

# Regional Disparity and Agricultural Growth in North-East India

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Received: 27 Oct 2023; Revised accepted: 17 Jan 2024; Published online: 06 Feb 2024

## Abstract

A pivotal sector in India is agriculture, engaging over half of the nation's workforce. This study investigates the regional growth trends in the agricultural sector, analyzing metrics such as area, production, and yield of various food grains. Utilizing a dataset spanning three decades from 1990-91 to 2019-20, the research employs the standard compound annual growth rate formula and sigma convergence analysis. The findings reveal that a significant number of states from the North-Eastern region exhibit substantial growth rates. Similar to the expansion seen in the cultivation of different categories of food and non-food grains based on area, the production of various crop types, both food and non-food grains, particularly rice, demonstrates higher growth rates in comparison to other crops. Furthermore, the convergence assessment demonstrates a consistent pattern of either converging or diverging trends across variables like area, production, and estimated yield for both food and non-food grains. While the cultivation area for all types of food and non-food grains maintains a constant tendency towards convergence over time, the production and yield of food grains display notable fluctuations. In contrast, non-food grain items show a higher propensity for divergence compared to food grain items.

**Key words:** Agricultural foodgrains, Agricultural growth, Regional convergence, Sigma convergence

Agriculture sector plays an important part in the economy and provides a living for a large portion of the people, ensuring food security, producing jobs and generating money for rural populations in most Indian states. The many Indian states cover a wide range of geographical areas, each with its own set of socio-economic and agro-ecological characteristics [5]. However, in certain regions, the agricultural sector has encountered many challenges, including poor infrastructure, limited market access, traditional farming practices, and vulnerability to climate change impacts [3]. These challenges have led to variations in agricultural growth trajectories across the North-Eastern states, with some states witnessing relatively higher growth rates compared to others [9], [13]. Further, the agricultural sector's growth is closely associated with overall economic development and poverty reduction. By analyzing agricultural growth trends and convergence across the North-Eastern states will help to identify the strategies that promote sustainable agricultural practices, enhance productivity, and reduce inter-state income disparities. The North-Eastern states exhibit varying levels of development and growth within the agricultural sector [18]. Exploring convergence trends can shed light on the factors contributing to disparities and help design interventions to bridge the gap [19]. Finally, studying agricultural growth trends and convergence across the North-Eastern states is of utmost importance for promoting sustainable development, enhancing food security, improving rural livelihoods, building climate resilience, and reducing regional disparities. Such research can serve as a foundation for evidence-based policies and strategies that contribute to the

overall socio-economic progress of the region. Convergence, within the realm of agricultural advancement, pertains to the reduction of discrepancies in productivity, income, and general progress among distinct states or regions. Examining whether, North-Eastern states are tending towards convergence or encountering sustained disparities in their agricultural growth stands as a pivotal analytical pursuit. This investigation illuminates the efficacy of development policies, the influence of technological interventions, and the contribution of local dynamics in shaping the agricultural scenario [7]. The present study aims to analyze the trends of agricultural growth and convergence patterns for the North-Eastern of India. By examining annual time series data, evaluating recent agricultural trends, and considering for economic growth process, the study seeks to accomplish the following objectives: (i) To analyze the agricultural growth trajectory across the North-Eastern states over the study period; and (ii) To assess the convergence tendency by examining, whether disparities in agricultural development are narrowing or persisting across states and the types of agricultural foodgrains and non-foodgrains. Additionally, the growth rate of agricultural sector and the convergence trends across states is a focal pace towards stimulating development through balanced and comprehensive manner [16]. Analyzing these trends provides insights into challenges and opportunities, guiding evidence-based policies and strategies for enhancing agricultural growth and livelihoods in the region.

Several studies have found regional divergence in agricultural growth over time for the Indian states. Regional

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Citation: Saikia B, Baruah M. 2024. Regional disparity and agricultural growth in North-East India. *Res. Jr. Agril. Sci.* 15(1): 214-220.

divergence has been found in agriculture growth for the 15 Indian states [6], [9]. Divergence tendency was also observed in spatio-temporal variations in agriculture for the 20 Indian states from 1990-91 to 2013-14 [2]. Regional disparities in per capita income of 32 states and UTs in India have been found during 1999-2000 to 2010-11 [8]. Further, the tendency of divergence has been found in the growth of Per Capita Income, sectors of the economy, and Net State Domestic Product for Indian states over time [1], [11]. The regional inequality in India, both at the aggregate and the sectoral level, has been found after the economic reform process [10]. Agricultural disparity on a number of agricultural parameters has been found in the district and regional level of Uttar Pradesh during 1990-91 and 2008-09 [17].

