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Livestock, Agricultural Growth and Poverty Alleviation

Pratap Singh Birthal

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NABARD Research and Policy Series No. 7/2022

पशुधन, कृषि विकास और गरीबी उन्मूलन
Livestock, Agricultural Growth and Poverty Alleviation

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Livestock, Agricultural Growth and Poverty Alleviation

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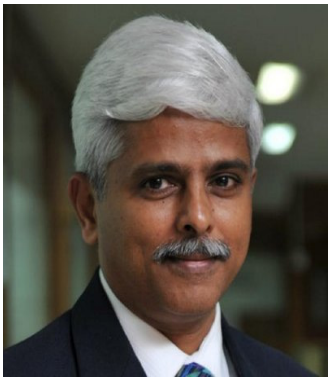
Foreword



There is a vast body of research available on topics related to agriculture and rural development in the academic world. But, most of it is in the technical realm and not in a form which could feed into the policy. Research must first lead to better understanding of a subject and then into a robust policy, wherever it can, so that it touches the multitude of Indians across the length and breadth of our country through better public policy & efficient services. Discussion with my colleagues on this issue lead to this new series "Research & Policy". We wish that this series will provide the breadth and depth of research into an area topped up by a lucid presentation for the policy makers.

I am happy to present the seventh publication in this series on "Livestock, Agricultural Growth and Poverty Alleviation" written by Dr. Pratap Singh Birthal, Professor and Acting Director, National Institute of Agricultural Economics and Policy Research, New Delhi.

I wish this new series acts as a bridge between the researchers & policy makers.

P. V. S. Suryakumar
Deputy Managing Director

Preface

Agriculture sector proved a silver lining in the pandemic period registering a positive growth in the covid times. Yet it faces various structural challenges to be addressed to make it profitable. For, most of the population is still dependent on the sector. As we all know, investing in research is one of the best strategies to address problems of agriculture. Equally important is to communicate the research findings to policy makers to design and tweak policies that matter. During one of our meetings with Shri P. V. S. Suryakumar, our DMD, we had loud thinking if we can commission a few review papers on select themes. We thought that it is appropriate to request veteran scholars who spent prime of their life on a given research theme to attempt such a work where they will distil their understanding and the research done on the theme in a short paper. Duly encouraged by DMD and former Chairman, we wrote to a dozen eminent scholars. And the response was overwhelming resulting in Department of Economic Analysis and Research (DEAR), the research wing of NABARD, initiating the 'Research and Policy' series. The motivation is, thus, to get a few handles from research that can help effective policy intervention. This series will be useful to policy makers and researchers alike.

The 'Research and Policy' series is an attempt to get a glimpse of hardcore research findings in a capsule form thereby making it more effective and communicative to policy makers. The group of researchers who agreed to prepare a review of research have spent their life in the field of agricultural research. Our purpose here, as we communicated to them, was not just to get literature survey but to get researcher's heart and their experience which they gained during their long passionate innings. The paper is expected to highlight various issues, policy relevance, prescription, and suggestion for future papers on the themes of interest to NABARD.

The livestock sector is crucial to the Indian economy as it accounts for one-third of the agriculture and allied sector's gross value addition. In addition to providing cheap and healthy food to millions of people, this sector provides a significant source of income, notably for landless, small and marginal farmers, and women. In view of this, the current paper on "Livestock, Agricultural Growth and Poverty Alleviation" written by Dr. Pratap Singh Birthal, Professor and Acting Director, National Institute

of Agricultural Economics and Policy Research, New Delhi, assumes importance. Dr. Birthal has an illustrious academic career, and his research interests include agricultural economics, livestock development policy, agri-food value chains and climate change impacts and adaptations.

The present paper aims to analyse the structural changes in India's livestock production system and tries to forecast opportunities in the domestic and global markets that can be leveraged to boost the income of millions of people dependent on this sector. It also emphasises how the livestock sector has emerged as an engine of agricultural growth, with disproportionately strong impacts on poverty reduction, family nutrition, and income gaps between men and women. The author highlights challenges being faced by the sector and identifies research and policy deficiencies that must be addressed immediately. Finally, the paper gives strategies for maximising the sector's unrealised potential for higher, more inclusive, and long-term agricultural growth. Overall, the paper provides readers food for thought.

