

# Crop Diversification in Rangpur Region

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## ABSTRACT

For the planning of future research and development elaborate information and a reliable database on existing cropping patterns, cropping intensity and crop diversity of a particular area are of prime importance for guiding policy makers, researchers, extensionists and development workers. A massive group work was accomplished over all 35 upazilas of Rangpur region during 2016 using pre-tested semi-structured questionnaire with a view to document the existing cropping patterns, cropping intensity and crop diversity in the area. Boro-Fallow-T. Aman occupied the largest portion (53%) of net cropped area (NCA) with its distribution in all upazilas. The second largest area, 5% of NCA, was covered by Maize-Fallow-T. Aman which was spread out over 23 upazilas. Under the current investigation 134 cropping patterns were identified. The highest number of cropping patterns was identified 31 in Badarganj of Rangpur and the lowest was 10 in Razibpur of Kurigram district. The highest value of CDI was observed 0.991 in Razibpur upazila followed by 0.989 in Chilmari of Kurigram. The range of cropping intensity values was recorded 190-255%. The maximum value was for Gangachara upazila of Rangpur and minimum for Gaibandha sadar upazila. The overall CDI of Rangpur region was calculated 0.871 and the average cropping intensity at regional level was 219%.

**Key words:** Cropping system, tobacco, land use, diversity index and Jamuna Floodplain

## INTRODUCTION

Five districts namely Rangpur, Gaibandha, Nilphamari, Lalmonirhat and Kurigram are included in Rangpur region. It belongs to mainly Tista Meander Floodplain (AEZ-3) and also to North-eastern Barind Tract (AEZ-27), Active Tista Floodplain (AEZ-2), Active Brahmaputra-Jamuna Floodplain (AEZ-7) and Young Brahmaputra and Jamuna Floodplains (AEZ-8). In this region some areas are susceptible to flooding when the Jamuna river overflows its banks leaving local communities without land, housing and sanitation, or any assets to make normal living to continue. Extreme weather events are already affecting crop production and water resources in this region. The region has been facing the early impact of climate change. These changes have already creates major impacts on the livelihoods of the large number of poor people. It has reduced fresh water availability, increased drought, floods, and natural disaster in different forms.

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 spatial 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; Rashid *et al.*, 2005). 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

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production (Shriar, 2000). There is a strong need for judicious and appropriate use limited resources in case of intervention selection that does not lead to increased mal adaptation or inequity in the society over long term. Existing trend of available agricultural lands are 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 Rangpur 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-five upazilas of Rangpur, Gaibandha, Nilphamari, Lalmonirhat and Kurigram were the location of this study. Data were collected using double stage procedure. At initial stage, data were collected through pre-tested semi-structured questionnaire from 35 pre-assigned Sub-Assistant Agriculture Officers (SAAO) of each upazila during June 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 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, checked and analyzed those find the inconsistencies of the supplied data before validation workshop. All the inconsistencies among the information were documented. The collected data along with documented inconsistencies were discussed in district level workshop to for necessary correction and validation. Second stage of data collection was day-long data validation workshop at district level. The workshop dates were 30 August for Kurigram; 31 August for Rangpur; 19 September for Lalmonirhat; 21 September for Gaibandha; and 5 October 2016 for Nilphamari. 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 BIRRI regional station, Rangpur participated in the data validation workshop. The number of participants of validation workshop ranged from 48 to 84 in each district. All the participants were divided into three to four groups for data validation. Each group was facilitated by two RFS scientists to finalize and validate the data and authenticated data were captured. Crop diversity index was calculated by using the following equation described by Kshirsagar *et al.* (1997).

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

Where,  $CDI_i$  = Crop Diversity Index

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

$A_i$  = Total area planted under all crops

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

## RESULTS AND DISCUSSION

### Land use

Table 1 lists status of agricultural land utilization. The net cropped area of the Rangpur region is 696,420 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 20 to 2,610 ha. The annual crops area accounted only 2% of the net cropped area (NCA) in the region. At a glance the region possesses about 6% single cropped area (SCA), 64% double cropped area (DCA), 27% triple cropped area (TCA). The quadruple cropped area (QCA) also exists as a very negligible portion (0.03%) and is limited in only two upazilas viz Gangachara and Rowmari. The SCA had the major share of NCA in Pirganj upazilas of Rangpur district; Chilmari and Nagesawari of Kurigram district; Sundarganj, Fulchhari and sadar upazila of Gaibandha district followed by corresponding double cropped area (DCA). Pirgachha upazila of Rangpur district, Palasbari of Gaibandha, Saidpur and Dimla of Nilphamari had no single cropped area at all. Most of the upazilas were dominated by DCA. The exceptions are Gangachara upazila of Rangpur district where triple cropped area is the dominating one (Table 1). The area, which could not be defined under SCA, DCA, TCA or QCA was considered as other whose coverage is less than 1% of the NCA.

### Cropping patterns of Rangpur

In total 134 cropping patterns were observed in Rangpur region of which five cropping patterns with exclusive rice crop covers over 58% of the NCA. There were 49 cropping patterns with exclusive non-rice crop covering over 6% of the NCA. Rest of the NCA ie about 36% area is covered by 80 rice - non rice cropping patterns (Appendix 1).

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

Rice is the only crop round the year in five cropping patterns (Table 2). It comprises

58.32% of the NCA in the region. Among them single rice and double rice represent around 4.12% and 54.20% respectively. There is no triple rice area in Rangpur region. It reflects the unparallel dominance of rice in the cropping systems in Rangpur region. In case of individual pattern Boro-Fallow-T. Aman has the highest coverage (53.33%) and was recorded in all 35 upazilas. The second dominant pattern single Boro area occupied 4.07% of NCA which was reported in 28 upazilas. Single T. Aman covered 0.05% area with its existence in Rangpur sadar upazila only.