Besides, few of the studies observed tendency for agricultural growth convergence across Indian states over time. Convergence in agricultural productivity was found for 17 Indian states during 1971 to 2010 [15]. Conditional convergence has been achieved in total factor productivity in agriculture across fourteen major agricultural states of India [13]. Conditional convergence has also been observed for the growth performance and per capita value of agricultural output across Indian States over different time periods [4], [16]. The convergence tendency has been found in land and labour productivity in agriculture for the 20 Indian states during 1991-2011 [3]. Further, the tendency of agricultural growth convergence in the context of globalization and economic liberalization of the Indian economy was found over 1980-81 to 2009-10 [12]. The convergence hypothesis in productivity of foodgrains in terms of output per unit of cropped area across 18 foodgrains producing states of India observed from 2000-01 to 2012-13 [14].

## MATERIALS AND METHODS

This study utilizes 30 years of secondary data (1990-91 to 2019-20) extracted from the "Handbook of Statistics on Indian States" published by RBI. The investigation covers eight North-Eastern states of India. It encompasses 27 agricultural variables linked to the area, production, and yield of both foodgrains and non-foodgrains.

### Compound annual growth rate (CAGR)

The CAGR is widely used method that helps to analyze the growth of any unit in a specific time period. The following exponential function has been used for computing the CAGR of area, production and yield of agricultural foodgrains:

$$Y = ab^t e^{ut} \dots\dots\dots (i)$$

Where, Y = Number of states, a = intercept, b = coefficient.

After taking log to equation (i), the transformed equation can be written as:

$$\ln Y = \ln a + t \ln b + u_t \dots\dots (ii)$$

After estimation of coefficient 'b', the CAGR is calculated as:

$$g = (b - 1) 100 \dots\dots\dots (iii)$$

Where, g= CAGR in per cent per annum, b = Anti log of ln b

### Sigma convergence analysis

The agriculture sectoral convergence has been analyzed in terms of variables comprising area, production and yield across the North-Eastern states of India over time by using Sigma Convergence approach. The sigma convergence method demonstrated that the dispersion of variables in terms of Coefficient of Variation across the regions or states falls over time. The following equation has been applied to calculate the Coefficient of Variation (CV):

$$CV_t = \frac{(\frac{1}{n} \sum_{i=1}^n (y_{it} - \bar{y}_t)^2)^{1/2}}{\bar{y}_t} \dots\dots (iv)$$

Where, 'n' is the number of objects (states in our case), 't' is time span, 'i' indicates considered i<sup>th</sup> states in turn, 'y' is the agricultural elements.

## RESULTS AND DISCUSSION

### Area and intensity of agriculture sector

Agriculture serves as the foundation of India's economy, supporting a substantial part of its populace and making a notable contribution to its GDP. Nonetheless, varying factors like agro-climatic conditions, technology adoption, policy execution, and infrastructure advancement have led to diverse agricultural growth patterns among Indian states. This comprehensive assessment investigates the growth trends in agriculture across North-Eastern states, spotlighting significant trends and influential factors. The current section focuses on analyzing the compound annual growth rate (CAGR) of the net sown area, net irrigated area, and cropping intensity for the North-Eastern states of India from 1990-91 to 2019-20. (Table 1) represents that, in case of North-Eastern region, all states, except Sikkim and Tripura have positive and significant growth trends in terms of NSA. In NIA, Assam, Manipur, and Sikkim have positive, while Arunachal Pradesh, Manipur and Mizoram have negative growth rates. In India, NSA is negative and NIA and CI are positive over time. The declining growth trend in NSA, for the majority of states, indicates that the states might have shifted their cultivation to other crops like horticulture. Like, Sikkim and Tripura, India also has negative growth trend in NSA, but positive and significant trend in NIA and CI.

Table 1 CAGR of area and intensity of agriculture sector (1990-91 to 2019-20)

States	Net sown area (NSA)#	Net irrigated area (NIA)#	Cropping intensity (CI)@
Arunachal Pradesh	1.691***	2.136***	-0.593***
Assam	0.056**	-1.064	0.115***
Manipur	4.179***	0.433	-1.004***
Meghalaya	1.182***	2.827***	0.065**
Mizoram	2.463***	3.041***	-0.381
Nagaland	2.694***	2.471***	0.928***
Sikkim	-1.210***	0.684	1.701***
Tripura	-0.380***	3.129***	1.118*
All India	-0.075**	1.303***	0.366***

Source: Handbook of Statistics on Indian States, RBI

Note: # and @ indicate thousand hectares and per cent, respectively; \*\*\*, \*\* & \* show 1, 5 and 10% of significance

