Diversity of Crops and Cropping Systems in Jessore Region

M M R Dewan[1*], M Harun Ar Rashid[2], M Nasim[3] and S M Shahidullah[3]

ABSTRACT

Thorough understanding and a reliable database on existing cropping patterns, cropping intensity and crop diversity of a particular area are needed for guiding policy makers, researchers, extensionists and development workers for the planning of future research and development. During 2016 a study was accomplished over all 34 upazilas of Jessore region using pre-tested semi-structured questionnaire with a view to document the existing cropping patterns, cropping intensity and crop diversity in the region. The most dominant cropping pattern Boro−Fallow−T. Aman occupied 32.28% of net cropped area (NCA) of the region with its distribution in all upazilas. The second largest area, 5.29% of NCA, was covered by single Boro, which was spread over 24 upazilas. A total of 176 cropping patterns were identified in the whole region under the current investigation. The highest number of cropping patterns was identified 58 in Kushtia sadar upazila and the lowest was 11 in Damurhuda upazila of Chuadanga district. The lowest crop diversity index (CDI) was reported 0.852 in Narail sadar upazila followed by 0.863 in Jessore sadar upazila. The highest value of CDI was observed 0.981 in Daulatpur followed by 0.978 in Bheramara upazila of Kushtia district. The range of cropping intensity values was recorded 175−286%. The maximum value was for Sreepur of Magura district and minimum for Abhaynagar of Jessore district. As a whole the CDI of Jessore region was calculated 0.955 and the average cropping intensity at regional level was 229%.

Key words: Cropping pattern, diversity index, favourable environment and non-rice cereal

INTRODUCTION

Cropping system is the crop production activity of a farm, which includes all cropping patterns grown on the farm resources, other household enterprises and the physical, biological, technological and socioeconomic factors or environments. A cropping pattern is the yearly sequence, temporal and partial arrangement of crops in a given land area. It is 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).

The Jessore region includes the western part of the Ganges river floodplain which is predominantly highland and medium highland and it consists of 34 upazilas under seven districts. General soil types predominantly include calcareous dark grey floodplain soils and calcareous brown floodplain soils. Organic matter content in the brown ridge soils is low but higher in the dark grey soils. Soils are slightly alkaline in reaction. General fertility level is low. This region is suitable for agricultural crop production especially in cereals and vegetables. The cropping intensity is much higher than the other region of the country. The whole area holds comparatively dry weather than theother parts of the country. Low water holding capacity is an overall limitation for modern Boro rice cultivation in the region. Water stagnation is also a problem in some specific locations.

[1]BRRI RS Kushtia; [2]BRRI RS Rajshahi; [3]Rice Farming Systems Division, BRRI, Gazipur; *Corresponding author's E-mail: dewanbrri@yahoo.com

The overall agricultural development in Bangladesh conceals considerable regional differences because of farming practices, techniques, availability of irrigation facilities, attitude of the farmer etc in different parts of the country. The differences in agricultural productivity among the regions to some natural phenomena, such as, rainfall, temperature, humidity and some other agro-ecological features which are relatively less favourable in the lagging regions. Jessore region plays a vital role of Agriculture in Bangladesh. The region produces a variety of crops year-round.

The yields of cereal crops are tending to stagnation, even in favourable environments. Moreover, cultivable land area is decreasing day by day in the country. To increase the system productivity of the total environment it needs to bring diversity in enterprises for better utilization of limited resources. 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). There is a strong need for judicious and appropriate use of limited resources in case of intervention selection that does not lead to increased mal adaption or inequity in the society over long term. Existing trends of available agricultural lands is most essential requirement for any land use planning related to farming and food security in a sustainable manner. Therefore, an increased understanding of arable land use based on the cropping system is essential for the appropriate intervention in sustainable way. In these context, existing cropping patterns along with their diversity of such complex agricultural region are very crucial for risk minimization and overall productivity improvement. The present study was designed with the following specific objectives to:

- Understand the existing cropping patterns scenario in Jessore region

- Visualize the existing land use pattern at upazila and regional level

- Determine the crop diversity and cropping intensity at upazila, district and regional level.

METHODOLOGY

Thirty-four upazilas of Jessore, Jhenaidaha, Magura, Narail, Kushtia, Meherpur and Chuadanga districts under Jessore 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 34 pre-assigned Sub-Assistant Agriculture Officers (SAAO) of each upazila during January 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. Second stage of data collection was day-long data validation workshop at district level. The workshop dates were 14 March for Narail and Magura; 15 March for Jhenaidaha; 12 April for Jessore; 13 April for Kushtia and 28 April 2016 for Chuadanga and Meherpur. 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 BRRI regional station, Kushtia and Satkhira participated in the data validation workshop. The number of participants of validation workshop ranged from 26 to 73 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).

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

Where, CDI_i = Crop Diversity Index
a_{ij} = Area planted to the jth crop in the ith 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
Table 1 presents the status of agricultural land utilization. The net cropped area of the Jessore region is 736,920 ha. 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 100 to 2,330 ha. The annual crops area accounted only 4.14 % of the net cropped area (NCA) in the region. At a glance the region possesses 6% single cropped area (SCA), 52% double cropped area (DCA), 37% triple cropped area (TCA). The quadruple cropped area also exists as a very negligible portion (0.63%). The SCA was dominant in Abhaynagar and had the major share of NCA in Keshabpur of Jessore and Narail sadar upazila followed by corresponding double cropped area (DCA). Most of the upazilas were dominated by DCA. The exceptions are Manirampur of Jessore district; Mirpur, Khoksa and Bheramara of Kushtia district; Shailkupa of Jhenaidaha district and Jibannagar of Chuadanga district

where triple cropped area was the dominating ones (Table 1). The area that 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 Jessore
In total 176 cropping patterns were observed in Jessore region of which nine cropping patterns with exclusive rice crop covers about 46% of the NCA. There were 47 cropping patterns with exclusive non-rice crop covering over 12% of the NCA. Rest of the NCA i.e. around 42% area is covered by 120 rice - non rice cropping patterns (Appendix 1).

Rice and non-rice crops at a glance
Table 2 presents nine cropping patterns where rice is the only crop round the year. It comprises about 46% of the NCA in the region. Among them single rice, double rice and triple riceareas represent over 5%, about 36% and about 3% respectively. It reflects the unparallel dominance of rice in the cropping systems in jessore region. In case of individual pattern Boro−Fallow−T. Aman has the highest coverage (32.28%) and was recorded in all 34 upazilas. The second dominant pattern single Boro area occupied 5.29% of NCA which was reported in 24 upazilas. Boro−Aus−T. Aman covered 2.76% area with its existence in only 15 upazilas.

