

Cropping Systems and Land Use Pattern in Rajshahi Region

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ABSTRACT

Attempts have been made in this paper to overview the existing cropping patterns, crops diversity and cropping intensity in Rajshahi region. The study was conducted in all the upazilas of four districts of Rajshahi region during 2014-15 using pre-tested semi-structured questionnaires. The most predominating crop in this area was rice where exclusive rice based patterns occupied 40.48% of NCA. Boro-Fallow-T. Aman was the dominant cropping pattern, occupied 22.83% of NCA in 27 upazilas out of 32. The second dominant cropping pattern in Rajshahi region was Boro-Fallow-Fallow. It occupied 7.23% of NCA of the region and existed in 28 upazilas. Wheat-Fallow-T. Aman was the 3rd dominant pattern and practiced in 4.34% of the NCA in 14 upazilas. The data also revealed that the wheat based patterns stands for 14.7% of NCA. Mustard-Boro-T. Aman was the 4th dominant cropping pattern. A total of 172 cropping patterns were recognized in this region and the maximum (36) numbers of cropping patterns were identified in Paba upazila nearly followed by Durgapur (35) and Chapainawabganj upazila (34) while the lower numbers of cropping patterns were identified in Charghat (11) followed by Bagha (12) upazila of Rajshahi district. The range of cropping intensity values was recorded 171–253%. The maximum value was for Badalgachhi of Naogaon district and minimum for Bagha of Rajshahi district. The overall CDI of Rajshahi region was calculated 0.970 and the average cropping intensity at regional level was 218%.

Key words: Crop diversity index, cropping pattern, fruit orchard, Barind tract and drought

INTRODUCTION

In Bangladesh, Rajshahi region especially the Barind Tract is different from other parts of the country due to its undulating topography having compact and low fertile soils. The High Barind Tract, lying in Rajshahi, Chapai Nawabganj and Naogaon districts, is one of the distinct areas of Barind, occupying 160,000 ha, roughly 21% of the region. The region experienced high temperature with limited soil moisture storage along with low and erratic rainfall (Ali, 2000). The maximum temperature can exceed 40°C in May and minimum temperature can fall to 6°C in January. Most of the rainfall occurs from June to September and moisture depletion starts from October and in December no residual moisture is available for crop emergence (Idris

and Huq, 1987). Land in the High Barind Tract exhibits grey terrace soil, silty loam to silty clay in texture, and is poorly drained, with a 6–8-cm thick plow pan and low organic matter content (0.8–1.2%). These situations make the area drought prone along with poor crop productivity. The east and southeast of the Barind is the lower Atrai Basin of Naogaon and Natore district. During the rainy season a vast area of lowland is flooded completely where silts and organic matter from aquatic weeds are deposited on soil and therefore the fertile soils of the specific areas are specially suited to Boro rice cultivation.

Cropping pattern is the yearly sequence, temporal and spatial arrangement of crops in a given land area. Cropping pattern depends on physical, historical, social, economic and institutional factor as well as government

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policies (Agarwall and Kassam, 1976). Rajshahi region is specially suited to lentil, chickpea, tomato and potato. Mango, litchi, palmyra palms and guava are also the major fruit crops in this area. Cropping pattern in a specified region is not static; day by day it is changing. The cropping pattern and the changes depend on a large number of factors like climate, soil type, rainfall, irrigation facilities, agricultural technology and other inputs, marketing and transport facilities and growth of agro industries (Gadge, 2003; Rashid *et al.*, 2005). Recently a number of farmers are converting their crops into mango orchard and continuing cultivation of field crops in the young mango orchard. Like other parts of the country, monsoon T. Aman rice is the major crop in Rajshahi region and backbone of the rural economy. Since 1985, the Barind Multipurpose Development Authority (BMDA) developed a network by installing deep tube wells bringing 162,000 ha land under irrigation across the entire Barind of Bangladesh. 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 Rajshahi 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

Thirty-two upazilas of Rajshahi, Naogaon, Chapainawabganj and Natore districts under Rajshahi 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 32 pre-assigned Sub-Assistant Agriculture Officers (SAAO) of each upazila during February 2016 at upazila level. The 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 the Directorate of Agricultural Extension (DAE) during monthly meeting for the sake of accurate data collection. The scientists of RFS Division collected the filled questionnaires. They also checked and analyzed those 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 daylong data validation workshop at district level. The workshop dates were 25 April for Naogaon; 26 April for Natore; 16 August for Rajshahi; and 17 August 2016 for Chapainawabganj. Four field-workers i.e. one SAPPO and three SAAOs experienced and engaged in crop-based data documentation, all officers from all upazilas viz UAOs, AEOs, AAEOs, DD (DAE), DD (Horticulture), DD of Seed Certification Agency, DTO and ADDs, one representative from Agricultural Training

Institute (ATI) and scientists of BRRRI regional station, Kushtia, and Rajshahi participated in the data validation workshop. The number of participants of validation workshop ranged from 56 to 98 in each district. All the participants were divided into three to four groups for data validation. Each group was facilitated by two RFSD scientists to finalize and validate the data and authenticated data were captured. Crop diversity index was calculated by using the following equation described by Kshirsagar *et al.* (1997).

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

Where, CDI_i = Crop Diversity Index

a_{ij} = Area planted to the j^{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 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 status of agricultural land utilization in the region. The net cropped area of the Rajshahi region is 693,620 ha. Crops occupying 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 crops area in different upazilas ranged from 40 to 7,940 ha. The annual crops area accounted only 5.96% of the net cropped area (NCA) in the region. At a glance the region possesses 10.73% single cropped area (SCA), 48.38% double cropped area (DCA), 33.58% triple cropped area (TCA). The quadruple cropped area QCA also exists as a very negligible portion (0.67%) and is limited in only six upazilas

viz Badalgachhi, Manda, Mohadevpur and Raninagar of Naogaon district, and Bagha and Mohanpur of Rajshahi district. Compared with DCA and TCA the SCA remained much lower in each and every upazilas. In Rajshahi region, DCA remained higher in Singra upazila of Natore district followed by Godagari upazila of Rajshahi district. Chapainawabganj sadar and Shibganj upazilas are the exceptions where TCA occupied the biggest share of NCA.

Cropping patterns of Rajshahi

In total 172 cropping patterns were observed in Rajshahi region of which eight cropping patterns with exclusive rice crop covers over 40% of the NCA. There were 40 cropping patterns with exclusive non-rice crop covering over 7% of the NCA. Rest of the NCA i.e. about 53% area is covered by 124 rice - non rice cropping patterns (Appendix 1).