In the current investigation, 49 cropping patterns were identified that was free from rice. Among them, first 30 have been arranged in descending order (Table 3). The rest 19 patterns with negligible area coverage are arranged in Table 8 with other patterns of different categories. Aggregate of the 49 patterns have had 6.41% of NCA. In critical comparison is clear that exclusive rice area is about nine folds of exclusive non-rice area. In Rangpur region crop diversity is much wider than that of other regions like Sylhet and Chittagong where exclusive rice area covers 37 folds and 23 fold, 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 cropping strategy against risks (Mandal and Bezbaruah, 2013). Typology of different cropping systems is the base for the managers of these systems to intensify production (Shriar, 2000).

### Non-rice cereal crops

Thirty-five cropping patterns holding different non-rice cereal crops viz maize, wheat, millets (*cheena* and *kaon*) (Table 4) which in-together covered 15.82% of NCA. Among them two cropping patterns viz Maize-Fallow-T. Aman and Wheat-Jute-T. Aman jointly occupied 8.65% of NCA. Maize is covering the largest

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

Upazila	Area of upazila	Annual crop	SCA	DCA	TCA	QCA	Other	NCA	C.I. (%)
01 Rangpur	13981	190	470	7510	3250	0	170	11590	223
02 Gangachara	24574	140	500	8150	11720	200	130	20840	255
03 Kaunia	14757	200	600	5620	5460	0	120	12000	239
04 Pirgachha	26518	630	0	13580	5500	0	120	19830	225
05 Pirganj	40932	940	5390	19000	7200	0	110	32640	203
06 Badarganj	30127	900	350	14010	6880	0	160	22300	225
07 Mithapukur	51584	630	1510	26320	15950	0	120	44530	231
08 Taraganj	12866	720	150	7300	3180	0	170	11520	220
09 Gaiba. sadar	32024	30	3340	14650	1360	0	150	19530	190
10 Palasbari	18525	500	0	11670	1950	0	130	14250	210
11 Gobindaganj	46003	2610	1740	20100	11780	0	180	36410	221
12 Saghata	23109	100	1080	11350	4220	0	150	16900	218
13 Fulchhari	30654	20	2270	11370	2320	0	140	16120	200
14 Sundarganj	41214	270	2090	23550	4950	0	110	30970	208
15 Sadullapur	22800	580	20	13290	3100	0	190	17180	215
16 Kurigram	26566	500	900	11140	6370	0	190	19100	226
17 Ulipur	45867	60	1450	17510	5090	0	150	24260	215
18 Chilmari	22998	50	3500	5750	2500	0	150	11950	191
19 Rowmari	19200	190	140	7630	5900	10	120	13990	240
20 Razibpur	11303	240	1750	4140	2480	0	130	8740	206
21 Bhurungamari	22800	220	1230	11190	4640	0	140	17420	218
22 Nageswari	42080	160	4000	19265	4275	0	160	27860	200
23 Phulbari	15658	250	50	9500	2600	0	150	12550	219
24 Rajarhat	16622	90	1010	9630	2610	0	150	13490	211
25 Nilphamari	37308	140	1200	18230	10510	0	160	30240	230
26 Saidpur	12167	160	0	7360	1420	0	120	9060	214
27 Domar	25084	310	150	14540	4920	0	140	20060	222
28 Dimla	32688	640	1050	16710	4940	0	100	23440	214
29 Jaldhaka	33675	540	0	16990	6030	0	130	23690	223
30 Kishoreganj	20502	520	250	7510	6690	0	150	15120	240
31 Lalmonirhat	26075	500	500	11300	6820	0	180	19300	230
32 Aditmari	19503	280	1090	8520	6115	0	125	16130	230
33 Kaliganj	23694	170	250	15040	3860	0	150	19470	218
34 Hatibandha	28777	230	1050	15820	5770	0	160	23030	220
35 Patgram	26151	110	200	16060	4390	0	150	20910	220
Rangpur region		13820	39280	451305	186750	210	5055	696420	219

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

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Boro-Fallow-T. Aman	371370	53.33	35
02 Boro-Fallow-Fallow	28320	4.07	28
03 Boro-Aus-T. Aman	5640	0.81	13
04 Fallow-Fallow-T. Aman	350	0.05	1
05 Boro-Sesbania-T. Aman	480	0.07	3
Total	406160	58.32	

**Table 3. Cropping patterns with exclusivenon-rice in Rangpur region, 2014-15.**

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Vegetab-Vegetab-Vegetab	10590	1.52	25
02 Vegetab-Vegetab-Fallow	4670	0.67	11
03 Maize-Fallow-Fallow	4220	0.61	6
04 Groundnut-Fallow-Fallow	2430	0.35	9
05 Chilli-Jute-Fallow	1950	0.28	6
06 Tobacco-Vegetab-Vegetab	1500	0.22	1
07 Wheat-Jute-Fallow	1460	0.21	6
08 Chilli-Vegetab-Fallow	1340	0.19	16
09 Maize-Jute-Fallow	1150	0.17	3
10 Vegetab-Fallow-Fallow	1150	0.17	3
11 Maize-Vegetab-Fallow	1120	0.16	4
12 Onion-Vegetab-Vegetab	1050	0.15	7
13 Onion-Jute-Fallow	980	0.14	5
14 Potato-Groundnut	930	0.13	6
15 Millet ( <i>cheena</i> )-Fallow-Fallow	890	0.13	3
16 S.Potato-Jute-Fallow	770	0.11	2
17 Lentil-Jute-Fallow	760	0.11	4
18 Vegetab-Jute-Fallow	730	0.10	3
19 Tobacco-Maize-Vegetab	600	0.09	1
20 Garlic-Vegetab-Vegetab	580	0.08	6
21 Chilli-Fallow-Fallow	530	0.08	4
22 Vegetab-Fallow-Blackgram	530	0.08	8
23 Maize-Sesame-Fallow	500	0.07	1
24 Tobacco-Fallow-Fallow	490	0.07	2
25 Millet ( <i>cheena</i> )-Jute-Fallow	450	0.06	1
26 S.Potato-Fallow-Fallow	360	0.05	5
27 Fallow-Fallow-Blackgram	290	0.04	4
28 Garlic-Jute-Fallow	260	0.04	4
29 Wheat-Ginger/Turmeric	230	0.03	1
30 Blackgram-Jute-Fallow	200	0.03	1
31-49 Other 19 patterns (in Table 8)	1930	0.28	-
Total for exclusive non-rice crop	44640	6.41	

area whereas millet is cultivated in the smallest area. After Maize, wheat is widely cultivated cereal crops under diversified cropping systems in Rangpur region. There were 21 patterns based on maize, which all-together covers 81,130 ha of land (11.65% of NCA) in the region. Wheat was leading 11 cropping patterns with an area coverage of 26,925 ha (3.87% of NCA). 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 for which this area is dominated by maize and wheat cropping systems (FAO, 1988).



