Crop Diversity and Cropping Patterns of Comilla Region

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ABSTRACT

Comilla region is highly diverse in respect to topography, agro-ecology, land-use pattern and cropping systems. Planning of agricultural development largely depends on the reliable and comprehensive statistics of the existing cropping patterns, cropping intensity and crop diversity of a particular area, which will provide guideline to our policy makers, researchers, extensionists and development workers. The study was conducted over all 33 upazilas of Comilla region during 2016 using pre-tested semi-structured questionnaire with a view to document the existing cropping patterns, cropping intensity and crop diversity. From the present study it was observed that 73.56% of net cropped area (NCA) is covered by exclusive rice cropping systems whereas deep water rice cropping system occupied 16.09% of the regional NCA. The most dominant cropping pattern single Boro alone occupied 26.18% of NCA with its distribution over 30 out of 33 upazilas. The second largest area, 19.93% of NCA, was covered by Boro−Fallow−T. Aman cropping pattern, which was spread over 25 upazilas. One hundred and forty-six cropping patterns were identified in the whole region under this investigation. The highest, 36 cropping patterns were identified in Debidwar upazila of Comilla district and the lowest, seven were in Akhura and Ashuganj of B.Baria and Comilla Adarsha upazila. The lowest crop diversity index (CDI) was reported 0.481 in Comilla Adrasha upazila followed by 0.637 in Hajiganj of Chandpur. The highest value of CDI was observed 0.964 in Haimchar of Chandpur followed by 0.956 in Muradnagar of Comilla. The range of cropping intensity (CI) value was recorded 126-292%. The maximum value was for Barura of Comilla and minimum for Hajiganj of Chandpur district. The grand mean of CDI values for Comilla region was calculated 0.935 and the average cropping intensity at regional level was 192%.

Key words: Cropping pattern, diversity index, Akhaura terrace and Floodplain

INTRODUCTION

Comilla region comprises 33 upazila*s* of Comilla, Chandpur and Brahmanbaria districts covering plains, char lands, terrace, basins and Lalmai hills. Comilla is the biggest district with 16 upazila*s*, located about 100 kilometers south-east of the capital city, Dhaka. The economy is mainly based on agriculture; the economy of Comilla has been flourished through trade and cottage industries, especially the 'Khadi' textile. Brahmanbaria and Chandpur include nine and eight upazila*s* respectively, also with agriculture based economy; Ashuganj fertilizer factory in Brahmanbaria and Chanpur CIP project are of major importance institutions in agriculture. Major rivers passing through

Comilla region include the Meghna, Gumti, Titas, Little Feni etc. Comilla region is bordered by Habiganj and Kishoreganj districts to the north, Noakhali, Laxmipur and Feni districts to the south, Tripura of India to the east, and Meghna river, Narsingdi, Narayanganj, Munsiganj and Shariatpur districts to the west. The tropic of cancer passes through the heart of the Comilla city; the climate is subtropical biased. Eight agro-ecological zones comprises the whole Comilla region, which are briefly described below (FAO, 1988).

Active Brahmaputra-Jamuna Floodplain (AEZ-7). Parts of Chandpur district belongs to this floodplain, which comprises the belt of unstable alluvial land along the Brahmaputra-Jamuna rivers where land is constantly being

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formed and eroded by shifting river channels. It has an irregular relief of broad and narrow ridges and depressions. The area is occupied by sandy and silty alluvium, rich in weatherable K minerals that are slightly alkaline in reaction. Organic matter status is low and fertility status is low to medium.

Middle Meghna River Floodplain (AEZ-16). Parts of all the three districts of Comilla, Brahmanbaria and Chandpur districts belong to this flood plain. This floodplain occupies an abandoned channel of the Brahmaputra river on the border between the greater Dhaka and Comilla districts. The region includes areas of old Brahmaputra chars within the Meghna river as well as adjoining parts of the mainland. Soils of the area are grey loam on the ridges and grey to dark grey clays in the basins. The dominant general soil type is non-calcareous grey floodplain soil. Topsoils are strongly acidic and subsoils are slightly acidic to slightly alkaline.

Lower Meghna River Floodplain (AEZ-17). Parts of Chandpur district belongs to this floodplain, this area occupies the transitional area between the middle Meghna river floodplain and the young Meghna estuarine floodplain. Soils of this area are relatively uniform, silt loams occupy relatively higher areas and silty clay loams occupy the depressions. Non-calcareous dark grey floodplain and calcareous grey floodplain soils are major components of general soil types. Topsoils are moderately acidic and subsoils neutral in reaction. General fertility level is medium to high with low to medium organic matter status and K-bearing minerals.

Old Meghna Estuarine Floodplain (AEZ-19). Parts of all the three districts of Comilla, Brahmanbaria and Chandpur districts belong to this flood plain, which occupies a large area, mainly low-lying land between the south of the Surma-Kushiyara floodplain and the northern edge of the young Meghna estuarine floodplain. Silt loam soils predominate on highlands and silty clay to clay on lowlands. Organic matter content of the soils is moderate. Topsoils are moderately acidic, but subsoils are neutral in reaction. General fertility level is medium with low N and organic matter.

Sylhet Basin (AEZ-21). Parts of Brahmanbaria district belong to Sylhet Basin which occupies the lower, western side of the Surma-Kushiyara floodplain. Relief is locally irregular near rivers. Soils of the area are grey silty clay loams and clay loam on the higher parts that dry out seasonally and grey clays in the wet basins. The soils have a moderate content of organic matter and soil reaction is mainly acidic. Fertility level is medium to high.

Northern and Eastern Piedmont Plains (AEZ-22). Parts of Brahmanbaria and Comilla belong to this piedmont plain, which is a discontinuous region occurring as a narrow strip of land at the foot of the northern and eastern hills. The region comprises merging alluvial fans which slope gently outward from the foot of the northern and eastern hills into smooth, low-lying basins. Grey piedmont soils and non-calcareous grey floodplain soils are the major general soil types of the area. Soils of the area are loams to clays, slightly acidic to strongly acidic in reaction. General fertility level is low to medium.

