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AGRICULTURAL INTENSIFICATION AND CROPPING DYNAMICS IN NORTH-EAST INDIA: A STATE WISE ANALYSIS (2004-05 TO 2022-23)

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Abstract

Agricultural intensification can involve increasing the use of existing cultivated land through repeated cropping rather than relying solely on expansion of the cultivated area. The present study examines cropping intensity and changes in the use of cultivated land across the eight North-Eastern states during 2004-05 to 2022-23 using annual state-wise data on gross sown area and net sown area obtained from the Reserve Bank of India. Area sown more than once (ASMO) was derived as the difference between gross sown area (GSA) and net sown area (NSA), while cropping intensity was calculated as the ratio of GSA to NSA. Mean, minimum, maximum, coefficient of variation and annual linear trend were used to assess the level, variability and temporal change in cropping intensity. ASMO increased in seven states and remained unchanged in Manipur, while the regional total rose from 1,359 to 1,893 thousand ha. Sikkim had the highest mean cropping intensity (179.82%), followed by Tripura (166.03%) and Assam (144.55%), while Manipur remained at 100%. Cropping intensity showed positive linear slopes in seven states, with the largest annual increases in Tripura, Mizoram and Sikkim. The results show substantial inter-state differences in the level, stability and trajectory of cropping intensity, indicating that repeated use of cultivated land has not followed a uniform pattern across North-East India.

Keywords: Agricultural intensification, Cropping dynamics, Cropping intensity, Gross sown area, North-East India, Repeated cropping.

Introduction

Agricultural land is a finite resource, and increases in agricultural production can be achieved not only by bringing additional land under cultivation but also by increasing the frequency with which existing cultivated land is used. Growing more than one crop on the same land within an agricultural year is an important form of such intensification. Gross sown area, net sown area and area sown more than once therefore provide useful measures for examining the intensity of land use. Cropping intensity, expressed as the ratio of gross sown area to net sown area, indicates the extent to which the cultivated land base is used repeatedly.

This issue is particularly relevant in North-East India, where agricultural conditions differ markedly among the eight states. The region includes areas with relatively intensive cultivation as well as rain-fed and hill-based farming systems. Variation in terrain, availability of cultivable land, water resources and cropping practices affects the scope for multiple cropping. Earlier studies have shown that improved land and water management can increase crop yield and improve the efficiency of rice-based systems in the region (Saha & Ghosh, 2010). Other studies have reported opportunities to raise cropping intensity by introducing additional crops into existing sequences and by utilising fallow periods, particularly in rice-based systems (Das et al., 2017; Layek et al., 2021). Research on maize-based systems has similarly examined their potential for improving productivity and increasing the use of cultivated land in North-East India (Panwar et al., 2021).

Much of the existing research on agricultural intensification in North-East India has examined individual locations, cropping systems or specific interventions rather than the long-term pattern across the region as a whole. Studies have focused, for example, on maize-based intensification in Sikkim (Babu et al., 2016), rice-fallow utilisation in Meghalaya (Das et al., 2017), and the identification of rice-fallow areas for cropping intensification across the rice belt of North-East India (Srivastava et al., 2023). However, relatively few studies have undertaken a comparable state-wise assessment covering all eight North-Eastern states over a common time period. Examining changes in net sown area, gross sown area

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and area sown more than once together can help distinguish expansion of the cultivated land base from greater repeated use of land that is already under cultivation.

The present study therefore assesses changes in agricultural land-use intensity across the eight North-Eastern states over the period 2004-05 to 2022-23. It focuses on changes in gross sown area, net sown area and area sown more than once, and uses cropping intensity to assess the extent of repeated cultivation. The study also compares the states in terms of the level, variability and trend in cropping intensity. These measures together help distinguish changes resulting from expansion of the cultivated land base from those associated with more frequent use of existing cultivated land.

Research Methodology

The study covers the eight states of North-East India namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. It uses annual data on gross sown area (GSA) and net sown area (NSA) for the period 2004-05 to 2022-23, obtained from the *Handbook of Statistics on Indian States 2023-24* published by the Reserve Bank of India (Reserve Bank of India, 2024). These data are used to examine changes in the cultivated land base, the extent of repeated cultivation and cropping intensity across the region.

Agricultural intensification was assessed from the relationship between gross sown area (GSA) and net sown area (NSA). GSA refers to the total area sown during the agricultural year, including areas cultivated more than once, whereas NSA refers to the area sown at least once. The difference between GSA and NSA was used to estimate the area sown more than once (ASMO), thereby indicating the extent of repeated use of cultivated land.

Area sown more than once (ASMO) was derived as:

$$ASMO = GSA - NSA$$

Where GSA is gross sown area and NSA is net sown area. The resulting value represents the area cultivated more than once during the agricultural year.

Cropping Intensity was calculated as the ratio of GSA to NSA, expressed as a percentage:

$$CI = \frac{\text{GSA}}{\text{NSA}} \times 100$$

Where GSA denotes gross sown area and NSA denotes net sown area.

