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Performance assessment of livestock sector in Assam versus India: Trends, productivity and policy interventions for sustainable development

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Abstract

The present study, based on secondary data taken from Basic Animal Husbandry and Fisheries Statistics, Basic Animal Husbandry Statistics Livestock Census reports, and annual reports from 2013 to 2025, to evaluate Assam's livestock sector performance compared to national trends, focusing on population dynamics, milk and meat production, per capita availability, demand-supply gaps for 2024–25, and projections for 2036 and 2047.

Data for cattle, buffalo, sheep, goat, and pig were analysed to study population dynamics from 1997 to 2019; however, milk and species wise meat production, per capita availability and demand supply gap were studied from 2007-08 to 2024-25. The AGR/ AAGR and CAGR were calculated to assess growth, while Pearson correlation coefficient was calculated to find out relationship between slaughter rates and meat output. Demand-supply gaps were compared between Assam and India using production data and projected through CAGR-based formulas to guide future planning and policy recommendations.

From 1997 to 2019, in the national context, sheep, goat and buffalo sector grew faster with negative growth rate in cattle and pig. While pig and goat sector grew fast in Assam and negative growth occurred in buffalo population. Although sheep population is very less scattering over certain specific pockets of the state, its growth was highest among all five livestock species.

In India, both milk and meat sector grew comfortably with CAGR being 5.00% and 5.84% when compared from 2007-08 to 2024-25. By 2024-25, India has already self-sufficient in milk production and consumption. It will be self-sufficient in meat production too by 2036. Conversely both meat and milk growth in Assam is far below than national average. Although improvement in meat production is observed (CAGR of 5.08%) than in milk (CAGR of 2.94%), but Assam is still a deficient state and likely to be deficient by 2047 if the present growth trend exists. Animal's productivity is a major challenge; Assam's average milk yield per bovine is just 81.21 kg/year versus the national average of 656 kg. Meat yield per animal is also 1.5–2 times lower in Assam. Emphasizing on breeding, nutrition, and management is vital to narrow the gaps and rising demand of meat.

Keywords: Livestock production, milk growth, meat growth, per-capita availability, demand-supply gap, policy intervention

1. Introduction

The livestock sector plays a significant role in India's rural economy, providing livelihood, nutrition, and employment to millions. According to the Periodic Labour Force Survey 2022–23 ^[10], about 6.45% of the Indian population is engaged in animal production, while 3.63% are involved in mixed farming activities ^[13]. Another report suggests that approximately 10.08 crore rural households in India are engaged in animal husbandry, including livestock and poultry rearing ^[14]. Livestock contributes significantly to household income, accounting for 16% of income for small farm households and 14% for overall rural households ^[32]. Nearly two-third of the country's rural populations are supported by livestock sector alone and it employs approximately 8.8% of Indian people ^[15]. In terms of national income, the livestock sector generated a Gross Value Added (GVA) of ₹13.55 lakh crore at current prices during FY 2022–23, which is 30.23% of the agricultural and allied sector's GVA and 5.5% of India's total GVA. According to the World Population Review ^[16], India holds

the second-largest cattle population globally, with approximately 194.5 million cattle, following Brazil, which ranks first. In terms of goat population, India leads the world with 150 million goats, accounting for 13.64% of the global goat population of 1.1 billion. India is followed by China and Nigeria, which occupy the second and third positions in goat population, respectively.

India possesses the largest buffalo population in the world, with approximately 109.85 million buffaloes ^[22]. In case of sheep, India stands second, with 75.3 million sheep, while China leads with 194 million. However, India ranks significantly lower in pig population, recording only 9.1 million pigs, as per data from the 20th Livestock Census.

On the other hand, Assam contributes just 3.25% to the total national livestock population but holds a unique status in the pig sector, accounting for nearly 23% of India's pig population, the highest in the country.

This study, based on secondary data, will explore the comparative performance of Assam's livestock sector in relation to national trends. Key focus areas include livestock

population dynamics, trends in milk and meat production, species-wise contribution to meat output, per capita availability, productivity per animal, and demand supply gap by 2024-25, and also projections for 2036 and for 2047 (a target year for Viksit Bharat). The study aims to: i) assess the performance, challenges, and disparities in Assam's livestock sector compared to the national scenario, ii) to identify critical gaps and growth opportunities to formulate future planning, and iii) to recommend region-specific policy interventions to enhance productivity.

Methodology

The study was based on secondary data obtained from the Basic Animal Husbandry & Fisheries Statistics for the years 2013 ^[1], 2014 ^[2], 2015 ^[3], and 2017 ^[4], as well as the Basic Animal Husbandry Statistics for 2019 ^[6], 2021 ^[7], 2023 ^[8], and 2025 ^[17]. Additional data were sourced from the Annual Report, 2023–24 ^[18] and the Livestock Census Report collected from the NDDB, 2017 ^[5] website. Animal populations dynamics for cattle, buffalo, sheep, goat, and pig were compared from 1997 (16th Livestock Census) to 2019 (20th Livestock Census), while milk production, meat production, per capita availability of milk and meat, the number of animals slaughtered, and demand supply gap were analysed and comparatively assessed from 2007–08 to 2024–25. Data with respect to meat production and slaughter of animals for the year 2014–15 could not be traced out from the available sources; hence, the figures were calculated using polynomial regression/ interpolation/ linear regression depending on the trend of the data.