Northern and Eastern Hills (AEZ-29). Small part of Comilla district is included in the country's hill areas. Highland comprises 93% of the total floodplain, relief is complex. Hills have been dissected to different degrees over different rocks. In general, slopes are very steep and few low hills have flat summits. Brown hill soil is the predominant general soil type of the area. Organic matter content and general fertility level are low.

Akhaura Terrace (AEZ-30). The region occupies the eastern border of Brahmanbaria district. The main soils in the uplands have strong brown clay. The valley soils range from silty clay to clays. Deep red brown terrace soils, grey piedmont soils and acid basin clays are the major components of the general soil types of the area. The general fertility including organic matter status is low. The soils are strongly acidic in reaction.

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 or crops and fallow 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).

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. In this context, there is no other alternative but to address less favourable and unfavourable environments. To increase the system productivity of the total environment it needs to bring diversity in enterprises for better utilization of limited resources. Detailed information on land situation and cropping systems is a prerequisite for a fruitful development programme. Upazila level office of the Department of Agricultural Extension (DAE) maintains a statistics on individual crop, which has some limitation for getting a real picture of existing cropping patterns and land utilization. The specific objectives of the present study were to:

- Understand the existing cropping pattern scenario in Comilla 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-three upazilas of Comilla, Brahmanbaria and Chandpur districts under Comilla 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 33 pre-assigned Sub-Assistant Agriculture Officers (SAAO) of each upazila during November 2015 at upazila level. SAAOs were purposively pre-selected 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 Directorate 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 26 January for Brahmanbaria; 18 February for Chandpur; and 8 May 2016 for Comilla. 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, Comilla participated in the data validation workshop. The number of participants of validation workshop ranged from 54 to 111 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 the collected data were done using Microsoft Excel programme. Descriptive statistics were used to facilitate the presentation of the findings.

RESULTS AND DISCUSSION

Land use pattern
Table 1 shows upazila-wise land use pattern including net crop area (NCA) and CI. NCA of the whole region is about 4.4 lac hectare with 192% CI, which is somewhat lower than the national average. Barura upazila of Comilla shows the highest CI of 292% followed by Debidwar (265%) and Chandina (250%) upazilas of the same district which are much more higher than the national average rendering those upazilas as the most intensive cropping area of the country. The highest CI

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

	Upazila	Area of upazila	Annual crop	SCA	DCA	TCA	QCA	Other	NCA	C.I. (%)
01	Akhaura	9888	20	1940	4100	320	0	90	6470	174
02	Ashuganj	6759	20	300	3650	1050	0	80	5100	215
03	B.Baria	23744	10	4800	8280	1820	50	140	15100	181
04	Bijoynagar	22007	70	8500	5630	350	0	120	14670	144
05	Bancharampur	21738	20	8060	5580	0	0	110	13770	141
06	Kasba	21000	110	3500	8800	2830	0	120	15360	195
07	Nabinagar	35750	20	10900	12340	3000	0	160	26420	170
08	Nasirnagar	30262	10	12260	12820	870	0	100	26060	156
09	Sarail	21527	10	9500	6190	680	0	120	16500	146
10	Chandpur	30880	130	4220	6900	400	0	80	11730	166
11	Faridganj	23150	200	2820	8070	580	40	190	11900	180
12	Haimchar	17400	230	1040	1930	1640	0	140	4980	208
13	Hajiganj	18991	40	9000	2610	250	0	140	12040	126
14	Kachua	24725	10	1300	10480	4760	0	150	16700	221
15	Matlab.N	27760	300	1120	6720	6540	80	120	14880	236
16	Matlab.S	13175	20	2900	6060	10	0	110	9100	168
17	Shaharasti	15400	15	1700	7430	1300	30	175	10650	197
18	Barura	24165	170	0	1460	14290	450	100	16470	292
19	Brahmanpara	12850	10	1870	3640	3870	0	110	9500	221
20	Burichang	16376	30	200	5880	5300	0	110	11520	244
21	Chauddagram	27730	30	3730	12980	1610	10	120	18480	188
22	Chandina	19804	80	760	4785	6205	340	110	12280	250
23	Com.Adarsha	12269	10	5120	2130	0	0	100	7360	129
24	Com.South	24073	80	600	9120	6600	450	130	16980	240
25	Daudkandi	21021	180	8200	6030	230	0	140	14780	144
26	Debidwar	23836	100	525	4435	10050	270	120	15500	265
27	Homna	13279	50	2500	7045	210	0	95	9900	176
28	Nangolkot	22595	20	1900	7400	5160	750	90	15320	231
29	Laksam	15652	20	4310	980	4780	30	100	10220	205
30	Meghna	9455	10	2100	4860	0	0	130	7100	170
31	Monoharganj	15940	30	6260	3915	115	0	110	10430	140
32	Muradnagar	34093	150	2630	15870	4980	0	120	23750	209
33	Titas	11465	10	4970	2010	150	0	170	7310	132
	Comilla region		2215	129535	210130	89950	2500	4000	438330	192

of Barura upazila was resulted from 14,290 ha triple cropped area which is about 87% of the NCA, at the same time the upazila is lacking single crop area(SCA). Four crop or quadruple crop area (QCA) of more than 300 ha is observed in Nangolkot, Barura, Chandina and Comilla south upazilas of Comilla district. Hajiganj upazila of Chandpur district possesses the lowest cropping intensity of 126% followed by Comilla Adarsha(129%) and Titas(132%) upazilas of Comilla district. Single cropped area (SCA) is the major land use pattern of those upazilas. Area under annual crops is the highest in Matlab South upazila (350 ha) followed by Haimchar (230 ha) and Faridganj (200 ha) upazilas of Chandpur district, while the lowest area (five hectares) under annual crops is found in B. Baria sadar and Sarail upazilas of B.Baria district. For availability of irrigation water, both surface and ground sources in dry season, supply of HYV of various crops, knowledge of modern crop management practices, good communication facilities help increasing land use efficiency in a given area (FAO, 1988).

