



Temporal Analysis of Livestock Production and Exports and its Significance for Food Security

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ABSTRACT

Background: Livestock provides diverse food and non-food products, supports rural households along with serving as a secondary source of income for small and marginal farmers. Livestock aids in food production, enriches soil fertility and supply raw material to various industries. Livestock directly contributes to nutritional security by providing essential proteins and micronutrients, preventing under-nutrition and deficiencies. This paper delves into the changing scenario of India's livestock sector by examining production, export patterns of livestock products and the role of livestock in food and nutritional security.

Methods: Available secondary data on production of livestock products in India have been divided into four sub periods: sub period-I (1980-81 to 1989-90), sub period-II (1990-91 to 1999-00), sub period-III (2000-01 to 2009-10) and sub period-IV (2010-11 to 2021-22) and have been analyzed along with export data covering the period 1991-2021 and population data from first livestock census (1951) after independence to 20th livestock census (2019). Compound Annual Growth Rate (CAGR) using trend equation and instability index using Cuddy Della Valle Index has been worked out for the data.

Result: Production of egg, milk and meat has shown consistent growth of around 6%, 5% and 8%, respectively over the past five decades with low to moderate overall instability (~8-21%). But wool production has turned negative in the last two decades despite India being the world's third-largest sheep population. The growth in exports of dairy and meat products has gained momentum after globalization with a significant overall growth rate of 10.37% and 7.10% for the period under study. But in terms of instability dairy exports are more volatile (68.11%) compared to meat products (30.39%). Exports of poultry products showed negative growth rates with the highest instability (86.77%) over the entire study period.

Key words: CAGR, Food security, Livestock, Instability index.

INTRODUCTION

The allied sectors of Indian agriculture - livestock, forestry, fishery and aquaculture are gradually becoming sectors of robust growth offering a prospective source to stabilize farm incomes. Livestock sector in our country has always been linked with agriculture since ages and presents significant potential for employment. The sector witnessed a compound annual growth rate (CAGR) of 7.9% during 2014-15 to 2020-21 (at constant prices) and its contribution to overall agriculture Gross Value Added (GVA) (at constant prices) increased from 24.3 % in 2014-15 to 30.47% in 2021-22 (GoI, 2023). For the past two decades, livestock sector has surpassed the agricultural sector with an annual growth rate of 5.6 % over 3.3 % of the latter. In value terms, at current prices livestock sector has added about Rs. 11, 14, 249 crores during FY 2020-21 that accounts to 6.17% of total GVA. Livestock sector is significant in the sense that while the contribution of agriculture and allied sector to the national GVA has been falling from a level of 22.93% in 1999-20 to 16.27% in 2020-21 (at constant prices) the contribution of livestock sector has increased during the same period. Apart from this, the livestock sector offers a prospective opportunity for export earnings.

This sector offers a wide range of products, both food and non-food. The livestock farming sector in India not only yields various products but also contributes significantly to socio-cultural stability (Talukdar *et al.*, 2023). Of all the

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components, dairy is the most critical and dairy products take lead as most prominent agrarian product followed by eggs and meat products. India ranks first in milk production, third in egg production and eighth in meat production globally. Most rural households, particularly small and marginal farmers, rely significantly on dairy farming as a supplementary source of income. This sector provides employment to nearly 8.8% of the labour force and contributes substantially by generating an income that constitutes 15-40 % of the total household income in different states across the country (Bairwa *et al.*, 2012). Its contribution to women employment is highest among all the sectors in the country constituting nearly 50% of both direct

and indirect employment (Gol, 2022). In India, nearly 70 % of the rural household have livestock and small animals such as sheep, goats, pigs and poultry. These are predominantly maintained by land-scarce impoverished households for commercial purposes due to their low initial investment and operational costs. The significance of livestock goes beyond the realm of food production as it provides manure to crop sector, raw material to the industries, moderates seasonality in livelihood patterns, absorb income shocks from crop failure and making a significant positive contribution to equity in terms of income, employment and poverty reduction (Singh and Hazell, 1993; Birthal and Singh, 1995; Birthal *et al.*, 2002; Birthal and Jabir, 2005; Anonymous, 2007; Vandamme *et al.*, 2010; Waters-Bayer and Letty, 2010; Birhanu *et al.*, 2021). India has a huge resource of livestock and poultry, there is a total livestock population of 536.76 million, out of which about 303.76 million are bovines (cattle, buffalo, mithun and yak), 74.26 million sheep, 148.88 million goats, 9.06 million pigs and 0.79 million are other animals (Gol, 2019). Out of total bovine population cattle comprises of nearly 64 % followed by buffalo with 36%. The poultry population in country is about 851.81 million as per 20th Livestock Census.