Rice and non-rice crops at a glance

A wide range of cropping patterns were recognized in the study area and the important feature of the region is that eight patterns were composed of absolutely rice crops. Of all lands used for cultivation, 40.48% was used only for rice production showing that the farmers are engaged with the traditional rice farming and it is also applicable in Bangladesh (Haque *et al.*, 2012). Boro-Fallow-T. Aman was the most predominant cropping pattern in this area (Table 2). Out of 32 upazilas, the Boro-Fallow-T. Aman cropping pattern remained in 27 upazilas and 22.83% of the NCA belonged to this pattern. Single Boro was the 2nd dominant pattern, which occupied about 7.23% of the net cropped area in 28 upazilas. Boro-T. Aus-T. Aman cropping pattern exists in 17 upazilas which was the 3rd dominant cropping pattern and occupied 3.65% of NCA in the region. Single T. Aman was also common in eight upazilas which covered 2.75% of NCA. Very negligible portion i.e less than 1% NCA was practiced by Fallow-Aus-T. Aman cropping system in this region.

In the current investigation, 40 cropping patterns were identified that was free from rice. Among thm first 24 have been arranged in descending order in Table 3. The rest 16 patterns

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

Upazila	Area of upazila	Annual crop	SCA	DCA	TCA	QCA	Other	NCA	C.I. (%)
01 Bholahat	12352	2200	500	5100	3030	0	170	11000	203
02 Chapainawabganj	45192	550	6050	4520	17640	0	190	28950	238
03 Gomastapur	31812	410	5430	13340	5410	0	120	24710	198
04 Nachol	28368	60	2600	17860	4400	0	140	25060	207
05 Shibganj	52543	7940	700	5350	16500	0	150	30640	226
06 Atrai	28300	40	6800	13950	2700	0	150	23640	182
07 Badalgachhi	21083	320	120	9090	4140	2400	150	16220	253
08 Dhamoirhat	30082	250	1300	13820	7980	0	100	23450	228
09 Manda	71744	360	4010	14790	11120	80	150	30510	223
10 Mohadebpur	39552	160	30	15670	14090	1000	110	31060	251
11 Naogaon sadar	27444	250	5630	6810	7610	0	150	20450	209
12 Niamatpur	44993	340	3300	17500	11650	0	150	32940	224
13 Porsha	27205	430	3500	12070	5820	0	110	21930	209
14 Patnitala	37927	240	3500	14430	11930	0	190	30290	227
15 Raninagar	24810	70	2200	12910	5260	50	180	20670	215
16 Shapahar	24462	40	3300	12480	3750	0	170	19740	202
17 Bagatipara	13992	5660	130	1240	2995	0	135	10160	172
18 Baraigram	30000	1680	1000	11000	10240	0	160	24080	232
19 Gurudaspur	19940	630	1040	8620	5260	0	180	15730	223
20 Lalpur	32987	2590	280	1770	6820	0	130	11590	234
21 Natore	27700	4830	0	4250	7300	0	150	16530	215
22 Naldanga	19500	1700	3500	5000	3600	0	150	13950	188
23 Singra	52778	150	7200	27900	7820	0	130	43200	201
24 Chorghat	16458	730	950	1840	5200	0	160	8880	240
25 Bagha	18426	4350	1700	4850	2250	0	150	13300	171
26 Bagmara	36558	450	2800	14370	9790	900	190	28500	229
27 Durgapur	22200	480	1510	3680	7800	0	110	13580	243
28 Godagari	47526	40	120	36580	2700	0	150	39590	206
29 Mohanpur	16276	50	2250	1020	7660	200	170	11350	252
30 Paba	29783	570	1370	5030	8290	0	160	15420	242
31 Puthia	19264	3600	1170	2880	6150	0	150	13950	210
32 Tanor	29580	150	450	15850	5980	0	120	22550	224
Rajshahi region	-	41320	74440	335570	232885	4630	4775	693620	218

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

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Boro-Fallow-T. Aman	158390	22.83	27
02 Boro-Fallow-Fallow	50130	7.23	28
03 Boro-Aus-T. Aman	25290	3.65	17
04 Fallow-Fallow-T. Aman	19100	2.75	8
05 Boro-B.Aman	11650	1.68	8
06 Boro-Aus-Fallow	9500	1.37	9
07 Fallow-Aus-T. Aman	6120	0.88	3
08 Boro-Sesbania-T. Aman	580	0.08	3
Total	280760	40.48	-

with negligible area coverage arranged in Table 8 with other patterns of different categories. Aggregate of the 40 patterns have had 7.43% of NCA. In critical comparison it is clear that exclusive rice area is about six folds of exclusive non-rice area. In Rajshahi 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 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

Table 4 presents detailed existing cropping patterns for non-rice cereal crops with area coverage. Forty-four cropping patterns were identified for non-rice cereal cropping systems covering 143,730 ha which represents 20.72% of NCA in the region. The dominant cropping pattern was the Wheat-Fallow-T. Aman which was practiced on 30,130 ha (4.34% of NCA) in 14 upazilas of Rajshahi region. Next cropping pattern under this combination was Wheat-Aus-T. Aman and existed in 2.31% of the NCA in 14 upazilas. Out of 44 cropping patterns under non-rice cereal systems, 22 patterns were wheat based and the aggregate area under wheat based patterns stands for 16.58% of NCA in this area. In Bangladesh, there is a vast market of wheat for human consumption and maize seeds for feed industries. Local production of wheat and maize is extremely insignificant to meet up the demand. The situation is increasing our dependency on import causing a great pressure on foreign currency (BBS, 2014). Loam and sandy-loam soil of the comparative dry area is very suitable for maize cultivation. Wheat cultivation with its better yield in this region is specially favoured by long winter season that is normally unavailable in southern

parts of the country. Light textured soil with 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 sun-shine and low humidity. All these are the factors this area is dominated by wheat-based cropping systems (FAO, 1988).

Pulse crops

Fifty cropping patterns are holding different pulse crops (Table 5). Among them blackgram is covering the largest area whereas pea in the smallest area. Thirteen cropping patterns of blackgram in-together cover 31,720 ha representing 4.57% of NCA in the Rajshahi region. Mungbean holds the second position in pulse crop cultivation in the region. There are 10 cropping patterns for mungbean covering 24,020 ha (3.46% of NCA). In some area of Rajshahi region specifically in Barind tract, Boro cultivation faces some constraints such as scarcity of irrigation water and low-water holding capacity of soil. Moreover, high market price of pulse crops is a driving force for ample cultivation of pulse crops. Among the Rabi crops stress-tolerant mungbean, blackgram, grasspea can easily be grown as relay system and other cropping systems (FAO, 1988).