Cropping patterns of Comilla
In total 146 cropping patterns is observed in Comilla region of which nine major cropping patterns with exclusive rice crop covers 73.5% of the NCA, while all 37 cropping patterns with exclusive non-rice crop covers only 8.5% of the NCA and the rest 18% of the NCA is covered by 100 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 73.56% of the NCA in the region. Among them single rice, double rice and triple areas represent 27.40%, 14.78% and 31.38% respectively. It reflects the unparallel dominance of rice in the cropping systems in Comilla region. In case of individual pattern single has the highest coverage (26.18%) and was recorded in 30 upazilas out of 33. The second dominant pattern Boro−Fallow−T. Aman area occupied 19.93% of NCA which was distributed in 25 upazilas. Triple rice area for Boro−Aus−T. Aman covered

14.78% area with its considerable existence in 26 upazilas.

In the current investigation, 37 cropping patterns were identified that was free from rice. Among these 37 patterns first 23 has been arranged in descending order in Table 3. The rest 14 patterns with negligible area coverage can be found in Table 7 where they are arranged with other patterns of different categories. Aggregate of the 37 patterns have had only 8.51% of NCA. In critical comparison it is clear that exclusive rice area is about nine folds of exclusive non-rice area. Among these 37 patterns, three patterns comprise year-round vegetables distributed over majority of the upazilas.They had the highest coverage (3.43%) which is practiced mainly at or around homestead area.

Deep water rice ecosystem
Deep water is a special type of ecosystem in the country. In context of Comilla region this ecosystem represents a large portion. The cropping patterns under deep water ecosystem are listed in the Table 4. Among the listed 24 patterns Boro−B.Aman cropping pattern covers the highest area coverage of 38,360 hectares which represents 8.75% of the region's NCA. This pattern is distributed throughout 19 upazilas out of 33. The second highest Mustard−B. Aman cropping pattern covers 9,690 hectares and distributed in nine upazilas. The first two patterns jointly covered 10.96% NCA and this area is about two-thirds of the total area under deep water ecosystem of the region.The water level of this ecosystem ranges between 150 and 400 cm, and water usually remains 3-4 months. Special rice varieties known as 'floating rice' are planted in these areas. In the past Bangladesh had had a land coverage of 3 million hectares for deepwater rice (Jackson *et al.*, 1972). In course of time the continuous effort on modern agriculture shifted DWR area mainly to modern Boro. Now the area under deep water rice in Bangladesh is reduced to 0.4 million hectares (Nasim *et al.*, 2017). Though this cropping system is less productive than the other modern cropping systems, however, the specific fragile ecosystem still struggling because of no other alternatives.

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

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Boro−Fallow−Fallow	114780	26.18	30
02	Boro−Fallow−T. Aman	87410	19.93	25
03	Boro−Aus−T. Aman	64830	14.78	26
04	Boro−B.Aman	38360	8.75	19
05	Boro−Aus−Fallow	4670	1.06	8
06	Fallow−Aus−T. Aman	4160	0.95	4
07	Fallow−Fallow−T. Aman	3430	0.78	1
08	Boro−Sesbania−T. Aman	3000	0.68	2
09	Boro−Sesbania−Fallow	1910	0.44	6
	Total	322550	73.56	-

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

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Potato−Maize−Fallow	7050	1.61	5
02	Vegetab−Vegetab−Vegetab	7030	1.60	22
03	Vegetab−Vegetab−Fallow	6840	1.56	16
04	Potato−Jute−Fallow	3870	0.88	11
05	Maize−Fallow−Fallow	1500	0.34	2
06	Vegetab−Fallow−Fallow	1180	0.27	6
07	S.Potato−Fallow−Fallow	1060	0.24	10
08	Maize−Vegetab−Fallow	800	0.18	1
09	Wheat−Jute−Fallow	780	0.18	5
10	Mustard−Jute−Fallow	730	0.17	5
11	Chilli−Jute−Fallow	725	0.17	6
12	Coriander−Fallow−Fallow	700	0.16	4
13	Soybean−Fallow−Fallow	700	0.16	2
14	Chilli−Fallow−Fallow	600	0.14	3
15	Potato−Sesbania	550	0.13	2
16	Onion−Jute−Fallow	400	0.09	2
17	Garlic−Jute−Fallow	390	0.09	2
18	Lentil−Jute−Fallow	360	0.08	3
19	Fallow−Fallow−Blackgram	350	0.08	5
20	Vegetab−Jute−Fallow	335	0.08	6
21	S.Potato−Vegetab−Fallow	330	0.08	4
22	Chilli−Vegetab−Fallow	220	0.05	5
23	Lentil−Sesame−Fallow	170	0.04	3
24-37	Other 14 patterns (in Table 8)	625	0.14	-
	Total	37295	8.51	

Oil-seed crops

Mustard is the most important one among the oil-seed crops in Comilla region. There are 31 cropping patterns for oil-seed crops among which 14 patterns had been led by mustard alone (Tables 5 and 7). The total share of oil-seed cropping patterns is 6.03% of NCA whereas Mustard alone occupies over 5%. The second prevailing soybean covers less than 1%. The most dominant Mustard−B.Aman pattern is distributed in nine upazilas whereas 2nd dominant Mustard−Boro−Fallow pattern is distributed in 12 upazilas out of 33.

Pulse crops

Twenty-two cropping patterns are holding different pulse crops (Table 6). Among them lentil is covering the largest area whereas pea is

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

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Boro−B.Aman	38360	8.75	19
02	Mustard−B.Aman	9690	2.21	9
03	Chilli−B.Aman	3820	0.87	9
04	Potato−B.Aman	3720	0.85	8
05	Lentil−B.Aman	2970	0.68	10
06	Vegetab−B.Aman	2480	0.57	7
07	Wheat−B.Aman	2140	0.49	9
08	Grasspea−B.Aman	1785	0.41	9
09	Fallow−Sesame+B.Aman	950	0.22	2
10	Coriander−B.Aman	790	0.18	3
11	Soybean−B.Aman	550	0.13	1
12	Mustard−Boro−B.Aman	500	0.11	4
13	Mustard−Sesame+B.Aman	500	0.11	1
14	Maize−B.Aman	450	0.10	3
15	S.Potato−B.Aman	440	0.10	2
16	Onion−B.Aman	395	0.09	6
17	Sesame−B.Aman	330	0.08	2
18	Garlic−B.Aman	220	0.05	4
19	Muskmelon−B.Aman	175	0.04	4
20	Blackgram−B.Aman	170	0.04	3
21	Potato+Maize−B.Aman	110	0.03	2
22-24	Other three patterns (in Table 8)	110	0.03	-
	Total deep-water rice	70655	16.11	

cultivated in the smallest area. Eight cropping patterns of lentil jointly cover more than one-half of the total pulse area in the region (Tables 6 and 8). Grasspea holds the second position in pulse crop cultivation in Comilla region. There are five cropping patterns for grasspea which in-together occupy over one-fourth of total pulse crop cultivation area in the region. In the documentation of pulse cropping system it is observed that majority of pulse crop are is under deep-water rice ecosystem. Finally the aggregate area of the pulse cropping system stands for 1.93% of the NCA in Comilla region.