**Table 4. Cropping patterns with wheat and maize and other minor cereals in Rangpur region, 2014-15.**

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Maize-Fallow-T. Aman	37630	5.40	24
02 Wheat-Jute-T. Aman	22660	3.25	34
03 Potato-Maize-T. Aman	12720	1.83	22
04 Maize-Jute-T. Aman	9760	1.40	16
05 Tobacco-Maize-T. Aman	6880	0.99	9
06 Maize-Fallow-Fallow	4220	0.61	6
07 Vegetab-Maize-T. Aman	2520	0.36	6
08 Boro-Fallow-Maize	1500	0.22	1
09 Wheat-Jute-Fallow	1460	0.21	6
10 Wheat-Fallow-T. Aman	1260	0.18	6
11 Maize-Jute-Fallow	1150	0.17	3
12 Maize-Vegetab-Fallow	1120	0.16	4
13 Maize-Aus-T. Aman	930	0.13	3
14 Millet ( <i>cheena</i> )-Fallow-Fallow	890	0.13	3
15 Millet ( <i>kaon</i> )-Fallow-T. Aman	800	0.11	2
16 Wheat-Aus-T. Aman	650	0.09	10
17 Tobacco-Maize-Vegetab	600	0.09	1
18 Mustard-Maize-T. Aman	550	0.08	3
19 Maize-Sesame-Fallow	500	0.07	1
20 Millet ( <i>cheena</i> )-Jute-Fallow	450	0.06	1
21 Wheat-Vegetab-T. Aman	305	0.04	2
22 Wheat-Ginger/Turmeric	230	0.03	1
23 Onion-Maize-T. Aman	220	0.03	2
24 Maize-Boro-T. Aman	200	0.03	1
25 Potato+Maize-Vegetab-T. Aman	200	0.03	1
26 Millet ( <i>kaon</i> )+Sesame-Fallow	40	0.01	1
27-35 Other nine patterns (in Table 8)	710	0.10	-
Total of non-rice cereal crops	110155	15.82	

### Vegetables and spices crops

Sixty-three cropping patterns have been arranged in descending order according to area coverage (Table 5). Potato and other vegetables of Rabi, Kharif-I and Kharif-II; spices (chilli, onion, garlic, coriander and black cumin) are included in this list. Total area for vegetables and spices crops in the region is 127,455 ha (18.30% of NCA). The most contributing cropping pattern is Potato-Boro-T. Aman covering 5.16% of NCA, which is distributed over 22 upazilas. The second one is Potato-Maize-T. Aman covering 1.83% of NCA. Year-round vegetables here is the most available pattern recorded in 25 upazilas out of 35. For availability of irrigation water in dry season, supply of modern varieties of various crops, skilled technology transfer system, knowledge on modern crop management practices, high market value of

fresh vegetables, good communication and marketing facilities enhanced the extensive production of various types of vegetables in Rangpur region (FAO, 1988). Vegetables like colocasia, okra, amaranthus, brinjal, cucurbits, etc are grown in medium upland adjacent to rice fields during rainy season and potato, sweet gourd, cole crops, leafy vegetables etc are grown during winter season in Tripura (Das *et.al.*, 2015).

### Pulses and oil-seed crops

Forty-three cropping patterns are holding different pulses and oilseed crops (Table 6). Among them mustard is covering the largest area. Nine cropping patterns of mustard all-together cover 29,210 ha (4.19% of NCA). The second largest area is covered by groundnut. There were five cropping patterns for

**Table 5. Cropping patterns with vegetables and spices in Rangpur region, 2014-15.**

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Potato-Boro-T. Aman	35960	5.16	22
02 Potato-Maize-T. Aman	12720	1.83	22
03 Potato-Jute-T. Aman	10790	1.55	24
04 Vegetab-Vegetab-Vegetab	10590	1.52	25
05 Potato-Aus-T. Aman	6470	0.93	16
06 Vegetab-Vegetab-Fallow	4670	0.67	11
07 Potato-Fallow-T. Aman	3850	0.55	5
08 Onion-Jute-T. Aman	3720	0.53	20
09 Vegetab-Vegetab-T. Aman	2710	0.39	12
10 Chilli-Fallow-T. Aman	2660	0.38	9
11 Vegetab-Maize-T. Aman	2520	0.36	6
12 Potato-Vegetab-T. Aman	2390	0.34	9
13 Potato-Boro-Fallow	2000	0.29	1
14 Chilli-Jute-Fallow	1950	0.28	6
15 Vegetab-Fallow-T. Aman	1650	0.24	7
16 Chilli-Jute-T. Aman	1560	0.22	9
17 Vegetab-Boro-T. Aman	1520	0.22	4
18 Tobacco-Vegetab-Vegetab	1500	0.22	1
19 Garlic-Jute-T. Aman	1380	0.20	16
20 Chilli-Vegetab-Fallow	1340	0.19	16
21 Vegetab-Fallow-Fallow	1150	0.17	3
22 Maize-Vegetab-Fallow	1120	0.16	4
23 Onion-Vegetab-Vegetab	1050	0.15	7
24 Onion-Jute-Fallow	980	0.14	5
25 Potato-Groundnut	930	0.13	6
26 Vegetab-Groundnut-T. Aman	860	0.12	2
27 Vegetab-Jute-Fallow	730	0.10	3
28 Vegetab-Aus-T. Aman	660	0.09	2
29 Boro-Vegetab(Float/Norm)	600	0.09	1
30 Tobacco-Maize-Vegetab	600	0.09	1
31 Vegetab-Jute-T. Aman	590	0.08	6
32 Garlic-Vegetab-Vegetab	580	0.08	6
33 Chilli-Fallow-Fallow	530	0.08	4
34 Vegetab-Fallow-Blackgram	530	0.08	8
35 Onion-Aus-T. Aman	400	0.06	1
36 Wheat-Vegetab-T. Aman	305	0.04	2
37 Vegetab-Boro-Fallow	300	0.04	1
38 Chilli-Vegetab-T. Aman	260	0.04	4
39 Garlic-Fallow-T. Aman	260	0.04	5
40 Garlic-Jute-Fallow	260	0.04	4
41 Onion-Fallow-T. Aman	260	0.04	3
42 Wheat-Ginger/Turmeric	230	0.03	1
43 Onion-Maize-T. Aman	220	0.03	2
44 Fallow-Vegetab-T. Aman	200	0.03	1
45 Potato+Maize-Vegetab-T. Aman	200	0.03	1
46-63 Other 18 patterns (in Table 8)	1700	0.24	-
Total vegetables and spices	127455	18.30	