Oil-seed crops

Twenty-eight cropping patterns have been arranged in descending order according to area coverage (Table 6). Mustard is the most important one among the oil-seed crops in Rajshahi region. There are 13 cropping had been led by mustard alone which in-together covers 66,050 ha (9.52% of NCA). The pattern Mustard-Boro-T. Aman has the highest coverage (3.70% of the NCA) and was recorded in 17 upazilas out of 32 followed by Mustard-Boro-Fallow (1.88% of NCA). Oil is an essential ingredient of human food and also for feed industries. The country is almost dependent on import for oil. Mustard is a very potential crop that can be grown widely in various parts of the country (BBS, 2014). At present, the lion-share

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

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Vegetable-Vegetable-Vegetable	10715	1.54	19
02 Wheat-Jute-Fallow	6720	0.97	6
03 Garlic-Jute-Fallow	4310	0.62	4
04 Vegetab-Vegetab-Fallow	3500	0.54	6
05 Maize-Fallow-Blackgram	3350	0.50	2
06 Lentil-Fallow-Fallow (Orchard)	2780	0.43	5
07 Wheat-Mungbean-Fallow	2670	0.40	4
08 Potato-Jute-Fallow	2450	0.35	3
09 Onion-Vegetab-Vegetab	2370	0.34	11
10 Wheat-Mung-Fallow (Orchard)	2150	0.31	3
11 Onion-Jute-Fallow	2010	0.29	5
12 Garlic-Vegetab-Vegetab	1030	0.15	10
13 Maize-Fallow-Fallow	1000	0.14	2
14 Potato-Chilli-Fallow	980	0.14	6
15 Lentil-Vegetab-Vegetab	760	0.11	2
16 Wht-Sesame-B.gram (Orchard)	730	0.11	2
17 Chilli-Vegetab-Fallow	600	0.09	5
18 Wheat-Vegetab-Vegetab	500	0.07	2
19 Wheat-Jute-Blackgram	370	0.05	2
20 Wheat-Chilli-Fallow	290	0.04	3
21 Potato-Maize-Fallow	270	0.04	3
22 Chilli-Fallow-Fallow	240	0.04	3
23 S.Potato-Fallow-Fallow	220	0.03	4
24 Groundnut-Fallow-Fallow	210	0.03	2
25-40 Other 16 patterns (in Table 8)	1540	0.22	
Total	51765	7.43	

of mustard cultivation is related to the land for double rice. If technology transfer activities could be strengthened much more area of the aforesaid category will be possible to make room for the mustard crop (FAO, 1988).

Vegetables and spices crops

A total of 66 cropping patterns were identified in Rajshahi region for vegetables and spices crops. Potato and other vegetables belong to Rabi, Kharif-I and Kharif-II, spices crops viz onion, garlic, coriander, blackcumin and chilli had been included in this list (Table 7). Total area coverage under spices and vegetables is 106,355 ha (15.27% of NCA). Among them Potato-Boro-T. Aman is holding the largest coverage with 15,610 ha (2.31% of NCA) distributed to 12 upazilas. The 2nd contributing pattern

in this category was year-round vegetables, which occupied 1.54% of NCA with its widest spreading into 19 upazilas.

Sporadic and distinct cropping patterns

Boro-Aus-Blackgram is an extremely location specific cropping pattern which is limited only in Chapainawabganj sadar upazila with an area of 8,000 ha. Felon-Fallow-T. Aman is another exception which is practiced in Porsha upazila of Naogaon district. This pattern has occupied an area of 6,400 ha of under Barind tract. The third one is the single T. Aman with fruit garden/orchard. The system practiced only in Porsha with an area coverage of 1,000 ha. Rice is cultivated from the time of garden establishment and it is continued up to 7 or 8 years age of fruit trees. The fourth one is Wheat-Aus-Blackgram which is absolutely

Table 4. Cropping patterns for wheat and maize in Rajshahi region, 2014-15 .

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Wheat-Fallow-T. Aman	30130	4.34	14
02	Wheat-Aus-T. Aman	16010	2.31	14
03	Wheat-Mungbean-T. Aman	12570	1.81	17
04	Wheat-Aus-Blackgram	12030	1.73	3
05	Wheat-Jute-T. Aman	10270	1.48	18
06	Wheat-Aus-Fallow	7020	1.01	8
07	Wheat-Jute-Fallow	6720	0.97	6
08	Potato-Maize-T. Aman	5350	0.77	11
09	Potato-Maize-Aus	4000	0.58	3
10	Maize-Fallow-T. Aman	3780	0.54	8
11	Wheat-F-T. Aman(Orchard)	3700	0.53	2
12	Maize-Fallow-Blackgram	3350	0.48	2
13	Wheat-Maize-T. Aman	2920	0.42	4
14	Lentil-Maize-T. Aman	2890	0.42	6
15	Wheat-Mungbean-Fallow	2670	0.38	4
16	Wheat-Mung-Fallow(Orchard)	2150	0.31	3
17	Wheat-Sesame-T. Aman	2100	0.30	7
18	Maize-B.Aman	2000	0.29	2
19	Wheat-Aus-Onion	1900	0.27	1
20	Maize-Aus-Blackgram	1300	0.19	1
21	Wheat-Vegetab-T. Aman	1160	0.17	6
22	Wheat-B.Aman	1150	0.17	2
23	Onion-Maize-T. Aman	1050	0.15	3
24	Maize-Fallow-Fallow	1000	0.14	2
25	Wht-Sesame-B.gram(Orchard)	730	0.11	2
26	Potato-Maize-Aus-Vegetab	700	0.10	1
27	Wheat-Vegetab-Vegetab	500	0.07	2
28	Maize-Aus-T. Aman	440	0.06	3
29	Vegetab-Maize-Fallow	430	0.06	1
30	Maize-Maize-Fallow	400	0.06	1
31	Onion-Maize-Fallow	400	0.06	1
32	Wheat-Jute-Blackgram	370	0.05	2
33	Boro-Maize-Blackgram	350	0.05	1
34	Boro-Maize-Fallow	350	0.05	1
35	Maize-Aus-Fallow	300	0.04	1
36	Potato-Maize-Vegetab	300	0.04	1
37	Wheat-Chilli-Fallow	290	0.04	3
38	Potato-Maize-Fallow	270	0.04	3
39-44	Other six patterns (table 8)	680	0.10	-
	Total maize and wheat	143730	20.72	

practiced in Chapainawabganj district with an area coverage of 12,030 ha. This pattern, as far known, does not exist anywhere in Bangladesh out of the district. Three upazilas of the district viz Shibiganj, sadar and Bholahat are holding 10,000 ha, 1,400 ha and 630 ha of land, respectively, for the cropping pattern.