Vegetables and spices crops
Table 7 presents 58 cropping patterns arranged in descending order according to area coverage. Potato and other vegetables of Rabi, Kharif-I and Kharif-II; spices (chilli, onion, garlic, coriander) are included in this list. The most contributing cropping pattern is Potato−Maize−Fallow covering 1.61% of NCA which is distributed over only five upazilas. The second one is Vegetable−Vegetable–Vegetable covering 1.60% of NCA and it is the most available pattern recorded in 22 upazilas out of 33.

Sporadic and distinct cropping patterns
There are some cropping patterns which are extremely location-specific, however, with a large area coverage. These are Single T. Aman (Table 2); Mustard−Aus−Fallow (Table 5) and Maize−Fallow−Fallow (Table 4). The single T. Aman is grown on 3,430 hectares in Chouddagram upazila of Comilla district. The area is situated on the foot hill border of India and the water holding capacity of its soil is low. Boro is not possible due the scarcity of irrigation water in dry season. Some non-rice crops viz maize might be grown after T. Aman. Sesame might be suggested in Kharif-I season. Mustard−Aus−Fallow is limited to two upazilas viz Muradnagar upazila of Comilla district (1,800 ha) and Chandpur sadar upazila (100 ha). Maize−Fallow−Fallow is available in Daudkandi upazila (1,200 ha) and Titas (300 ha) of Comilla district.

Table 5. Cropping patterns for oil-seed crops in Comilla region, 2014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Mustard−B.Aman	9690	2.21	9
02	Mustard−Boro−Fallow	3810	0.87	12
03	Mustard−Boro−T. Aman	2100	0.48	6
04	Mustard−Aus−Fallow	1900	0.43	2
05	Mustard−Boro−Aus−T. Aman	1470	0.34	9
06	Mustard−Maize−T. Aman	1030	0.23	2
07	Mustard−Jute−Fallow	730	0.17	5
08	Soybean−Fallow−Fallow	700	0.16	2
09	Soybean−B.Aman	550	0.13	1
10	Mustard−Boro−B.Aman	500	0.11	4
11	Mustard−Sesame+B.Aman	500	0.11	1
12	Mustard−Fallow−T. Aman	400	0.09	1
13	Soybean−Fallow−T. Aman	400	0.09	1
14	Mustard−Boro−Aus	330	0.08	2
15	Sesame−B.Aman	330	0.08	2
16	Sesame−Fallow−T. Aman	300	0.07	1
17	Mustard−Aus−T. Aman	245	0.06	4
18	Lentil−Sesame−Fallow	170	0.04	3
19	Groundnut− Aus−T. Aman	160	0.04	2
20	Groundnut−Sesame−Fallow	150	0.03	1
21	Soybean−Jute−Fallow	130	0.03	1
22	Potato−Sesame−T. Aman	125	0.03	4
23-31	Other nine patterns (in Table 8)	530	0.12	-
	Total oil-seed crops	26250	6.03	

Table 6. Cropping patterns for pulse crops in Comilla region, 2014-15.

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Lentil−B.Aman	2970	0.68	10
02	Grasspea−B.Aman	1785	0.41	9
03	Boro−Fallow−Blackgram	880	0.20	2
04	Lentil−Jute−T. Aman	500	0.11	1
05	Grasspea−Jute−T. Aman	400	0.09	1
06	Lentil−Jute−Fallow	360	0.08	3
07	Lentil−Jute−Fallow	360	0.08	3
08	Fallow−Fallow−Blackgram	350	0.08	5
09	Blackgram−B.Aman	170	0.04	3
10	Lentil−Sesame−Fallow	170	0.04	3
11-22	Other 12 patterns (in Table 8)	495	0.11	-
	Total pulse crops	8440	1.93	

Rare cropping patterns

In the present investigation, 44 cropping patterns have been identified as rare cropping patterns with a negligible area coverage with seldom existence (Table 8). These are location specific system and are limited in one or two and in some cases three upazilas of the region. Total area coverage of the 44 patterns is far less than 1% of NCA. Among these the highest area was allotted for Grasspea−Jute−Fallow, Groundnut−Aus−Fallow, Mungbean−Aus−T. Aman, Potato−Vegetab−T. Amanand Soybean−Aus−T. Aman (100 ha for each) and these are recoded dispersedly in Haimcharand Faridganj upazila of Chandpur district, Titas upazila of Comilla district and B. Baria sadar

