.

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Sreenagar	9300	74.82	8.49
02	Raipur	8400	36.82	7.67
03	Kaliganj	6950	55.76	6.35
04	Nawabganj	6800	41.67	6.21
05	Savar	6400	45.18	5.84
06	Sreepur	5800	27.53	5.30
07	Rupganj	5500	53.40	5.02
08	Sonargaon	5400	60.61	4.93
09	Kaliakair	5200	38.97	4.75
10	Narsingdi	5100	43.44	4.66
11	Kapasia	3700	18.82	3.38
12	Kalihati	3600	17.34	3.29
13	Gazipur	3500	18.52	3.20
14	Araihazar	3100	23.18	2.83
15	Dohar	2900	47.29	2.65
16	Lohajang	2700	32.49	2.47
17	Tangail	2500	12.45	2.28
18	Gazaria	2400	39.09	2.19
19	Bandar	2100	60.34	1.92
20	Shibalaya	1900	16.38	1.73
21	Gopalpur	1600	10.77	1.46
22	Daulatpur	1450	10.18	1.32
23	Mirzapur	1300	4.83	1.19
24	Serajdikhan	1200	8.74	1.10
25	Bsail	1200	9.35	1.10
26	Keraniganj	1150	12.33	1.05
27	Shibpur	900	7.36	0.82
28	Palash	800	16.23	0.73
29	Bhuanpur	800	5.03	0.73
30	Harirampur	600	4.20	0.55
31	Munsiganj	600	5.39	0.55
32	Ghior	550	5.30	0.50
33	Dhamrai	500	2.25	0.46
34	Belabo	500	5.71	0.46
35	Dhanbari	500	4.55	0.46
36	Ghatail	500	1.69	0.46
37	Shakhipur	500	2.28	0.46
38	Monohardi	400	3.39	0.37
39	Saturia	350	3.70	0.32
40	Narayanganj	300	8.29	0.27
41	Manikganj	230	1.34	0.21
42	Tungbari	200	1.98	0.18
43	Singair	100	0.62	0.09
44	Madhupur	50	0.20	0.05
	Dhaka region	109530	16.74	100.00

Table 11. Distribution of the third dominant Mustard−Boro-Fallow cropping pattern in Dhaka region, 2014-15.

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Manikganj	6100	35.42	11.89
02	Mirzapur	5100	18.97	9.94
03	Ghior	4300	41.44	8.38
04	Nagarpur	4300	20.04	8.38
05	Dhamrai	3700	16.65	7.21
06	Singair	3350	20.64	6.53
07	Daulatpur	3000	21.07	5.85
08	Harirampur	2900	20.29	5.65
09	Bsail	2800	21.81	5.46
10	Nawabganj	2700	16.54	5.26
11	Tangail	2600	12.95	5.07
12	Serajdikhan	1500	10.92	2.92
13	Keraniganj	1400	15.01	2.73
14	Kaliakair	1400	10.49	2.73
15	Shibalaya	800	6.90	1.56
16	Savar	700	4.94	1.36
17	Delduar	700	5.33	1.36
18	Bandar	500	14.37	0.97
19	Sonargaon	500	5.61	0.97
20	Narsingdi	500	4.26	0.97
21	Kalihati	450	2.17	0.88
22	Sreenagar	350	2.82	0.68
23	Gazaria	300	4.89	0.58
24	Araihazar	300	2.24	0.58
25	Rupganj	300	2.91	0.58
26	Shakhipur	300	1.37	0.58
27	Dohar	150	2.45	0.29
28	Lohajang	150	1.81	0.29
29	Tungibari	70	0.69	0.14
30	Kapasia	50	0.25	0.10
31	Shibpur	30	0.25	0.06
	Dhaka region	51300	7.84	100.00

area of Dhaka region under this investigation. The highest number of cropping patterns was identified 35 in Tangail sadar upazila and Dhamrai upazila of Dhaka district followed by 31 in Daulatpur upazila in Manikganj district (Table 14). The lowest number of cropping patterns was identified seven in Bandar of Narayanganj district and Palash of Narsingdi district followed by eight in Sreenagar and sadar upazila of Munsiganj district. Higher number of cropping patterns is generally related to higher level of diversity indices for cropping pattern. The upazilas having lower number of cropping patterns were related to water logging. The lowest diversity index for cropping pattern was recorded 0.37 in Dhanbari of Tangail district followed by 0.47 in Shibpur of Narsingdi. In a study Shahidullah *et al.* (2006) also found lowest values for all the diversity and intensity parameters in salt affected and water-stagnant area of greater Noakhali. The highest value of diversity index for cropping pattern was found 0.93 in Tangail sadar upazila and that was followed by 0.90 in Bhuanpur upazila of the same district. The lowest CDI was reported 0.70 in Dhanbari of Tangail followed by 0.72 in Monohardi of Narsingdi district. The highest value of CDI was observed 0.97 in Tangail sadar upazila followed by 0.95

Table 12. Distribution of the fourth dominant Boro-B. Aman cropping pattern in Dhaka region, 2014-15.