groundnut, which unitedly has a coverage of 3,460 ha (0.50% of NCA). Other pulses and oil-seed crops hold a number of cropping patterns, however, with non-significant coverage for each individual. 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 of mustard cultivation is related to the land for double rice. If technology transfer activities are strengthened much more area of the aforesaid category will be possible to make room for the mustard crop (FAO, 1988).

### **Hazardous crop**

In this investigation, tobacco was found to grow under eight cropping patterns covering 19,120 ha (Table 7) which is equivalent to 2.75% of total NCA in the region. The major pattern Tobacco–Maize–T. Aman solely cover 6,800 ha that represents one-third of total tobacco area. The most distributed pattern in this region is Tobacco–Fallow–T. Aman that found in 10 upazilas out of 35. Vegetables, fibre and cereal are grown after tobacco cultivation. Tobacco is one of the major cash crop in Rangpur region. But now-a-day's government and some other organizations are making campaign for not growing tobacco. 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 the cultivation of tobacco. Farmers consider the crop as an insurance of his property. Industry personnel make assurance to purchase their products with price. Moreover, they pay money in advance as production cost. They supply all inputs and technologies for successful production of tobacco. These are privileges of farmers for tobacco cultivation.

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

Tobacco–Vegetables–Vegetables is an extremely location specific cropping pattern which is limited only in Aditmari upazila of Lalmonirhat district with an area of 1,500 ha (Table 7). Potato–Boro–Fallow is another exception, which is practiced in Pirgachha

upazila of Rangpur district. This pattern has occupied an area of 2,000 ha (Table 5). The third one is Boro–F–Maize, which is practiced only in Gobindaganj upazila of Gaibandha district with an area coverage of 1,500 ha (Table 4).

### **Rare cropping patterns**

In the present investigation, 40 cropping patterns have been identified as rare cropping patterns with negligible area coverage and seldom existence (Table 8). These are location specific system and are limited in one to three upazilas of the region. Total area coverage of the 40 patterns is far less than 1% of NCA. Among them the highest area was allotted for Lentil–Vegetables–Vegetables (190 ha) and it is recorded only in Razibpur upazila of Kurigram district and Pirganj upazila of Rangpur district. The smallest area was recorded for two cropping patterns whose coverage was five hectares for each (Table 8).

### **Most dominant cropping pattern**

Boro–Fallow– T. Aman was the most dominant cropping pattern in Rangpur region. It covers 53.33% of NCA in the region and is available in almost all upazilas (Table 9). The highest area under this cropping was recorded 23,200 ha in Sundarganj upazila which represents 6.25% of the total Boro–Fallow–T. Aman area of the region. In consideration of individual upazila, Palasbari upazila stand 15<sup>th</sup> position (11,000 ha), however, this upazila has allocated highest share and it is 80% of its NCA for this pattern alone. Razibpur, Chilmari and Kaunia upazila had negligible area coverage for this cropping pattern. In the country-wide compilation of data it was observed that Boro–F–T. Aman was the most dominant cropping pattern in Bangladesh covering 2.31 million ha (27% of NCA in the country) with its distribution in 426 upazilas of 63 districts (Nasim *et al.*, 2017).

### **Second dominant cropping pattern**

The second dominant cropping pattern in Rangpur region is Maize–Fallow–T. Aman. It belongs to 5.40% of NCA of the region and spread out over 23 upazilas (Table 10). Patgram



**Table 6. Cropping patterns with pulses and oil-seed crops in Rangpur region, 2014-15.**

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Mustard-Boro-T. Aman	22840	3.28	30
02 Mustard-Boro-Fallow	2650	0.38	5
03 Groundnut-Fallow-Fallow	2430	0.35	9
04 Mustard-Jute-T. Aman	2210	0.32	6
05 Potato-Groundnut	930	0.13	6
06 Vegetab-Groundnut-T. Aman	860	0.12	2
07 Lentil-Jute-Fallow	760	0.11	4
08 Boro-Fallow-Blackgram	700	0.10	2
09 Mustard-Maize-T. Aman	550	0.08	3
10 Vegetab-Fallow-Blackgram	530	0.08	8
11 Maize-Sesame-Fallow	500	0.07	1
12 Groundnut-Fallow-T. Aman	490	0.07	2
13 Lentil-Jute-T. Aman	460	0.07	10
14 Lentil-Fallow-T. Aman	440	0.06	4
15 Groundnut-Jute-T. Aman	390	0.06	3
16 Mustard-Aus-T. Aman	350	0.05	2
17 Mustard-Fallow-T. Aman	350	0.05	2
18 Blackgram-Jute-T. Aman	320	0.05	2
19 Fallow-Fallow-Blackgram	290	0.04	4
20 Blackgram-Jute-Fallow	200	0.03	1
21-43 Other 23 patterns (in Table 8)	1260	0.18	-
Total pulses and oil-seeds	39510	5.67	