Keeping in view the importance of livestock sector, the Government has made several critical interventions to enhance infrastructure and improve livestock productivity and disease control. The interventions are (i) Animal Husbandry Infrastructure Development Fund (AHIDF) (ii) National Livestock Mission (NLM) scheme, (iii) Livestock Health and Disease Control (LH and DC) Scheme (iv) National Animal Disease Control Programme (NADCP).

Scope of the study

The livestock sector has immense potential for contributing to country's economic and development by providing additional income, employment, food and nutritional security, rural development and earning foreign exchange. For designing appropriate policies to boost growth of livestock sector and making it a mainstream occupation especially in rural areas it is important to gain an insight into the nature and extent of changes happening in the sector. This creates the need to study the production, export growth pattern of livestock products in India.

Based on the above significance of the livestock sector, this paper attempts to achieve the following objectives:

- i. To study the role of livestock in food and nutritional security.
- ii. To study the growth and instability in production of livestock products.
- iii. To study the growth and instability in export of livestock products.

MATERIALS AND METHODS

The study was conducted in the year 2023 (August to December) in the Department of Agricultural Economics, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The study analyzed time series data of production for milk, eggs, wool and meat in India along with export

data for livestock products in India. The data is secondary and was collected from various publications *viz.* Annual Report and Basic Animal Statistics Report of Ministry of Fisheries, Animal Husbandry and Dairying, Government of India and various websites *viz.* <https://dahd.nic.in>, www.indiastat.com and <https://dgciskol.gov.in/>. The overall period taken for the study was from 1980-81 to 2021-22, which was further divided into four sub periods: Sub period-I (1980-81 to 1989-90), sub period-II (1990-91 to 1999-00), sub period-III (2000-01 to 2009-10) and sub period-IV (2010-11 to 2021-22).

Compound annual growth rate

To estimate compound annual growth rate (CAGR) the exponential time trend equation was applied, in the functional form:

$$Y = A(1+r)^t$$

Where:

Y= Time series data of livestock population, production and export data of livestock products *viz.* dairy, poultry and meat - for which growth rate is calculated.

A= Constant coefficient.

r = Rate of annual increment or annual growth rate.

t = Time element.

Using the compound formula, the log-linear or the exponential regression model was obtained by taking logarithms to base 'e'.

$$\ln Y = \ln A + t \ln (1+r)$$

The values were also tested for their significance using the student 't' test.

Instability analysis

The instability in production and export of livestock products was measured by Cuddy Della Valle Index (%) (Cuddy and Della Valle, 1978) using the formula:

$$\text{Instability index} = CV (1-R^2)$$

Where,

CV= Co-efficient of variation.

$$CV = \frac{SD}{MEAN} \times 100$$

R² = Adjusted coefficient of determination from a time-trend regression.

RESULTS AND DISCUSSION

Role of livestock in food and nutritional security

Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (Shaw, 2007). The contribution of livestock sector to food security is twofold, including both direct and indirect impacts. Direct impact can be seen for rural households where livestock supports sustenance and income whereas indirect benefit to the urban consumers in terms of access to affordable, high-quality animal-based products (Abu Hatab *et al.*, 2019). Livestock contributes to food supply by converting low-value inedible

materials into high value products like milk, meat and eggs thus reducing pressure on arable land for crop production. The contribution of livestock products in supplying 13% of energy and 28% of protein consumed globally has been recorded (FAO, 2009). In India the per capita availability of milk has reached a level of 444 grams per day which was more than the world average (394 grams per day) in 2021-22, ensuring to fulfil the needs of growing population in near future also. Livestock directly contribute to nutritional security as milk, meat and eggs are nutritionally dense with high-quality protein and micronutrients (iron, zinc, vitamin A and calcium) that are essential for good health (Steinfeld *et al.*, 2006; Ndlovu, 2010; Bordoni and Danesi, 2017). Animal-source foods significantly contribute to prevent under-nutrition and deficiencies which positively impacts children's physical growth and cognitive function along with improving pregnancy outcomes, reducing illness morbidity and boosting immunity (Keusch and Farthing, 1986; Neumann *et al.*, 2002; Bithal and Jabir, 2005; Sadler *et al.*, 2012;). Livestock also offers a wide range of food source, enhancing food security and resilience amid environmental challenges. The valuable nutrients (carbon, nitrogen, phosphorus, potassium, magnesium and zinc) in livestock manure contribute to soil fertility and boost crop yields, thereby supporting overall food production (Devendra, 2001; Anonymous, 2007; Favley, 2015). Therefore, raising different types of livestock, such as cows, pigs, sheep, goats and poultry, provide a diverse range of food products, reducing dependency on a single source of food and enhancing food and nutritional security.