The Growth rate over previous year, Average Growth Rate (AGR) and Compounded Annual Growth Rate (CAGR) were calculated for studying population dynamics; however, Year-to-Year (YoY) growth rate, Average Annual Growth Rate (AAGR) and CAGR were calculated for milk and meat production, species-wise meat production, no. of animals slaughtered, per capita milk and meat availability, and projections of demand-supply by 2036 and 2047. The per capita availability of meat in India from 2007-08 to 2016-17 was calculated indirectly from production data for the respective periods and projected human population figures of 1st March, as reported by the Registrar General of India ^[17]. However, to calculate the same for Assam, human populations were projected depending on CAGR's of 2001 and 2011 census data. To calculate year-to-year (YoY) growth rate or growth rate over previous year, formula used was = (present year value – earlier year value / earlier year

value) X 100. The AAGR or AGR was determined by $AAGR/AGR = [\text{summation of all YoY growth rate or all year's growth rate} \div \text{Number of Years}]$, whereas the CAGR was calculated using the formula $CAGR = (\text{First year value} / \text{Last year value})^{1/n} - 1$, where n stands for number of years.

The correlation between rate of animal slaughter and meat production CAGR for both Indian and Assam context and also correlation between India and Assam in terms of CAGR of animal slaughter and CAGR of meat production were calculated through Pearson correlation Coefficient between -1 to +1, where +1= perfect positive linear correlation and -1= perfect negative linear correlation.

Species wise meat productivity per animal was calculated from the total numbers of animals slaughtered and total meat production during the respective years. Total demand of milk and meat for 2036 and 2047 was calculated from the projected human population and milk and meat requirement. The projections of human populations and total production (supply) of milk and meat for 20236 and 2047 was calculated using the same CAGR found between 2024-25 and 2007-08 of respective sectors and was calculated by the formula = (Value of 2024-25) X $(1+r)^n$, where r is the CAGR and n is the number of years. These calculations were compared for the state of Assam with national trends. Based on the findings, strategic measures have been proposed for successful adoption.

Results and Discussion

1. population status

Livestock population trend in India

The population trends of cattle, buffalo, sheep, goat, and pig in India from 1997 to 2019 are illustrated in Figure-I. Although fluctuations were observed across all five species, the overall cattle population declined from 1997 to 2003, rose in 2007, then declined but remained stable in 2012 and 2019. However, the number of adult female cows remained unchanged from 1997 to 2003, but increased thereafter up to 2019. The buffalo and the adult female buffalo populations have increased from 1997 to 2019. When only adult female bovines (including both cattle and buffalo) were considered, the population showed a steady increase over the study period. This indicates a mere shift in focus from quantity to quality, emphasizing on the importance of more productive, milch animals. Rather than aiming for a larger overall population, the trend reflects a strategic effort to enhance milk production through a growing number of high-yielding adult female bovines.

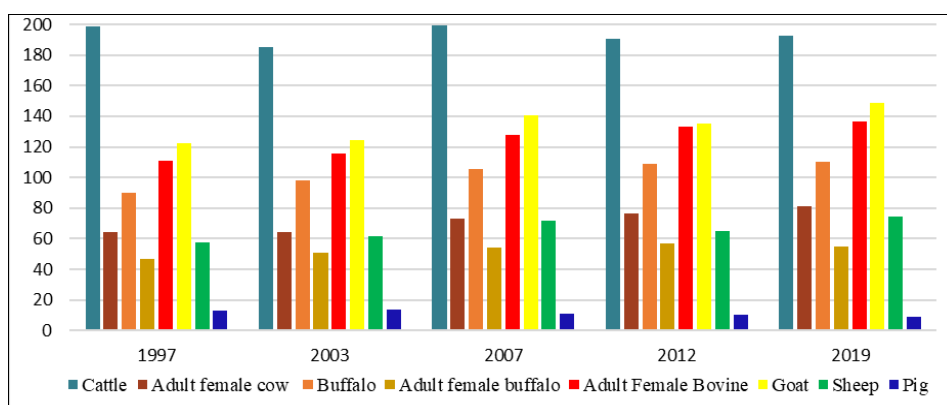


Fig 1: Livestock population in India from 1997 to 2019 (in million)

Similarly, sheep and goat populations increased steadily since 1997 except slight declined in 2012. Pig population played a very minor role in total studied population of five species of livestock containing only 2.02% of the average of the total combined population of these five species. Moreover, its population decreased from 2003 onwards. Highest population was contributed by cattle (37.30%), followed by goat (26.87%), buffalo (20.49%) and sheep (13.32%), when the average values of populations of all five species from 1997 to 2019 were taken into account.