Cropping intensity was analysed using the annual series for 2004-05 to 2022-23. For each state, the mean, minimum and maximum values were calculated to describe the level and range of cropping intensity during the study period. The coefficient of variation (CV), calculated as the standard deviation relative to the mean and expressed as a percentage, was used to assess variability over time. A linear trend was fitted to the annual cropping-intensity series, with the slope expressed in percentage points per year to indicate the direction and magnitude of change.

Results and discussion

Changes in Area sown more than once

Changes in area sown more than once (ASMO) provide a measure of the extent to which cultivated land was used repeatedly during the study period. Table 1 presents the changes in ASMO across the eight North-Eastern states between 2004-05 and 2022-23.

ASMO increased in seven of the eight states between 2004-05 and 2022-23, while Manipur recorded no change. Assam had the largest absolute increase, from 1,143 to 1,290 thousand ha, followed by Tripura, where ASMO increased from 1 to

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230 thousand ha. Nagaland recorded an increase from 71 to 110 thousand ha, while Arunachal Pradesh, Meghalaya, Sikkim and Mizoram also registered increases. In Manipur, GSA and NSA remained equal in both years, resulting in an ASMO value of zero throughout the comparison.

Table 1. Changes in Area sown more than once (ASMO) in North-East India, 2004-05 to 2022-23

State	ASMO 2004-05 (thousand ha)	ASMO 2022-23 (thousand ha)	Absolute change (thousand ha)	Relative change (%)
Arunachal Pradesh	53	90	+37	69.81
Assam	1,143	1,290	+147	12.86
Manipur	0	0	0	--
Meghalaya	46	56	+10	21.74
Mizoram	0	61	+61	--
Nagaland	71	110	+39	54.93
Sikkim	45	56	+11	24.44
Tripura	1	230	+229	22,900.00
North-East India	1,359	1,893	+534	39.29

Source: Calculated from gross sown area and net sown area data obtained from Reserve Bank of India (2024).

Note: ASMO = GSA − NSA. Relative change is not expressed for Mizoram because the initial ASMO was zero.

At the regional level, ASMO increased from 1,359 to 1,893 thousand ha, an absolute increase of 534 thousand ha or 39.29%. The increase indicates a larger area being sown more than once during the study period, pointing to greater repeated use of cultivated land across North-East India. This finding is in line with earlier research highlighting the potential for increasing land-use intensity through additional cropping and the utilisation of fallow periods, particularly in rice-based systems of the region (Das et al., 2017; Layek et al., 2021).

The states differed considerably in both the level and change in ASMO. Assam had the largest ASMO in both 2004-05 and 2022-23, reflecting the substantial difference between its gross and net sown areas. Its relative increase was modest compared with Tripura because the initial ASMO was already large. In Tripura, ASMO increased from 1 thousand ha to 230 thousand ha, giving a relative increase of 22,900%. This very high percentage is mainly a result of the extremely small initial value; the absolute increase was 229 thousand ha. Mizoram also recorded an increase from a zero base, reaching 61 thousand ha in 2022-23, for which relative change cannot be calculated. Arunachal Pradesh and Nagaland also showed notable increases relative to their initial ASMO values.

The changes in ASMO show that increases in annual sown area did not occur in the same way across the region. In several states, growth in GSA was accompanied by a larger difference between GSA and NSA, indicating greater repeated use of cultivated land. In Manipur, however, GSA and NSA increased by the same amount, leaving ASMO unchanged. The results therefore suggest that the contribution of repeated cultivation to changes in agricultural land use varied substantially among the eight states.

Temporal Pattern and Variability of Cropping intensity

Table 2 summarises the level, variability and linear trend of cropping intensity across the eight North-Eastern states during 2004-05 to 2022-23. The mean, minimum and maximum values show the range of cropping intensity over the study period, while the coefficient of variation indicates its variability. The estimated trend coefficients show the direction and rate of change in cropping intensity over time.

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Table 2. Temporal Pattern and Variability of Cropping Intensity in North-East India, 2004-05 to 2022-23

State	Mean CI (%)	Minimum CI (%)	Maximum CI (%)	CV	Annual trend (percentage points/year)
Arunachal Pradesh	132.60	126.24	139.09	2.47	+0.55
Assam	144.55	136.69	148.55	2.27	+0.25
Manipur	100.00	100.00	100.00	0.00	0.00
Meghalaya	120.53	115.49	123.67	1.62	+0.18
Mizoram	114.59	100.00	142.07	15.73	+2.85
Nagaland	130.08	120.38	138.02	4.25	+0.51
Sikkim	179.82	153.25	210.39	10.01	+1.89
Tripura	166.03	100	192.55	23.10	+5.52

Source: Calculations based on gross sown area and net sown area data from Reserve Bank of India (2024).

Note: CI = Cropping Intensity. CI was calculated as (GSA/NSA) × 100 from the annual GSA and NSA data. CV = coefficient of variation. Annual trend represents the slope from a linear trend fitted to the annual cropping-intensity series.

Mean cropping intensity varied considerably among the eight states. Sikkim had the highest mean value at 179.82%, followed by Tripura (166.03%) and Assam (144.55%). Arunachal Pradesh and Nagaland recorded mean values of 132.60% and 130.08%, respectively, while Meghalaya stood at 120.53%. Mizoram had a mean cropping intensity of 114.59%. Manipur was the only state with a mean of 100%, with the value remaining unchanged throughout the study period.