Rare cropping patterns

Rajshahi region is a diversified cropping zone. Forty-four rare cropping patterns with negligible area coverage in the specific one or two upazilas had been identified in this region (Table 8). However, total area coverage of these patterns was only 0.54% of NCA. Out

Table 5. Cropping patterns of pulses crops in Rajshahi region, 2014-15.

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Wheat-Mungbean-T. Aman	12570	1.81	17
02 Wheat-Aus-Blackgram	12030	1.73	3
03 Boro-Aus-Blackgram	8000	1.15	1
04 Felon-Fallow-T. Aman	6400	0.92	1
05 Lentil-Fallow-T. Aman	4370	0.63	6
06 Maize-Fallow-Blackgram	3350	0.48	2
07 Lentil-Maize-T. Aman	2890	0.42	6
08 Lentil-Fallow-Fallow(Orchard)	2780	0.40	5
09 Wheat-Mungbean-Fallow	2670	0.38	4
10 Garlic-Mungbean-T. Aman	2500	0.36	2
11 Lentil-Jute-T. Aman	2410	0.35	6
12 Wheat-Mung-Fallow(Orchard)	2150	0.31	3
13 Chickpea-Fallow-T. Aman	2110	0.30	5
14 Boro-Fallow-Blackgram	2000	0.29	4
15 Grasspea-Boro-Aus	1800	0.26	1
16 Lentil-Mungbean-T. Aman	1750	0.25	5
17 Mustard-Mungbean-T. Aman	1700	0.25	2
18 Mustard-Aus-Blackgram	1500	0.22	1
19 Vegetab-Aus-Blackgram	1500	0.22	1
20 Grasspea-B.Aman	1380	0.20	3
21 Maize-Aus-Blackgram	1300	0.19	1
22 Onion-Aus-Blackgram	870	0.13	2
23 Lentil-Vegetab-Vegetab	760	0.11	2
24 Wht-Sesame-B.gram(Orchard)	730	0.11	2
25 Lentil-Aus-T. Aman	710	0.10	3
26 Lentil-Sesame-T. Aman	710	0.10	3
27 Lentil-Aus-Fallow	620	0.09	2
28 Mungbean-Aus-T. Aman	600	0.09	1
29 Wheat-Jute-Blackgram	370	0.05	2
30 Boro-Maize-Blackgram	350	0.05	1
31 Grasspea-Fallow-T. Aman	350	0.05	4
32 Lentil-Sesame-Fallow	300	0.04	1
33 Grasspea-Aus-Blackgram	250	0.04	1
34-50 Other 17 patterns (Table 8)	1410	0.20	
Total pulse crop	85190	12.23	

of 43 patterns, each of nine patterns namely Groundnut-Aus-Fallow, Lentil-B. Aman, Lentil-Jute-Fallow, Lentil-Jute-Fallow, Lentil-Jute-Fallow, Vegetab-Onion-Jute-T. Aman, Wheat-Fallow-Fallow, Wheat-Jute-Vegetab and Wheat-Sesame-Fallow occupied the same areas of 200 ha land in different nine upazilas of this region.

Most dominant cropping pattern

Boro-Fallow-T. Aman was the major cropping pattern in Rajshahi region and the pattern was common in 27 upazilas which occupied 22.83%

of NCA in the region (Table 9). The highest area coverage under Boro-Fallow-T. Aman pattern was found in Singra (19,100 ha) upazila of Natore district followed by Dhamoirhat (13,000 ha), Mohadebpur (12,800 ha), Patnitala (12,600 ha) and Raninagar (12,600 ha) upazilas of Naogaon district indicated that Naogaon district was the dominant rice growing zone. Although the higher area coverage was found in Singra upazila but the percent of upazila net cropped area with this pattern remained higher in Raninagar (61%) upazila followed by Dhamoirhat upazila (56%) of Naogaon district.

Table 6. Cropping patterns of oil-seed crops in Rajshahi region, 2014-15.

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Mustard-Boro-T. Aman	25650	3.70	17
02 Mustard-Boro-Fallow	13050	1.88	9
03 Mustard-Boro-Aus	10200	1.47	8
04 Mustard-Fallow-T. Aman	6000	0.87	7
05 Mustard-Aus-T. Aman	3800	0.55	4
06 Wheat-Sesame-T. Aman	2100	0.30	7
07 Mustard-Boro-B.Aman	1800	0.26	1
08 Mustard-Boro-Aus-T. Aman	1700	0.25	4
09 Mustard-Mungbean-T. Aman	1700	0.25	2
10 Mustard-Aus-Blackgram	1500	0.22	1
11 Wht-Sesame-Blackgram (Orchard)	730	0.11	2
12 Lentil-Sesame-T. Aman	710	0.10	3
13 Lentil-Sesame-Fallow	300	0.04	1
14 Onion-Sesame-Fallow	280	0.04	1
15 Mustard-Aus-Fallow	250	0.04	1
16 Groundnut-Fallow-Fallow	210	0.03	2
17-28 Other 12 patterns (in Table 8)	1120	0.16	-
Total oil-seed crop	71100	10.21	

The lowest area coverage as well as percent of upazila net cropped area under Boro-Fallow-T. Aman cropping pattern in Rajshahi region existed in Charghat upazila decreasingly followed by Paba upazila of Rajshahi district. 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 most dominant cropping pattern in Rajshahi region was Boro-Fallow-Fallow. It occupied 7.23 of NCA of the region and existed in 28 upazilas (Table 10). The area coverage under single Boro remained higher in Singra upazila of Natore holds the largest area 7,200 ha which is equivalent to 14.36% of the total area for the pattern in the region. Naldanga upazila of Natore district stands fifth position for area coverage (3,500 ha), however, this upazila had allocated the biggest share i.e. 28.57% of its NCA. The lowest area (50 ha) coverage under Boro-Fallow-Fallow cropping pattern has been identified in Chapainawabganj sadar and Charghat upazila of Rajshahi district. Out of

nine upazilas of Rajshahi district, only Bagmara upazila holds considerable area 2,800 ha (9.98% of upazila NCA) under this single Boro cropping pattern. This pattern is frequent and concurrently experienced by early flashflood 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 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

Third dominant cropping Wheat-Fallow-T. Aman occupied the 30,130 ha of land and represented 4.34% of NCA in Rajshahi region (Table 11). This pattern distributed over 14 upazilas where Shapahar ranked top position covering 7,500 ha of land. Godagari and Nachol ranked the 2nd and 3rd position under Wheat-Fallow-T. Aman cropping pattern covering 6,000 ha and 5,000 ha of land, respectively.