In the current investigation, 47 cropping patterns were identified that was free from rice. Among these 47 patterns, first 32 have been arranged in descending order in Table 3. The rest 15 patterns with negligible area coverage (Table 9) are arranged with other patterns of different categories. Aggregate of the 47 patterns have had over 12% of NCA. In critical comparison, it is clear that exclusive rice area is about four folds of exclusive non-rice area. In Jessore 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 Jessore region (area in hectare), 2014-15.

	Upazila	Area of upazila	Annual crop	SCA	DCA	TCA	QCA	Other	NCA	C.I. (%)
01	Jessore sadar	43298	460	80	19790	10520	100	160	31110	233
02	Keshabpur	25903	990	6000	8300	4560	0	190	20040	188
03	Manirampur	44499	570	2500	15800	16200	1000	100	36170	242
04	Abhaynagar	24719	590	8100	4010	3200	200	190	16290	168
05	Jhikargachha	30809	320	100	14450	8550	0	150	23570	235
06	Sarsha	33642	180	700	14650	8900	1200	150	25780	241
07	Bagherpara	27096	350	660	10320	7410	80	130	18950	235
08	Chougachha	26919	560	1300	10420	5320	300	160	18060	223
09	Kushtia sadar	31857	1890	230	11640	8760	400	170	23090	232
10	Mirpur	30454	690	1110	5120	16350	200	120	23590	264
11	Kumarkhali	25837	700	710	8850	6660	0	180	17100	231
12	Khoksa	10376	1020	0	2530	4030	0	140	7720	240
13	Daulatpur	48228	1330	750	17590	14400	0	160	34230	236
14	Bheramara	15370	1650	460	2530	4210	100	100	9050	226
15	Magura sadar	40130	590	680	11680	15480	0	160	28590	250
16	Sreepur	17719	720	170	2200	10730	0	200	14020	271
17	Shalikha	22864	120	0	9000	8120	0	130	17370	246
18	Mohammadpur	22930	230	1730	5310	8400	0	160	15830	241
19	Meherpur sadar	26152	1060	40	10300	9910	0	150	21460	241
20	Gangni	33932	620	0	12000	11090	0	110	23820	244
21	Mujibnagar	11354	660	600	4600	2830	0	120	8810	218
22	Narail sadar	37226	600	5000	17410	5090	0	100	28200	198
23	Lohagara	28485	370	1450	13020	7090	0	140	22070	224
24	Kalia	30177	700	0	19900	2930	0	170	23700	209
25	Jhenaidaha sadar	46775	1620	350	15500	9200	0	150	26820	227
26	Shailkupa	37345	1980	3000	8900	15380	700	120	30080	239
27	Kotchandpur	16095	1090	1040	7550	2780	0	130	12590	205
28	Moheshpur	41903	1310	1970	21360	9020	0	150	33810	217
29	Harinakundu	22723	2330	0	8920	3340	0	140	14730	207
30	Kaliganj	31114	1820	430	11360	8060	0	150	21820	227
31	Chuadnga sadar	29855	990	20	15130	4230	0	120	20490	216
32	Alamdanga	36528	1670	2200	20000	5450	350	100	29770	208
33	Jibannagar	19933	100	0	6500	8450	0	150	15200	255
34	Damurhuda	30344	640	0	14250	7980	0	120	22990	232
	Jessore region		30520	41380	380890	274630	4630	4870	736920	229

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

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Boro−Fallow−T. Aman	237850	32.28	34
02	Boro−Fallow−Fallow	39010	5.29	24
03	Boro−Aus−T. Aman	20350	2.76	15
04	Boro−Aus−Fallow	17000	2.31	16
05	Boro−B.Aman	8250	1.12	6
06	Fallow−B.Aus+B. Aman	500	0.07	1
07	Fallow-Fallow-T. Aman	300	0.04	1
08	Fallow-B.Aman	180	0.02	3
09	Fallow-Aus-Fallow	70	0.01	1
	Total	323510	43.90	

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

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Vegetab−Vegetab−Vegetab	19170	2.60	25
02	Maize−Jute−Fallow	9900	1.34	7
03	Wheat−Jute−Fallow	7960	1.08	9
04	Lentil−Jute−Fallow	7550	1.02	13
05	Grasspea−Jute−Fallow	6140	0.83	6
06	Vegetab−Vegetab−Fallow	4120	0.56	9
07	Wheat−Chilli−Fallow	3350	0.45	4
08	Lentil−Vegetab−Vegetab	2780	0.38	10
09	Wheat−Jute−Blackgram	2750	0.37	4
10	Onion−Jute−Fallow	2600	0.35	9
11	Onion−Vegtab−Vegetab	2090	0.28	10
12	Mustard−Jute−Vegetab	1900	0.26	5
13	Maize−Vegetab−Fallow	1750	0.24	4
14	Vegetab−Jute−Fallow	1730	0.23	5
15	Chilli−Vegetab−Fallow	1330	0.18	13
16	Vegetab−Fallow−Blackgram	1250	0.17	4
17	Wheat−Vegetab−Vegetab	1240	0.17	6
18	Pea−Jute−Fallow	1170	0.16	6
19	Wheat−Jute−Vegetab	1100	0.15	3
20	Garlic−Jute−Fallow	1040	0.14	5
21	Garlic−Vegetab−Vegetab	850	0.12	8
22	Chilli−Fallow−Fallow	840	0.12	6
23	Maize−Mungbean−Vegetab	800	0.11	1
24	Pea−Vegetab−Fallow	800	0.11	3
25	Vegetab−Jute−Vegetab	800	0.11	1
26	Lentil−Sesame−Fallow	770	0.11	3
27	Maize−Groundnut	620	0.08	1
28	Potato−Sesame−Fallow	540	0.07	2
29	Potato−Jute−Fallow	530	0.07	4
30	Vegetab−Maize−Fallow	510	0.07	2
31	Mustard−Jute−Fallow	450	0.06	2
32	Coriander−Fallow−Fallow	300	0.04	3
33-47	Other 15 patterns (in Table 9)	1410	0.19	-
	Total	90140	12.23	

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
Forty cropping patterns are holding different non-rice cereal crops (Table 4). Among them wheat, with the largest area, is leading 17 patterns cultivated on 59,920 hectares that is equivalent to 8.11% of NCA. Maize holds the second position in non-rice cereal crop cultivation in Jessore region. There are 24 cropping patterns for maize, which in-together occupy 7.27% of NCA. In the documentation of non-rice cereal cropping systems wheat reported widest spreading e.g. Wheat−Jute−T. Aman is distributed over 29 upazilas out of 34. Overall, the aggregate area of the non-rice cereal cropping system stands for 15.41% of the NCA in Jessore 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