From 1997 to 2019, the AGR of cattle was negative (-0.67%), which was aligned with negative CAGR of -0.15%. In comparison, buffaloes exhibited a positive growth, with AGR of 5.20% and CAGR of 0.92%. However, both adult female cow and adult female buffalo grew at an AGR of 6.14% and 4.21%, and CAGR of 1.07% and 0.74%, respectively, which contributed to the higher growth rate of overall adult female bovine with AGR of 5.29% and CAGR of 0.93%.

Out of all five species, the highest growth was observed in sheep population with AGR of 7.11% and CAGR of 1.17%. Conversely, the pig population showed negative growth, with an AGR of -8.62% and CAGR of -1.71% during the study period showing lesser demand and consumer preference.

Livestock population trend in Assam

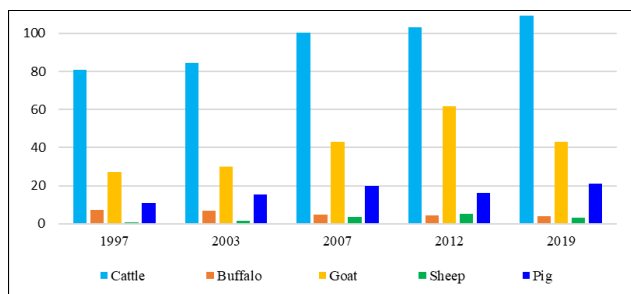


Fig 2: Livestock population in Assam from 1997 to 2019 (in lacs)

The livestock production data (in lakhs) of Assam are presented in Figure-II. Since 1997, the populations of cattle have shown a consistent upward trend, in contrast to buffaloes, whose numbers have been declining. The decline in buffalo population may be attributed to the gradual shrinking of grazing land, as buffalo rearing in Assam traditionally follows the "Khuti" system, a low-input rearing method, where buffaloes are reared in open spaces under a free-ranging system with minimal shelter primarily for newborns or young animals.

The goat population increased steadily from 1997 to 2012, when its population reached 61.69 lacs and then sharply reduced to 43.15 lacs in 2019. The sheep populations also increased slowly from 1997 to 2012, when it reached 5.11 lacs and then declined to 3.32 lacs in 2019. The pig population, which had dropped in 2012, showed significant recovery by 2019. Out of average total population of five species in Assam from 1997 to 2019, highest share was contributed by cattle (59.09%), followed by goat (25.35%) and pig (10.34%); buffalo and sheep contributed only 3.42% and 1.79%, respectively.

The highest growth rate was observed for sheep population,

followed by pig, goat and cattle. The buffalo population declined drastically with AGR of -12.28% and CAGR of -2.36%. The sheep showed the highest AGR (54.99%) and CAGR (6.37%), although its population was meagre, followed by the pig with AGR of 20.57% and CAGR of 2.93%, respectively. Goat had the third position in terms of AGR (16.83%) and CAGR (2.06%). Cattle population also increased slowly and steadily showing AGR of 7.93% and CAGR of 1.35%.

A clear shift towards small ruminants (sheep and goat) and pig population was probably due to consumer preference and changing market demand, adaptability to the Assam condition for small farming practices due to low maintenance cost. Slow, steady growth in the cattle population is due to the continued value of cattle milk in the state.

2. Growth of Milk and Meat production in India and Assam (2007-08 to 2024-25)

India ranked first in milk production since 1998 reaching 247.9 million tons in 2024-25. This becomes nearly 25% ^[19] of the estimated global milk production of 950 million tons ^[9]. The production exhibited a year-to-year (YoY) growth rate fluctuating between 3.55% in 2012-13 and peaking at 6.61% in 2017-18, with AAGR and CAGR of 5.00% and 5.02%, respectively. The closely aligned AAGR and CAGR values for milk suggest that India's milk production has experienced steady and relatively consistent growth over the past two decades. The productivity of milch animals, as measured by their yields, indicated a stable and steady increase, reflecting the positive contribution of technological change in breeding and feeding ^[25]. In Maharashtra, a 4.96 percent compounded growth rate of milk was recorded during 1998-99 and 2018-19 ^[25].

India produced 10.50 million tons meat per annum in the year 2024-25, which is nearly 3% of world meat production, considering global meat production of 350.64 million metric tons by 2023 ^[33]. India is the 5th largest producer of meat following China, USA, Brazil and Russia in chronological order ^[11].

India's total meat production grew at a rate ranging from as low as 2.33% during 2020-21 to as high as 13.14% during 2011-12 with AAGR and CAGR of 5.58% and 5.84%, respectively, indicating steady growth similar to that of milk and reflecting parallel progress in the dairy and meat sector. Compared to India's average production, milk and meat production in Assam is very low and is unable to fulfil even its domestic demand. Out of total milk production of 247.9 MT by 2024-25 in India, Assam produced only 1.22408 MT constituting only 0.49%. Similarly, in meat sector Assam contributed only 0.66% (69.49 million kg), out of total meat production of 10.50 million tons in India during the same year. When poultry meat is excluded from the total meat production during the same year, Assam contributed 0.98% (52.49 million kg), out of India's total meat production of 5329.25 thousand tons from the five species.