### Area, production and yield of total agriculture foodgrains

The compound annual growth rate (CAGR) of the area, production and yield of total agricultural foodgrains for the

eight North-Eastern states of India, from 1990-91 to 2019-20 in (Table 2). It is observed that, in case of North-Eastern region, Assam, Mizoram and Sikkim have negative growth rates and

other five states have positive growth rates. Further, in terms of Production of total foodgrains (POTF) and Yield of total foodgrains (YOTF), all the states from the region have positive and significant growth rates at different levels over time, except for Mizoram and Sikkim for POTF and Manipur and Mizoram for YOTF. In India, AOTF is negative and FOTF and YOTF

are positive over time. Thus, it is clear that, though there is negative growth in area of total foodgrains across the states, but majority of states have shown positive growth in production and yield of total foodgrains over time. It might show that the states have facilitated some advancement in agricultural practices like seed varieties, better irrigation and enhanced fertilizers.

Table 2 CAGR of area, production and yield of total agriculture foodgrains (1990-91 to 2019-20)

States	Area of total foodgrains (AOTF)#	Production of total foodgrains (POTF)\$	Yield of total foodgrains (YOTF)Δ
Arunachal Pradesh	0.772***	2.592***	1.809***
Assam	-0.252***	1.479***	1.967***
Manipur	2.278***	1.554***	-0.708**
Meghalaya	0.184***	2.983***	2.794***
Mizoram	-2.129***	-2.431***	-0.309
Nagaland	2.475***	4.396***	1.887***
Sikkim	-1.353***	-0.435***	0.848***
Tripura	0.353**	2.499***	2.089***
All India	-0.213***	1.686***	1.705***

Source: Handbook of Statistics on Indian States, RBI

Note: #, \$ and Δ indicates Thousand Hectares, Thousand Tonnes and Kg/ha, respectively; \*\*\*, \*\* & \* shows 1, 5 and 10 % of significance

#### Area of agriculture foodgrains

The compound annual growth rate (CAGR) of area of agricultural foodgrains and non-foodgrains, in terms of rice, wheat, pulses, coarse cereals, cotton, oilseeds and sugarcane for the North-Eastern states, from 1990-91 to 2019-20 is presented in (Table 3). The results show that, in case of AOFR, all the states have positive and significant growth rates, except Mizoram and Sikkim. In terms of AOFW, all the North-Eastern states have shown negative growth trends, except Manipur and Nagaland. In respect of AOFN, all the other states are showing negative growth trends, except Arunachal Pradesh, Manipur, Meghalaya, Nagaland and Tripura. Again, all the North-Eastern states, except Mizoram and Sikkim have positive growth in

AOFCC. In India also, the growth rate is negative for AOFCC. Further, among the North-Eastern region, Assam, Meghalaya, and Tripura have negative growth rates in AONFC and other states have either positive growth or insignificant during the study period. In respect of AONFO, Arunachal Pradesh, Manipur, Meghalaya, and Nagaland have positive and significant growth rates, but in India AONFO growth rate is insignificant. The states of Arunachal Pradesh, Manipur, Mizoram, and Nagaland have positive growth rates in AONFS, across the eight states of the region. India also has had positive and significant growth over time. Thus, it is observed that majority of North-Eastern states are having positive growth in all the foodgrains, except wheat, cotton, and oilseeds.

Table 3 CAGR of area of agricultural foodgrains and non-foodgrains (1990-91 to 2019-20) (Thousand Hectares)

States	Area of foodgrains			Area of non-foodgrains			
	Rice	Wheat	Pulses	Coarse cereals	Cotton	Oilseeds	Sugarcane
Arunachal Pradesh	1.989***	-0.560**	3.201***	1.198***	--	1.900***	2.740***
Assam	1.942***	-5.513***	-0.468	0.592**	-2.918***	-0.230	-0.750***
Manipur	3.195***	3.546***	16.823***	7.186***	7.208***	11.349***	5.635***
Meghalaya	2.632***	-10.530***	2.878***	0.086	-8.604***	1.762***	0
Mizoram	-1.114*	--	-0.486	-0.558	-0.356	-5.456***	2.917***
Nagaland	3.242***	6.489***	5.061***	3.349***	8.431***	5.649***	2.992***
Sikkim	-0.647**	-13.200***	-2.444***	-0.182*	--	-1.496***	-6.480***
Tripura	3.296***	-10.860***	0.808	6.662***	-0.687*	-0.716	-2.576***
All India	2.749***	0.854***	-0.558	-1.293***	1.958***	0.175	1.075***