Table 4. Cropping patterns based on maize and wheat in Jessore region, 2014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Wheat−Jute−T. Aman	30300	4.11	29
02	Maize−Aus−Fallow	10850	1.47	6
03	Maize−Jute−Fallow	9900	1.34	7
04	Maize−Fallow−T. Aman	9000	1.22	7
05	Wheat−Jute−Fallow	7960	1.08	9
06	Maize−Jute−T. Aman	5580	0.76	9
07	Maize−Mungbean−T. Aman	4900	0.66	3
08	Wheat−Sesame−T. Aman	3750	0.51	9
09	Wheat−Chilli−Fallow	3350	0.45	4
10	Maize−Aus−Vegetab	3000	0.41	4
11	Wheat−Fallow−T. Aman	2910	0.39	8
12	Wheat−Jute−Blackgram	2750	0.37	4
13	Wheat−Aus−T. Aman	2130	0.29	8
14	Wheat−Aus−Fallow	1910	0.26	5
15	Maize−Vegetab−Fallow	1750	0.24	4
16	Maize−Sesame−T. Aman	1530	0.21	7
17	Maize−Vegetab−T. Aman	1260	0.17	3
18	Wheat−Vegetab−Vegetab	1240	0.17	6
19	Wheat−Jute−Vegetab	1100	0.15	3
20	Mustard−Maize−T. Aman	900	0.12	2
21	Vegetab−Maize−T. Aman	880	0.12	1
22	Wheat−Mungbean−T. Aman	810	0.11	6
23	Maize−Mungbean−Vegetab	800	0.11	1
24	Wheat−Vegetab−T. Aman	670	0.09	4
25	Maize−Groundnut	620	0.08	1
26	Wheat−Aus−Cotton	600	0.08	1
27	Maize−Aus−T. Aman	580	0.08	3
28	Potato−Maize−T. Aman	550	0.07	2
29	Vegetab−Maize−Fallow	510	0.07	2
30	Wheat−Aus−Blackgram	300	0.04	2
31	Maize−Sesame−Fallow	280	0.04	2
32	Mustard−Maize−Jute	200	0.03	1
33	Tobacco−Maize−T. Aman	190	0.03	2
34-40	Other seven patterns (in Table 9)	480	0.07	
	Total area for wheat and maize	113540	15.41	

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

Fibre crops

Jute is the main fibre crop in Bangladesh. Once it is called Golden Fibre. Socially and economically jute is an important crop in the Jessore region. There are 41 cropping patterns were identified based on jute (Table 5). It is observed that the jute based cropping patterns covered 23.90% of NCA of the Jessore region. Among them Wheat-Jute-T. Aman cropping pattern absolutely occupies 4.11% of the NCA which is distributed over 29 upazilas out of 34 covering 30,300 hectares of land area. The

second prevailing Lentil-Jute-T. Aman covers 29,650 hectare area which is 4.02% of the NCA. Tobacco-Jute-T. Aman stands in third position in terms of area coverage, however, it is narrowly distributed in only eight upazilas out of 34. Well-drained light-textured soil makes the friendly situation for early growth stages of jute. High temperature, high humidity, satisfactory rainfall are the pre-requisites for cultivation of the crop. Plenty of flood water is timely available in the region for jute retting. Clear sun-shine during the harvesting period is

an extra facility for post-harvest management of fibre and stick. Now-a-days jute-stick also has a good market value with export potential. All these make a favourable package which encourages the farmers for extensive jute cultivation in the region (FAO, 1988).

Tobacco in cropping systems

Tobacco is the exceptional crop which is cultivated in Jessore region mainly in Kushtia district. Product of tobacco is harmful to the human. Table 6 presents nine cropping

Table 5. Jute-based cropping patterns in Jessore region, 2014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Wheat−Jute−T. Aman	30300	4.11	29
02	Lentil−Jute−T. Aman	29650	4.02	23
03	Tobacco−Jute−T. Aman	12180	1.65	8
04	Onion−Jute−T. Aman	10740	1.46	21
05	Mustard−Jute−T. Aman	10710	1.45	15
06	Maize−Jute−Fallow	9900	1.34	7
07	Wheat−Jute−Fallow	7960	1.08	9
08	Lentil−Jute−Fallow	7550	1.02	13
09	Boro−Jute−T. Aman	6320	0.86	11
10	Boro−Jute−Fallow	6250	0.85	7
11	Grasspea−Jute−Fallow	6140	0.83	6
12	Maize−Jute−T. Aman	5580	0.76	9
13	Tobacco−Jute−Fallow	3950	0.54	6
14	Garlic−Jute−T. Aman	3100	0.42	14
15	Wheat−Jute−Blackgram	2750	0.37	4
16	Onion−Jute−Fallow	2600	0.35	9
17	Mustard−Boro−Jute−T. Aman	2500	0.34	5
18	Grasspea−Jute−T. Aman	2150	0.29	10
19	Mustard−Jute−Vegetab	1900	0.26	5
20	Vegetab−Jute−Fallow	1730	0.23	5
21	Vegetab−Jute−T. Aman	1310	0.18	4
22	Mustard−Boro−Jute	1200	0.16	1
23	Pea−Jute−Fallow	1170	0.16	6
24	Potato−Jute−T. Aman	1150	0.16	9
25	Wheat−Jute−Vegetab	1100	0.15	3
26	Garlic−Jute−Fallow	1040	0.14	5
27	Coriander−Jute−T. Aman	1010	0.14	8
28	Vegetab−Jute−Vegetab	800	0.11	1
29	Chilli−Jute−T. Aman	740	0.10	6
30	Potato−Jute−Fallow	530	0.07	4
31	Mustard−Jute−Fallow	450	0.06	2
32	Blackgram−Jute−T. Aman	300	0.04	1
33	Potato−Boro−Jute	250	0.03	1
34	Coriander−Jute−Fallow	200	0.03	2
35	Mustard−Maize−Jute	200	0.03	1
36	Potato−Boro−Jute−T. Aman	200	0.03	1
37-41	Other five patterns (in table 9)	520	0.07	-
	Total area for jute	176130	23.90	

patterns that comprises 3.20% of the NCA in the region mainly of triple cropped areas. The pattern Tobacco−Jute−T. Aman has the highest coverage (1.65% of the NCA) and was recorded in eight upazilas out of 34 followed by Tobacco−Jute−Fallow. In consideration of human health and social impact the tobacco crop is discouraged on principle. However, people of the concerned area can not give up tobacco cultivation. Famers consider the crop as an insurance of his property. Industry personnel make assurance to purchase their products with high price. Moreover, they pay advance money as production cost. They supply all inputs and technologies for successful production of tobacco. These are privileges of farmers for tobacco cultivation.

Pulse crops under the cropping systems

Forty-four cropping patterns are holding different pulse crops (Table 7). Among them lentil is covering the largest area whereas chickpea in the smallest area. Twelve cropping patterns of lentil in-together cover 8.52% of NCA. Grasspea holds the second position in pulse crop cultivation in Jessore region. There are 11 cropping patterns for grasspea covering 2.11% NCA in the region. Top three patterns viz Grasspea−Jute−Fallow, Grasspea−B.Aman and Grasspea−Jute−T. Aman in-together occupy over 0.92% of NCA. Finally the aggregate area of the pulse cropping system stands for 12.02% of the NCA in Jessore region. In some specific area of Jessore region Boro cultivation faces some constraints such as scarcity of irrigation water, very light soil with low-water holding capacity. Moreover, high market price of pulse crops is driving force for ample cultivation of pulse crops. Among the Rabi crops stress-tolerant grasspea can easily be grown as relay system (FAO, 1988).