The YoY growth rate of milk production from 2007-08 to 2024-25 ranged from as low as 0.13% during 2008-09 to as high as 12.07% during 2024-25, with AAGR and CAGR of 3.19% and 2.94%, respectively, showing a slow, consistent growth with minor fluctuations only. In meat, YoY growth rate ranged from 0.59% during 2011-12 to 17.93%, during

2023-24 with AAGR and CAGR of 4.7% and 5.08%, respectively, reflecting that meat production grew faster than milk production. Improvement in meat sector than in milk, may be due to shift in market demand or consumer's preferences, cost volatility of inputs, or policy changes.

In India report of NFHS-5 shows that during 2019-21, 83.4% men and 70.6% women within the age group of 15-49 years are non-vegetarian and has increased from 78.4% men and 70.8% women in 2015-16 as per report of NFHS-4 [21]. Natarajan and Jacob (2018) [31] reported that vegetarian population of India is around 31%, and realistically less than 20% as majority eat some form of meat either at regular or occasional basis. The same report also suggests that Assam with West Bengal and Kerala have less than 5% vegetarians and remaining North Eastern states less than 2%. This finding aligns with the 2022-23 expenditure survey, where Assam ranked second only to Kerala in the share of household food budgets spent (17% of their food budget on non-vegetarian food) on eggs, fish, and meat [29].

3. Trends of Livestock Slaughter in India and Assam (2007-08 to 2024-25)

The trends of slaughtering of five major species of livestock in India and Assam are depicted in Figure-III and IV. Over the last two decades, the highest numbers of goats and sheep have been slaughtered in India. Cattle slaughter has shown significant fluctuations, ranging from a decline of -20.78% in 2022-23 to a peak growth of 29.70% in 2011-12. The AAGR and CAGR of cattle slaughter during the study period stood at -0.16% and -0.68%, respectively, indicating a long-term declining trend. This decline may be attributed

to regulatory restrictions, reduced market demand, cultural factors, and shifting consumption patterns.

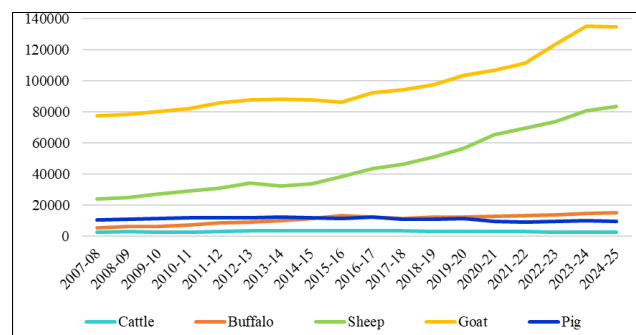


Fig 3: Species wise Animal slaughtered in India (000 No)

Buffalo slaughter, despite experiencing negative growth in 2016-17 and 2017-18, maintained a strong AAGR of 7.13% and CAGR of 7.02%, respectively, suggesting a consistent rise in buffalo slaughter over time, likely driven by high export demand for buffalo meat. The YoY growth rate of sheep slaughter ranged from -5.39% in 2013-14 to 15.73% in 2020-21. Both AAGR (7.77%) and CAGR (7.96%) of sheep slaughter were found to be the highest among all five livestock species, reflecting a robust growth. Goat slaughter also increased simultaneously with sheep, which is reflected through a high and aligned values of both CAGR (3.33%) and AAGR (3.36%). However, pig slaughter declined over the last 16 years showing negative growth (AAGR:-0.33% and CAGR:-0.55%), indicating decreasing popularity or market demand.

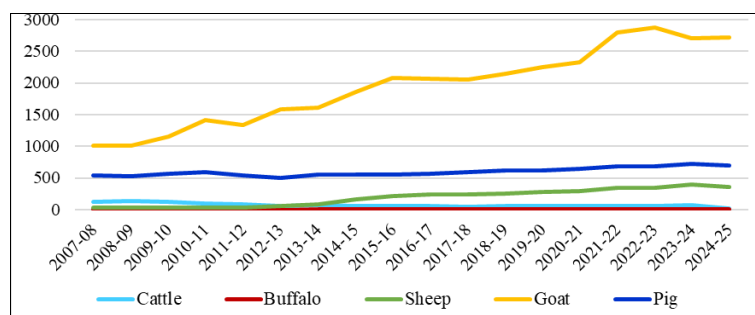


Fig 4: Species wise Animal slaughtered in Assam (000 No)

Similar to Indian trend in cattle slaughter, in Assam too, both cattle and buffalo slaughter declined significantly over the 18-year study period. Both CAGR and AAGR of cattle slaughter were found to be highly negative, with -7.06% and -11.34%, respectively. Similarly, the CAGR and AAGR of buffalo slaughter were also found to be negative, with -6.56% and -2.69%, respectively. On the other hand, sheep slaughter in Assam drastically surged from 27,000 animals in 2007-08 to nearly 3.51 lakhs in 2024-25 with AAGR of 19.03%, which was aligned with high CAGR (16.29%) value. Sheep meat is a preferred meat amongst some sections of the people of the state due to its rearing in certain confined areas, however there is tremendous scope for utilizing its potential fully [23].