Table 7. Cropping patterns for vegetables and spices crops in Rajshahi region, 2014-15.

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Potato-Boro-T. Aman	15610	2.25	12
02 Vegetable-Vegetable-Vegetable	10715	1.54	19
03 Potato-Boro-Aus	7200	1.04	4
04 Garlic-B.Aman	6200	0.89	3
05 Potato-Boro-Fallow	5800	0.84	2
06 Onion-Aus-Fallow	4450	0.64	5
07 Garlic-Jute-Fallow	4310	0.62	4
08 Potato-Fallow-T. Aman	4050	0.58	6
09 Vegetab-Aus-Fallow	3680	0.53	4
10 Vegetab-Vegetab-T. Aman	3550	0.51	7
11 Vegetab-Vegetab-Fallow	3500	0.50	6
12 Onion-Jute-T. Aman	2750	0.40	6
13 Chilli-Aus-T. Aman	2600	0.37	2
14 Potato-Aus-T. Aman	2600	0.37	5
15 Potato-Jute-Fallow	2450	0.35	3
16 Onion-Vegetab-Vegetab	2370	0.34	11
17 Garlic-Jute-T. Aman	2320	0.33	8
18 Onion-Jute-Fallow	2010	0.29	5
19 Potato-Jute-T. Aman	1980	0.29	5
20 Onion-Fallow-T. Aman	1840	0.27	7
21 Vegetab-Aus-T. Aman	1640	0.24	5
22 Vegetab-Fallow-T. Aman	1550	0.22	4
23 Potato-Aus-Fallow	1300	0.19	4
24 Garlic-Vegetab-Vegetab	1030	0.15	10
25 Potato-Chilli-Fallow	980	0.14	6
26 Lentil-Vegetab-Vegetab	760	0.11	2
27 Potato-Vegetab-T. Aman	700	0.10	2
28 Chilli-Fallow-T. Aman	670	0.10	6
29 Garlic-Aus-Fallow	660	0.10	5
30 Boro-Vegetab(Float/Norm)	630	0.09	2
31 Chilli-Vegetab-Fallow	600	0.09	5
32 Wheat-Vegetab-Vegetab	500	0.07	2
33 Garlic-Aus-T. Aman	490	0.07	3
34 Garlic-Fallow-T. Aman	410	0.06	4
35 Chilli-Aus-Fallow	400	0.06	3
36 Garlic+Muskmelon-B.Aman	320	0.05	2
37 Garlic+W.Melon-B.Aman	320	0.05	2
38 Vegetab-Boro-T. Aman	300	0.04	2
39 Wheat-Chilli-Fallow	290	0.04	3
40 Potato-Maize-Fallow	270	0.04	3
41 Vegetab-Jute-T. Aman	270	0.04	2
42 Potato-Boro-Aus-T. Aman	230	0.03	2
43 Coriander-Fallow-Fallow	220	0.03	2
44 Chilli-Fallow-Fallow	240	0.03	3
45 Chilli-Vegetab-T. Aman	210	0.03	2
46-66 Other 21 patterns (in Table 8)	1380	0.20	-
Total veg. and spices crops	106355	15.27	

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

	Cropping pattern	Area (ha)	% of NCA	Frequency	Upazila
01	Groundnut- Aus-Fallow	200	0.03	1	Lalpur
02	Lentil-B.Aman	200	0.03	1	Gurudaspur
03	Lentil-Jute-Fallow	200	0.03	1	Nachol
04	Lentil-Vegetab-T. Aman	200	0.03	1	Nachol
05	Lentil-Jute-Fallow	200	0.03	1	Gurudaspur
06	Vegetab-Onion-Jute-T. Aman	200	0.03	1	Mohanpur
07	Wheat-Fallow-Fallow	200	0.03	1	Bagatipara
08	Wheat-Jute-Vegetab	200	0.03	1	Naogaon sadar
09	Wheat-Sesame-Fallow	200	0.03	1	Bagatipara
10	Grasspea-Jute-T. Aman	190	0.03	2	Lalpur+Bagatipara
11	Fallow-Fallow-Blackgram	170	0.02	3	Manda+Gurudaspur+Paba
12	Chilli-Jute-T. Aman	170	0.02	2	Dhamoirhat+Shibganj
13	Grasspea-Boro-Fallow	150	0.02	1	Paba
14	Mustard-Fallow-Fallow	150	0.02	1	Paba
15	Garlic-Fallow-Fallow	120	0.02	1	Lalpur
16	Potato-Sesame-Aus	120	0.02	1	Bagmara
17	Groundnut-Fallow-T. Aman	100	0.01	1	Atrai
18	Boro-Sesbania-Fallow	80	0.01	1	Godagari
19	Boro-Vegetab-T. Aman	70	0.01	1	Paba
20	Coriander-Fallow-T. Aman	50	0.01	2	Chapai sadar +Gomastapur
21	Grasspea-Mungbean-T. Aman	50	0.01	1	Lalpur
22	Mustard-Maize-T. Aman	50	0.01	1	Manda
23	Grasspea-Sesame-T. Aman	40	0.01	1	Lalpur
24	Pea-Aus-Vegetab	40	0.01	2	Paba+Nachol
25	Pea-Fallow-T. Aman	40	0.01	2	Chapai sadar +Gomastapur
26	Blackgram-Jute-Fallow	30	0.00	1	Manda
27	Coriander-Vegetab-Fallow	30	0.00	1	Naogaon sadar
28	Potato-Sesame-T. Aman	30	0.00	1	Durgapur
29	Blackcumin-Jute-T. Aman	20	0.00	1	Gurudaspur
30	Chickpea-Aus-T. Aman	20	0.00	1	Paba
31	Chilli-Jute-Fallow	20	0.00	1	Badalgachhi
32	Coriander-B.Aman	20	0.00	1	Gurudaspur
33	Coriander-Jute-T. Aman	20	0.00	2	Gurudaspur+Dhamoirhat
34	Grasspea-Jute-Fallow	20	0.00	1	Manda
35	Maize-Jute-T. Aman	20	0.00	1	Durgapur
36	Pea-Jute-Fallow	20	0.00	1	Lalpur
37	Potato-Mungbean-T. Aman	20	0.00	2	Durgapur+Chapai sadar
38	Coriander-Sesame-T. Aman	10	0.00	1	Mohadebpur
39	Grasspea-Fallow-Fallow	10	0.00	1	Gomastapur
40	Maize-Vegetab-T. Aman	10	0.00	1	Durgapur
41	Mungbean-Fallow-T. Aman	10	0.00	1	Charghat
42	Potato-Groundnut	10	0.00	1	Raninagar
43	Potato-Groundnut-T. Aman	10	0.00	1	Raninagar
44	Vegetab-Fallow-Fallow	10	0.00	1	Durgapur
	Total	3730	0.54		

Table 9. Distribution of the most dominant Boro–Fallow–T. Aman cropping patterns in Rajshahi region, 2014-15.

Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01 Singra	19100	45.00	12.06
02 Dhamoirhat	13000	56.00	8.21
03 Mohadebpur	12800	41.00	8.08
04 Patnitala	12600	42.00	7.96
05 Raninagar	12600	61.00	7.96
06 Niamatpur	12000	37.00	7.58
07 Godagari	12000	30.00	7.58
08 Badalgachhi	8500	53.00	5.37
09 Tanor	7400	33.00	4.67
10 Manda	6500	22.00	4.10
11 Naogan Sodar	6000	30.00	3.79
12 Gomastapur	5800	23.90	3.66
13 Atrai	5300	22.50	3.35
14 Nachol	5000	20.00	3.16
15 Porsha	4100	19.00	2.59
16 Naldanga	3500	29.00	2.21
17 Shapahar	3000	15.00	1.89
18 Bholahat	1900	22.00	1.20
19 Natore	1700	15.00	1.07
20 Puthia	1700	17.00	1.07
21 Chapainawabganj	1000	3.50	0.63
22 Durgapur	1000	7.60	0.63
23 Baraigram	700	3.10	0.44
24 Bagatipara	490	10.90	0.31
25 Shibganj	400	1.80	0.25
26 Paba	200	1.40	0.13
27 Chorghat	100	1.20	0.06
Rajshahi region	158390	22.83	100.00

The lowest area coverage (100 ha) under this cropping pattern existed in Chapai sadar upazila decreasingly followed by Porsha and Raninagar upazila where each of two upazila held only 150 ha of land.

Fourth dominant cropping pattern

The fourth dominant cropping pattern in Rajshahi region was Mustard-Boro-T. Aman existed in 17 upazilas representing 3.70% share of NCA (Table 12). The area coverage under this pattern remained higher (4,700 ha each) in Patnitala and Manda upazilas of Naogaon district. The distribution of %NCA under this pattern in Patnitala and Manda upzilas was 15.6% for both. Dhamoirhat upazila ranked in 3rd in terms of area coverage (3,000 ha) and % NCA (12.93%) for this pattern. Out of top 11 upazilas of Rajshahi region, the Mustard-Boro- T. Aman

cropping pattern existed in top 10 upazilas of Naogaon district covering 88% (22600 ha) of total Mustard-Boro- T. Aman area in the region indicating that the Naogaon district remained predominated with this pattern. In the country-wide compilation of data it was observed that Mustard–Boro– T. Aman was the 6th dominant cropping pattern in Bangladesh covering 1.85 lac ha (2.16% of NCA in the country) with its distribution in 203 upazilas of 51 districts (Nasim *et al.*, 2017).

Fifth dominant cropping pattern

Fifth dominant cropping pattern Boro-Aus-T. Aman existed in 17 upazilas of Rajshahi region covering 25,290 ha of land (Table 13). The pattern represented 3.65% of NCA where Niamatpur upazila of Naogaon district ranked

Table 10. Distribution of the 2nd dominant Boro-Fallow-Fallow cropping patterns in Rajshahi region, 2014-15.

Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01 Singra	7200	16.72	14.36
02 Atrai	5900	25.00	11.77
03 Naogaon sadar	5500	27.23	10.97
04 Manda	4000	13.27	7.98
05 Naldanga	3500	28.57	6.98
06 Baghmara	2800	9.98	5.59
07 Porsha	2500	11.63	4.99
08 Shapahar	2500	12.69	4.99
09 Gomastapur	2300	9.47	4.59
10 Mohanpur	2250	19.91	4.49
11 Raninagar	2100	10.19	4.19
12 Durgapur	1500	11.45	2.99
13 Paba	1100	7.41	2.19
14 Baraigram	1000	4.46	1.99
15 Gurudaspur	1000	6.62	1.99
16 Patnitala	800	2.66	1.60
17 Nachol	600	2.40	1.20
18 Shibganj	600	2.64	1.20
19 Niamatpur	500	1.53	1.00
20 Bagha	500	5.59	1.00
21 Bholahat	500	5.68	1.00
22 Tanor	450	2.01	0.90
23 Puthia	400	3.86	0.80
24 Dhamoirhat	300	1.29	0.60
25 Bagatipara	130	2.89	0.26
26 Godagari	100	0.25	0.20
27 Chapai sadar	50	0.18	0.10
28 Chorghat	50	0.61	0.10
Rajshahi region	50130	7.23	100.00

the top position in terms of area coverage (6,000 ha) and % NCA (18.4%). Next to Niamatpur, Gomastapur upazila of Chapainawabganj district occupied the highest area (3,600 ha) and % of NCA (14.8%) for the pattern. Patnitala and Raninagar upazilas of Naogaon district ranked in 3rd position with this pattern in terms of area coverage and %NCA, respectively. The area coverage as well as of %NCA under Boro-Aus- T. Aman cropping system remained lower in Mohanpur upazila of Rajshahi district represented only 0.02% of total Boro-Aus-T. Aman area in the region.

Crop diversity and cropping intensity

A wide variation was observed in cropping patterns and crops among the different

upazilas of Rajshahi region (Table 14). A total of 172 cropping patterns were recognized in this region. The maximum (36) numbers of cropping patterns were identified in Paba upazila nearly followed by Durgapur (35) and Chapainawabganj upazila (34) while the lower numbers of cropping patterns were found in Chorghat (11), which is decreasing followed by Bagha (12) upazila of Rajshahi district. It was evident that Rajshahi region represented a lower rainfall area in the country and thus BMDA established lots of deep tube-wells for irrigation purpose. It has been assumed that lower number of cropping patterns existed in those upazilas where irrigation facilities were limited. The higher number of cropping patterns is generally related to higher level of diversity for cropping pattern.