Growth and instability in production of livestock products

Table 1 presents the compound growth rates of various livestock products over the past five decades in the country. Egg production has exhibited a robust growth rate of approximately 6% during this period, with the highest growth rate recorded between 1981 and 1990. This impressive growth can be attributed to the Silver Revolution that took place from 1969 to 1978. Presently, the country ranks third in global egg production. Gaware *et al.* (2020) observed that between 1996 and 2016, egg production in India experienced a compound annual growth rate of 5.61%. Similarly, milk production has consistently grown by around 5% over the last 40 years. Milk production constitutes around 25-30 percent of the total income generated from livestock. (Deshmukh and Paramasivam, 2016). The operation flood

program, initiated in 1970, made a significant contribution to increasing milk production from 35 million tonnes in 1980 to 210 million tonnes in 2020-an almost sevenfold increase. The White Revolution prompted the growth of cooperatives, which bolstered the supply chain of milk and its related products.

Lyngkhai *et al.* (2022) found a compound annual growth rate of 4.36 % in milk production between 1990 and 2019. Over the past two decades, meat production has shown impressive growth of around 8%. Notably, the period between 2001 and 2010 experienced a remarkable 9% compound annual growth rate, followed by 5.79% during 2011-2020. Agnihotri and Rana (2013) estimated substantial growth in sheep and goat meat production at 20.01% between 1993 and 2020, while beef and buffalo meat increased at 4.41% during the same period. However, wool production showed modest progress from 1980 to 2000 but turned negative in the last two decades. Kumar and Misra (2021) reported a steady increase in wool production since independence, yet there was a decline from 1987 to 1993 and again from 2003 onward, with intermittent fluctuations. Despite being the home to the world's third-largest sheep population, the country ranks 9th in global wool production, contributing only 2% to the total global wool production. To address this, the government initiated the Integrated Wool Development Programme (IWDP) to enhance both the quantity and quality of wool produced in the country.

Table 2 depicts the production instability of eggs, milk, meat and wool during the period of 1981-2000, measured using the Cuddy Della Valle Index. Across all livestock products, except for egg production, instability levels were generally low. Egg production displayed the highest instability during the 1991-2000 period (4.90%), followed by 3.87% during 2011-2020. The overall instability in egg production noted at 21.13%, indicating a moderate level of instability. In contrast, milk production demonstrated consistently low instability across all periods, signifying a stable production trend throughout the decades. Meat production experienced moderate instability (18.14%) in the early years of the 21st century but stabilized during 2011-2020. Overall, meat production exhibited an 8.40% instability. Wool production-maintained stability in its production, with the highest instability observed during the 2011-2020 period (4.21%). Across three decades, instability remained around 2.50% in production, leading to an overall instability in wool production categorized as low at 8.63%.

Table 1: Compound annual growth rates of livestock products in India (1981-2020).

Period	Eggs	Milk	Meat	Wool
1981-1990	6.85**	4.62**	0.00%	2.21**
1991-2000	5.24**	3.76**	0.00%	1.53**
2001-2010	4.99**	3.74**	9.00**	-1.40**
2011-2020	6.27**	5.08**	5.79**	-1.89**
1981-2020	6.23**	4.63**	7.84**	0.27**

** and * denote 1 and 5 % levels of significance, respectively.

The provided table (Table 3) outlines the decade-wise % change in livestock populations in India since 1950. Whereas to get better comprehension of trend over the time figure has also been used to depict the growth rate of livestock population (Fig 1). Cattle population maintained a steady increase until 1992 but experienced a decline afterward, growing modestly at a rate of 0.84% in the last decade. Buffalo population consistently grew since 1950 but slowed to a rate of 1.10% in the recent decade. The sheep population has exhibited substantial growth since 1950, aside from the negative growth rate of 0.50% during the 1961-72 decade. This impressive pace has been maintained in recent times. Goat population has consistently shown remarkable growth rates across all studied decades, notably achieving an astounding growth rate of 41.19% during the 1972-82 period. Pig population demonstrated impressive growth until 2003, but subsequently experienced negative growth rates of 23.70% during 2003-12 and 11.65% during 2012-19. The poultry population exhibited exceptional growth from 1950 onwards, surpassing growth rate of any other livestock population, with rates varying between a low of 16.81% during 2012-19 and a high of 55.37% during 1951-61. This remarkable expansion corresponds with the consistent growth rate observed in egg production as well. Dinesh *et al.* (2023) corroborated similar observations, noting a consistent growth rate in goat and sheep populations from 1997 to 2019. The researchers also highlighted a stagnation or deceleration in the cattle and buffalo populations across India. Yasmeen *et al.* (2019) undertaken an analysis of six livestock censuses conducted between 1982 and 2012. Their findings indicated an overall livestock growth rate of 0.21% during this period. Specifically, cattle exhibited an

annual growth rate of 0.21%, while buffalo, sheep and goats displayed annual growth rates of 2.31%, 1.95% and 1.31%, respectively.