Goat slaughter also showed steady growth showing AAGR of 6.35% and CAGR of 5.88%. Pig slaughter in Assam experienced slow and irregular growth, with an AAGR of 1.62% and a CAGR of 1.47% over the 18-year span. In

Assam more goats are slaughtered due to wider consumer acceptance and market demand. Conversely, pig slaughter growth has been modest and region-specific, while cattle and buffalo slaughter have declined, possibly due to changing in socio-cultural dynamics and regulatory restrictions.

4. Species-wise meat production: India versus Assam perspective

The highest meat production was recorded from buffaloes, contributing 18.00% (13.89% to 22.95%) of the total average meat production in India during 2007-08 to 2024-25. Goat meat occupied second position with 15.33% (13.43% to 19.18%) of the total share, while sheep meat contributed 8.39% (6.91% to 11.29%). Cattle and pig meat contributed relatively lower shares of 4.16% (2.30% to 5.83%) and 6.34% (3.65% to 9.91%), respectively. Poultry remained the leading contributor to total meat production,

comprising around 47.81% (ranging between 44.15% and 51.45%) of the overall output. This trend has remained consistent over the years (2007–08 to 2024–25), with buffalo, goat, and sheep being the top three meat-producing livestock species in the country (Figure-V).

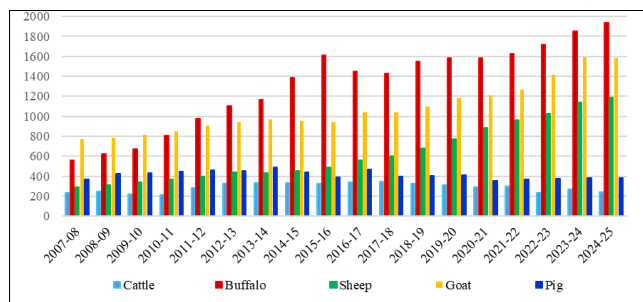


Fig 5: Species wise estimates of Meat production in India in 000 tons

The increased production of goat and sheep meat might be due to the highest numbers of animals of respective species slaughtered during the same period as found in the slaughtering trend described above. Goat and sheep meat are widely accepted across diverse communities in India, which contributes to their consistent demand. Buffalo meat, on the other hand, is primarily produced for export. In 2023–24, India exported approximately 70% of its total buffalo meat production. Out of 1,854,460 metric tons produced, 1,295,603.15 metric tons were exported, mainly to Vietnam, Egypt, Malaysia, Indonesia, and Iraq, earning USD 3,740.53 million ^[12]. Despite this large volume of raw buffalo meat exports, processed meat exports remained negligible. India exported only 813.72 metric tons of processed meat, of all species, worth just USD 2.48 million in the same year.

The highest AAGR (8.64%) was recorded for sheep meat, with YoY growth rate ranging from -2.10% to 14.82%, and aligning with highest CAGR (8.41%) value too. The growth was found second highest in buffalo meat production with AAGR of 7.91%, YoY growth rate ranging from -9.94% to 21.09% and CAGR of 7.56%. In terms of growth in meat production, goat occupied third position with AAGR of 4.42% (YoY growth ranging from -1.46% to 12.4%) and CAGR of 4.33%. Cattle and pig meat showed comparatively slower growth, with CAGR values of only 0.25% and 0.21% and AAGR of 0.90% and 0.63%, respectively. The YoY growth rates of cattle meat and pig meat production ranged from -19.84% to 35.16% and from -15.53% to 20.98%, respectively. The relatively low growth in cattle and pig meat production may be attributed to limited consumer preference and cultural or religious factors affecting demand in several parts of the country, and this finding simulates the cattle and buffalo slaughtering trend discussed above.

In Assam, pig meat contributed the highest share of 39.54% (36.59% to 44.12%) out of the total average year wise meat production of 46.05 million kg during the study period of 18 years. The goat meat contributed second-highest share with 28.55% (22.58% to 32.48%) during the same period and both pig and goat meat surpassed average poultry meat production of 20.29% (ranging from 16.41% to 25.08%), unlike India's trend of the highest share of poultry meat production. Comparing pig and goat meat production with

the number of animals slaughtered it was observed that although the number of goats slaughtered was higher than that of pigs, pig meat production was greater, as the meat yield per pig is 4 to 5 times higher than that of a goat (Table-1). Cattle and sheep meat contributed 8.86% (1.81% to 16.74%) and 2.32% (0.58 to 3.58%), respectively, while buffalo meat remained the least preferred, accounting for just 0.43% (0.21 to 1.33%) of the total meat output during the studied period (Figure-VI).

