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Cropping Patterns, Crop Diversification and Their Spatial Variations in Assam

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Abstract

This paper examines the nature and extent of cropping pattern change in Assam and its spatial variations across the districts and Agro Climatic Zones (ACZs) in the state during 2003-04 to 2015-16. To see the extent of crop diversification, Simpson Index of diversification is used. The study is completely based on secondary data. The results indicate that rice has the highest area share in Assam and among the three categories of rice, winter rice has highest area share in total cropped area. However the area share of rice is changing away from winter rice to summer rice over time. Among food grains and non-food grains, food grains have higher area share but the share is changing away from the former to the later. Among the non-food grains, area under oilseeds and vegetables has been increasing at a faster rate compared to other crops. Also the districts with higher diversification show cropping pattern away from food grains to non-food grains. Similar pattern is observed across the ACZs as well. The relative importance of non-food grains has been increasing in all agro climatic zones.

Key words: Cropping pattern, crop diversification, food grains, non-food grains, ACZs.

I. Introduction: Assam, a state in the north-eastern region of India, is more agricultural than the rest of the country in the sense of agricultural GDP and proportion of people dependent on the sector (Mandal and Bezbaruah, 2013). The sector is prone to vagaries of weather as is evident from large scale damage by floods every year. However, the extent of damage depends on the cropping pattern adopted by the farmers. Some researchers have shown with the help of both aggregate and household level data that many farmers in the state have sought to minimize the damage by adjusting the cropping pattern (Goyari, 2005; Mandal, 2010; Mandal, 2014). Moreover, a judicious cropping pattern choice can play an important role in ensuring food security of the region concerned and if executed efficiently can enhance farm income, employment, conserve soil and water resources and most importantly can alleviate poverty (Joshi et al, 2004). A diversified cropping pattern is seen to be the most popular strategy adopted by farmers to gain higher profit and to eradicate the risks of price fluctuation and production failure (Mandal, 2014). An efficient crop diversification not only helps the farmers to generate higher profit, but also helpful in the long run to push the GDP of the state or nation as a whole. At the time when the cultivable

land area is shrinking due to their conversion into non-agricultural activities and no technological breakthrough in the agricultural sector is coming up in the state, the option open to the farmers is to diversify their cropping pattern to high value crops to enhance not only farm productivity but also earnings (Mandal, 2011; GoI, 2006).

In this backdrop, the present paper seeks to examine the cropping pattern in Assam and its changes over time and space using latest secondary data. Moreover, it tries to examine the extent of crop diversification and how it has changed over time at the state, district and agro-climatic zone level. This will provide useful insights about the strategies adopted by the farmers of the state as regards their cropping pattern choice and how they vary with respect to agro-climatic conditions.

The rest of the paper is organised into the following sections. Section 2 deals with the data and methodology of the study, section 3 discusses results and section 4 concludes the study.

II. Data and Methods: The study is carried out with secondary data. Data on area under various crops at the district and state level are collected from Directorate of Agriculture, Government of Assam. Our study covers a period of 2003-04 to 2015-16. This is because data on vegetables at the district level are not available prior to 2003-04.

In this study, we have included only the non-perennial crops. The perennial crops like tea, rubber and other plantation crops and tree crops like arecanut, coconut etc. are excluded from this study. This is because the economics of investment in perennial crops from which returns are generated over a period of time is different from that of non-perennial crops.

On the basis of the relative importance of crops, some crops are taken individually (autumn rice, winter rice, summer rice, rapeseed and mustard and sugarcane) while some other in terms of crop groups as non-rice cereals (wheat, maize, others), pulses (tur, gram, arhar, green gram, black gram, peas, other rabi pulses, summer green gram and summer black gram), oilseeds (sunflower, safflower, castor, linseed, soyabean, nizer), fibers (cotton, jute and mesta), fruits (banana, papaya, pineapple), vegetables (kharif and rabi), spices and condiments(turmeric, Chillies, Black pepper, Ginger, onion, garlic, coriander and other spices).

The cropping pattern is defined as the proportion of total cropped area under each crop/crop group under study. The cropping pattern thus obtained has been summarized into a crop diversification index. This index measures whether the cropping in a location is concentrated towards a few crops or diversified towards a larger number of crops. To measure crop diversification we have used Simpson Index (SI). The index is measured as follows.

$$SI = 1 - \sum (P_i / \sum P_i)^2$$

Where, P_i = area under crop i , and $0 \leq SI \leq 1$. With complete diversification, SI approaches 1 while with complete specialisation or concentration, the value of SI approaches 0.