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Mirzapur	6000	22.31	14.98
02	Dhamrai	5600	25.20	13.98
03	Nagarpur	5500	25.63	13.73
04	Kalihati	4000	19.27	9.99
05	Delduar	3600	27.42	8.99
06	Araihazar	3100	23.18	7.74
07	Bsail	2500	19.47	6.24
08	Tangail	1600	7.97	4.00
09	Ghatail	1500	5.08	3.75
10	Saturia	1400	14.80	3.50
11	Bhuanpur	1150	7.23	2.87
12	Kapasia	700	3.56	1.75
13	Manikganj	500	2.90	1.25
14	Raipur	500	2.19	1.25
15	Shakhipur	500	2.28	1.25
16	Keraniganj	470	5.04	1.17
17	Serajdikhan	400	2.91	1.00
18	Sonargaon	400	4.49	1.00
19	Nawabganj	200	1.23	0.50
20	Kaliakair	100	0.75	0.25
21	Bandar	100	2.87	0.25
22	Rupganj	100	0.97	0.25
23	Kaliganj	80	0.64	0.20
24	Gopalpur	50	0.34	0.12
	Dhaka region	40050	6.12	100.00

Table 13. Distribution of the fifth dominant Mustard-Boro-B. Aman cropping pattern in Dhaka region, 2014-15.

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Shibalaya	4300	37.07	16.17
02	Singair	3800	23.41	14.29
03	Bsail	2900	22.59	10.9
04	Nagarpur	2400	11.18	9.02
05	Daulatpur	1900	13.34	7.14
06	Mirzapur	1900	7.07	7.14
07	Ghior	1300	12.53	4.89
08	Manikganj	1300	7.55	4.89
09	Narsingdi	1000	8.52	3.76
10	Nawabganj	800	4.90	3.01
11	Delduar	800	6.09	3.01
12	Tangail	750	3.74	2.82
13	Harirampur	700	4.90	2.63
14	Araihazar	700	5.23	2.63
15	Kalihati	600	2.89	2.26
16	Gopalpur	500	3.36	1.88
17	Keraniganj	400	4.29	1.50
18	Serajdikhan	300	2.18	1.13
19	Dohar	100	1.63	0.38
20	Kaliakair	100	0.75	0.38
21	Savar	50	0.35	0.19
	Dhaka region	26600	4.06	100.00

Table 14. Crop diversity and cropping intensity in Dhaka region , 2014-15.

	Upazila	No. of identified pattern	No. of crop	Diversity index for cropping pattern	Crop diversity index (CDI)	C.I. (%)
01	Dhamrai	35	20	0.88	0.95	224
02	Dohar	30	20	0.76	0.84	161
03	Keraniganj	22	21	0.89	0.94	213
04	Nawabganj	18	19	0.77	0.90	175
05	Savar	14	13	0.72	0.91	177
06	Gazipur sadar	19	12	0.84	0.91	180
07	Kapasia	14	12	0.78	0.84	158
08	Kaliakair	17	13	0.75	0.87	167
09	Kaliganj	15	16	0.64	0.83	150
10	Sreepur	18	11	0.77	0.85	148
11	Daulatpur	31	23	0.90	0.94	193
12	Ghior	21	16	0.80	0.89	201
13	Harirampur	21	21	0.90	0.94	178
14	Manikganj sadar	29	21	0.85	0.93	219
15	Saturia	16	14	0.84	0.93	239
16	Shibalaya	10	10	0.79	0.89	222
17	Singair	25	16	0.87	0.94	233
18	Gazaria	12	11	0.79	0.89	153
19	Lohaganj	15	18	0.79	0.90	162
20	Munsiganj sadar	18	17	0.66	0.82	197
21	Sreenagar	8	9	0.66	0.82	124
22	Serajdikhan	17	12	0.89	0.95	212
23	Tungibari	14	14	0.73	0.86	201
24	Araihazar	25	17	0.83	0.92	186
25	Bandar	7	7	0.60	0.85	146
26	Nrayanganj sadar	8	8	0.76	0.88	206
27	Rupganj	20	17	0.67	0.80	136
28	Sonargaon	22	18	0.61	0.75	127
29	Belabo	19	17	0.61	0.75	226
30	Monohardi	11	11	0.49	0.72	195
31	Narsingdi sadar	14	14	0.76	0.88	158
32	Palash	7	6	0.60	0.77	187
33	Raipur	20	17	0.79	0.89	156
34	Shibpur	19	17	0.47	0.73	201
35	Basail	18	15	0.85	0.93	225
36	Bhuanpur	25	24	0.90	0.95	208
37	Delduar	22	18	0.84	0.93	220
38	Dhanbari	12	11	0.37	0.70	207
39	Ghatail	14	13	0.62	0.79	189
40	Gopalpur	24	18	0.57	0.81	213
41	Kalihati	24	16	0.82	0.92	209
42	Madhupur	16	13	0.79	0.83	157
43	Mirzapur	26	21	0.87	0.94	205
44	Nagarpur	19	15	0.85	0.94	227
45	Shakhipur	13	13	0.58	0.80	212
46	Tangail sadar	35	26	0.93	0.97	208
	Dhaka region	164	36	0.90	0.94	191