The coefficient of variation shows clear differences in the stability of cropping intensity among the states. Manipur had no variation, with cropping intensity remaining at 100% throughout the study period. Meghalaya, Assam and Arunachal Pradesh showed relatively low variability, with CV values of 1.62%, 2.27% and 2.47%, respectively. Nagaland had a somewhat higher CV of 4.25%. Variability was considerably greater in Sikkim (10.01%) and Mizoram (15.73%), while Tripura had the highest CV at 23.10%. The relatively high CV values in these states indicate greater year-to-year fluctuations in cropping intensity.

The linear trend was positive in seven of the eight states, although the magnitude of change differed considerably. Tripura had the steepest increase, with cropping intensity rising by 5.52 percentage points per year, followed by Mizoram (2.85) and Sikkim (1.89 percentage points per year). Arunachal Pradesh and Nagaland recorded smaller increases of 0.55 and 0.51 percentage points per year, respectively, while Assam and Meghalaya showed only modest upward trends. Manipur recorded no change, as its cropping intensity remained at 100% throughout the study period.

The results point to different patterns of agricultural intensification across North-East India. Assam, Arunachal Pradesh and Meghalaya maintained relatively stable cropping-intensity levels, whereas Tripura, Mizoram and Sikkim experienced greater fluctuations along with positive trends. The differences suggest that repeated use of cultivated land has progressed at different rates across the region. Earlier studies have similarly shown that opportunities for increasing cropping intensity depend on local cropping systems, moisture availability and the scope for introducing additional crops into existing sequences (Babu et al., 2016; Das et al., 2017; Layek et al., 2021).

Conclusion

The study shows that agricultural intensification followed different trajectories across the eight North-Eastern states during 2004-05 to 2022-23. Area sown more than once increased in seven states, contributing to a regional rise from 1,359 to 1,893 thousand ha, while Manipur showed no change. Cropping intensity also varied considerably, with Sikkim recording the highest mean value and Manipur remaining at 100% throughout the period. The trend and variability measures further

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reveal contrasting patterns: Assam, Arunachal Pradesh and Meghalaya had relatively stable cropping intensity, whereas Tripura, Mizoram and Sikkim showed greater fluctuations alongside positive trends. Overall, the results suggest that agricultural intensification in North-East India has not followed a common pathway. The extent to which existing cultivated land is used repeatedly differs substantially among the states, highlighting the need to consider state-specific cropping systems and agro-ecological conditions when assessing changes in agricultural land-use intensity.

References

1. Babu, S., Singh, R., Avasthe, R. K., Yadav, G. S., & Rajkhowa, D. J. (2016). Intensification of maize (Zea mays)-based cropping sequence in rainfed ecosystem of Sikkim Himalayas for improving system productivity, profitability, employment generation and energy-use efficiency under organic management condition. The Indian Journal of Agricultural Sciences, 86(6), 778-784. https://doi.org/10.56093/ijas.v86i6.58980
2.Das, A., Chowdhury, S., Layek, J., et al. (2017). Agro-physical assessment of different pea (Pisum sativum) cultivars in lowland rice (Oryza sativa) fallow under no-till system for enhancing cropping intensity and productivity in mid hills of northeast India. The Indian Journal of Agricultural Sciences, 87(12), 1612-1618. https://doi.org/10.56093/ijas.v87i12.76487
3.Layek, J., Das, A., Krishnappa, R., Ramkrushna, G. I., Chowdhury, S., & Das, S. (2021). Intensifying rice (Oryza sativa) based cropping system through pulses and oilseeds in North-East India. The Indian Journal of Agricultural Sciences, 91(6), 819–823. https://doi.org/10.56093/ijas.v91i6.114241
4.Panwar, A. S., Babu, S., Kohima, N., & Kumar, S. (2021). Maize (Zea mays)-based cropping system on raised beds influenced the productivity, soil quality and profitability in North-East India. Indian Journal of Agronomy, 66(3), 333-338. https://doi.org/10.59797/ija.v66i3.2858
5.Reserve Bank of India. (2024). Handbook of Statistics on Indian States 2023–24. Mumbai: Reserve Bank of India.
6.Saha, R., & Ghosh, P. K. (2010). Effect of land configuration on water economy, crop yield and profitability under rice (Oryza sativa)-based cropping system in north-east India. The Indian Journal of Agricultural Sciences, 80(1), 16-20.
7.Singh, A. K., Rahman, B., & Thakur, R. (2019). Assessment of land suitability and irrigation potential for improving cropping intensity and ensuring food security in North East India. Journal of the Indian Society of Soil Science, 67(3), 281–290. https://doi.org/10.5958/0974-0228.2019.00031.8
8.Srivastava, A. K., Borah, S. B., Ghosh Dastidar, P., et al. (2023). Rice-fallow targeting for cropping intensification through geospatial technologies in the rice belt of Northeast India. Agriculture, 13(8), 1509. https://doi.org/10.3390/agriculture13081509