Oil-seed crops

Thirty-two cropping patterns have been arranged in descending order according to area coverage in Table 8. Mustard is the most important one among the oil-seed crops in Jessore region. There are 17 cropping patterns had been led by mustard alone which in-together covers 55,700 ha (7.56% of NCA). The pattern Mustard−Boro−T. Aman has the highest coverage (3.07% of the NCA) and was recorded in 21 upazilas out of 34 followed by Mustard−Jute−T. Aman (1.45% of NCA).

Sporadic and distinct cropping patterns

There are some cropping patterns, which are extremely location-specific, however, with a large area coverage. These are Mustard−Boro−Jute (Table 8), Tobacco−Sesbania−T. Aman (Table 6) and Onion−Fallow−T. Aman (Appendix 1). The Mustard−Boro−Jute is grown on 1,200 haonly in Sarsha of Jessore district. Tobacco−Sesbania−T. Aman is cultivated on 1,600 ha only in Mirpur upazila of Kushtia district. Onion−Fallow−T. Aman is limited to two upazilas viz Bheramara (250 ha) and Kumarkhali (1,500 ha).

Rare cropping patterns

In the present investigation, 40 cropping patterns have been identified as rare cropping patterns with a negligible area coverage with seldom existence (Table 9). 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 is far below

Table 6. Tobacco based cropping patterns in Jessore region, 2014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
1	Tobacco−Jute−T. Aman	12180	1.65	8
2	Tobacco−Jute−Fallow	3950	0.54	6
3	Tobacco−Aus−T. Aman	2950	0.40	3
4	Tobacco−Fallow−T. Aman	1670	0.23	6
5	Tobacco−Sesbania−T. Aman	1620	0.22	2
6	Tobacco−Aus−Fallow	930	0.13	3
7-9	Other three patterns (in table 9)	280	0.04	
	Total tobacco	23580	3.20	

Table 7. Cropping patterns with pulse crops in Jessore region, 2014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Lentil−Jute−T. Aman	29650	4.02	23
02	Lentil−Jute−Fallow	7550	1.02	13
03	Lentil−Sesame−T. Aman	6630	0.90	17
04	Grasspea−Jute−Fallow	6140	0.83	6
05	Lentil−Mungbean−T. Aman	5080	0.69	14
06	Lentil−Aus−T. Aman	4800	0.65	5
07	Grasspea−B.Aman	4450	0.60	5
08	Lentil−Aus−Fallow	2950	0.40	4
09	Lentil−Vegetab−Vegetab	2780	0.38	10
10	Wheat−Jute−Blackgram	2750	0.37	4
11	Lentil−Vegetab−T. Aman	2250	0.31	4
12	Grasspea−Jute−T. Aman	2150	0.29	10
13	Vegetab−Fallow−Blackgram	1250	0.17	4
14	Pea−Jute−Fallow	1170	0.16	6
15	Grasspea−Fallow−T. Aman	1100	0.15	9
16	Grasspea−Aus−T. Aman	900	0.12	5
17	Pea−Aus−Vegetab	900	0.12	4
18	Pea−Vegetab−Fallow	800	0.11	3
19	Lentil−Sesame−Fallow	770	0.10	3
20	Pea−Fallow−T. Aman	740	0.10	6
21	Boro−Fallow−Blackgram	530	0.07	3
22	Blackgram−Jute−T. Aman	300	0.04	1
23	Wheat−Aus−Blackgram	300	0.04	2
24	Pea−B.Aman	280	0.04	3
25	Lentil−Fallow−T. Aman	240	0.03	3
26	Grasspea−B.Aus+B.Aman	200	0.03	1
27	Grasspea−Sesame−Fallow	200	0.03	2
28	Onion−Aus−Blackgram	200	0.03	1
29-44	Other 16 patterns (in table 9)	1500	0.20	
	Total area for pulse crops	88560	12.02	

1% of NCA. Among these the highest area was allotted for Groundnut−Fallow−Fallow (190 ha) and it is recorded in Kumarkhali of Kushtia, Mohammadpur upazila of Magura district and of Meherpur sadar upazila. The smallest area was recorded for four cropping patterns whose coverage was 20 hectares for each (Table 9).

Most dominant cropping pattern

Boro−Fallow−T. Aman was the most dominant cropping pattern in Jessore region. It covers 32.28% of NCA in the region and is available in all 34 upazilas (Table 10). The highest area under this cropping pattern was recorded 17,000 ha in Jessore sadar upazila which represents 7.15% of the total Boro−Fallow−T. Aman area of the region. In consideration of individual upazila

Jhenaidaha sadar upazila stand on the 2nd position for area coverage, however, this upazila has allocated biggest share i.e. 58% of its NCA for this pattern alone. Bheramera upazila had a negligible area coverage for this pattern. In the country-wide data compilation 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

Single Boro cropping pattern holds the second largest area coverage 39,010 ha in Jessore region. This area is an equivalent to 5.29% of NCA in the region. This pattern Boro−Fallow−

Table 8. Cropping patterns with oil-seed crops in Jessore region, 2014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Mustard−Boro−T. Aman	22600	3.07	21
02	Mustard−Jute−T. Aman	10710	1.45	15
03	Lentil−Sesame−T. Aman	6630	0.90	17
04	Mustard−Boro−Aus	5050	0.69	4
05	Wheat−Sesame−T. Aman	3750	0.51	9
06	Mustard−Boro−Jute−T. Aman	2500	0.34	5
07	Mustard−Mungbean−T. Aman	2370	0.32	10
08	Mustard−Aus−T. Aman	2220	0.30	6
09	Mustard−Sesame−T. Aman	2060	0.28	6
10	Mustard−Jute−Vegetab	1900	0.26	5
11	Mustard−Boro−Aus−T. Aman	1650	0.22	6
12	Maize−Sesame−T. Aman	1530	0.21	7
13	Mustard−Boro−Fallow	1290	0.18	4
14	Mustard−Boro−Jute	1200	0.16	1
15	Mustard−Maize−T. Aman	900	0.12	2
16	Lentil−Sesame−Fallow	770	0.10	3
17	Onion−Sesame−T. Aman	650	0.09	2
18	Maize−Groundnut	620	0.08	1
19	Potato−Sesame−T. Aman	620	0.08	5
20	Potato−Sesame−Fallow	540	0.07	2
21	Groundnut− Aus−T. Aman	500	0.07	1
22	Mustard−Jute−Fallow	450	0.06	2
23	Mustard−Fallow−T. Aman	300	0.04	1
24	Maize−Sesame−Fallow	280	0.04	2
25	Mustard−Aus−Fallow	200	0.03	3
26	Grasspea−Sesame−Fallow	200	0.03	2
27	Mustard−Maize−Jute	200	0.03	1
28-32	Other five patterns (in table 9)	430	0.06	
	Total area for oil-seed crops	72120	9.79	