Source: Handbook of Statistics on Indian States, RBI

Note: \*\*\*, \*\* & \* shows 1, 5 and 10 % of significance, respectively

#### Production of agriculture foodgrains

The compound annual growth rate (CAGR) of production of agricultural foodgrains and non-foodgrains, in terms of rice, wheat, pulses, coarse cereals, cotton, oilseeds and sugarcane for the North-Eastern states, from 1990-91 to 2019-20 is represented in (Table 4). The result demonstrates that, in case of Production of foodgrains-Rice (POFR), majority of the states have positive and significant growth rates, except for Mizoram and Sikkim. Again, the state of Sikkim has positive and other states have negative and significant growth in terms of POFW, while India has shown positive growth trend over time. In respect of POFP, all the North-Eastern states, except Mizoram and Sikkim have positive and significant growth rates. Further, all the North-Eastern states have positive growth rate,

except Mizoram, which has negative growth but insignificant in POFCC over time. In India also the growth rate is positive for POFCC. Furthermore, all five states have positive growth rates, except Meghalaya, Mizoram and Tripura, which have either negative growth or insignificant during study period. In respect of PONFO, all the North-Eastern states have positive growth, except Mizoram, Sikkim and Tripura. India also has positive and significant growth rate in terms of PONFO. As like AONFS, from the states of Arunachal Pradesh, Manipur, Mizoram, and Nagaland have positive growth rates in Production of non-foodgrains-sugarcane (PONFS). India also has had positive and significant growth over time. Majority of states have positive and significant growth in production of foodgrains and non-foodgrains such as rice, wheat, and cotton.

For other crops, there is either negative growth or insignificant across the states. The declining trends across the states might be

due to decrease in soil fertility, traditional methods of irrigation and reduction in agricultural land.

Table 4 CAGR of Production of Agricultural Foodgrains and Non-Foodgrains (1990-91 to 2019-20) (Thousand Hectares)

States	Production of foodgrains				Production of non-foodgrains		
	Rice	Wheat	Pulses	Coarse cereals	Cotton	Oilseeds	Sugarcane
Arunachal Pradesh	2.981***	0.010	3.971***	1.844***	--	1.915***	4.171***
Assam	1.829***	-5.585***	1.077**	5.947***	0.413	0.717**	-1.083***
Manipur	0.854**	--	16.516***	6.181***	7.156***	14.775***	5.576*
Meghalaya	3.252***	-4.634***	5.475***	2.166***	-7.377***	3.882***	-6.845***
Mizoram	-2.601***	--	-1.651***	-1.969	-4.330***	-5.032***	7.994***
Nagaland	3.677***	-0.206	6.468***	6.420***	6.552***	6.325***	2.863***
Sikkim	-0.854***	4.086**	-2.129***	0.791***	--	-0.927**	--
Tripura	2.482***	-3.038	2.245**	9.631***	-1.244**	-0.548	-2.255***
All India	1.550***	-11.810***	0.891**	1.604***	5.387***	1.921***	1.515***

Source: Handbook of Statistics on Indian States, RBI

Note: \*\*\*, \*\* & \* shows 1, 5 and 10 % of significance, respectively

#### Estimates of yield in agriculture foodgrains

The compound annual growth rate (CAGR) of yield in agricultural foodgrains, in terms of rice, wheat, pulses, coarse cereals, cotton, oilseeds and sugarcane for the North-Eastern states, from 1990-91 to 2019-20 is presented in (Table 5). The result indicates that, in case of EYR, all the states are having positive and significant growth rates, except Arunachal Pradesh, Manipur, and Mizoram. Only Sikkim have negative and significant growth in Estimates of yield-wheat (EYW), while Assam, Nagaland, and Tripura have insignificant growth over time. In respect of Estimates of yield-pulses (EYP), positive growth has been achieved by all the states, except Mizoram, but the state of Sikkim is showing insignificant