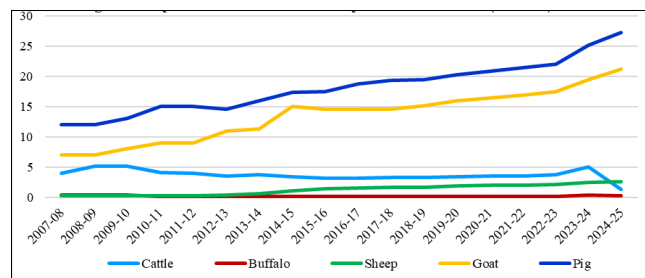


Fig 6: Species wise estimates of meat production in Assam (000 tons)

The AAGR of sheep meat production was highest (20.11%), aligning with the highest CAGR (15.74%) out of all five species. This trend draws the attention of all the stakeholders that Assam should give more emphasis or focus on sheep meat rearing and production system in the coming years as documented in our previous report too ^[23]. The AAGR of goat meat was found as 7.17%, (YoY growth rate ranging from -0.55% to 22.69%) with CAGR of 6.76%. Similar to goat meat, the growth of pig meat was also found satisfactory as reflected by AAGR and CAGR of 5.06% and 4.95%, respectively and YoY growth rate ranging from -2.60% to 15.38%. This aligned trend of YoY growth rate with AAGR and CAGR in goat and pig meat reflects a stable production in both the sectors and thereby necessitating its further expansion. Negative AAGR (-2.23%) and CAGR (-6.48%) in cattle meat production clearly showed decline of the cattle sector growth and is might be due to least preference because of socio-cultural practices and regulatory constraints. Low AAGR (2.63%), and negative CAGR (-2.51%) values were observed in buffalo meat production, showing its volatility due to sharp jumps in YoY growth rate ranging in between -68.75% and 94.12%.

These trends suggest that India's strategic focus should continue to prioritize buffalo, sheep and goat meat both for domestic consumption and export due to its steady growth and wide societal acceptance. Whereas, Assam's meat sector should emphasize pig and goat production with special emphasis in sheep sector as well. These three species align closely with the state's cultural preferences, local demand, and economic potential.

5. Correlation between slaughter of animals and meat production

In the national perspective, the Pearson correlation coefficient between meat production CAGR and slaughter CAGR was 0.99, indicating extremely strong positive linear relationship. This means that as the number of animals slaughtered rises, meat production tends to increase proportionally across species. Assam too showed strong

positive correlation of 0.96 between these two, showing a small variability between India and Assam.

A correlation of 0.57 was observed between India and Assam in terms of animal slaughter's CAGR, indicating that Assam's slaughter trends follow the national pattern, but few diversity is because of differences in regionalism, demand-supply chain or some local issues.

The correlation between India and Assam in terms of CAGR of meat production was moderate at 0.42, showing some alignment in production growth across species, like buffalo meat production declined in Assam while pig meat production increased, with goat and sheep trends showing similarities. These findings highlight the need for region-specific policies that account for Assam's distinct livestock dynamics and the factors influencing meat production beyond slaughter numbers.

6. Growth of Per Capita Milk and Meat Availability in India and Assam

The growth in per capita milk availability at national level has shown a steady upward trend over the years increasing from 260 g/ day in 2007-08 to 485 g/ day in 2024-25 surpassing ICMR's recommendation of 300 ml/ day^[20] during 2013-14. The YoY growth rate ranged from as low as 2.31% during 2008-09 to as high as 5.41% during 2016-17, with AAGR being 4.59% and the CAGR being 3.81%, indicating consistent and sustainable growth in milk consumption.

Like per capita milk consumption trend, the per capita meat availability has also increased over the years from 3.52 kg/ annum during 2007-08 to 7.39 kg/ annum during 2024-25. Fiala (2008)^[26] projected that global meat consumption in 2030 will be more than 70% higher than the levels in 2000. In rapidly developing nations like India, China, and Brazil, meat demand has been rising^[24]. In India, specifically since the 1970s, consumption of whole grains, pulses, fruits, and vegetables has declined, accompanied by an increase in meat intake^[28].

The YoY growth rate of per capita meat availability ranged from as low as 1.09% in 2020-21 to as high as 10.71% in 2011-12, with AAGR being 4.59 and CAGR being 4.65%. Although consumption of livestock product varies greatly among different states and regions of India^[27], overall consumption of animal products has been increasing and it has nullified the earlier projection report of UNFAO, 2007^[30], which had anticipated low rates of meat consumption among Indians. The parallel growth of meat and milk, found in the present study, can be attributed to increasing diversification in diets, rising income levels, improved affordability and better availability of both animal-based protein sources.

In Assam, per capita milk availability remained largely stagnant for over the study period, marginally increased from 70 g/day in 2007-08 to 92 g/day in 2024-25. The per capita milk availability ranged from -1.43% in 2009-10 to 9.52% in 2024-25 with an AAGR of only 2% and CAGR of 1.63%. This reflects slow progress in milk production and supply in the state, and limits its impact on individual consumption.