Fallow is distributed over only 24 upazilas (Table 11). Abhaynagar has an area of 7,800 ha for single Boro which stands for 19.99% of the total area under this pattern in the region. Jessore sadar had a negligible area coverage for this pattern. 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 data compilation it was observed that the single Boro was the 2nd 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

The third dominant cropping pattern in Jessore region is Wheat-Jute-T. Aman. It belongs to 4.11% of NCA of the region and spread out over 29 upazilas (Table 12). Shailkupa upazila of Jhenaidaha district hold the highest area (3,500 ha) which represents 11.55% of the total Wheat-Jute-T. Aman area of the region. Sreepur stands in the third position, however, this upazila of Magura district has allocated the biggest share i.e. 21% surface of its NCA. In the country-wide compilation of data it was observed that Wheat−Jute−T. Aman was the 9th dominant cropping pattern in Bangladesh covering 1.47 lac ha (1.72% of NCA in the country) with its distribution in 216 upazilas of 43 districts (Nasim *et al.*, 2017).

Table 9. Rare cropping patterns covering non-significant area in Jessore region, 2014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency	Upazila
01	Groundnut−Fallow−Fallow	190	0.03	3	Kumarkhali+Md.pur+Meherpur
02	Tobacco−Maize−T. Aman	190	0.03	2	Daulatpur+Mirpur
03	Fallow−B.Aman	180	0.02	3	Kotchandpur+Kushtia+Magura
04	Chilli−Jute−Fallow	180	0.02	2	Lohagara+Kalia
05	Potato−Aus−Fallow	180	0.02	2	Harinakundu+Jessore
06	Grasspea−Mungbean−T. Aman	170	0.02	1	Narail sadar
07	Garlic−Aus−Fallow	160	0.02	3	Chougachha+Khoksa+Kumarkhali
08	Potato−Boro−T. Aman	150	0.02	3	Jessore+Kaliganj+Moheshpur
09	Grasspea−Fallow−Fallow	150	0.02	1	Magura sadar
10	Vegetab−Fallow−Fallow	150	0.02	1	Kotchandpur
11	Potato−Boro−Fallow	140	0.02	2	Chougachha+Kaliganj
12	Fallow−Fallow−Blackgram	130	0.02	1	Bheramara
13	Chickpea−Fallow−T. Aman	110	0.01	3	Bagherpara+Jessore+Kushtia
14	Coriander−Vegetab−Fallow	110	0.01	3	Khoksa+Kumarkhali+Shalikha
15	Chickpea−Jute−T. Aman	100	0.01	3	Jessore+Magura+Sreepur
16	Coriander−Fallow−T. Aman	100	0.01	3	Jhikargachha+Kushtia+Mirpur
17	Lentil−Mungbean−Jute−T. Aman	100	0.01	1	Manirampur
18	Maize−Fallow−Blackgram	100	0.01	1	Chuadanga sadar
19	Mungbean−Fallow−T. Aman	100	0.01	1	Jessore sadar
20	Mungbean−Jute−Fallow	100	0.01	1	Daulatpur
21	Mustard−M.bean−Aus−T. Aman	100	0.01	1	Manirampur
22	Sesame−Fallow−T. Aman	100	0.01	2	Magura sadar+Kaliganj
23	Wheat−Mungbean−Fallow	100	0.01	1	Jhikargachha
24	Potato−Aus−T. Aman	80	0.01	1	Jessore sadar
25	Potato+S.gourd−M.bean−T. Aman	80	0.01	1	Bagherpara
26	Fallow−Aus−Fallow	70	0.01	1	Mohammadpur
27	Grasspea−Boro−Fallow	70	0.01	1	Kumarkhali
28	S.Potato−Fallow−Fallow	60	0.01	3	Moheshpur+Kumarkhali+Magura
29	Garlic−Aus−T. Aman	60	0.01	1	Moheshpur
30	Grasspea−Sesame−T. Aman	50	0.01	1	Kumarkhali
31	Lentil−B.Aman	50	0.01	1	Kumarkhali
32	Tobacco−Mungbean−T. Aman	50	0.01	1	Mirpur
33	Garlic−Fallow−T. Aman	40	0.01	1	Bheramara
34	S.Potato−Jute−Fallow	40	0.01	1	Daulatpur
35	Tobacco−Mungbean−Vegetab	40	0.01	1	Bheramara
36	Maize−Maize−T. Aman	30	0.00	1	Jessore sadar
37	Onion−Maize−Fallow	20	0.00	1	Kumarkhali
38	Potato−Sesame−Aus	20	0.00	1	Jessore sadar
39	Wheat−Maize−Fallow	20	0.00	1	Kumarkhali
40	Wheat−Sesame−Fallow	20	0.00	1	Chuadanga sadar
	Total	3890	0.53	-	

Table 10. Distribution of the most dominant Boro−Fallow−T. Aman cropping patterns in Jessore region, 2014-15.

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Jessore sadar	17000	55.46	7.15
02	Jhenaidaha sadar	14500	57.54	6.10
03	Manirampur	13500	37.92	5.68
04	Sarsha	13000	50.78	5.47
05	Kalia	12900	56.09	5.42
06	Moheshpur	10700	32.92	4.50
07	Kaliganj	10300	51.50	4.33
08	Bagherpara	9800	52.69	4.12
09	Jhikargachha	9800	42.15	4.12
10	Magura sadar	9500	33.93	3.99
11	Narail sadar	9200	33.33	3.87
12	Damurhuda	8900	39.82	3.74
13	Shailkupa	8900	31.67	3.74
14	Chougachha	8300	47.43	3.49
15	Kushtia sadar	8100	38.21	3.41
16	Alamdanga	8000	39.80	3.36
17	Shalikha	7800	45.22	3.28
18	Harinakundu	6500	52.42	2.73
19	Jibannagar	6500	43.05	2.73
20	Keshabpur	5600	29.40	2.35
21	Chuadanga sadar	5400	27.69	2.27
22	Meherpur sadar	4500	22.06	1.89
23	Kotchandpur	4000	34.78	1.68
24	Abhaynagar	3700	23.57	1.56
25	Mirpur	3500	15.28	1.47
26	Gangni	3500	15.09	1.47
27	Kumarkhali	3300	20.12	1.39
28	Lohagara	2850	13.13	1.20
29	Mohammadpur	2200	14.10	0.92
30	Mujibnagar	1800	22.09	0.76
31	Daulatpur	1600	4.86	0.67
32	Sreepur	1300	9.77	0.55
33	Khoksa	1200	17.91	0.50
34	Bheramara	200	2.70	0.08
	Jessore region	237850	32.28	100.00

Fourth dominant cropping pattern

Fourth dominant cropping pattern Lentil−Jute−T. Aman has occupied 29,650 hectares representing 4.02% share of NCA in Jessore region (Table 13). This pattern is distributed over 23 upazilas where Magura sadar ranked in top position. This upazila has 4,400 ha area Lentil−Jute−T. Aman which is only 15.71% of upazila NCA. Mohammadpur upazila ranks in second position with 2,700 ha area for this pattern, however, this upazila has allotted the biggest share (17.31%) of its NCA.