Growth and instability in exports of livestock products

Table 4 illustrates the export growth of livestock products ensuing India's adoption of globalization. The findings indicate that dairy products exhibited a compound annual growth rate of 4.87 % from 1991 to 2021. The most notable decade was from 2001 to 2010, showcasing a peak export growth rate of 9.76%, followed a more moderate 2.15% during recent decade (2011-21). This impressive growth suggests that India's LPG policy facilitated the global outreach of surplus milk production achieved through the Operation Flood program. However, the poultry sector experienced fluctuations in export growth. Over the entire period from 1991 to 2021, the poultry sector demonstrated growth rate of 12.11%. The peak export growth for poultry occurred during 2001-2010. In contrast, the other two decades in the study recorded negative growth rates, with a substantial decline of -4.69 % in exports from 2011 to 2021, followed by a -2.90% during 1991-2000. Over the entire study period, meat exports increased by 7.10%. The decade spanning 1991-2000 exhibited the highest growth rate of 8.00%, followed by 7.29 % from 2001-10 and the lowest growth rate of -0.18% observed in the most recent decade. Kumar *et al.* (2012) reported a substantial growth of 11.8% in buffalo meat exports from India between 1991 and 2011. Bardhan (2007) estimated that egg exports surged by 19.08% from 1980 to 2004, while milk equivalent exports and meat/meat preparations increased by 19.08% and 8.23%, respectively, during the same period.

Table 2: Instability indices of livestock products in India (1981-2020).

Instability Index (%)	Eggs	Milk	Meat	Wool
1981-1990	2.34	1.58	-	2.34
1991-2000	4.90	0.45	-	2.79
2001-2010	2.50	1.55	18.14	2.65
2011-2020	3.87	2.08	1.12	4.21
1981-2020	21.13	14.21	8.40	8.63

0-15, 15-30, >30.

Table 3: Per cent (%) change in livestock population in India (1951-2019).

Species (Percent (%) change)	1951-61	1961-72	1972-82	1982-92	1992-2003	2003-2012	2012-19
Cattle	13.07	1.54	7.96	6.29	-9.48	3.08	0.84
Buffalo	17.97	12.11	21.60	20.63	16.27	11.03	1.10
Total bovines	14.14	3.92	11.24	10.14	-1.97	5.83	0.90
Sheep	2.81	-0.50	22.00	4.10	21.06	5.85	14.13
Goat	29.03	10.84	41.19	20.99	7.89	8.68	10.13
Pigs	18.18	32.69	46.38	26.73	5.47	-23.70	-11.65
Poultry	55.37	21.28	49.96	47.86	59.23	49.12	16.81
Total livestock	14.89	4.96	18.80	12.23	2.99	5.59	4.63

All the values in the table are percentages.