The per capita meat availability in Assam has been relatively better than milk, although it still lags behind the national average. In 2024-25, the per capita meat availability in Assam was 1.93 kg/year compared to the national average of 7.52 kg/year. The YoY growth rate of per capita meat availability ranged from -0.9% to 10.08% with AAGR and CAGR of 3.89% and 3.82%, respectively, indicating that per capita meat availability in Assam grew quite faster than per capita milk availability. However, the sluggish growth in per capita milk and meat availability in Assam compared to national context highlights the urgent need to strengthen the milk supply chain, improve animal productivity and enhance distribution to support balanced nutritional intake in the region.

7. Status of Milk and meat production per animal

In 2019, India had a total bovine population of 302.4 million, and the country produced 198.44 million tonnes of milk in 2019-20. This translates to an average milk yield of approximately 656 kg per animal per year. When considering only adult female bovines, during the same year, the average yield increases significantly to around 1,454 kg per animal per year. Meat production per animal (in carcass weight) has improved over the years (Table-i), indicating a positive shift from the earlier presumption, which stated that the average annual per capita meat supply in India is too low^[30].

In 2019, Assam's bovine population reached 11.331 million, contributing to a milk production of 920 million kg during 2019-20. This results in a much lower average yield of 81.21 kg per animal per year, which is significantly below the national average. Similar to milk production, meat production per animal in Assam is also 1.5 to 2 times lower than the national average in all five major livestock species (Table-1).

These figures clearly indicate that Assam faces a considerable productivity gap. Therefore, the state needs to shift its focus from merely increasing livestock numbers to enhancing per-animal productivity in both milk and meat sectors. Targeted interventions in breeding, feeding, healthcare, and management practices will be critical to improve overall efficiency and ensure sustainable livestock development in the region.

Table 1: Meat Productivity per animal in kg (Calculated from meat production versus animals slaughtered during the respective periods)

Year	Cattle		Buffalo		Sheep		Goat		Pig	
	India	Assam	India	Assam	India	Assam	India	Assam	India	Assam
2007-08	90.87	34.19	112.63	57.14	12.39	7.41	9.94	6.92	35.25	22.14
2008-09	92.02	39.32	103.92	52.86	12.62	8.00	10.03	6.94	39.60	22.64
2009-10	90.01	42.55	110.57	49.61	12.64	7.45	10.14	6.91	38.23	22.77
2010-11	90.21	43.97	116.85	46.30	12.78	6.17	10.30	6.39	38.69	25.14
2011-12	94.02	50.17	115.36	53.33	12.94	6.42	10.58	6.77	38.64	27.95
2012-13	102.43	59.35	122.43	61.54	12.92	7.33	10.74	6.89	38.55	29.58
2013-14	104.27	57.96	119.55	58.82	13.36	7.37	11.01	7.01	40.26	29.00

2014-15	101.94	58.92	120.85	62.87	13.03	7.08	10.92	6.99	37.78	30.72
2015-16	100.96	61.87	122.38	70.42	12.71	7.03	10.95	7.01	34.83	31.95
2016-17	101.79	61.24	119.58	69.62	12.86	6.48	11.29	7.08	38.13	32.78
2017-18	102.73	61.04	126.17	65.12	13.05	6.69	11.10	7.06	36.31	32.56
2018-19	106.85	60.63	129.64	62.76	13.33	6.69	11.29	7.10	37.69	31.70
2019-20	102.32	60.34	130.13	65.31	13.61	6.67	11.38	7.11	36.89	32.68
2020-21	101.63	60.90	123.10	72.87	13.50	6.71	11.36	7.08	38.48	32.45
2021-22	108.01	59.26	125.53	69.96	13.80	5.87	11.37	6.04	41.16	31.68
2022-23	109.29	59.27	126.28	68.00	13.93	5.94	11.45	6.07	40.29	32.37
2023-24	109.09	76.37	127.62	123.60	14.14	6.03	11.76	7.20	39.66	34.83
2024-25	106.6	78.3	127.8	122.6	14.3	7.2	11.8	7.8	40.1	39.1
Average	100.77	56.87	121.15	68.82	13.23	6.79	10.97	6.90	38.40	30.08

8. Demand-supply analysis of milk and meat

In India, milk production increased from 108MT in 2007-08 to 247.9 MT by 2024-25 with per capita milk availability increased by 52.04% during this period. By 2024-25, India produced surplus milk of 94.49 MT, taking the average milk consumption of minimum ICMR's recommendation. In few states like Maharashtra, a much sharper rise was reported, where per capita milk availability increased from 541 g to 944 g/day during 2001-02 and 2018-19 [25], far exceeding the national average. If the current CAGR of 5.00% in milk production from 2007-08 to 2024-25 exist, India's projected milk production will be

nearly double by 2036 and nearly triple by 2047 as compared to production in 2024-25.

The per capita availability of meat in India rose significantly from 3.52 kg/year in 2007-08 to 7.52 kg/year in 2024-25, marking a significant increase by 113.64% and is aligning with overall increase in meat production (162.5%) too during this period. However, India is still deficit in overall meat production by 4.91 MT, when average meat requirement per person is considered as 11kg/ annum but with the same CAGR growth India will be surplus by 2036 and 2047 (Table-2).