Fifth dominant cropping pattern

Fifth dominant cropping pattern Mustard-Boro−T. Aman had been covering 22,600 hectares representing 3.07% share of NCA in Jessore region (Table 14). This pattern is distributed over 21 upazilas where Magura sadar ranked in top position. This upazila had 3,500 ha area for Mustard-Boro−T. Aman pattern which is only 12.50% of upazila NCA and 15.49 % of total Mustard−Boro−T. Aman area in the region.

Crop diversity and cropping intensity

Higher number of available crops under cultivation in an area dictates its higher

Table 11. Distribution of the 2nd dominant Boro−Fallow−Fallow cropping pattern in Jessore region, 2014-15.

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Abhaynagar	7800	49.68	19.99
02	Keshabpur	6000	31.50	15.38
03	Narail sadar	5000	18.12	12.82
04	Shailkupa	3000	10.68	7.69
05	Manirampur	2500	7.02	6.41
06	Alamdanga	2200	10.90	5.64
07	Moheshpur	1960	6.03	5.02
08	Mohammadpur	1500	9.62	3.85
09	Chougachha	1300	7.43	3.33
10	Lohagara	1200	5.53	3.08
11	Mirpur	1100	4.80	2.82
12	Kotchandpur	850	7.39	2.18
13	Sarsha	700	2.73	1.79
14	Bagherpara	650	3.49	1.67
15	Mujibnagar	600	7.36	1.54
16	Kumarkhali	600	3.66	1.54
17	Kaliganj	400	2.00	1.29
18	Jhenaidaha sadar	350	1.39	1.13
19	Magura sadar	300	1.07	0.97
20	Bheramara	300	4.05	0.97
21	Daulatpur	250	0.76	0.81
22	Kushtia sadar	200	0.94	0.65
23	Sreepur	170	1.28	0.55
24	Jessore sadar	80	0.26	0.26
	Jessore region	39010	5.29	100.00

diversity. Number of cropping patterns is also a gross indicator of crop diversity. A total of 176 cropping patterns were identified in the whole area of Jessore region under this investigation. The highest number of cropping patterns was identified 58 in Kushtia sadar, Mirpur and Kumarkhali upazilas; and that was 57 in Jessore sadar; and 46 in Daulatpur (Table 15). The lowest number of cropping patterns was identified 11 in Damurhuda followed by 12 in Jibannagar of Chuadanga district. The higher number of cropping patterns is generally related to higher level of diversity indices for cropping pattern. The lowest diversity index for cropping pattern was recorded 0.649 in Jhenaidaha sadar followed by 0.661 in Narail sadar. Lower diversity index for crops and cropping patterns is associated with water stagnation. In a study Shahidullah *et al.* (2006) found the lowest values for all the diversity and intensity parameters in salt affected area of greater Noakhali. The highest value of diversity index for cropping pattern was found 0.954 in Daulatpur upazila that was followed by 0.938 in Bheramara upazila. The lowest CDI was reported 0.852 in Narail sadar followed by 0.863 in Jessore sadar. The highest value of CDI was observed 0.981 in Daulatpur followed by 0.978 in Bheramara upazila. The range of cropping intensity values was recorded 168-271%. The maximum value was for Sreepur of Magura district and minimum for Abhaynagar of Jessore district. As a whole the CDI of Jessore region was calculated 0.955 and the average cropping intensity at regional level was 229%. 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

Table 12. Distribution of the 3rd dominant Wheat-Jute-T. Aman cropping pattern in Jessore region, 2014-15.

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Shailkupa	3500	12.46	11.55
02	Meherpur sadar	3000	14.71	9.90
03	Sreepur	2800	21.05	9.24
04	Alamdanga	2700	13.40	8.91
05	Mohammadpur	1900	12.18	6.27
06	Daulatpur	1700	5.17	5.61
07	Gangni	1600	6.90	5.28
08	Kalia	1500	6.52	4.95
09	Khoksa	1300	19.40	4.29
10	Bheramara	1200	16.22	3.96
11	Lohagara	1150	5.30	3.80
12	Magura sadar	1100	3.93	3.63
13	Mirpur	860	3.76	2.84
14	Harinakundu	650	5.24	2.15
15	Mujibnagar	600	7.36	1.98
16	Kushtia sadar	580	2.74	1.91
17	Kumarkhali	500	3.05	1.65
18	Damurhuda	500	2.24	1.65
19	Sarsha	500	1.95	1.65
20	Manirampur	500	1.40	1.65
21	Jibannagar	400	2.65	1.32
22	Jhenaidaha sadar	350	1.39	1.16
23	Shalikha	350	2.03	1.16
24	Keshabpur	320	1.68	1.06
25	Bagherpara	200	1.08	0.66
26	Moheshpur	200	0.62	0.66
27	Chougachha	140	0.80	0.46
28	Jhikargachha	100	0.43	0.33
29	Kotchandpur	100	0.87	0.33
	Jessore region	30300	4.11	100.00

in 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).

COCLUSION

The cropping intensity of the Jessore region was higher than the national average. Boro−Fallow−T. Aman, Single Boro, Wheat-Jute-T. Aman, Lentil-Jute-T. Aman and Mustard-Boro−T. Aman were the dominant cropping patterns in the region. Exclusive rice area is about four folds of exclusive non-rice area. In Jessore region crop diversity is much wider than that of other regions. 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. The high yielding varieties of rice along with recommended crop management packages to be adopted.

- Effort might be invested so that a portion of double-rice area could be brought under Potato-Boro-T. Aman and/or other alternative three cropping systems.

Table 13. Distribution of the 4th dominant Lentil−Jute−T. Aman cropping pattern in Jessore region, 2014-15.