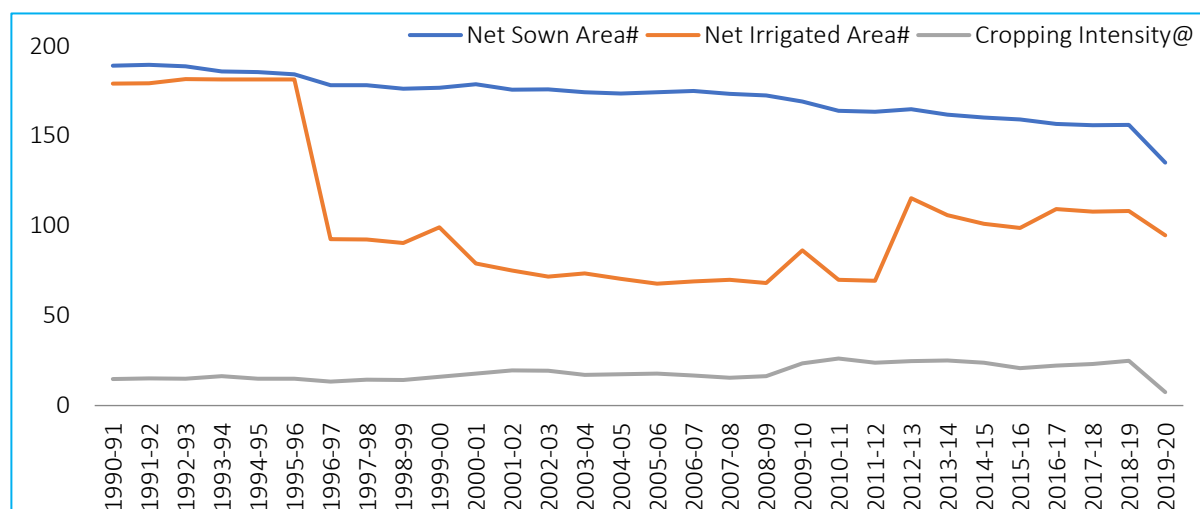
growth trends. Again, in terms of EYCC, all the states, from the North-Eastern region have positive and significant growth, except Manipur, and Mizoram. Further, the states of Nagaland and Tripura have positive growth rate in EYC, and other states have insignificant during study period. In respect of EYO also, all the states are having positive and significant growth rates, except for Arunachal Pradesh, Mizoram, and Tripura. The states of Assam and Meghalaya have positive and significant growth and other states have negative growth rates, except Nagaland, but it is insignificant across the region. At all India level, the growth of estimates of yield in terms of rice, wheat, pulses, coarse cereals, cotton, oilseeds, and sugarcane is positive and significant over time.

Table 5 CAGR of estimates of yield in agriculture foodgrains (1990-91 to 2019-20) (Kg. per hectare)

States	Estimates of yield						
	Rice (EYR)	Wheat (EYW)	Pulses (EYP)	Coarse cereals (EYCC)	Cotton (EYC)	Oilseeds (EYO)	Sugarcane (EYS)
Arunachal Pradesh	-8.057	0.655**	0.746***	0.640***	--	0.016	8.602***
Assam	1.971***	0.297	1.521***	5.321***	0.003	0.948***	-0.333***
Manipur	-0.479	4.166***	5.627***	-0.939***	--	3.078**	2.610***
Meghalaya	3.185***	1.233***	2.538***	2.081***	0.307	2.079***	-7.544***
Mizoram	-0.076	--	-1.165**	-1.408	1.818	0.457	4.960***
Nagaland	1.817***	-1.126	1.338***	2.971***	-5.780***	0.711***	-0.125
Sikkim	4.362*	-1.836***	0.106	0.973***	--	0.584**	--
Tripura	2.258***	0.427	1.291***	2.765***	1.228***	0.178	0.394***
All India	1.469***	1.224***	1.246***	2.928***	3.364***	1.780***	0.435***

Source: Handbook of Statistics on Indian States, RBI

Note: \*\*\*, \*\* & \* shows 1, 5 and 10 % of significance, respectively



Source: Handbook of Statistics on Indian States, RBI

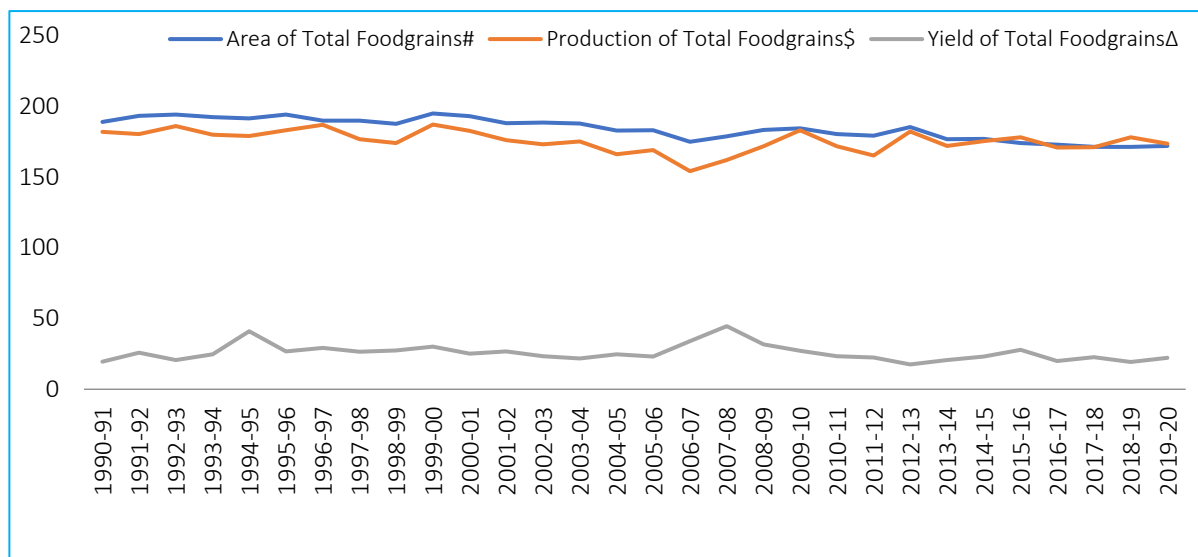
Fig 1 Agricultural convergence in terms of area and cropping intensity: North-Eastern States