In bringing this series as planned, we would like to express our sincere gratitude to Dr. G. R. Chintala, former Chairman, NABARD for his inspiring leadership, unstinted support and guidance. We also wish to express our sincere thanks to Shri P. V. S. Suryakumar, DMD, for being the inspiration and the driving force behind the publication of this first of its kind series. We are grateful to the authors of this series who agreed to write on themes relevant to NABARD in such a short period of time. Indeed, it has been a great privilege for us.

I also acknowledge the contributions of the officers of DEAR, NABARD especially Dr. Ashutosh Kumar, DGM; Mrs. Geeta Acharya, Manager; Ms. Neha Gupta, Vinay Jadhav, Assistant Managers, and others who coordinated with the authors and the editor to bring out the series as envisaged.

Thanks are due to Dr. J. Dennis Rajakumar, Director, EPWRF and his team for their contribution in copy editing and bringing uniformity to the document.

Hope this booklet and the series would interest all stakeholders.

K. J. Satyasai
Chief General Manager
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Acknowledgement

My sincere thanks to the Department of Economic Analysis and Research (DEAR) of National Bank for Agriculture and Rural Development (NABARD) for their financial support to undertake this work. I express my gratitude to Dr. K. J. Satyasai, Chief General Manager, DEAR, NABARD, for giving me this opportunity and the useful comments.

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Abbreviations

BQ	Black Quarter
DEAR	Department of Economic Analysis and Research
FMD	Foot-and-Mouth Disease
GVA	Gross Value Added
ILRI	International Livestock Research Institute
MMPO	Milk and Milk Products Order
NABARD	National Bank for Agriculture and Rural Development
NPK	Nitrogen, Phosphorous and Potassium
PPP	Public-Private Partnership
PPR	Peste des Petits Ruminant
VDC	Village Dairy Cooperative
WTO	World Trade Organisation

Executive Summary

Driven by the changes in the consumer preferences for animal-source foods, India has continued to experience a robust growth in its livestock sector. Between 2010-11 and 2019-20, gross value-added (GVA) from livestock sector grew at an unprecedented rate of 7.6% annually, which is comparable to the overall economic growth but twice the agricultural growth rate and five times the growth rate recorded in the dominant crop sector. In fact, the livestock sector has emerged as an engine of agricultural growth, raising its share close to 30% in the agricultural GVA.

The distribution of livestock resources is more egalitarian than that of land, and thus the growth in the livestock sector is more pro-poor; at a similar rate of growth, the livestock sector has a 1.4 times larger impact on poverty reduction than does the crop sector. The ownership of livestock, unlike land, is not bounded by any property rights, and in an agrarian society where the land rights are biased towards males, women can acquire livestock with a small startup capital and multiply them effortlessly through reproduction to upscale the herd. And, when women have control over livestock resources and incomes, they tend to allocate a large share of the household budget to the children's nutrition, health and education. In India, the primary livestock production engages about 8% of the agricultural workforce, and more than 70% of it are women.

Despite such a significant role in socio-economic development, the livestock sector in India has remained understudied because of paucity of public data on several of its aspects, especially on the use of inputs, cost of production, marketing and prices of outputs and inputs, and adoption of technologies related to animal breeding, nutrition and health. Nonetheless, the macroeconomic indicators point towards the existence of huge regional differences in livestock development and its supporting infrastructures and institutions. In states like Punjab, Haryana, Gujarat, Maharashtra, Tamil Nadu and Karnataka, the livestock production systems are relatively more productive and commercialised, while in most other states, especially in eastern and north-eastern regions, they are primarily subsistence-oriented. For instance, the milk yield of a cow or buffalo in Punjab and Haryana is much larger than that in other states. So is the adoption of crossbreeding technology and input use.

Nevertheless, the available evidences on the performance of the livestock sector and its social and economic implications suggest that there exists a considerable scope to exploit the untapped potential of livestock for higher, sustainable and inclusive agricultural growth in the lagging as well as advanced states through designing comprehensive livestock development strategies and their effective implementation. A few of these are as follows.