III. Results :

III. 1 Cropping patterns in Assam: Table 1 shows the cropping pattern in Assam along with crop diversification across the districts in Assam for the year 2015-16. There is a huge variation in cropping pattern across the districts of Assam¹. For example, share of summer rice in Morigaon is as high as 34.94% which is not even 1% in Tinsukia, Dibrugarh and is not at all produced in Dima Hasao. Similarly mustard which has more than 10% share in Dima Hasao, Dhubri and Karbi Anglong is having a negligible area share in some other districts like Karimganj, Sibsagar, Hailakandi. As far as the share of pulses, vegetables and oil seeds is concerned, almost all districts are showing a good area share.

The variation in cropping pattern is summarized in terms of Simpson Index (SI) of crop diversification in the districts of Assam in the year 2015-16 which is shown in table 2. Following Mandal (2011) the districts are categorized into highly diversified ($SI \geq 0.7$), moderately diversified ($0.7 > SI \geq 0.5$) and less diversified ($SI < 0.5$). Thus, Dima Hasao, Dhubri, Barpeta, Goalpara, Darrang, Bangaigaon, Kokrajhar, Morigaon, Kamrup, Sonitpur and Nagaon fall under highly diversified category. Among them diversification is found to be highest in Dima Hasao district (0.884) followed by Dhubri (0.838) and Barpeta (0.827). The moderately diversified districts are Dhemaji, Lakhimpur, Nalbari, Karbi Anglong, Tinsukia, Jorhat, Hailakandi, Cachar and Golaghat. Finally, the less diversified districts are Karimganj, Dibrugarh and Sibsagar where it is lowest in Sibsagar (0.315). The interesting fact emanating from our analysis is that the districts in the highly diversified category have shifted their cropping pattern away from rice, especially winter rice to other crops unlike the districts with low diversification as observed from table 1. For instance in Dima Hasao district area share is found to be highest in case of rape seed and mustard with 37.99% followed by winter rice (18.51%), fruits (12.95%) and spices (12.15%). On the other hand, less diversified district Sibsagar has the highest area share of winter rice with 83.69% followed by vegetables (7.57%) and fruits (1.96%). Moreover it can also be observed that the districts with higher value of diversification follow particular agro climatic zones. For instance districts Dhubri, Barpeta, Goalpara, Bangaigaon, Kokrajhar and Kamrup, fall under Lower Brahmaputra Valley Zone (LBVZ) while Morigaon and Nagaon in Central Brahmaputra Valley Zone (CBVZ). This shows that the cropping patterns in a location depend largely on its agro-climatic zones. Hence, an in-depth analysis of the cropping pattern and its variations at the level of agro-climatic zones is done in the following paragraph.

¹ Total number of districts in Assam has increased. However, our analysis is done for 23 districts by adjusting the new districts to their parent districts