**Table 7. Cropping patterns of hazardous crop in Rangpur region, 2014-15.**

Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01 Tobacco-Maize-T. Aman	6880	0.99	9
02 Tobacco-Aus-T. Aman	3090	0.44	9
03 Tobacco-Jute-T. Aman	3010	0.43	9
04 Tobacco-Boro-T. Aman	1850	0.27	3
05 Tobacco-Fallow-T. Aman	1700	0.24	10
06 Tobacco-Vegetab-Vegetab	1500	0.22	1
07 Tobacco-Maize-Vegetab	600	0.09	1
08 Tobacco-Fallow-Fallow	490	0.07	2
Total	19120	2.75	

upazila of Lalmonirhat district holds the highest area of 10,200 ha followed by Hatibandha upazila of the same district (6,500 ha) under this Maize-Fallow-T. Aman cropping pattern. These two upazilas jointly contribute about 45% share of Maize-Fallow-T. Aman cropping area in the region. Sadullapur and Kishoreganj upazilas are holding the lowest area (below 1%) of this pattern.

### Third dominant cropping pattern

Potato-Boro-T. Aman cropping pattern holds the third largest area coverage 35,960 ha in Rangpur region. This area is an equivalent

to 5.16% of NCA in the region. Potato is the most cultivated vegetable crop in Rangpur region. This pattern Potato-Boro-T. Aman is distributed over 22 upazilas. Mithapukur upazila of Rangpur district has an area of 6,300 ha for this pattern, which alone stands for 17.52% of the total area under this pattern in the region (Table 11). In the country-wide compilation of data it was observed that Potato-Boro-T. Aman was the 8<sup>th</sup> dominant cropping pattern in Bangladesh covering 1.80 lac ha (2.11% of NCA in the country) with its distribution in 115 upazilas of 33 districts (Nasim *et al.*, 2017).

**Table 8. Rare cropping patterns covering non-significant areain Rangpur region, 2014-15.**

	Cropping pattern	Area (ha)	% of NCA	Frequency	Upazila
01	Lentil-Vegetab-Vegetab	190	0.03	2	Razibpur+Pirganj
02	Wheat-Vegetab-Vegetab	170	0.02	1	Badarganj
03	Coriander-Fallow-Fallow	160	0.02	3	Rowmari+Domar+Pirganj
04	Potato-Chilli-Fallow	160	0.02	1	Domar
05	Coriander-Jute-Fallow	150	0.02	2	Fulchhari+Saghata
06	Lentil-Sesame-Fallow	150	0.02	1	Kurigram sadar
07	Mustard-Jute-Fallow	150	0.02	1	Lalmonirhat sadar
08	Potato-Jute-Fallow	150	0.02	1	Nageswari
09	Maize-Mungbean-Vegetab	120	0.02	1	Kurigram sadar
10	S.Potato-Fallow-T. Aman	120	0.02	3	Kurigramsadar+Domar+Kishoreganj
11	Groundnut- Aus-Fallow	100	0.01	1	Nageswari
12	Mustard- Aus-Fallow	100	0.01	1	Pirganj
13	Vegetab-Jute-Vegetab	100	0.01	1	Kishoreganj
14	Coriander-Vegetab-Fallow	90	0.01	3	Dimla+Kishoreganj+Saidpur
15	Potato-Maize-Fallow	90	0.01	2	Rajarhat+Saidpur
16	Grasspea-Jute-T. Aman	80	0.01	2	Rajarhat+Sundarganj
17	Maize-Vegetab-T. Aman	80	0.01	2	Phulbari+Kaliganj
18	Wheat-Maize-T. Aman	80	0.01	1	Kurigram sadar
19	Potato-Mungbean-T. Aman	70	0.01	3	Kaliganj+Dimla+Badarganj
20	Coriander-Fallow-T. Aman	60	0.01	1	Jhaldhaka
21	Onion-Maize-Fallow	60	0.01	1	Lalmonirhat sadar
22	Wheat-Mungbean-T. Aman	60	0.01	3	Sundarganj+Domar+Kishoreganj
23	Grasspea-Fallow-T. Aman	50	0.01	1	Fulchhari
24	Groundnut-Sesame-Fallow	50	0.01	1	Sundarganj
25	Blackgram-Aus-T. Aman	40	0.01	1	Aditmari
26	Fallow-Sesame-T. Aman	40	0.01	1	Rajarhat
27	Millet( <i>kaon</i> )+Sesame-Fallow	40	0.01	1	Sundarganj
28	S.Potato-Vegetab-Fallow	40	0.01	2	Dimla+Mithapukur
29	Lentil-Vegetab-T. Aman	30	0.00	1	Phulbari
30	Wht-Sesame-B.gram(Orchard)	30	0.00	1	Badarganj
31	Blackcumin-Jute-Fallow	20	0.00	1	Rowmari
32	Sesame-Fallow-T. Aman	20	0.00	1	Aditmari
33	Wheat-Aus-Fallow	20	0.00	1	Bhurungamari
34	Grasspea-Fallow-Fallow	10	0.00	1	Gaibandha sadar
35	Lentil-Aus-T. Aman	10	0.00	1	Phulbari
36	Mustard-Boro-Jute-T. Aman	10	0.00	1	Rowmari
37	Potato-Groundnut-T. Aman	10	0.00	1	Kishoreganj
38	Potato-Sesame-T. Aman	10	0.00	1	Mithapukur
39	Mungbean-Fallow-T. Aman	5	0.00	1	Nageswari
40	Mungbean-Jute-T. Aman	5	0.00	1	Nageswari
	Total	2930	0.40		