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Magura sadar	4400	15.71	14.84
02	Mohammadpur	2700	17.31	9.11
03	Shalikha	2400	13.91	8.09
04	Sreepur	2300	17.29	7.76
05	Lohagara	2200	10.14	7.42
06	Manirampur	2200	6.18	7.42
07	Bagherpara	1980	10.65	6.68
08	Kaliganj	1600	8.00	5.40
09	Jhenaidaha sadar	1600	6.35	5.40
10	Jhikargachha	1300	5.59	4.38
11	Gangni	1200	5.17	4.05
12	Kumarkhali	1000	6.10	3.37
13	Sarsha	800	3.13	2.70
14	Mirpur	750	3.28	2.53
15	Khoksa	700	10.45	2.36
16	Bheramara	600	8.11	2.02
17	Chougachha	600	3.43	2.02
18	Keshabpur	550	2.89	1.85
19	Narail sadar	350	1.27	**1.18**
20	Jessore sadar	200	0.65	**0.67**
21	Alamdanga	100	0.36	**0.34**
22	Mujibnagar	80	0.98	**0.27**
23	Chuadanga sadar	40	0.21	**0.13**
	Jessore region	29650	4.02	100.00

Table 14. Distribution of the 5th dominant Mustard-Boro−T. Aman cropping pattern in Jessore region, 2014-15.

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Magura sadar	3500	12.50	15.49
02	Jhenaidaha sadar	2400	9.52	10.62
03	Jessore sadar	2200	7.18	9.73
04	Moheshpur	2150	6.62	9.51
05	Bagherpara	1700	9.14	7.52
06	Shalikha	1600	9.28	7.08
07	Chougachha	1300	7.43	5.75
08	Kaliganj	1000	5.00	4.42
09	Meherpur sadar	1000	4.90	4.42
10	Gangni	1000	4.31	4.42
11	Narail sadar	950	3.44	4.20
12	Shailkupa	600	2.14	2.65
13	Kotchandpur	500	4.35	2.21
14	Kushtia sadar	450	2.12	1.77
15	Alamdanga	400	1.42	1.77
16	Abhaynagar	400	2.55	1.77
17	Jhikargachha	400	1.72	1.77
18	Harinakundu	400	3.23	1.77
19	Mujibnagar	400	4.91	1.77
20	Khoksa	200	2.99	0.88
21	Kumarkhali	50	0.30	0.22
	Jessore region	22600	3.07	100.00

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

	Upazila	No. of identified pattern	No. of crop	Diversity index for cropping pattern	Crop diversity index (CDI)	C.I. (%)
01	Jessore sadar	57	16	0.679	0.863	233
02	Keshabpur	22	18	0.800	0.921	188
03	Manirampur	24	14	0.792	0.923	242
04	Abhaynagar	20	16	0.685	0.871	168
05	Jhikargachha	30	20	0.797	0.925	235
06	Sarsha	19	18	0.723	0.903	241
07	Bagherpara	27	22	0.695	0.889	235
08	Chougachha	22	18	0.747	0.903	223
09	Kushtia sadar	58	18	0.818	0.946	232
10	Mirpur	58	24	0.900	0.963	264
11	Kumarkhali	58	23	0.928	0.973	231
12	Khoksa	20	20	0.887	0.970	240
13	Daulatpur	46	23	0.954	0.981	236
14	Bheramara	29	19	0.938	0.978	226
15	Magura sadar	33	23	0.830	0.939	250
16	Sreepur	17	16	0.858	0.948	271
17	Shalikha	22	16	0.749	0.911	246
18	Mohammadpur	30	18	0.906	0.960	241
19	Meherpur sadar	23	17	0.892	0.961	241
20	Gangni	25	14	0.925	0.972	244
21	Mujibnagar	19	13	0.902	0.962	218
22	Narail sadar	15	14	0.661	0.852	198
23	Lohagara	19	16	0.906	0.959	224
24	Kalia	22	13	0.830	0.924	209
25	Jhenaidaha sadar	19	17	0.649	0.876	227
26	Shailkupa	14	16	0.842	0.947	239
27	Kotchandpur	22	12	0.794	0.917	205
28	Moheshpur	33	22	0.857	0.942	217
29	Harinakundu	25	17	0.710	0.903	207
30	Kaliganj	26	18	0.712	0.902	227
31	Chuadnga sadar	22	19	0.849	0.938	216
32	Alamdanga	24	18	0.855	0.939	208
33	Jibannagar	12	14	0.767	0.922	255
34	Damurhuda	11	13	0.775	0.914	232
	Jessore region	176	35	0.884	0.955	229

- In the single Boro area suitable vegetables might be grown on floating bed system in wet season.
- The upazilas having unique or exceptional cropping patterns with large area coverage might be studied in-depth to extrapolate to similar environments.

REFERENCES

Agrawal, D J and A H Kassam. 1976. The importance of multiple cropping in increasing world food supplies. A special publication No. 27, American Society of Agronomy, Madison, Wisconsin. pp. 2-3.

Blade, S F and A E Slinkard 2002. New Crop Development: The Canadian Experience. *In*: Trends in New Crops

and New Uses. J Janick and A Whipkey (Editors). ASHS Press, Alexandria.

FAO, 1988. Land Resources Appraisal of Bangladesh for Agricultural Development- Report 2: Agroecological regions of Bangladesh. Food and Agriculture Organization of the United Nations, Rome, Italy, 570p.

Gadge, S S. 2003. Influence of changes in cropping pattern on farmers' economic status. Indian J. Ext. Edu. 39(1&2): 99-101.

Kshirsagar, K G, S Pandey and M R Bellon. 1997. Farmers' perception, varietal characteristics and technology adoption: the case of rainfed village in eastern India. Discussion paper 5/97. Social Sciences Division, International Rice Research Institute. Los Baños, Laguna, Philippines.

Mahesh, R. 1999. Causes and consequences of change in cropping pattern: A location specific study. Discussion Paper No. 11, Kerala Research Programme on Local Level Development, Centre for Development Studies, Thiruvananthapura.

Mandal, R and M P Bezbaruah. 2013. Diversification of cropping pattern: its determinants and role in flood affected agriculture of Assam Plains. Indian J. Agric. Econ. 68(2): 169-181.

Muttaleb, M A, S M Shahidullah, M Nasim and A Saha. 2017. Cropping systems and land uuse in Sylhet region. Bangladesh Rice J. 21(2): 273-288.

Nasim, M, S M Shahidullah, A Saha, M A Muttaleb, T L Aditya, M A Ali and M S Kabir. 2017. Distribution of Crops and Cropping Patterns in Bangladesh. Bangladesh Rice J. 21(2): 1-55.

Neena, D. 1998. Interstate variation in cropping pattern in India. Indian J. Regi. Sci. 30(2): 57-69.

Shahidullah, S M, M S A Talukder, M S Kabir, A H Khan and N E Elahi. 2006. Cropping patterns in the South East Coastal Region of Bangladesh. J. Agric. Rural Dev. 4(1&2): 53-60.

Shahidullah, S M, M Nasim, M K Quais and A Saha. 2017. Diversity of Cropping Systems in Chittagong Region. Bangladesh Rice J. 21(2): 109-122.

Shriar, A J. 2000. Agricultural intensity and its measurement in frontier regions. Agroforestry Systems. 49(3): 301–318.