in Dhanbari and Bhuanpur of Tangail and Serajdikhan upazila of Munsiganj district.

The range of cropping intensity values was recorded 124-239%. The maximum value was for Saturia upazila of Manikganj district and minimum for Sreenagar upazila of Munsiganj district. As a whole the CDI of Dhaka region was calculated 0.94 and the average cropping intensity at regional level was 191%. In a simultaneous study, the investigators identified 316 cropping patterns for whole Bangladesh; where the CDI value was 0.95 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).

CONCLUSION

In total, the highest cropping intensity was observed in Saturia upazila and lowest was in Sreenagar upazila under Dhaka region. The cropping intensity of the Dhaka region was little bit lower than the national average. Boro−Fallow−T. Aman, Single Boro, Mustard−Boro−Fallow, Boro−B. Aman were the dominant cropping patterns in the region. Exclusive rice area is about three folds of exclusive non-rice area. In Dhaka region, crop diversity is much wider than that of other regions. However, pulse crops and oil-seed crops are not sufficient in the crop distributions and cropping sequences. Based on the findings of the study, the following recommendations were made.

- Initiative should to be taken to increase productivity of exclusive rice based cropping patterns with high yielding varieties of rice along with recommended crop management packages.
- The upazilas having unique or exceptional cropping patterns with large area coverage might be studied in-depth to extrapolate to similar environments.
- A portion of single T. Aman area could be bought under double rice area with inclusion of Aus.
- Emphasis should be given so that a portion of double-rice area could be brought under Mustard-Boro-T. Aman cropping system or other three cropping systems.
- Area under deepwater rice might be intensified by relay cropping.