### Sigma convergence analysis

The present section analyzes the sigma convergence analysis of the agricultural net sown area, net irrigated area and cropping intensity for the North-Eastern states, from 1990-91 to 2019-20. (Fig 1) demonstrates that, in terms of net sown area and cropping intensity, the states have convergence tendency over time in case of NSA, and constant variation in terms of CI, but it tends to converge after 2018-19. Further, in case of NIA, the states have significant reduction in 1995-96 and it is

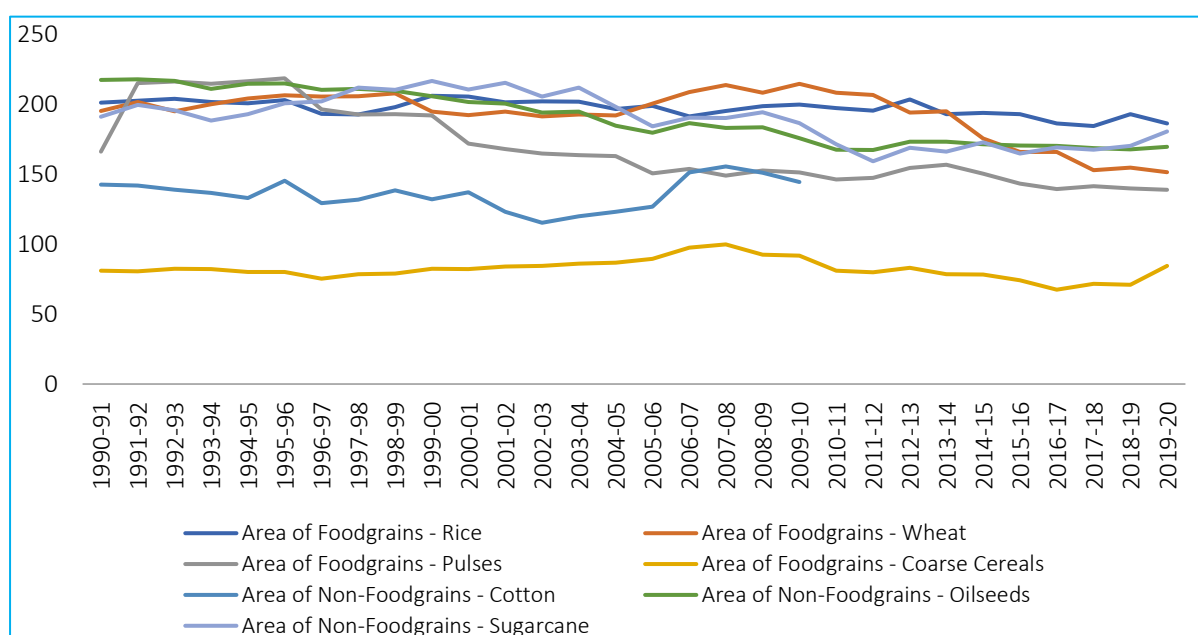
constantly varying, after that, from 2011-12, it tends to increase but again it tends to decline during 2019-20.

The convergence tendency of area, production and yield of total agricultural foodgrains for the North-Eastern states, from 1990-91 to 2019-20 in (Fig 2). It is observed that the states tend toward convergent in terms of area and yield of total foodgrains over time. Further, the states had constant variation with respect to production of total foodgrains during the study period.