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

Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01 Sundarganj	23200	74.91	6.25
02 Mithapukur	22500	50.53	6.06
03 Gobindaganj	17800	48.89	4.79
04 Nageswari	17400	62.46	4.69
05 Ulipur	17200	70.90	4.63
06 Nilphamri sadar	16000	52.91	4.31
07 Gaibandha sadar	14600	74.76	3.93
08 Pirganj	14000	42.89	3.77
09 Domar	13100	65.30	3.53
10 Kaliganj	12500	64.20	3.37
11 Sadullapur	12300	71.59	3.31
12 Badarganj	12000	53.81	3.23
13 Jaldhaka	12000	50.65	3.23
14 Saghata	11070	65.50	2.98
15 Palasbari	11000	77.19	2.96
16 Dimla	10700	45.65	2.88
17 Bhurungamari	10000	57.41	2.69
18 Rajarhat	9300	68.94	2.50
19 Kurigram sadar	9300	48.69	2.50
20 Phulbari	9200	73.31	2.48
21 Lal. sadar	9200	47.67	2.48
22 Hatibandha	8800	38.21	2.37
23 Aditmari	8400	52.08	2.26
24 Pirgachha	8000	40.34	2.15
25 Kishoreganj	7000	46.30	1.88
26 Gangachara	7000	33.59	1.88
27 Rangpur sadar	6800	58.67	1.83
28 Fulchhari	6700	41.56	1.80
29 Saidpur	6500	71.74	1.75
30 Taraganj	6000	52.08	1.62
31 Patgram	5700	27.26	1.53
32 Rowmari	5100	36.45	1.37
33 Kaunia	5000	41.67	1.35
34 Razibpur	3000	34.32	0.81
35 Chilmari	3000	25.10	0.81
Rangpur region	371370	53.33	100.00

#### Fourth dominant cropping pattern

Single Boro cropping pattern holds the fourth largest area coverage 28,320 ha in Rangpur region. This area is an equivalent to 4.07% of NCA in the region. This pattern Boro–Fallow–Fallow is distributed over 28 upazilas. Pirgachha has an area of 4,900 ha for single Boro which stands for 17.3% of the total area under this pattern in the region (Table 12). This pattern is frequent and concurrently experienced by early flash flood in April and cold injury at reproductive

stage. Diversified cropping pattern may be resort for the farmer as a coping strategy with flood related risk (Mandal and Bezbaruah, 2013) but scope of diversification is limited due to environmental and climatic condition (FAO, 1988). In the country-wide compilation of data it was observed that the single Boro was the 2<sup>nd</sup> 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).

**Table 10. Distribution of the 2<sup>nd</sup> dominant Maize–Fallow–T. Aman cropping pattern in Rangpur region, 2014-15.**

Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01 Patgram	10200	49.04	27.11
02 Hatibandha	6500	28.51	17.27
03 Dimla	5000	21.93	13.29
04 Kaliganj	2250	11.66	5.98
05 Pirganj	2900	9.15	7.71
06 Mithapukur	3600	8.20	9.57
07 Jaldhaka	1350	5.83	3.59
08 Gobindaganj	1200	3.55	3.19
09 Nilphamari sadar	1000	3.32	2.66
10 Badarganj	750	3.50	1.99
11 Lalmonirhat sadar	600	3.19	1.59
12 Palasbari	400	2.91	1.06
13 Domar	370	1.87	0.98
14 Pirgachha	300	1.56	0.80
15 Nageswari	200	0.72	0.53
16 Rajarhat	200	1.49	0.53
17 Kaunia	200	1.69	0.53
18 Sundarganj	150	0.49	0.40
19 Ulipur	150	0.62	0.40
20 Kurigram sadar	100	0.54	0.27
21 Saaidpur	90	1.01	0.24
22 Sadullapur	60	0.36	0.16
23 Kishoreganj	50	0.34	0.13
Rangpur region	37630	5.40	100.00

**Table 11. Distribution of the 3<sup>rd</sup> dominant Potato–Boro–T. Aman cropping pattern in Rangpur region, 2014-15.**

Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01 Mithapukur	6300	14.35	17.52
02 Gobindaganj	4700	13.91	13.07
03 Nilphamari sadar	4000	13.29	11.12
04 Pirganj	3000	15.63	8.34
05 Kishoreganj	2100	14.38	5.84
06 Kaunia	1700	14.41	4.73
07 Badarganj	1500	7.01	4.17
08 Gangachara	1500	7.25	4.17
09 Pirgachha	1200	3.79	3.34
10 Jaldhaka	1170	5.05	3.25
11 Sundarganj	1100	3.58	3.06
12 Sadullapur	1000	6.02	2.78
13 Dimla	1000	4.39	2.78
14 Domar	1000	5.06	2.78
15 Saidpur	800	8.99	2.22
16 Palasbari	800	5.82	2.22
17 Kurigram sadar	780	4.19	2.17
18 Rajarhat	700	5.22	1.95
19 Lalmonirhat sadar	550	2.93	1.53
20 Phulbari	500	4.07	1.39
21 Saghata	400	2.38	1.11
22 Patgram	160	0.77	0.44
Rangpur region	35960	5.16	100.00

### Fifth dominant cropping pattern

Fifth dominant cropping pattern Mustard–Boro–T. Aman had been covering 22,840 ha representing 3.28% share of NCA in Rangpur region (Table 13). This pattern is distributed over 30 upazilas where Gobindaganj ranked in top position. This upazila has 3,600 ha area for this pattern which is only 10.65% of upazila NCA. In consideration of area coverage Rowmari upazila stands in second position, however, it has allotted the biggest share ie 18.12% of upazila NCA. In the country-wide compilation of data, it was observed that Mustard–Boro–T. Aman was the 6<sup>th</sup> 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).

### Crop diversity and cropping intensity

Higher number of available crops under cultivation in an area dictates its higher diversity. Number of cropping patterns is also a gross indicator of crop diversity. A total of 134 cropping patterns were identified in the whole area of Rangpur region under this investigation. The highest number of cropping patterns was identified 31 in Badarganj of Rangpur and Dimla upazila of Nilphamari respectively (Table 14). The lowest number of cropping patterns was identified 10 in Razibpur followed by 13 in Saghata and 14 in Rangpur sadar, Kaunia and Gobindaganj. Higher number of cropping patterns is generally related to higher level of diversity indices. The upazilas having lower number of cropping patterns were related to either drought or flood or both. The