Table 2: Demand-supply analysis of milk and meat in India during 2007-08 to 2024-25 and projection for 2036 and 2047

Particulars	Milk					Meat				
	2007-08	2024-25	CAGR	2036*	2047*	2007-08	2024-25	CAGR	2036*	2047*
Human population (Million)	1138	1401	1.23%	1603.3*	1832.5*	1138	1401	1.23%	1602	1831
Requirement as per ICMR	300 g/day/person					11 kg/ person/annum				
Total demand (MT)	124.61	153.41		175.56*	200.66*	12.52	15.41		17.62*	20.14*
Total production/ Supply (MT)	108	247.9	5.00%	423.9*	720.7*	4	10.5	5.84%	19.6*	36.8*
Surplus/ deficit production (MT)	-16.61	94.49		223.24*	520.04*	-8.52	-4.91		1.98*	16.56*

N.B.: * Projected value on the basis of CAGR

Contrary to the Indian scenario, milk production in Assam has marginally increased by 0.47 million tons during 2007-08 to 2024-25 with per capita milk availability increased by 22 gm during the same period. In meat consumption per person too, there has been improvement of only 0.91

kg/annum during 18 years' period. In both sector, Assam is highly deficient by 2024-25 and will continuously be a deficient state as shown by the projected value for 2036 and 2047 (Table-3).

Table 3: Demand-supply analysis of milk and meat in Assam during 2007-08 to 2024-25 and projection for 2036 and 2047

*Particulars	Milk					Meat				
	2007-08	2024-25	CAGR	2036*	2047*	2007-08	2024-25	CAGR	2036*	2047*
Human population (Million)	29.3	36	1.21%	41*	46.7*	29.3	36	1.21%	41*	46.7*
Requirement as per ICMR	300 g/day/person					11 kg/ person/annum				
Total demand (MT)	3.21	3.94		4.48*	5.11*	0.32	0.40		0.451*	0.51*
Total production/ Supply (MT)	0.75	1.22	2.94%	1.68*	2.31*	0.03	0.07	5.08%	0.12*	0.218*
Surplus/ deficit production (MT)	-2.46	-2.72		-2.82*	-2.85*	-0.29	-0.33		-0.33*	-0.32*

N.B.: * Projected value on the basis of CAGR

This situation highlights mounting pressure on the livestock sector, necessitating urgent and targeted interventions. Enhancing productivity, strengthening supply chains, and adopting sustainable livestock practices will be critical to address existing deficits and meet future demand. A comprehensive development strategy is essential to reduce the gap and ensure long-term food and nutritional security for the state's growing population.

9. Policy Priorities for Enhancing Livestock Productivity in Assam

1. Enhance Animal Productivity, Not Just Population:

Assam's per-animal milk and meat productivity is significantly below the national average (e.g., 81.2 kg milk/animal/year vs. 656 kg in India), highlighting the need for policies that prioritize genetic improvement, maintaining a proper breeding policy, enhanced feed

and fodder availability and scientific management practices to boost output per animal.

2. **Promote Pig and Goat Rearing:** Pig and goat meat contributed almost 68.09% of Assam's total meat production during 2007-08 to 2024-25, underscoring the need for development schemes focused on breed improvement, animal health care and enhanced marketing support for these locally preferred and adaptable species.
3. **Bridge the Milk Demand-Supply Gap:** Despite a national surplus, Assam faces a significant milk deficit of over 2.72 million tons per year by 2024-25, necessitating targeted investments in dairy value chains, rural milk cooperatives and cold chain infrastructure.
4. **Focus on Meat Sector Growth and Safety:** Meat production in Assam has grown faster than milk, driven by rising per capita consumption, highlighting the need for policies that ensure small ruminant production upliftment, quality standards, hygienic slaughter facilities and strong market linkages.
5. **Region-Specific Livestock Strategies:** Considering Assam's diverse agro-climatic zones, strategies should be tailored to local strengths such as promoting pigs in tribal belts and goats in elevated, non-flooded areas through encouraging community-led livestock cooperatives and farmer capacity-building programs.
6. **Special emphasis on Sheep production:** Although the sheep population has decreased to 3.32 lakhs during 2019 from 5.11 lakhs during 2012, special emphasis should be given in the sheep rearing belt for bringing a holistic improvement in this unattended sector, as the growth rate was highest in sheep in comparison to all four other species.

Conclusion

India's livestock sector continues to expand and enhance productivity, Assam's sector lags significantly in terms of yield, availability, and meeting demand. Enhancing animal productivity rather than just increasing numbers, with special attention to genetic improvement, feed availability, and scientific management. Promoting pig and goat rearing, bridging the milk deficit, ensuring meat safety, and implementing location-specific strategies through holistic approaches are vital for sustainable growth. Special emphasis should be laid on sheep rearing, as it showed the highest growth rate among livestock species, to bring visible changes to this neglected sector.

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Animal Welfare Ethics

The study involves only data analysis and does not raise any

animal welfare concerns.

Conflict of Interest

Both the authors declare no conflict of interest

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