Source: Handbook of Statistics on Indian States, RBI

Fig 2 Agricultural convergence in terms of area, production and yield of total foodgrains: North-Eastern States



Source: Handbook of Statistics on Indian States, RBI (1990-91 to 2019-20)

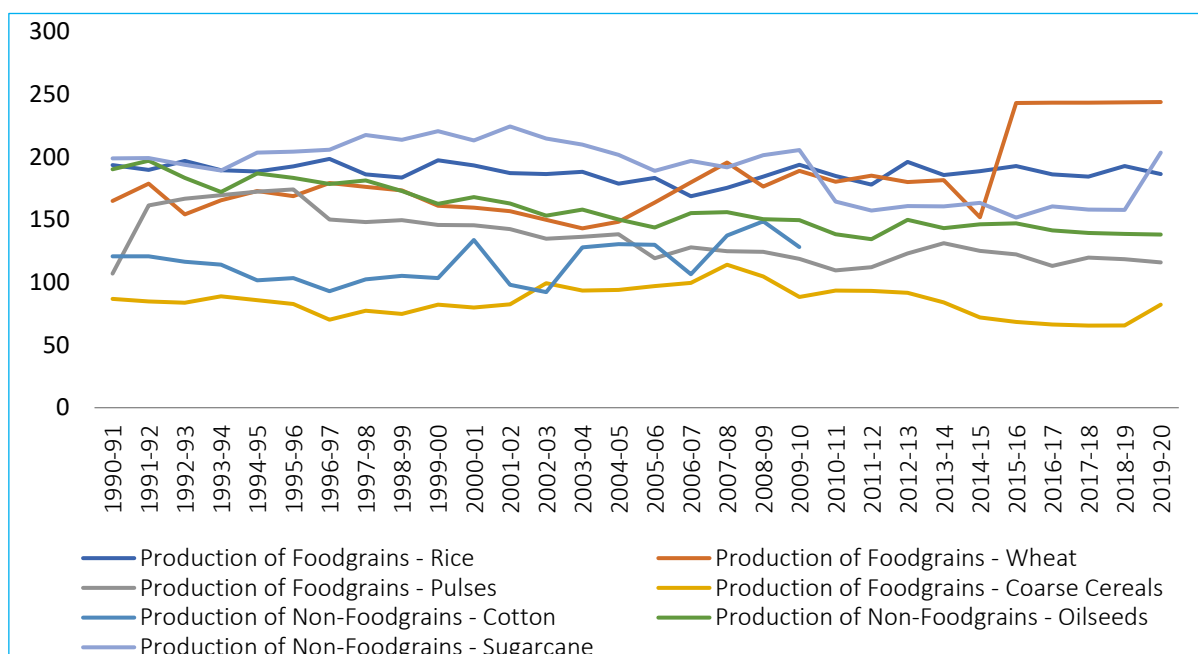
Fig 3 Agricultural convergence in terms of area of foodgrains: North-Eastern States

The sigma convergence tendency of area of agricultural foodgrains and non-foodgrains, in terms of rice, wheat, pulses, coarse cereals, cotton, oilseeds and sugarcane for the North-Eastern states, from 1990-91 to 2019-20 in (Fig 3). The result shows that, the trend of area of foodgrains of rice stands at constant variation, while area of foodgrains of wheat is tending towards convergence. The states have significant reduction in terms of area of foodgrains of pulses, and tending to convergence tendency. The area of foodgrains of coarse cereals trend shows constant variation till 2012-13, and afterward, it

tends to converge. In case of area of non-foodgrains of cotton, data is available till 2009-10, which demonstrate divergence tendency over time. Further, the trend of area of non-foodgrains of oilseeds has shown convergence tendency across the states over time. The variation trend of area of foodgrains of sugarcane has fluctuated and tends to converge.

The convergence tendency of production of agricultural foodgrains and non-foodgrains, in terms of rice, wheat, pulses, coarse cereals, cotton, oilseeds and sugarcane for the North-Eastern region of India, from 1990-91 to 2019-20 in (Fig 4).