Table 11. Distribution of the 3rd dominant Wheat–Fallow–T. Aman cropping patterns in Rajshahi region, 2014-15.

Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01 Shapahar	7500	38.07	24.89
02 Godagari	6000	15.17	19.91
03 Nachol	5000	20.00	16.59
04 Gomastapur	4600	18.93	15.27
05 Niamatpur	2500	7.67	8.30
06 Paba	1100	7.41	3.65
07 Bholahat	1100	12.50	3.65
08 Durgapur	730	5.57	2.42
09 Manda	700	2.32	2.32
10 Bagatipara	300	6.67	1.00
11 Dhamoirhat	200	0.86	0.66
12 Raninagar	150	0.73	0.50
13 Porsha	150	0.70	0.50
14 Chapai sadar	100	0.35	0.33
Rajshahi region	30130	4.34	100.00

Table 12. Distribution of the 4th dominant Mustard–Boro–T. Aman cropping patterns in Rajshahi region, 2014-15.

Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01 Patnitala	4700	15.64	18.32
02 Manda	4700	15.59	18.32
03 Dhamoirhat	3000	12.93	11.70
04 Naogaon sadar	2500	12.38	9.75
05 Niamatpur	2100	6.44	8.19
06 Mohadebpur	1600	5.18	6.24
07 Raninagar	1400	6.80	5.46
08 Shapahar	1000	5.08	3.90
09 Porsha	1000	4.65	3.90
10 Tanor	850	3.79	3.31
11 Badalgachhi	600	3.77	2.34
12 Nachol	600	2.40	2.34
13 Naldanga	500	4.08	1.95
14 Paba	400	2.69	1.56
15 Gomastapur	400	1.65	1.56
16 Shibganj	200	0.88	0.78
17 Bholahat	100	1.14	0.39
Rajshahi region	25650	3.70	100.00

The highest (0.972) diversity index for cropping pattern was found Bagatipara upazila of Natore district followed by Puthia (0.965) upazila of Rajshahi district while the lowest value of diversity for cropping pattern remained in Raninagar upazila of Naogaon district. Crop diversity index (CDI) ranged from 0.528 in Bagmara upazila to 0.989 in Puthia upazila of Rajshahi district. Next to Puthia, the CDI remained higher (0.979) in Charghat and Durgapur upazila of Rajshahi district indicated that this district represented a diversified cropping zone. The

highest cropping intensity (253%) remained in Badalgachhi upazila of Naogaon district closely followed by Mohanpur (252) upazila of Rajshahi district. Next to Mohanpur upazila, the highest cropping intensity existed in Mohadebpur upazila of Naogaon district while the lowest cropping intensity was found in Bagha (171%) upazila of Rajshahi district. However, the average cropping intensity in Rajshahi region was 218%. 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

Table 13. Distribution of the 5th dominant Boro–Aus–T. Aman cropping patterns in Rajshahi region, 2014-15.

Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01 Niamatpur	6000	18.40	23.72
02 Gomastapur	3600	14.81	14.23
03 Patnitala	2900	9.65	11.47
04 Singra	2800	6.50	11.07
05 Raninagar	2500	12.14	9.89
06 Chapai sadar	2040	7.18	8.07
07 Shapahar	1000	5.08	3.95
08 Naogaon sadar	1000	4.95	3.95
09 Godagari	900	2.28	3.56
10 Tanor	700	3.13	2.77
11 Nachol	700	2.80	2.77
12 Baraigram	500	2.23	1.98
13 Bholahat	300	3.41	1.19
14 Natore sadar	100	0.85	0.40
15 Porsha	100	0.47	0.40
16 Dhamoirhat	100	0.43	0.40
17 Mohanpur	50	0.44	0.20
Rajshahi region	25290	3.65	100.00

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

Upazila	No. of identified pattern	No. of crop	Diversity index for cropping pattern	Crop diversity index (CDI)	C.I. (%)
01 Bholahat	13	09	0.923	0.962	203
02 Chapainawabganj	34	19	0.862	0.942	238
03 Gomastapur	29	18	0.859	0.929	199
04 Nachol	20	11	0.876	0.943	207
05 Shibganj	14	13	0.869	0.925	226
06 Atrai	18	13	0.853	0.933	190
07 Badalgachhi	19	12	0.694	0.897	253
08 Dhamoirhat	21	16	0.665	0.867	228
09 Manda	32	19	0.884	0.951	223
10 Mohadebpur	23	12	0.762	0.914	251
11 Naogaon sadar	26	17	0.814	0.926	209
12 Niamatpur	16	09	0.810	0.918	224
13 Porsha	16	11	0.831	0.922	209
14 Patnitala	15	12	0.775	0.907	227
15 Raninagar	18	13	0.596	0.823	215
16 Shapahar	15	11	0.803	0.906	202
17 Bagatipara	15	13	0.972	0.978	172
18 Baraigram	21	12	0.930	0.969	232
19 Gurudaspur	29	17	0.929	0.969	223
20 Lalpur	20	17	0.905	0.949	234
21 Natore	20	14	0.953	0.970	215
22 Naldanga	12	07	0.852	0.931	188
23 Singra	17	13	0.749	0.881	201
24 Charchat	11	07	0.955	0.979	240
25 Bagha	12	07	0.933	0.956	171
26 Bagmara	22	13	0.664	0.528	206
27 Durgapur	35	21	0.940	0.979	243
28 Godagari	29	18	0.859	0.934	206
29 Mohanpur	15	08	0.801	0.916	252
30 Paba	36	24	0.911	0.958	242
31 Puthia	21	17	0.965	0.989	210
32 Tanor	16	11	0.799	0.902	224
Rajshahi region	172	34	0.928	0.970	218

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 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

The survey results conducted in 32 upazilas of Rajshahi region indicated that the Boro-Fallow-T. Aman was the most predominant cropping pattern. The number of cropping pattern ranged from 11 to 35 while the cropping intensity values varied from 171 to 253%. The average cropping intensity of the region is 218% which is higher than the national average. A wide ranged also existed in CDI. Based on the findings following recommendations were made.

- Initiative to be taken to increase productivity of exclusive rice based cropping pattern. As rice is the synonym of the primary food security, the high yielding stress tolerant varieties of rice along with recommended crop management packages to be adopted.
- The upazila s having unique or exceptional cropping patterns with large area coverage might be studied in-depth to extrapolate to similar environments.
- In the single Boro area suitable vegetables might be grown on floating bed system in wet season.
- A large portion of single T. Aman area might be intensified by the inclusion of some stress-tolerant Rabi crops like felon, grasspea etc.