**Table 12. Distribution of the 4<sup>th</sup> dominant Boro–F–F cropping pattern in Rangpur region, 2014-15.**

Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01 Pirgachha	4900	15.46	17.30
02 Nageswari	4000	14.44	14.12
03 Gaibandha	2400	12.31	8.47
04 Chilmari	1700	14.29	6.00
05 Gobindaganj	1600	4.73	5.65
06 Mithapukur	1500	3.42	5.30
07 Razibpur	1450	17.06	5.12
08 Bhurungamari	1200	6.98	4.24
09 Nilphamari sadar	1200	3.99	4.24
10 Fulchhari	1100	6.83	3.88
11 Saghata	1000	5.95	3.53
12 Aditmari	1000	6.31	3.53
13 Ulipur	750	3.10	2.65
14 Kurigram sadar	750	4.03	2.65
15 Rajarhat	700	5.22	2.47
16 Kaunia	600	5.08	2.12
17 Sundarganj	600	1.95	2.12
18 Lalmonirhat	500	2.66	1.77
19 Kaliganj	250	1.30	0.88
20 Badarganj	200	0.93	0.71
21 Kishoreganj	200	1.37	0.71
22 Patgram	200	0.96	0.71
23 Hatibandha	150	0.66	0.53
24 Rangpur sadar	120	1.05	0.42
25 Gangachara	100	0.48	0.35
26 Taraganj	50	0.46	0.18
27 Dimla	50	0.22	0.18
28 Phulbari	50	0.41	0.18
Rangpur region	28320	4.07	100.00



**Table 13. Distribution of the 5<sup>th</sup> dominant Mustard-Boro-T. Aman cropping pattern, 2014-15.**

Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01 Gobindaganj	3600	10.65	15.76
02 Rowmari	2500	18.12	10.95
03 Badarganj	2000	9.35	8.76
04 Kurigram sadar	1500	8.06	6.57
05 Nageswari	1500	5.42	6.57
06 Nilphamari sadar	1500	4.98	6.57
07 Ulipr	1200	4.96	5.25
08 Fulchhari	1100	6.83	4.82
09 Sadullapur	700	4.22	3.06
10 Phulbari	700	5.69	3.06
11 Saghata	500	2.98	2.19
12 Bhurungamari	500	2.91	2.19
13 Mithapukur	500	1.14	2.19
14 Sundarganj	450	1.47	1.97
15 Hatibandha	450	1.97	1.97
16 Jaldhaka	450	1.94	1.97
17 Pirgachha	400	2.08	1.75
18 Pirganj	350	1.10	1.53
19 Kaliganj	340	1.76	1.49
20 Palasbari	300	2.18	1.31
21 Lalmonirhat sadar	300	1.60	1.31
22 Patgram	300	1.44	1.31
23 Dimla	300	1.32	1.31
24 Kishoreganj	300	2.05	1.31
25 Kaunia	300	2.54	1.31
26 Domar	200	1.01	0.88
27 Rangpur sadar	200	1.75	0.88
28 Taraganj	200	1.85	0.88
29 Rajarhat	100	0.75	0.44
30 Saidpur	100	1.12	0.44
Rangpur region	22840	3.28	100.00

lowest diversity index for cropping pattern was recorded 0.281 in Sundarganj followed by 0.527 in Gobindaganj. The highest value of diversity index for cropping pattern was found 0.991 in Rajibpur upazila that was followed by 0.989 in Chilmari upazila. The lowest CDI was reported 0.651 in Sundarganj followed by 0.745 in Pirganj. The highest value of CDI was observed 0.991 in Razibpur followed by 0.989 in Chilmari upazila. The range of cropping intensity values was recorded 190-255%. The maximum value was for Gangachara upazila of Rangpur district and minimum for Gaibandha sadar upazila. As a whole the CDI of Rangpur region was calculated 0.871 and the average cropping intensity at regional

level was 219%. 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). Diversified cropping pattern may enabled the farmers compulsion of extracting the maximum possible utilization of land in the flood free period (Mandal and Bezbaruah, 2013). Singh and Sidhu (2006) reported that a number of crops like sun hemp, cluster beans and sorghum had almost disappeared and there is reduced varietal diversification in rice and wheat. Crop diversification index of wheat-rice system has decreased from 0.75 in 1975-76 to 0.58 in 2006-07 in Punjab though diversification

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

Upazila	No. of identified pattern	No. of crop	Diversity index for cropping pattern	Crop diversity index (CDI)	C.I. (%)
01 Rangpur	14	11	0.935	0.968	223
02 Gangachara	26	13	0.913	0.954	255
03 Kaunia	14	12	0.958	0.978	239
04 Pirgachha	20	17	0.721	0.876	225
05 Pirganj	29	15	0.685	0.745	203
06 Badarganj	31	14	0.799	0.902	225
07 Mithapukur	23	12	0.788	0.872	231
08 Taraganj	18	11	0.874	0.902	220
09 Gaibandha sadar	16	15	0.710	0.860	190
10 Palasbari	18	13	0.839	0.921	210
11 Gobindaganj	14	12	0.527	0.772	221
12 Saghata	13	16	0.833	0.918	218
13 Fulchhari	21	17	0.932	0.967	200
14 Sundarganj	26	18	0.281	0.651	208
15 Sadullapur	18	12	0.798	0.901	215
16 Kurigram	28	19	0.778	0.823	227
17 Ulipur	20	17	0.601	0.804	210
18 Chilmari	18	16	0.978	0.989	191
19 Rowmari	24	15	0.756	0.829	240
20 Razibpur	10	14	0.982	0.991	206
21 Bhurungamari	18	13	0.855	0.929	218
22 Nageswari	25	17	0.678	0.874	200
23 Phulbari	18	12	0.772	0.845	219
24 Rajarhat	23	17	0.852	0.935	211
25 Nilphamari	19	13	0.630	0.819	230
26 Saidpur	20	12	0.943	0.972	214
27 Domar	25	16	0.725	0.836	222
28 Dimla	31	14	0.701	0.835	214
29 Jaldhaka	19	11	0.915	0.913	223
30 Kishoreganj	28	14	0.919	0.960	240
31 Lalmonirhat	25	17	0.698	0.865	230
32 Aditmari	16	11	0.795	0.924	230
33 Kaliganj	20	14	0.674	0.872	237
34 Hatibandha	20	12	0.914	0.918	220
35 Patgram	17	13	0.815	0.909	220
Rangpur region	134	31	0.694	0.871	219

forces pests to continuously relocate and re-colonize their preferred host plants from year to year (Tschardtke *et al.*, 2005, 2007).