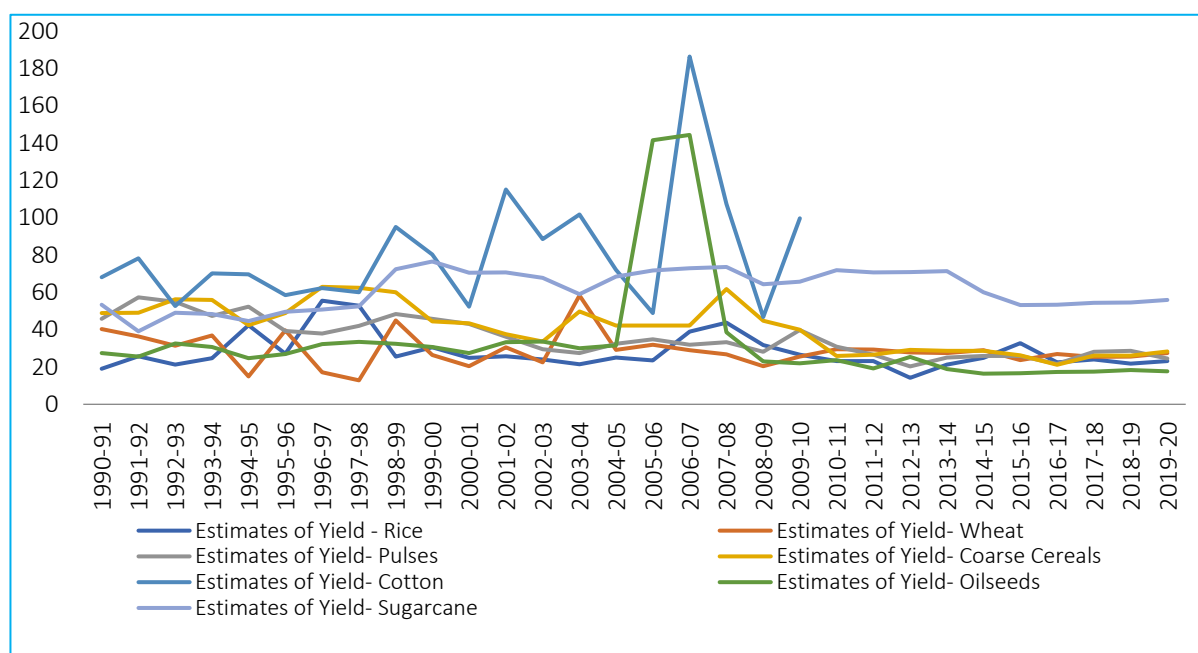
Source: Handbook of Statistics on Indian States, RBI

Fig 3 Agricultural convergence in terms of production of foodgrains: North-Eastern States

The result shows that, like area of foodgrains of rice, the trend of production of rice demonstrated constant variation, while production of foodgrains of wheat is tending towards divergence. The states are having increasing variation in production of foodgrains of pulses, and it is declining and tending to convergence tendency over time. The trend of production of foodgrains of coarse cereals also has a constant variation till 2001-02, and then it varies more, afterward it tends to convergence from 2008-09. In case of production of non-foodgrains of cotton (though data is available till 2009-10), shows high variation and tending toward divergence. Further, the trend of production of non-foodgrains of oilseeds has shown convergence tendency across the states. The variation trend of production of foodgrains of sugarcane has also convergence tendency over time.

The convergence tendency of yield in agricultural foodgrains, in terms of rice, wheat, pulses, coarse cereals,

cotton, oilseeds and sugarcane for the North-Eastern states, from 1990-91 to 2019-20 in (Fig 5). The result shows that, the trend of estimates of yield of rice and estimates of yield of wheat is tending towards convergence over time. The states are having increasing variation in estimates of yield of pulses and coarse cereals, tending to convergence tendency. This could be due to factors such as varying climate conditions, soil quality, farming practices, or access to resources and technologies. In case of estimates of yield of cotton (data is available till 2009-10), significant variation has been observed and tends towards divergence. Further, the trend of estimates of yield of oilseeds has shown convergence tendency across the states over time. The variation trend of estimates of yield of sugarcane has fluctuated and tends to converge from 2013-14 to 2019-20. This convergence may have implications for agricultural policy-making and resource allocation to ensure equitable and sustainable agricultural development across states.



Source: Handbook of Statistics on Indian States, RBI (1990-91 to 2019-20)

Fig 3 Agricultural convergence in terms of estimates of yield in foodgrains: North-Eastern States

## CONCLUSION

Comprehending the patterns of agricultural growth and convergence among states is crucial for tailoring targeted policies and interventions to promote regional development. The study reveals that, in the North-Eastern region, most states exhibit substantial growth rates in production and yield estimates of total foodgrains, despite negative growth in total foodgrain area. Manipur and Nagaland display positive growth in area and production for all types of crops, both foodgrains and non-foodgrains, over time. Similar to the expansion in area-wise food and non-foodgrains, the majority of states experience greater production growth in rice compared to other crops. The convergence test demonstrates a similar tendency for convergence or divergence across variables such as area,

production, and yield estimates of foodgrains and non-foodgrains. While the total area cultivated with foodgrains and non-foodgrains maintains a consistent trend of convergence over time, fluctuations are significant in terms of foodgrain production and yield, with non-foodgrain items showing a more pronounced divergence tendency. This variation may arise from a diverse landscape of challenges, prospects, and strategies unique to each state. While some states have harnessed technological advancements and policy measures for substantial growth, others are gradually overcoming barriers to unlock their agricultural potential. A holistic approach considering regional disparities, local conditions, and sustainable practices will be pivotal to ensure balanced and inclusive agricultural growth across states or the entire country.

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