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

Cropping pattern	Area (ha)	Cropping pattern	Area (ha)
001 Boro-Fallow-T. Aman	158390	065 Mustard-Boro-Aus-T. Aman	1700
002 Boro-Fallow-Fallow	50130	066 Mustard-Mungbean-T. Aman	1700
003 Wheat-Fallow-T. Aman	30130	067 Vegetab-Aus-T. Aman	1640
004 Mustard-Boro-T. Aman	25650	068 Vegetab-Fallow-T. Aman	1550
005 Boro-Aus-T. Aman	25290	069 Boro-Jute-T. Aman	1500
006 Fallow-Fallow-T. Aman	19100	070 Mustard-Aus-Blackgram	1500
007 Wheat-Aus-T. Aman	16010	071 Vegetab-Aus-Blackgram	1500
008 Potato-Boro-T. Aman	15610	072 Grasspea-B.Aman	1380
009 Mustard-Boro-Fallow	13050	073 Maize-Aus-Blackgram	1300
010 Wheat-Mungbean-T. Aman	12570	074 Potato-Aus-Fallow	1300
011 Wheat-Aus-Blackgram	12030	075 Boro-Jute-Fallow	1200
012 Boro-B.Aman	11650	076 Wheat-Vegetab-T. Aman	1160
013 Vegetab-Vegetab-Vegetab	10715	077 Wheat-B.Aman	1150
014 Wheat-Jute-T. Aman	10270	078 Onion-Maize-T. Aman	1050
015 Mustard-Boro-Aus	10200	079 Garlic-Vegetab-Vegetab	1030
016 Boro-Aus-Fallow	9500	080 Fallo-Fallo-T. Aman(Orchard)	1000
017 Boro-Aus-Blackgram	8000	081 Maize-Fallow-Fallow	1000
018 Potato-Boro-Aus	7200	082 Potato-Chilli-Fallow	980
019 Wheat-Aus-Fallow	7020	083 Onion-Aus-Blackgram	870
020 Wheat-Jute-Fallow	6720	084 Lentil-Vegetab-Vegetab	760
021 Felon-Fallow-T. Aman	6400	085 Wht-Sesame-B.gram(Orchard)	730
022 Garlic-B.Aman	6200	086 Lentil-Aus-T. Aman	710
023 Fallow-Aus-T. Aman	6120	087 Lentil-Sesame-T. Aman	710
024 Mustard-Fallow-T. Aman	6000	088 Potato-Maize-Aus-Vegetab	700
025 Potato-Boro-Fallow	5800	089 Potato-Vegetab-T. Aman	700
026 Potato-Maize-T. Aman	5350	090 Chilli-Fallow-T. Aman	670
027 Onion-Aus-Fallow	4450	091 Garlic-Aus-Fallow	660
028 Lentil-Fallow-T. Aman	4370	092 Boro-Vegetab(Float/Norm)	630
029 Garlic-Jute-Fallow	4310	093 Lentil-Aus-Fallow	620
030 Potato-Fallow-T. Aman	4050	094 Chilli-Vegetab-Fallow	600
031 Potato-Maize-Aus	4000	095 Mungbean-Aus-T. Aman	600
032 Mustard-Aus-T. Aman	3800	096 Boro-Sesbania-T. Aman	580
033 Maize-Fallow-T. Aman	3780	097 Wheat-Vegetab-Vegetab	500
034 Wheat-F-T. Aman(Orchard)	3700	098 Garlic-Aus-T. Aman	490
035 Vegetab-Aus-Fallow	3680	099 Maize-Aus-T. Aman	440
036 Vegetab-Vegetab-T. Aman	3550	100 Vegetab-Maize-Fallow	430
037 Vegetab-Vegetab-Fallow	3500	101 Garlic-Fallow-T. Aman	410
038 Maize-Fallow-Blackgram	3350	102 Chilli-Aus-Fallow	400
039 Wheat-Maize-T. Aman	2920	103 Maize-Maize-Fallow	400
040 Lentil-Maize-T. Aman	2890	104 Onion-Maize-Fallow	400
041 Lentil-Fallow-F (Orchard)	2780	105 Vegetab-B.Aman	400
042 Onion-Jute-T. Aman	2750	106 Wheat-Jute-Blackgram	370
043 Wheat-Mungbean-Fallow	2670	107 Boro-Maize-Blackgram	350
044 Chilli-Aus-T. Aman	2600	108 Boro-Maize-Fallow	350
045 Potato-Aus-T. Aman	2600	109 Grasspea-Fallow-T. Aman	350
046 Garlic-Mungbean-T. Aman	2500	110 Garlic+Muskmelon-B.Aman	320
047 Potato-Jute-Fallow	2450	111 Garlic+W.Melon-B.Aman	320
048 Lentil-Jute-T. Aman	2410	112 Lentil-Sesame-Fallow	300

Appendix 1. Continued.

Cropping pattern	Area (ha)	Cropping pattern	Area (ha)
049 Onion-Vegtab-Vegtab	2370	113 Maize-Aus-Fallow	300
050 Garlic-Jute-T. Aman	2320	114 Potato-Maize-Vegtab	300
051 Wheat-Mung-F (Orchard)	2150	115 Vegtab-Boro-T. Aman	300
052 Chickpea-Fallow-T. Aman	2110	116 Vegtab-Jute-Fallow	300
053 Vegtab-Onion-Aus	2100	117 Wheat-Chilli-Fallow	290
054 Wheat-Sesame-T. Aman	2100	118 Onion-Sesame-Fallow	280
055 Onion-Jute-Fallow	2010	119 Potato-Maize-Fallow	270
056 Boro-Fallow-Blackgram	2000	120 Vegtab-Jute-T. Aman	270
057 Maize-B.Aman	2000	121 Grasspea-Aus-Blackgram	250
058 Potato-Jute-T. Aman	1980	122 Mustard-Aus-Fallow	250
059 Wheat-Aus-Onion	1900	123 Chilli-Fallow-Fallow	240
060 Onion-Fallow-T. Aman	1840	124 Potato-Boro-Aus-T. Aman	230
061 Grasspea-Boro-Aus	1800	125 Coriander-Fallow-Fallow	220
062 Mustard-Boro-B.Aman	1800	126 S.Potato-Fallow-Fallow	220
063 Potato-Boro-Jute-T. Aman	1800	127 Chilli-Vegtab-T. Aman	210
064 Lentil-Mungbean-T. Aman	1750	128 Groundnut-Fallow-Fallow	210
		129-172 Other 44 patterns (Table 8)	3730