Table 1: Cropping patterns across districts of Assam, 2015-16

Districts	Autumn Rice	Winter Rice	Summer Rice	non rice cereals	Pulses	rapeseed and mustard	Total Oilseed	total fiber	tuber crops	total spices	total vegetables	non perennial fruits	sugar cane
Dima Hasao	11.24	18.51	0	7.03	3.1	37.99	8.46	0.33	10.37	12.15	8.36	12.95	7.5
Dhubri	2.29	21	28.84	2.81	5.83	13.38	10.84	8.65	3.54	6.49	8.74	0.82	0.16
Barpeta	8.77	33.83	18.05	2.28	5.94	6.73	9.56	2.44	3.97	4.74	8.75	1.48	0.18
Goalpara	5.12	38.94	20.19	2.03	5.75	5.22	8.52	3.71	1.6	2.98	6.66	4.32	0.19
Darrang	10.08	41.4	8.88	2.87	4.23	6.93	8.89	3.46	4.39	3.61	10.31	1.44	0.46
Bongaigaon	6.15	41.32	10.84	2.05	6.14	4.96	10.88	2.72	4.24	3	10.57	1.84	0.26
Kokrajhar	10.91	39.29	12.05	1.24	3.96	3.15	16.45	2.9	3.58	2.34	5.43	1.66	0.19
Morigaon	2.19	33.07	34.94	2.17	2.33	6.57	8.96	5.3	1.43	2.33	4.9	1.75	0.65
Kamrup	4.54	43.96	18.86	0.87	3.25	1.99	6.55	2.23	2.7	4.62	8.98	2.95	0.49
Sonitpur	6.69	52.12	9.25	0.75	4.85	1.45	8.24	1.64	3.82	2.8	6.47	2.31	1.07
Nagaon	2.39	51.37	16.42	1.28	2.92	2.49	5.75	3.73	2.44	3.59	6.63	1.62	1.85
Dhemaji	8.01	56.44	3.19	0.26	2.09	0.46	14.46	0.07	5.92	1.97	5.55	1.76	0.29
Lakhimpur	3.65	56.88	7.23	0.2	2.32	0.35	13.28	0.03	6.78	1.95	5.72	1.79	0.18
Nalbari	3.9	58.01	6.49	0.5	5.02	0.87	8.15	1.75	2.87	3.5	8	1.58	0.22
Karbi-Anglong	4.13	59.95	1.18	6	2.44	10.01	11.75	1.09	1.07	2.77	3.35	2.37	3.88
Tinsukia	5.56	59.75	0.1	1.43	4.08	2.4	8.2	0.01	3.33	3.09	11.31	2.88	0.26
Jorhat	2.47	64.23	3.57	0.12	6.9	0.19	7.82	0.05	2.07	1.75	8.13	2.27	0.62
Hailakandi	3.13	63.66	3.22	0.03	6.14	0.05	0.38	0.06	2.1	3.37	12.92	4.75	0.23
Cachar	6.21	67.73	6.34	0.14	2.82	0.2	1.38	0.11	1.94	2.15	7.32	3.74	0.13
Golaghat	1.11	71.43	3.52	0.24	1.89	0.33	5.82	0.19	2.02	2.95	7.08	2.42	1.34
Karimganj	1.16	73.47	7.31	0.04	0.57	0.06	0.21	0.09	2.7	2.94	9.6	1.71	0.21
Dibru-	2.8	77.1	0.7	0.12	1.9	0.15	2.65	0.0	1.57	1.9	9.81	1.1	0.25

garh	6							2		2			
Sibsagar	0.2	83.6 9	1.05	0.05	1.2 3	0.06	1.7	0.0 3	1.17	1.5 6	7.59	1.63	0.08
Assam	5.1 6	50.9 5	10.9 2	1.51	3.8 4	2.96	8.37	2.0 9	3.22	3.3	7.64	2.21	0.79

Note: The figures represent area under specific crops as a per cent of total cropped area.
 Source: Author’s calculation from data on area under crops collected from directorate of Agriculture, Government of Assam

Table 2: Crop diversification across districts of Assam in 2012-13

Category	Districts	SI
Highly diversified	Dima Hasao	0.884
	Dhubri	0.838
	Barpeta	0.827
	Goalpara	0.799
	Darrang	0.799
	Bongaigaon	0.794
	Kokrajhar	0.781
	Morigaon	0.771
	Kamrup	0.77
	Sonitpur	0.726
Nagaon	0.719	
Moderately diversified	Dhemaji	0.681
	Lakhimpur	0.681
	Nalbari	0.675
	Karbi Anglong	0.658
	Tinsukia	0.654
	Jorhat	0.611
	Hailakandi	0.571
	Cachar	0.537
	Golaghat	0.524
Less diversified	Karimganj	0.446
	Dibrugarh	0.422
	Sibsagar	0.315
Highly diversified	Assam	0.734

Source: Author’s own calculation from data on area under crops collected from directorate of Agriculture, Government of Assam

III.2 Cropping pattern and its change across agro-climatic conditions of Assam: On the basis of rainfall, terrain and soil type and climatic condition Assam has been broadly classified into six agro-climatic zones (ACZs). They are Lower Brahmaputra Valley Zone (LBVZ), Central Brahmaputra Valley Zone (CBVZ), North Bank Plain Zone (NBPZ), Upper Brahmaputra Valley Zone (UBVZ), Hill Zone (HZ), and Barak Valley Zone (BVZ). LBVZ includes ten districts of Kamrup (Metro), Nalbari, Bongaigaon, Barpeta, Dhubri,

Kokrajhar, Goalpara, Baksa, Chirang and Kamrup (Rural) of lower Assam Plain. CBVZ comprises the district of Nagaon and Morigaon. NBPZ consists of Lakhimpur, Dhemaji, Sonitpur, Darrang and Udalguri on the north of the Brahmaputra. UBVZ comprises the districts of Dibrugarh, Sibsagar, Tinsukia, Jorhat and Golaghat. HZ is covered by two hill districts of Karbi Anglong and Dima Hasao. Finally, BVZ has three districts - Cachar, Karimganj and Hailakandi.