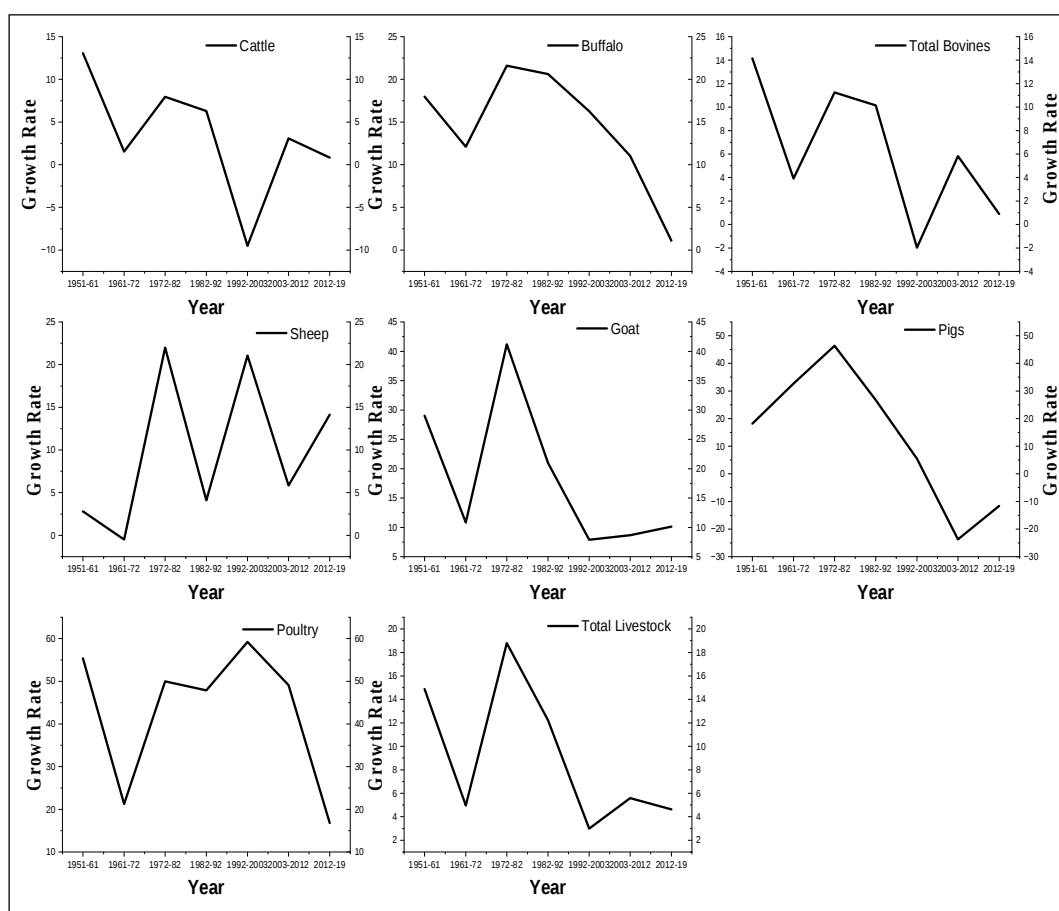


Fig 1: Livestock population growth in India from 1951-2019.

Table 4: Compound annual growth rates (CAGR) of export of livestock products from India (1991-2021).

CAGR (%)	Dairy	Poultry	Meat
1991-00	4.87*	-2.90	8.00**
2001-10	9.76	3.00*	7.29**
2011-21	2.15	-4.69*	-0.18
1991-2021	10.37**	12.11**	7.10**

** and * denote 1 and 5 % levels of significance, respectively.

Table 5: Instability indices of export of livestock products from India (1991-2021).

Instability index (%)	Dairy	Poultry	Meat
1991-00	81.65	107.47	18.19
2001-10	48.83	52.79	10.38
2011-21	57.43	17.53	12.67
1991-2021	68.11	86.77	30.39

Table 5 depicts the variability in livestock product exports from 1991 to 2021. Across all livestock categories, there was notable stability, ranging from 30.39% to 86.77% throughout the study duration. Examining specific commodities, dairy product exports experienced considerable instability, recording 81.65% during the 1991-2000 decade and 57.43% in the most recent decade (2011-

2021), with an overall instability of 68.11%, highlighting its volatile export nature. Poultry products exhibited the highest instability, at 86.77% over the entire study period. The post-globalization decade displayed the highest instability at 107.47%, which decreased notably to 52.79% from 2001-2010 and further reduced to 17.53% during the last decade, indicating a trend toward increased stability since 1991. Meat

exports showed relatively more stability compared to dairy and poultry, with a moderate range of instability at 30.39% during the study period. The 1991-2000 decade showcased 18.19% instability, followed by 12.67% in the last decade. Overall, the findings suggest that since the post-WTO period, livestock product exports from India have demonstrated instability.

CONCLUSION

Besides offering great potential and outstanding contribution in agricultural sector over the past years, livestock sector is performing well in the terms of production and exports. These findings collectively indicate the dynamic nature of livestock sector in India, with varying growth rates, production stability, population changes and export patterns across different livestock products. There are challenges and opportunities, such as the need to address fluctuations in wool production with focus on enhancing both its production and productivity. Along with generating income, livestock rearing also provide nutritional security and help the rural household to overcome poverty especially marginal and small farmers.

Future scope

Promoting livestock sector can break poverty-micronutrient malnutrition cycle, making animal-based foods a strategic intervention for vulnerable groups as policy options. Also, rapidly increasing population, increasing income levels and changing food habits are going to put continuous pressure on the demand for livestock products, thus a brief knowledge about the trends and development of the sector gives a broad view to the policymakers. This can be used as a potential opportunity for the rural people to enhance their livelihood incomes through greater participation in the livestock activities.

Conflict of interest

There is no conflict of interest.

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