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

	Cropping pattern	Area (ha)	% of NCA	Frequency (no. of upazila)
01	Potato−Maize−Fallow	7050	1.61	5
02	Vegetab−Vegetab−Vegetab	7030	1.60	22
03	Vegetab−Vegetab−Fallow	6840	1.56	16
04	Potato−Boro−Fallow	4250	0.97	4
05	Potato−Jute−Fallow	3870	0.88	11
06	Potato−Aus−T. Aman	2500	0.57	8
07	Potato−Boro−T. Aman	2120	0.48	9
08	Vegetab−Aus−T. Aman	1775	0.40	7
09	Vegetab−Aus−Fallow	1640	0.37	7
10	Boro−Vegetab(Float/Norm)	1230	0.28	3
11	Vegetab−Fallow−Fallow	1180	0.27	6
12	Vegetab−Fallow−T. Aman	1160	0.26	6
13	Potato−Maize−T. Aman	930	0.21	4
14	Maize−Vegetab−Fallow	800	0.18	1
15	Potato+S.gourd−Aus−T. Aman	740	0.17	3
16	Chilli−Jute−Fallow	725	0.17	6
17	Chilli−Aus−T. Aman	710	0.16	3
18	Coriander−Fallow−Fallow	700	0.16	4
19	Potato−Boro−Aus−T. Aman	630	0.14	4
20	Chilli−Fallow−Fallow	600	0.14	3
21	Vegetab−Vegetab−T. Aman	580	0.13	3
22	Potato−Sesbania	550	0.13	2
23	Chilli−Fallow−T. Aman	425	0.10	7
24	Onion−Jute−Fallow	400	0.09	2
25	Garlic−Jute−Fallow	390	0.09	2
26	Vegetab−Boro−Aus−T. Aman	370	0.08	3
27	Vegetab−Jute−Fallow	335	0.08	6
28	Vegetab−Jute−T. Aman	310	0.07	5
29	Onion−Fallow−T. Aman	305	0.07	2
30	Coriander−Fallow−T. Aman	220	0.05	5
31	Chilli−Vegetab−Fallow	220	0.05	5
32	Potato−S.gourd−Aus	180	0.04	3
33	Garlic−Fallow−T. Aman	155	0.04	2
34	Chilli−Jute−T. Aman	150	0.03	1
35	Potato−Aus−Fallow	120	0.03	3
36	Potato+Maize−B.Aman	110	0.03	2
37-58	Other 22 patterns (in Table 8)	845	0.19	-
	Total for vegetables and spices	52145	11.90	

upazila. The smallest area was recorded for three cropping patterns whose coverage was five hectares for each (Table 8).

Most dominant cropping pattern

Single Boro was the most dominant cropping pattern in Comilla region. It covers 26.18% of NCA in the region and is available in 30 upazilas out of 33 (Table 9). The highest area 1,1650 ha under this cropping pattern was recorded in Nasirnagar upazila of B. Baria district, which represents 10.15% of the total Boro−Fallow−Fallow area of the region. In consideration of individual upazila Hajiganj upazila of Chandpur district has allocated the highest area and it is 75% of its NCA for this pattern alone. This area covered by deepwater in wet season and is only cultivable in the dry season. Farmers are not interested to cultivate deepwater rice because of its low yield. If

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

	Cropping pattern	Area (ha)	% of NCA	Frequency	Upazila
01	Grasspea−Jute−Fallow	100	0.02	1	Haimchar
02	Groundnut− Aus−Fallow	100	0.02	1	Titas
03	Mungbean−Aus−T. Aman	100	0.02	2	Faridganj+Haimchar
04	Potato−Vegetab−T. Aman	100	0.02	1	B.Baria sadar
05	Soybean−Aus−T. Aman	100	0.02	1	Haimchar
06	Onion−Sesame−Fallow	90	0.02	2	Bancharampur+Homna
07	Chilli−Aus−Fallow	80	0.02	1	Homna
08	Mustard−Jute−T. Aman	80	0.02	1	Brahmanpara
09	Soybean−Jute−T. Aman	70	0.02	1	Faridganj
10	Vegetab−Maize−Fallow	70	0.02	1	Faridganj
11	Garlic−Fallow−Fallow	60	0.01	1	Bancharampur
12	Lentil−Aus−T. Aman	60	0.01	1	Matlab North
13	Coriander−Vegetab−Fallow	55	0.01	3	Burichang+Laksam+Monoharganj
14	Mungbean−B.Aus+B.Aman	50	0.01	1	Matlab South
15	Onion−Vegtab−Vegetab	50	0.01	1	Brahmanpara
16	Potato−Fallow−T. Aman	50	0.01	2	Haimchar+Burichang
17	Vegetab−Fallow−Blackgram	50	0.01	2	Comilla South+Nangolkot
18	Onion−Aus−T. Aman	40	0.01	3	B.Baria sadar+Chandina+Debidwar
19	Pea−B.Aman	40	0.01	3	Homna+Meghna+Muradnagar
20	Groundnut−Fallow−Fallow	35	0.01	3	Bancharampur+Nasirnagar+Debidwar
21	Potato−Jute−T. Aman	30	0.01	1	Brahmanpara
22	Potato−Maize−Aus−Vegetab	30	0.01	1	Debidwar
23	Sesame−Fallow−Blackgram	30	0.01	1	Homna
24	S.Potato−Jute−Fallow	30	0.01	1	ComillaSouth
25	Vegetab−Boro−T. Aman	30	0.01	1	Kachua
26	Garlic−Vegetab−Vegetab	25	0.01	2	Brahmanpara+Debidwar
27	Fallow−B.Aman	20	0.00	1	Laksam
28	Lentil−Fallow−T. Aman	20	0.00	1	Chauddagram
29	Lentil−Maize−T. Aman	20	0.00	1	Matlab North
30	Muskmelon−F−T. Aman	20	0.00	1	Debidwar
31	Potato−Boro−Aus	20	0.00	1	Brahmanpara
32	Groundnut−Fallow−T. Aman	15	0.00	2	Chandina+Chauddagram
33	Blackgram−Jute−T. Aman	10	0.00	1	B.Baria sadar
34	Coriander−Jute−T. Aman	10	0.00	1	Kachua
35	Garlic−Aus−Fallow	10	0.00	1	Debidwar
36	Garlic−Aus−T. Aman	10	0.00	1	Chandina
37	Garlic−Jute−T. Aman	10	0.00	1	Nasirnagar
38	Grasspea−Fallow−Fallow	10	0.00	1	Titas
39	Mustard−Fallow−Fallow	10	0.00	1	Monoharganj
40	Onion−Jute−T. Aman	10	0.00	1	Nasirnagar
41	Wheat−Vegetab−Vegetab	10	0.00	1	Homna
42	Chilli−Vegetab−T. Aman	5	0.00	1	Monoharganj
43	Mungbean−Jute−T. Aman	5	0.00	1	Debidwar
44	W.Melon−Fallow−T. Aman	5	0.00	1	Debidwar
	Total	1775	0.40		

Table 9. Distribution of the most dominant Boro−F−F cropping pattern in Comilla region, 2014-15.