The variations in the agro-climatic conditions can influence the cropping pattern and also changes in it over time. Table 3 shows the cropping pattern across the agro-climatic conditions of Assam. As evident from Table 3 there is distinct variations in the change of cropping patterns across the zones. For example, the share of autumn rice fallen in all agro climatic Zones during the time span while the same for summer rice has increased in almost all agro climatic Zones except Hill Zone and Barak Valley Zone. The share of winter rice has fallen in LBVZ, NBPZ, and UBVZ and has increased marginally in rest of the ACZs. Among non-food grain crops, the share of vegetables, rapeseed and mustard and tubers has increased in all ACZs during 2003-04 to 2015-16. The share of fruits has increased in LBVZ, NBPZ, HZ and BVZ while in rest of the zones, it has declined. The share of fibres has decreased in all regions except LBVZ and CBVZ. The share of sugarcane has increased in all regions except LBVZ. Another important fact observed from the table is that cropping pattern in Highly diversified Zones like LBVZ and CBVZ has changed towards profit oriented crops like oilseeds and vegetables. To be brief cropping pattern is changing across all ACZs.

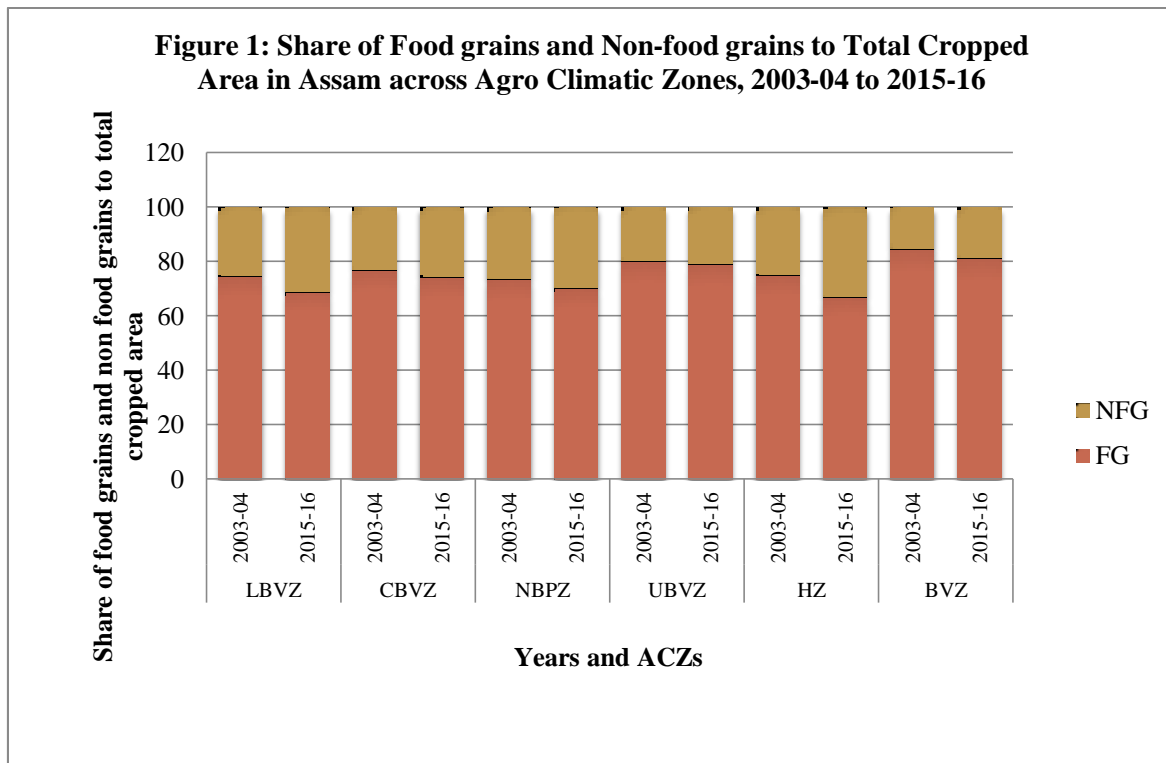
Figure 1 shows the percentage share of food grains and non-food grains to total cropped area over the period of 2003-04 to 2012-13. Figure 1 shows the dominance of food grain in all agro climatic zones. However the share of food grains has decreased over 2003-04 to 2015-16 while the share of non-food grains has increased. And as regards the districts are concerned, the increasing importance of non-food grains is seen to be highest in Dima Hasao district followed by Dhubri and Nagaon as shown in Figure 2.