- **Optimise the livestock population:** India has a huge population of different livestock species but limited natural resources to adequately support it. The debate on the surplus cattle that started in the 1970s remains inconclusive because of the conflicting agricultural development policies. A typical example is of agricultural mechanisation vis-à-vis draught animal power. The mechanisation has rendered the male cattle and buffaloes redundant as a source of draught power, while the slaughtering of surplus cattle is banned except in a few states. The exports of live cattle and beef are also banned. Given such a situation, it becomes imperative to assess the livestock carrying capacity of the natural resources (land and water) in different agro-climatic regions, and accordingly evolve breeding policies with due consideration of the technological changes happening in animal science (sexed semen and embryo transfer technologies, and nutrition-enhancement technologies), crop science (high-yielding fodder seeds) and lifecycle productivity of different animal breeds.

- **Enhance and prioritise the public spending on livestock:** Livestock sector has remained underinvested. In the past two decades, its share in the agricultural spending has hardly ever exceeded 5%. The economic and social payoffs of the public spending on livestock development are likely to be larger than the spending on other sub-sectors of agriculture. Sustaining rapid growth in the livestock sector is, thus, dependent upon the extent of the resources that the livestock sector receives. Further, it is equally important to correct imbalances in the allocation of resources within the livestock sector. Generally, in the lagging states the activities that are basic to the animal husbandry need a greater focus in the livestock development agenda. These include the feed and fodder supplies, availability of water, extension services and mechanisms to protect livestock against diseases and climate

risks. In the advanced states, the emphasis should be on the activities that, one, sustain productivity growth such as breeding and veterinary services and animal science research, and, two, enhance competitiveness of livestock products in the global market through food safety standards, tariffs and export subsidies.

- **Improve the supply of feeds and fodders:** The scarcity of feeds and fodders remains a major challenge in improving livestock productivity. In mixed farming systems, the crop residues comprise the largest component of feed (on dry matter basis), but these are low in their nutritive values and cannot support the levels of high production. The supply of roughages (green fodders) and concentrates is grossly inadequate. There are several ways of augmenting the feed supplies: (i) allocate more area to high-yielding green fodder crops, (ii) better manage common grazing lands and pastures, (iii) promote processing, storage and trade in dry fodder, (iv) address problems of micronutrients deficiencies, and (v) promote feed-enriching technologies such as urea treatment of straws, urea molasses mineral blocks and bypass protein that have the potential to improve palatability of dry fodders and roughages.

- **Improve the delivery of livestock services:** The population-driven growth will create pressures not only on the natural resources but also on the livestock service delivery systems. Currently, most livestock services are in the public domain, and their delivery to livestock producers remains poor. This is reflected in the low conception rate through artificial insemination and frequent outbreaks of diseases. In case of animal breeding, there is a need to improve the collection and storage of quality semen, and to ensure its timely delivery. The emphasis should be on the improvement of indigenous breeds of cattle, buffaloes and small ruminants that are more resilient to diseases and climate change.

  The disease reporting and surveillance systems in the country remain weak. In view of the emerging zoonotic diseases, the need for improving the efficiency of the reporting and surveillance systems cannot be undermined. At the local level, the emphasis should be on evolving cost-effective disease management strategies. Towards this, a two-pronged strategy encompassing organisation of animal health campaigns for diagnosis and treatment of diseases, and

door-step delivery of veterinary services through the mobile dispensaries will be useful. Greater emphasis should be on preventive treatment.

There is also a need to improve the animal breeding and health infrastructures and veterinary manpower in the lagging states.

- **Invest more in the animal science research and extension systems:** Research and its dissemination are crucial for sustainable livestock production. Yet, both of these remain underinvested, and also the linkages between the two are weak. In fact, the livestock extension system is extremely poor, while the farmers need information on several aspects of livestock production, ranging from animal breeding, health and nutrition, credit, markets, prices, international trade, and food safety regulations. It is, therefore, essential to evolve a livestock extension system and strengthen its linkages with the research system.

- **Enhance the flow of short-term credit:** Animal husbandry has remained neglected in the provision of institutional credit. The credit to animal husbandry is treated as an investment credit and often advanced against tangible collateral, for the purchase of animals and construction of cattle sheds. The poor can acquire animals through initial financial support and also scale up their herd through reproduction, but they also need short-term credit to meet the operational expenses towards inputs like feeds, fodders and medicines. The recent initiative of providing Kisan credit cards for animal husbandry is expected to expedite the flow of short-term credit.