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

	Cropping pattern	Area (ha)		Cropping pattern	Area (ha)
001	Boro−Fallow−T. Aman	147820	061	Maize−Sesbania−Fallow	1000
002	Boro−Fallow−Fallow	109530	062	Grasspea−Sesame−Fallow	920
003	Mustard−Boro−Fallow	51300	063	Blackgram−Aus−T. Aman	850
004	Boro−B.Aman	40050	064	Chilli−B.Aman	820
005	Mustard−Boro−B.Aman	26600	065	Vegetab−Boro−T. Aman	820
006	Vegetab−Vegetab−Vegetab	26050	066	Mustard−Sesame+B.Aman	800
007	Mustard−Boro−T. Aman	22400	067	Onion−Vegtab−Vegetab	800
008	Potato−B.Aman	19960	068	Vegetab−Fallow−Blackgram	790
009	Potato−Sesbania	10220	069	Boro−Aus−Fallow	780
010	Fallow−Fallow−T. Aman	9650	070	Fallow−Vegetab−T. Aman	720
011	Vegetab−Vegetab−Fallow	8750	071	Cotton−Aus−Fallow	700
012	Vegetab−Fallow−Fallow	6980	072	Mustard−Boro−Sesbania	700
013	Onion−B.Aman	5230	073	Maize−Sesame−Fallow	690
014	Boro−Jute−T. Aman	4780	074	Wheat−B.Aman	690
015	Boro−Sesbania−Fallow	4410	075	Vegetab−Aus−T. Aman	680
016	Potato−Jute−Fallow	4360	076	Blackgram−Jute−Fallow	660
017	Potato−Boro−Fallow	4050	077	Garlic−B.Aman	640
018	Boro−Fallow−Blackgram	3955	078	Potato−Maize−Fallow	610
019	Groundnut−Fallow−Fallow	3620	079	Sesame+B.Aman−Blackgram	600
020	Fallow−Fallow−Blackgram	3415	080	Coriander−Vegetab−Fallow	580
021	Potato−Jute−T. Aman	3360	081	Chilli−Vegetab−Fallow	570
022	Maize−Maize−Fallow	3280	082	Mustard−Jute−Fallow	560
023	Wheat−Jute−T. Aman	3245	083	Coriander−B.Aman	550
024	Blackgram−B.Aman	3090	084	Garlic−Jute−Fallow	530
025	Potato−Boro−T. Aman	3090	085	Onion−Jute−T. Aman	530
026	Grasspea−B.Aman	2970	086	Tobacco−Boro−T. Aman	450
027	Maize−Jute−Fallow	2790	087	Potato−Vegetab−T. Aman	440
028	Vegetab−Boro−Fallow	2590	088	Grasspea−Jute−Fallow	420
029	Boro−Sesbania−T. Aman	2440	089	Groundnut−B.Aman	420
030	Boro−Vegetab(Float/Norm)	2360	090	Chilli−Fallow−T. Aman	400
031	Maize−Fallow−Fallow	2265	091	Potato−Fallow−T. Aman	400
032	Vegetab−Jute−Fallow	2170	092	Potato−Maize−T. Aman	400
033	Maize−B.Aman	1920	093	Tobacco−Maize−T. Aman	400
034	Sesame−Fallow−Blackgram	1850	094	Coriander−Fallow−Fallow	390
035	Fallow−Jute−T. Aman	1770	095	Vegetab−Fallow−T. Aman	360

Appendix 1. Continued.

	Cropping pattern	Area (ha)		Cropping pattern	Area (ha)
036	Maize–Vegetab–Fallow	1700	096	Lentil–Sesame–Fallow	355
037	Vegetab–B.Aman	1690	097	Blackgram–Jute–T. Aman	350
038	Vegetab–Vegetab–T. Aman	1660	098	Pea–Vegetab–Fallow	350
039	Wheat–Jute–Fallow	1560	099	Coriander–Jute–Fallow	330
040	Chilli–Fallow–Fallow	1490	100	Lentil–B.Aman	330
041	S.Potato–Fallow–Fallow	1430	101	Potato–Chilli–Fallow	330
042	Maize–Fallow–T. Aman	1390	102	Lentil–Vegetab–Vegetab	320
043	Potato–Sesame–Fallow	1390	103	Grasspea–B.Aus+B.Aman	300
044	Grasspea–Sesbania–Fallow	1350	104	Potato+Maize–B.Aman	300
045	Onion–Jute–Fallow	1350	105	Boro–Jute–Fallow	280
046	Mustard–B.Aman	1340	106	Mustard–Boro–Jute–T. Aman	240
047	S.Potato–Jute–Fallow	1230	107	Mustard–Jute–T. Aman	220
048	Boro–Aus–T. Aman	1215	108	Fallow–Sesame+B.Aman	200
049	Boro–Vegetab–T. Aman	1200	109	Potato–Sesame–Aus	200
050	Vegetab–Maize–Fallow	1170	110	Pea–B.Aman	170
051	Grasspea–Jute–T. Aman	1150	111	Potato–Groundnut	170
052	Lentil–Jute–T. Aman	1120	112	Chilli–Vegetab–T. Aman	150
053	Vegetab–Jute–T. Aman	1120	113	Fallow–Aus–T. Aman	150
054	Mustard–Boro–Jute	1100	114	Garlic–Fallow–Fallow	150
055	Wheat–Maize–T. Aman	1100	115	Maize–Fallow–Blackgram	150
056	Grasspea–Fallow–Fallow	1060	116	Garlic–Vegetab–Vegetab	135
057	Chilli–Jute–Fallow	1050	117	Garlic–Jute–T. Aman	110
058	Maize–Jute–T. Aman	1050	118	Potato–Aus–Fallow	110
059	Lentil–Jute–Fallow	1040	119	Wheat–Chilli–Fallow	110
060	Maize–Maize–T. Aman	1000	120-164	Other 45 patterns (Table 8)	3045