Table 3: Cropping pattern change in different Agro Climatic Zones of Assam, 2003-04 to 2015-16

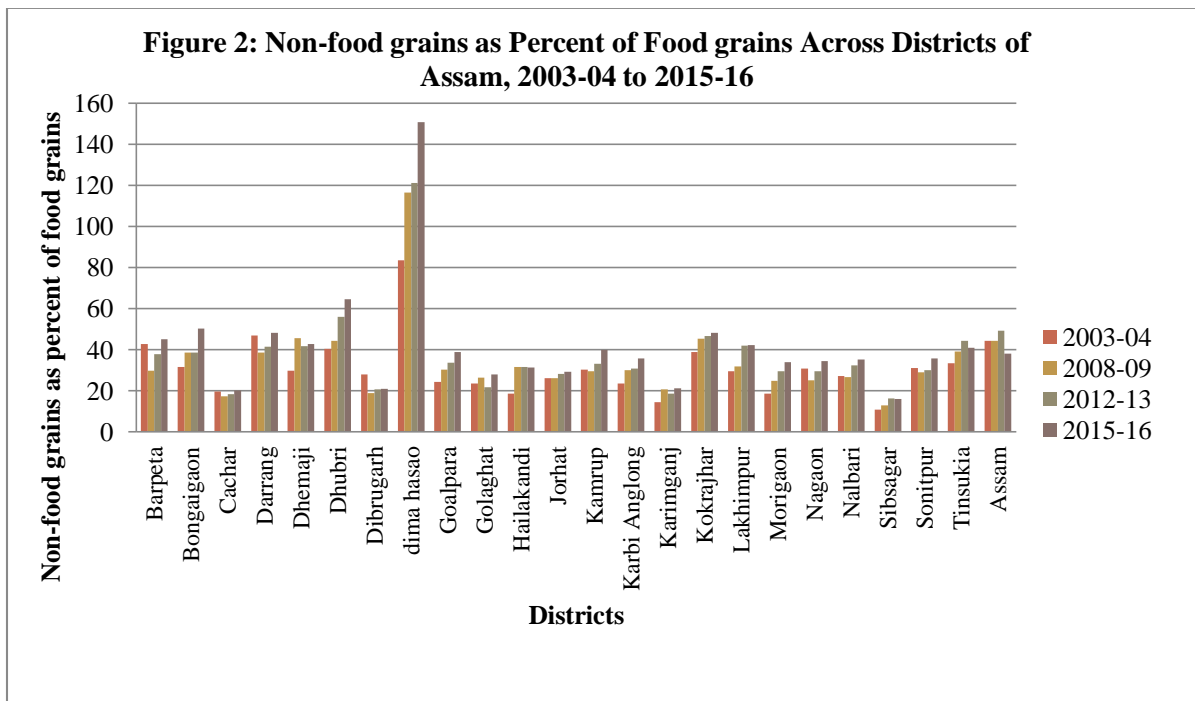
ACZ	Year	Autumn Rice	Winter Rice	Summer Rice	Non-rice cereals	Pulses	Fruits	Tuber Crops	Vegetables	Rape & Mustard	Non-mustard oilseeds	Fibres	Sugar-cane
LBVZ	2003-04	15.89	39.56	11.56	3.91	4.03	1.38	2.97	6.01	3.55	5.42	2.64	0.44
	2015-16	5.67	35.80	14.93	1.49	4.55	1.83	2.96	7.37	6.85	11.66	2.98	0.23
CBVZ	2003-04	11.59	41.27	20.42	2.37	2.79	1.94	1.53	4.97	0.27	7.70	2.73	0.16
	2015-16	2.18	42.82	20.75	1.46	2.57	1.56	1.99	5.71	5.79	6.84	3.95	1.38
NBPZ	2003-04	16.20	45.95	6.80	2.17	2.89	1.39	3.52	6.00	0.33	10.37	1.93	0.27
	2015-16	6.57	45.60	7.06	1.12	3.32	1.66	4.51	6.69	9.10	9.91	1.47	0.50
UBVZ	2003-04	4.22	71.92	0.80	0.97	2.95	2.21	1.79	6.95	0.15	5.94	0.17	0.13
	2015-16	2.11	67.69	1.95	0.33	3.05	1.99	1.90	8.09	4.96	5.15	0.06	0.56
HZ	2003-04	26.35	0.37	29.89	33.04	1.43	2.35	0.50	1.92	0.64	5.71	0.63	0.14
	2015-16	22.05	0.40	24.81	27.70	1.92	3.14	1.51	2.89	3.92	15.00	0.29	1.96
BVZ	2003-04	6.93	69.44	5.92	0.08	2.54	3.04	1.79	7.13	0.64	0.60	0.13	0.17
	2015-16	3.89	68.15	5.91	0.08	2.81	3.30	2.20	9.22	0.67	0.89	0.05	0.18