- **Improve the coverage of livestock insurance:** Livestock are vulnerable to several diseases, and on occasions, these cause huge morbidity and mortality losses. Climate change has also emerged as a big threat to sustainable livestock production. To protect livestock and livestock-based livelihoods from diseases and climate risks, there is a need to evolve farmer-friendly models of livestock insurance.

- **Strengthen markets and value chains:** Except for the poultry and to some extent milk, the markets for livestock products are in the domain of the informal sector. Markets for live animals are weak and lack basic infrastructure and amenities. Slaughtering facilities are also inadequate.

Although the dairy cooperatives have played an important role in improving farmers' access to markets, their outreach is highly asymmetrical across states. For instance, Gujarat and Karnataka together account for 60% of the total milk procurement. Eastern and north-eastern states have been bypassed by the cooperatives. Access to markets is essential to kick-start the development process in the lagging states.

Although there is a fair understanding of the value chains of main livestock products, there is a lack of information on value chains of their by-products like dung, hides and skins. Mapping value chains of products and by-products, and knowing their efficiency and inclusiveness are essential to the targeting of efforts and investment. Issues related to food safety need greater attention.

Importantly, the price mechanisms of live animals and their products have not received much attention in academic research and public policy. For instance, the milk is priced using the two-axis formula, namely, the fat and solid non-fat in it, but without any consideration of its cost of production. Prices of adult female bovines are decided based on their age, lactation order, yield, colour, appearance and sex of offspring, but it is done arbitrarily. It is, therefore, imperative to create a level playing field for buyers and sellers by evolving suitable mechanisms for price discovery and pricing of live animals and their products and by-products.

- **Improve the livestock statistics:** Good statistics is essential for good economics and policy research. Livestock statistics, however, is poor. Hardly any statistical information is available on the consumption of feed and other inputs, cost of production and flow of returns, and the adoption of technologies and their impacts. Such information is crucial for knowing the comparative advantage in production and export competitiveness. An institutional setup needs to be established for the collection, compilation, collation and distribution of livestock data.

Livestock, Agricultural Growth and Poverty Alleviation

1. Introduction

Livestock are multifunctional. Through their food and non-food functions, they make significant contributions towards improving the sustainability of agriculture, farm incomes, nutrition and human health, and reducing rural poverty (Livestock in Development 1999; Otte *et al.* 2012). They produce nutrient-rich foods such as milk, meat and eggs, and provide draught services for agricultural operations and rural transportation and dung for use as manure and bio-fuel for domestic purposes. Besides, they assume the function of a financial institution – a living bank with offspring as an interest and insurance during economic crisis.

Nevertheless, there is considerable context specificity in the functions that different livestock species perform. The utility of different functions is determined and influenced by a host of geographical, environmental, socio-cultural, religious, economic, institutional, regulatory, technological and policy factors. Overall, the relative utility of different functions of the livestock depends upon the stage of economic development of the societies and states. Often, their non-food production functions degenerate with the modernisation of agriculture and the socio-economic progress of the agrarian societies. For instance, the modernisation of agriculture is associated with the substitution of draught animal energy by the mechanical and electrical energy and the dung-manure by the chemical fertilizers. Transformations of the agrarian structure also influence the relative utility of the livestock's functions. Over the past five decades, India's agrarian structure has undergone a significant change in terms of size and distribution of landholdings and cropping system intensification (Rajakumar *et al.* 2021). Between 1970-71 and 2015-16, the average landholding size shrunk to half, from 2.28 hectares to 1.08 hectares. During this period, the number of marginal land holdings (less than or equal to one hectare) proliferated, raising their share to 68.5% in the total landholdings in 2015-16 from 50.6% in 1970-71. It is, therefore, inconceivable that such households can afford to own and maintain a pair of bullocks exclusively for the agricultural operations and transportation of agricultural commodities. On the other hand, the large farm households have been increasingly switching over to the inanimate sources of energy to

ensure the timeliness of agricultural operations. Thus, on both the small and large farms, the mechanisation has become inevitable. Furthermore, the development of formal financial institutions for credit and insurance and their expanding outreach in rural areas have rendered the livestock less relevant as a 'store of capital and means of risk management'.