## CONCLUSION

Boro-Fallow-T. Aman , Maize-Fallow-T. Aman , Potato-Boro-T. Aman and Single Boro were the dominant cropping patterns in

the region. The area under pulses and oil-seed crops was much lower, which is a challenge to food and nutritional security for the people of the Rangpur region. Based on the findings of the study, the following recommendations were made.

- Initiative has to be taken to increase productivity of exclusive rice based cropping pattern along with recommended crop management packages.

- Effort might be given so that a portion of double-rice area could be brought under Potato-Boro-T. Aman and/or Mustard-Boro-T. Aman cropping systems.
- In the single Boro area suitable vegetables might be grown on floating bed system in wet season.
- For sustainable food and nutritional security the area under pulses and oil seed crops should be escalated
- The upazilas having unique or exceptional cropping patterns with large area coverage might be studied in-depth to extrapolate the similar environments.
- Scope might be explored for the establishment of agro-food industry on the basis of potato crop.

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

	Cropping pattern	Area (ha)		Cropping pattern	Area (ha)
01	Boro-Fallow-T. Aman	371370	48	Potato-Groundnut	930
02	Maize-Fallow-T. Aman	37630	49	Millet( <i>cheena</i> )-Fallow-Fallow	890
03	Potato-Boro-T. Aman	35960	50	Vegetab-Groundnut-T. Aman	860
04	Boro-Fallow-Fallow	28320	51	Millet( <i>kaon</i> )-F-T. Aman	800
05	Mustard-Boro-T. Aman	22840	52	S.Potato-Jute-Fallow	770
06	Wheat-Jute-T. Aman	22660	53	Lentil-Jute-Fallow	760
07	Potato-Maize-T. Aman	12720	54	Vegetab-Jute-Fallow	730
08	Potato-Jute-T. Aman	10790	55	Boro-Fallow-Blackgram	700
09	Vegetab-Vegetab-Vegetab	10590	56	Vegetab-Aus-T. Aman	660
10	Maize-Jute-T. Aman	9760	57	Wheat-Aus-T. Aman	650
11	Tobacco-Maize-T. Aman	6880	58	Boro-Vegetab(Float/Norm)	600
12	Potato-Aus-T. Aman	6470	59	Tobacco-Maize-Vegetab	600
13	Boro-Aus-T. Aman	5640	60	Vegetab-Jute-T. Aman	590
14	Vegetab-Vegetab-Fallow	4670	61	Garlic-Vegetab-Vegetab	580
15	Maize-Fallow-Fallow	4220	62	Mustard-Maize-T. Aman	550
16	Potato-Fallow-T. Aman	3850	63	Chilli-Fallow-Fallow	530
17	Onion-Jute-T. Aman	3720	64	Vegetab-Fallow-Blackgram	530
18	Tobacco-Aus-T. Aman	3090	65	Maize-Sesame-Fallow	500
19	Tobacco-Jute-T. Aman	3010	66	Groundnut-Fallow-T. Aman	490
20	Vegetab-Vegetab-T. Aman	2710	67	Tobacco-Fallow-Fallow	490
21	Chilli-Fallow-T. Aman	2660	68	Boro-Sesbania-T. Aman	480
22	Mustard-Boro-Fallow	2650	69	Lentil-Jute-T. Aman	460
23	Vegetab-Maize-T. Aman	2520	70	Millet( <i>cheena</i> )-Jute-Fallow	450
24	Groundnut-Fallow-Fallow	2430	71	Lentil-Fallow-T. Aman	440
25	Potato-Vegetab-T. Aman	2390	72	Onion-Aus-T. Aman	400
26	Mustard-Jute-T. Aman	2210	73	Groundnut-Jute-T. Aman	390
27	Boro-Jute-T. Aman	2080	74	S.Potato-Fallow-Fallow	360
28	Fallow-Jute-T. Aman	2030	75	Fallow-Fallow-T. Aman	350
29	Potato-Boro-Fallow	2000	76	Mustard-Aus-T. Aman	350
30	Chilli-Jute-Fallow	1950	77	Mustard-Fallow-T. Aman	350
31	Tobacco-Boro-T. Aman	1850	78	S.Potato-Jute-T. Aman	350
32	Tobacco-Fallow-T. Aman	1700	79	Blackgram-Jute-T. Aman	320
33	Vegetab-Fallow-T. Aman	1650	80	Wheat-Vegetab-T. Aman	305
34	Chilli-Jute-T. Aman	1560	81	Boro-Jute-Fallow	300
35	Vegetab-Boro-T. Aman	1520	82	Boro-Sesbania-Fallow	300
36	Boro-Fallow-Maize	1500	83	Vegetab-Boro-Fallow	300
37	Tobacco-Vegetab-Vegetab	1500	84	Fallow-Fallow-Blackgram	290
38	Wheat-Jute-Fallow	1460	85	Chilli-Vegetab-T. Aman	260
39	Garlic-Jute-T. Aman	1380	86	Garlic-Fallow-T. Aman	260
40	Chilli-Vegetab-Fallow	1340	87	Garlic-Jute-Fallow	260
41	Wheat-Fallow-T. Aman	1260	88	Onion-Fallow-T. Aman	260
42	Maize-Jute-Fallow	1150	89	Wheat-Ginger/Turmeric	230
43	Vegetab-Fallow-Fallow	1150	90	Onion-Maize-T. Aman	220
44	Maize-Vegetab-Fallow	1120	91	Blackgram-Jute-Fallow	200
45	Onion-Vegetab-Vegetab	1050	92	Fallow-Vegetab-T. Aman	200
46	Onion-Jute-Fallow	980	93	Maize-Boro-T. Aman	200
47	Maize-Aus-T. Aman	930	94	Potato+Maize-Vegetab-T. Aman	200
			95-134	Other 40 patterns (Table 8)	2930