Note: The figures represent area under specific crops as a per cent of total cropped area.

Source: Author’s calculation from data on directorate of Agriculture, Government of Assam.



Source: Author’s own calculation from the data collected from Directorate of Agriculture, Government of Assam



Source: Author’s own calculation from the data collected from Directorate of Agriculture, Government of Assam

III.3 Cropping pattern diversification across agro-climatic conditions of Assam: Crop diversification is considered to be an important indicator of changing cropping pattern of any region. If farmers diversify their cropping pattern towards higher value crops then it is expected that such diversification will help the farmers to increase their farm income. Table 4 is used to examine the extent of crop diversification across the ACZs. From this table, it is visible that diversification of cropping patterns has increased during 2003-04 to 2015-16 in all ACZs except CBVZ. The value of SI indicates that diversification is highest in LBVZ followed by CBVZ and HZ and it is lowest in BVZ. The highly diversified regions are showing cropping pattern away from rice to rest of the crops especially non-food grains (shown in Table 2).

Table 4: SI of Diversification of crops across ACZs during 2003-04 to 2015-16

Year	LBVZ	CBVZ	NBPZ	UBVZ	HZ	BVZ
2003-04	0.791	0.763	0.740	0.470	0.727	0.502
2004-05	0.814	0.785	0.747	0.503	0.735	0.558
2005-06	0.794	0.739	0.723	0.427	0.744	0.528
2006-07	0.819	0.783	0.763	0.490	0.740	0.482
2007-08	0.799	0.726	0.743	0.466	0.745	0.545
2008-09	0.794	0.714	0.714	0.431	0.751	0.535
2009-10	0.798	0.762	0.727	0.441	0.752	0.517
2010-11	0.789	0.748	0.721	0.473	0.753	0.522
2011-12	0.785	0.728	0.714	0.459	0.757	0.516
2012-13	0.787	0.723	0.710	0.462	0.754	0.508
2013-14	0.814	0.735	0.741	0.561	0.780	0.642
2014-15	0.815	0.755	0.762	0.660	0.782	0.501
2015-16	0.817	0.758	0.756	0.527	0.785	0.519

Source: Author’s calculation from the data collected from Directorate of Agriculture, Government of Assam

IV. Conclusion: This paper has examined the nature and extent of cropping pattern change in Assam and its spatial variations during 2003-04 to 2015-16. Simpson Index of diversification is used to see whether the cropping pattern is diversified or not and, if any, to what extent the cropping pattern is diversified. In this paper, cropping pattern change is examined across districts and also across ACZs to capture the heterogeneity in cropping pattern within the state. It is found that Assam is a rice dominated state where winter rice has highest area share in total cropped area. However the area share of rice is changing away from winter rice to summer rice over time. Also the highly diversified districts have shifted their cropping pattern away from rice, especially winter rice to other crops unlike the districts with low diversification.

Among food grains and non-food grains, food grain has higher area share in Assam but the area share is changing away from the former to the later. Moreover looking at cropping pattern of non-food grains in particular, we can see that area under oilseeds and vegetables has been increasing at a faster rate compared to other crops. As regards ACZs, a huge disparity can be observed across the zones with respect to cropping pattern and extent of its diversification. In all agro climatic zones, the cropping pattern is shifting from food grains

to non-food grains. The relative importance of non-food grains has been increasing in all agro climatic zones.

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