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Nasirnagar	11650	44.72	10.15
02	Nabinagar	10600	40.15	9.24
03	Sarail	9500	57.58	8.28
04	Hajiganj	9000	75.00	7.84
05	Bijoynagar	8500	58.22	7.41
06	Bancharampur	7500	54.55	6.53
07	Dauadkandi	7000	47.95	6.10
08	Monoharganj	6250	60.10	5.45
09	B.Baria	4800	31.79	4.18
10	Laksam	4250	41.67	3.70
11	Titas	4200	57.53	3.66
12	Kasba	3500	22.95	3.05
13	Chandpur	3000	25.86	2.61
14	Matlab sadar	2900	31.87	2.53
15	Faridganj	2800	23.93	2.44
16	Homna	2500	25.38	2.18
17	Muradnagar	2500	10.59	2.18
18	Meghna	2100	29.58	1.83
19	Nangolkot	1900	12.42	1.66
20	Brahmanpara	1870	19.58	1.63
21	Akhaura	1700	26.36	1.48
22	Sarail	1700	15.96	1.48
23	Kachua	1300	7.78	1.13
24	Matlab North	900	6.16	0.78
25	Chandina	760	6.23	0.66
26	Haimchar	500	10.53	0.44
27	Comilla South	500	2.96	0.44
28	Debidwar	500	3.25	0.44
29	Ashuganj	300	5.88	0.26
30	Chouddagram	300	1.63	0.26
	Comilla region	114780	26.18	100.00

modern varieties of deepwater rice can be made available, hopefully farmers will cultivate the land in wet season also. Debidwar, Ashuganj and Chouddagram upazila had a negligible area coverage for this pattern. 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).

Second dominant cropping pattern
The second dominant cropping pattern in Comilla region is Boro−Fallow−T. Aman. It belongs to 19.93% of NCA of the region

and spread out over 25 upazilas (Table 10). Chouddagram upazila of Comilla district holds the highest area (10,900 ha) under this double rice cropping system. This upazila contributes 12.47% share of Boro−Fallow−T. Aman cropping area in the region. Faridganj upazila of Chandpur district stands in the sixth position, however, this upazila has allocated 62.39% surface, the biggest share, of its NCA. In some portion of the double rice area some short duration Rabi crops can be grown before Boro transplanting if appropriate varieties and other related technologies are made available (FAO, 1988). In the country-wide compilation of data it was observed that Boro−F−T. Aman was the most dominant cropping pattern in

Table 10. Distribution of the 2nd dominant Boro−F−T. Aman cropping pattern in Comilla region, 2014-15.

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Chouddagram	10900	59.08	12.47
02	Comilla sadar South	8000	47.34	9.15
03	B.Baria	7800	51.66	8.92
04	Faridganj	7300	62.39	8.35
05	Kasba	6700	43.93	7.67
06	Matlab North	5000	34.25	5.72
07	Bijoynagar	4700	32.19	5.38
08	Burichang	4600	40.00	5.26
09	Sarail	4400	26.67	5.03
10	Comilla Adorsho sadar	4400	59.86	5.03
11	Nangolkot	4400	28.76	5.03
12	Akhaura	3500	54.26	4.00
13	Nabinagar	2800	10.61	3.20
14	Ashuganj	2400	47.06	2.75
15	Chandpur	2300	19.83	2.63
16	Brahmanpara	2000	20.94	2.29
17	Debidwar	1600	10.39	1.83
18	Nasirnagar	1350	5.18	1.54
19	Barura	1110	6.81	1.27
20	Muradnagar	900	3.81	1.03
21	Chandina	500	4.10	0.57
22	Bancharampur	360	2.62	0.41
23	Laksam	300	2.94	0.34
24	Haimchar	50	1.05	0.06
25	Matlab South	40	0.44	0.05
	Comilla region	87410	19.93	100.00

Table 11. Distribution of the 3rd dominant Boro−Aus−T. Aman cropping pattern in Comilla region, 2014-15.

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Barura	11200	68.71	17.28
02	Debidwar	7500	48.70	11.57
03	Comilla sadar South	5700	33.73	8.79
04	Chandina	5000	40.98	7.71
05	Nangolkot	4900	32.03	7.56
06	Laksam	4700	46.08	7.25
07	Kachua	3900	23.35	6.02
08	Burichang	3700	32.17	5.71
09	Matlab North	3300	22.60	5.09
10	Brahmanpara	3160	33.09	4.87
11	Muradnagar	2000	8.47	3.08
12	Kasba	1700	11.15	2.62
13	Comilla Adarsha sadar	1500	20.41	2.31
14	Chouddagram	1300	7.05	2.01
15	Saharasti	1200	11.27	1.85
16	Ashuganj	900	17.65	1.39
17	Nabinagar	900	3.41	1.39
18	B.Baria	800	5.30	1.23
19	Haimchar	470	9.89	0.72
20	Chandpur sadar	400	3.45	0.62
21	Bijoynagar	200	1.37	0.31
22	Nasirnagar	200	0.77	0.31
23	Sarail	150	0.91	0.23
24	Akhaura	20	0.31	0.03
25	Monoharganj	20	0.19	0.03
26	Matlab South	10	0.11	0.02
	Comilla region	64830	14.78	100.00

Table 12. Distribution of the 4th dominant Boro−B. Aman cropping pattern in Comilla region, 2014-15.

	Upazila	Area (ha)	% of upazila NCA	% of the pattern in region
01	Shaharasti	6800	63.85	17.73
02	Kachua	6700	40.12	17.47
03	Nabinagar	5700	21.59	14.86
04	Muradnagar	4000	16.95	10.43
05	Monoharganj	3850	37.02	10.04
06	Homna	2900	29.44	7.56
07	Nasirnagar	2200	8.45	5.74
08	Bancharampur	1600	11.64	4.17
09	Meghna	1200	16.90	3.13
10	Chandina	750	6.15	1.96
11	Nangolkot	650	4.25	1.69
12	Debidwar	550	3.57	1.43
13	Laksam	500	4.90	1.30
14	Sarail	350	2.12	0.91
15	Brahmanpara	330	3.46	0.86
16	Hajiganj	100	0.83	0.26
17	Barura	100	0.61	0.26
18	Chandpur sadar	50	0.43	0.13
19	Bijoynagar	30	0.21	0.08
	Comilla region	38360	8.75	100.00

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).