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

	Cropping pattern	Area (ha)		Cropping pattern	Area (ha)
001	Boro−Fallow−T. Aman	237850	069	Wheat−Vegetab−Vegetab	1240
002	Boro−Fallow−Fallow	39010	070	Mustard−Boro−Jute	1200
003	Wheat−Jute−T. Aman	30300	071	Pea−Jute−Fallow	1170
004	Lentil−Jute−T. Aman	29650	072	Potato−Jute−T. Aman	1150
005	Mustard−Boro−T. Aman	22600	073	Potato−Vegetab−T. Aman	1120
006	Boro−Aus−T. Aman	20350	074	Grasspea−Fallow−T. Aman	1100
007	Vegetab−Vegetab−Vegetab	19170	075	Wheat−Jute−Vegetab	1100
008	Boro−Aus−Fallow	17000	076	Onion−Aus−T. Aman	1060
009	Tobacco−Jute−T. Aman	12180	077	Garlic−Jute−Fallow	1040
010	Maize−Aus−Fallow	10850	078	Coriander−Jute−T. Aman	1010
011	Onion−Jute−T. Aman	10740	079	Onion−Aus−Fallow	1000
012	Mustard−Jute−T. Aman	10710	080	Potato−Mungbean−T. Aman	930
013	Maize−Jute−Fallow	9900	081	Tobacco−Aus−Fallow	930
014	Maize−Fallow−T. Aman	9000	082	Grasspea−Aus−T. Aman	900
015	Boro−B.Aman	8250	083	Mustard−Maize−T. Aman	900
016	Wheat−Jute−Fallow	7960	084	Pea−Aus−Vegetab	900
017	Lentil−Jute−Fallow	7550	085	Vegetab−Maize−T. Aman	880
018	Boro−Sesbania−T. Aman	6850	086	Garlic−Vegetab−Vegetab	850
019	Lentil−Sesame−T. Aman	6630	087	Chilli−Fallow−Fallow	840
020	Boro−Jute−T. Aman	6320	088	Wheat−Mungbean−T. Aman	810
021	Boro−Jute−Fallow	6250	089	Maize−Mungbean−Vegetab	800
022	Grasspea−Jute−Fallow	6140	090	Pea−Vegetab−Fallow	800
023	Maize−Jute−T. Aman	5580	091	Vegetab−Jute−Vegetab	800
024	Lentil−Mungbean−T. Aman	5080	092	Lentil−Sesame−Fallow	770
025	Mustard−Boro−Aus	5050	093	Chilli−Jute−T. Aman	740
026	Maize−Mungbean−T. Aman	4900	094	Pea−Fallow−T. Aman	740

Appendix 1. Continued.

	Cropping pattern	Area (ha)		Cropping pattern	Area (ha)
027	Lentil–Aus–T. Aman	4800	095	Wheat–Vegetab–T. Aman	670
028	Grasspea–B.Aman	4450	096	Onion–Sesame–T. Aman	650
029	Vegetab–Vegetab–T. Aman	4360	097	Cotton–Aus–Fallow	630
030	Vegetab–Vegetab–Fallow	4120	098	Maize–Groundnut	620
031	Tobacco–Jute–Fallow	3950	099	Potato–Sesame–T. Aman	620
032	Wheat–Sesame–T. Aman	3750	100	Vegetab–Boro–T. Aman	600
033	Wheat–Chilli–Fallow	3350	101	Wheat–Aus–Cotton	600
034	Garlic–Jute–T. Aman	3100	102	Maize–Aus–T. Aman	580
035	Maize–Aus–Vegetab	3000	103	Chilli–Fallow–T. Aman	570
036	Lentil–Aus–Fallow	2950	104	Potato–Maize–T. Aman	550
037	Tobacco–Aus–T. Aman	2950	105	Potato–Sesame–Fallow	540
038	Wheat–Fallow–T. Aman	2910	106	Boro–Fallow–Blackgram	530
039	Boro–Vegetab(Float/Norm)	2850	107	Potato–Jute–Fallow	530
040	Lentil–Vegetab–Vegetab	2780	108	Vegetab–Maize–Fallow	510
041	Wheat–Jute–Blackgram	2750	109	Fallow–B.Aus+B.Aman	500
042	Onion–Jute–Fallow	2600	110	Groundnut– Aus–T. Aman	500
043	Mustard–Boro–Jute–T. Aman	2500	111	Potato–S.gourd–Aus	500
044	Mustard–Mungbean–T. Aman	2370	112	Vegetab–Fallow–T. Aman	500
045	Lentil–Vegetab–T. Aman	2250	113	Mustard–Jute–Fallow	450
046	Mustard–Aus–T. Aman	2220	114	Boro–Chilli–Fallow	350
047	Grasspea–Jute–T. Aman	2150	115	Coriander–Fallow–Fallow	300
048	Wheat–Aus–T. Aman	2130	116	Blackgram–Jute–T. Aman	300
049	Onion–Vegtab–Vegetab	2090	117	03.Fallow–Fallow–T. Aman	300
050	Mustard–Sesame–T. Aman	2060	118	Mungbean–Aus–T. Aman	300
051	Wheat–Aus–Fallow	1910	119	Mustard–Fallow–T. Aman	300
052	Mustard–Jute–Vegetab	1900	120	Potato–Boro–Vegetab	300
053	Maize–Vegetab–Fallow	1750	121	Wheat–Aus–Blackgram	300
054	Onion–Fallow–T. Aman	1750	122	Pea–B.Aman	280
055	Vegetab–Jute–Fallow	1730	123	Maize–Sesame–Fallow	280
056	Tobacco–Fallow–T. Aman	1670	124	Chilli–Aus–T. Aman	270
057	Mustard–Boro–Aus–T. Aman	1650	125	Potato–Boro–Jute	250
058	Boro–Vegetab–T. Aman	1620	126	Lentil–Fallow–T. Aman	240
059	Tobacco–Sesbania–T. Aman	1620	127	Garlic–B.Aman	210
060	Vegetab–Aus–Fallow	1600	128	Mustard–Aus–Fallow	200
061	Vegetab–Boro–Fallow	1550	129	Chilli–Aus–Fallow	200
062	Maize–Sesame–T. Aman	1530	130	Coriander–Jute–Fallow	200
063	Vegetab–Aus–T. Aman	1400	131	Grasspea–B.Aus+B.Aman	200
064	Chilli–Vegetab–Fallow	1330	132	Grasspea–Sesame–Fallow	200
065	Vegetab–Jute–T. Aman	1310	133	Mustard–Maize–Jute	200
066	Mustard–Boro–Fallow	1290	134	Onion–Aus–Blackgram	200
067	Maize–Vegetab–T. Aman	1260	135	Potato–Boro–Aus	200
068	Vegetab–Fallow–Blackgram	1250	136	Potato–Boro–Jute–T. Aman	200
			137-176	Other 40 patterns (Table 9)	3890