Third dominant cropping pattern

Triple rice cropping system, Boro−Aus−T. Aman cropping pattern holds the third largest area coverage 64,830 hectares in Comilla region. This area is an equivalent to 14.78% of NCA in the region. This three-rice pattern is widely distributed over 26 upazilas. Barura upazila of Comilla district has the highest area coverage of 11,200 ha for three-rice system which stands for 17.28% of the total area under this pattern in the region (Table 11). Debidwar upazila of the same district ranks in second position for three-rice (7,500 ha) which represents 48.70% of its NCA and this area is 11.57% of the total area for this particular pattern in the region. Though continuous rice cropping is not suggested by the researchers and extension personnel, however, this type of land is not suitable for cultivation of non-rice crops. In this context, to maintain the fertility of the soils and for better crop production suggestions should be recommended for proper dose of chemical fertilizer, application of organic manure and retention of sufficient rice straw in the field.

Fourth dominant cropping pattern

Fourth dominant cropping pattern Boro−B. Aman has occupied 38,360 hectares representing 8.75% share of NCA in Comilla region (Table 12). This pattern is distributed over 19 upazilas where Shaharasti upazila of Chandpur district ranked in top position. This upazila has 6,800 ha area of Boro−B.Aman which alone represents 63.85% of upazila NCA. In consideration of the whole this area is equivalent to 17.73% of total area for this particular pattern in the region. Kachua upazila of the same district ranks in second position with 6,700 ha area for this pattern. In the same way this upazila has allotted the second biggest share (40.12%) of its NCA. The area normally belongs to medium high land-II and medium low land. Therefore, in wet season there is no scope of T. Aman cultivation. In some portion of this area mixed B. Aus+B.Aman cropping system might be introduced to boost up the productivity.

Fifth dominant cropping pattern

Fifth dominant cropping pattern Mustard−B. Aman had been covering 9,690 hectares representing 2.21% share of NCA in Comilla region (Table 13). This pattern is distributed over only nine upazilas where Nasirnagar

Table 13. Distribution of the 5th dominant Mustard−B.Aman cropping pattern in Comilla region, 2014-15.

	Upazila	Area (ha)	%of upazila NCA	% of the pattern in region
01	Nasirnagar	4880	18.73	50.36
02	Muradnagar	2600	10.95	26.83
03	Bancharampur	600	4.36	6.19
04	Nabinagar	440	1.67	4.54
05	Kasba	400	2.60	4.13
06	Meghna	270	3.80	2.79
07	Nangolkot	250	1.63	2.58
08	Brahmanpara	220	2.32	2.27
09	Shaharasti	30	0.28	0.31
	Comilla region	9690	2.21	100.00

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

	Upazila	No. of identified pattern	No. of crop	Diversity index for cropping pattern	Crop diversity index (CDI)	C.I. (%)
01	Akhaura	07	07	0.624	0.776	174
02	Ashuganj	07	08	0.705	0.872	215
03	B.Baria	15	14	0.627	0.772	181
04	Bijoynagar	11	07	0.559	0.737	144
05	Bancharampur	24	20	0.682	0.829	141
06	Kasba	12	11	0.739	0.872	195
07	Nabinagar	16	15	0.774	0.898	170
08	Nasirnagar	24	20	0.751	0.877	156
09	Sarail	13	12	0.594	0.774	146
10	Chandpur	20	20	0.865	0.925	166
11	Faridganj	14	10	0.566	0.749	180
12	Haimchar	24	17	0.930	0.964	208
13	Hajiganj	13	11	0.433	0.637	126
14	Kachua	16	08	0.761	0.891	221
15	Matlab.N	20	17	0.822	0.925	236
16	Matlab.S	17	14	0.801	0.894	168
17	Shaharasti	11	09	0.558	0.773	197
18	Barura	15	13	0.522	0.832	292
19	Brahmanpara	20	17	0.800	0.903	221
20	Burichang	13	15	0.724	0.889	244
21	Chouddagram	18	17	0.605	0.785	188
22	Chandina	33	20	0.806	0.911	250
23	Com.Adarsha	07	08	0.590	0.481	129
24	Com.South	19	12	0.659	0.862	240
25	Daudkandi	12	07	0.668	0.791	144
26	Debidwar	36	21	0.739	0.891	265
27	Homna	27	16	0.832	0.891	176
28	Nangolkot	16	13	0.769	0.900	231
29	Laksam	14	10	0.612	0.806	205
30	Meghna	15	13	0.828	0.911	170
31	Monoharganj	13	13	0.504	0.677	140
32	Muradnagar	35	20	0.909	0.956	209
33	Titas	20	13	0.656	0.795	132
	Comilla region	146	33	0.859	0.935	192

upazila of B.Baria district ranked in top position. This upazila had 4,880 ha area for Mustard−B.Aman pattern which alone represented 50.36% of the total area for this pattern in the region. Muradnagar upazila of Comilla district had the 2nd largest area 2,600 ha for this cropping. These two upazilas had contributed more than three-fourths share of the total Mustard−B. Aman area in the region. In this land type irrigation water might be less available. Boro cultivation is not possible in the dry season. In this situation other high yielding non-rice crop e.g. maize and mixed cropping of lentil+mustard might be suggested.

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 146 cropping patterns were identified in the whole area of Comilla region under this investigation. The highest number of cropping patterns was identified 36 in Debidwar upazila of Comilla district (Table 14). The lowest number of cropping patterns was identified seven in Akhura and Ashuganj upazila of B.Baria and Adarsha upazila of Comilla district followed by 11 in Shaharasti upazila of Chandpur and Bijoynagar upazila of B.Baria district. The higher number of cropping patterns is generally related to higher level of diversity indices for cropping pattern. The upazilas having lower number of cropping patterns were normally related to water logging. The lowest diversity index for cropping pattern was recorded 0.433 in Hajiganj upazila of Chandpur district followed by 0.504 in Monoharganj of Comilla district. In a study Shahidullah *et al.* (2006) also found lowest values for all the diversity and intensity parameters in water stagnant area of greater Noakhali. The highest value of diversity index for cropping pattern was found 0.930 in Haimchar upazila of Chandpur district and that was followed by 0.909 in Muradnagar upazila of Comilla district. The lowest crop diversity index (CDI) was reported 0.481 in Comilla Adrasha upazila followed by 0.637 in Hajiganj

upazila of Chandpur district. The highest value of CDI was observed 0.964 in Haimchar upazila of Chandpur followed by 0.956 in Muradnagar upazila of Comilla district. The range of cropping intensity (CI) value was recorded 126-292%. The maximum value was for Barura upazila of Comilla district and minimum for Hajiganj upazila of Chandpur district. As a whole the CDI for Comilla region was calculated 0.935 and the average cropping intensity at regional level was 192%. In a simultaneous study, the investigators identified 316 cropping patterns for whole Bangladesh; where the CDI value was 0.952 at national level and the national average of cropping intensity was 200% (Nasim *et al.*, 2017). Diversification of crops helps risk reduction as diversification allows a producer to balance low price in one or two crops with reasonable prices in 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 cropping intensity of the Comilla region was little bit lower than the national average. Single Boro, Boro-Fallow-T. Aman, Boro-T. Aus-T. Aman, Boro-B.Aman, Mustard-B. Aman were the major cropping patterns in the region. Exclusive rice area is about nine folds of exclusive non-rice area. The non-rice based cropping patterns were either few or area under those cropping patterns were much lower, which are the challenges to food and nutritional security for the people of the Comilla region. 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 cropping patterns with minor area coverage but wider existence might be expanded in the same upazilas or other upazilas of the region.

- 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.

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

	Cropping pattern	Area(ha)		Cropping pattern	Area(ha)
001	Boro−Fallow−Fallow	114780	052	Vegetab−Vegetab−T. Aman	580
002	Boro−Fallow−T. Aman	87410	053	Potato−Sesbania	550
003	Boro−Aus−T. Aman	64830	054	Soybean−B.Aman	550
004	Boro−B.Aman	38360	055	S.Potato−Fallow−T. Aman	540
005	Mustard−B.Aman	9690	056	Lentil−Jute−T. Aman	500
006	Potato−Maize−Fallow	7050	057	Mustard−Boro−B.Aman	500
007	Vegetab−Vegetab−Vegetab	7030	058	Mustard−Sesame+B.Aman	500
008	Vegetab−Vegetab−Fallow	6840	059	Maize−B.Aman	450
009	Boro−Aus−Fallow	4670	060	S.Potato−B.Aman	440
010	Potato−Boro−Fallow	4250	061	Chilli−Fallow−T. Aman	425
011	Fallow−Aus−T. Aman	4160	062	Wheat−Fallow−T. Aman	405
012	Potato−Jute−Fallow	3870	063	Grasspea−Jute−T. Aman	400
013	Chilli−B.Aman	3820	064	Mustard−Fallow−T. Aman	400
014	Mustard−Boro−Fallow	3810	065	Onion−Jute−Fallow	400
015	Potato−B.Aman	3720	066	Soybean−Fallow−T. Aman	400
016	Fallow−Fallow−T. Aman	3430	067	Onion−B.Aman	395
017	Boro−Sesbania−T. Aman	3000	068	Garlic−Jute−Fallow	390
018	Lentil−B.Aman	2970	069	Vegetab−Boro−Aus−T. Aman	370
019	Potato−Aus−T. Aman	2500	070	Lentil−Jute−Fallow	360
020	Vegetab−B.Aman	2480	071	Fallow−Fallow−Blackgram	350
021	Wheat−B.Aman	2140	072	Vegetab−Jute−Fallow	335
022	Potato−Boro−T. Aman	2120	073	Mustard−Boro−Aus	330
023	Mustard−Boro−T. Aman	2100	074	Sesame−B.Aman	330
024	Boro−Sesbania−Fallow	1910	075	S.Potato−Vegetab−Fallow	330
025	Mustard−Aus−Fallow	1900	076	Vegetab−Jute−T. Aman	310
026	Grasspea−B.Aman	1785	077	Wheat−Jute−T. Aman	310
027	Vegetab−Aus−T. Aman	1775	078	Onion−Fallow−T. Aman	305
028	Vegetab−Aus−Fallow	1640	079	Sesame−Fallow−T. Aman	300
029	Maize−Fallow−Fallow	1500	080	Wheat−Aus−Fallow	300
030	Mustard−Boro−Aus−T. Aman	1470	081	Wheat−Aus−T. Aman	250
031	Boro−Vegetab(Float/Norm)	1230	082	Mustard−Aus−T. Aman	245
032	Vegetab−Fallow−Fallow	1180	083	Chilli−Vegetab−Fallow	220
033	Vegetab−Fallow−T. Aman	1160	084	Coriander−Fallow−T. Aman	220
034	S.Potato−Fallow−Fallow	1060	085	Garlic−B.Aman	220
035	Mustard−Maize−T. Aman	1030	086	Maize−Jute−Fallow	190
036	Fallow−Sesame+B.Aman	950	087	Boro−Jute−T. Aman	180
037	Potato−Maize−T. Aman	930	088	Potato−S.gourd−Aus	180
038	Boro−Fallow−Blackgram	880	089	Muskmelon−B.Aman	175
039	Maize−Aus−Fallow	800	090	Blackgram−B.Aman	170
040	Maize−Vegetab−Fallow	800	091	Lentil−Sesame−Fallow	170
041	Coriander−B.Aman	790	092	Groundnut− Aus−T. Aman	160
042	Wheat−Jute−Fallow	780	093	Garlic−Fallow−T. Aman	155
043	Potato+S.gourd−Aus−T. Aman	740	094	Chilli−Jute−T. Aman	150
044	Mustard−Jute−Fallow	730	095	Groundnut−Sesame−Fallow	150
045	Chilli−Jute−Fallow	725	096	Maize−Aus−T. Aman	150
046	Chilli−Aus−T. Aman	710	097	Maize−Fallow−T. Aman	140
047	Coriander−Fallow−Fallow	700	098	S.Potato−Jute−T. Aman	140
048	Fallow−Jute−T. Aman	700	099	Soybean−Jute−Fallow	130
049	Soybean−Fallow−Fallow	700	100	Potato−Sesame−T. Aman	125
050	Potato−Boro−Aus−T. Aman	630	101	Potato−Aus−Fallow	120
051	Chilli−Fallow−Fallow	600	102	Potato+Maize−B.Aman	110
			103-146	Other 44 patterns (Table 8)	1775