Livestock are now valued more for their food production function. Over time, the sustained rise in per capita income, growing population accompanied by strong urbanisation trends and increasing participation of women in the workforce, improvements in supply chain infrastructure and logistics, and rise of supermarkets have led to a significant transformation in the food consumption pattern in favour of high-value nutrient-rich foods of plant and animal origin (Rao and Birthal 2008; Kumar and Joshi 2016). On the supply side, the food systems have responded positively to these signals, producing more such foods to meet their growing demand. For instance, the milk production, which had rarely exceeded 30 million tons (mt) during the 1970s, has gradually increased to 188 mt in 2018-19. Compared to that of staple food grains, the consumption of animal-source foods is more responsive to income and price changes (Kumar *et al.* 2011); and hence, their demand is expected to increase faster with an increase in the household income and an improvement in its distribution. Projections suggest significant growth in the future demand for animal-source foods even under a business-as-usual scenario (Hamshere *et al.* 2014; Kumar and Joshi 2016).

Expanding demand for animal-source foods offers a plausible pathway for the land- and capital-constrained smallholder farmers to improve their livelihood and nutrition status, and to escape the low-income poverty traps through the livestock route. For such households, the agriculture alone is not the sole source of income (Birthal *et al.* 2014), and quite often, they supplement their crop income with the earnings from other activities, including animal farming and off-farm employment. In fact, with the farm size shrinking, the Indian farm households have been increasingly diversifying their income portfolios towards such activities. The share of non-cropping activities in the total household income is estimated to have increased to 63% in 2018-19 from 53% in 2012-13.

Livestock have some unique biological and economic characteristics that bestow upon them a high potential to contribute to socio-economic and human development.

First, the animals are a natural reproducible asset, and can be effortlessly multiplied by the poor households to improve upon their capital stock or scale of production and inter-temporal cash flows by selling livestock and their products. Second, they produce nutrient-rich foods, regularly or at shorter intervals, which can be consumed within the owning households to improve the nutrition status and sold for cash to purchase daily consumption needs and meet other household expenditures like the school fees, medical expenses and repayment of debt. Third, the animal husbandry is labour-intensive, and smallholders have sufficient labour of low opportunity cost within their households. Fourth, in the mixed farming systems, the energy requirement of animals is mostly met from the crop residues and by-products and grazing on common lands and harvested fields. And, finally, the livestock by providing dung manure contribute towards improving soil fertility, organic carbon and microbial activities that ultimately lead to sustainable improvements in agricultural productivity and farm income. All these characteristics indicate that smallholder farmers have a comparative advantage in livestock production over large farmers. These characteristics closely match the resource endowments and cash flow requirements of smallholder farmers, and hence, render animal husbandry a self-perpetuating source of nutritional security, income growth and poverty reduction.

Nevertheless, there are apprehensions regarding the capabilities of smallholder farmers in exploiting the pro-poor potential of livestock (Chen *et al.* 2015; Ramdas 2015, 2018). Although small farms in the mixed farming systems appear more efficient in production even under low-input conditions, their lack of access to technologies, markets, finances and support services may put them at a disadvantage in the marketplace vis-à-vis commercial farms (Chen *et al.* 2015). Besides, the growing consumer concerns for the safe and hygienic food, and consequently the stringent food safety standards and regulations in international as well as domestic markets create a disincentive for smallholders to scale up their production activities. The possibility that the expanding markets for animal-source foods may trigger the development of commercialisation of livestock production cannot be ignored. For instance, in the case of poultry production in India, about 63% of the poultry birds (broilers and layers) are raised on commercial farms (Government of India 2020a).

The livestock economy of India is huge, dynamic and resilient. In 2019-20, different livestock species dispensed products and by-products worth Rs. 5,777

billion (at 2011-12 prices), which equalled 4.5% of overall gross value added (GVA) and 29.4% of agricultural GVA. Notably, the livestock economy experienced an all-time high growth of 7.6% during 2010-11 to 2019-20, which is comparable to the overall economic growth, and twice the growth rate of GVA in agriculture. In fact, during this period, the livestock sector emerged as an engine of agricultural growth. Nevertheless, the apprehension that the smallholder livestock production systems may come under the adjustment pressure of changing rules of the game in domestic and international markets remains. Sustaining such a high rate of growth is likely to compel smallholder farmers to rely more on improved technologies, quality inputs and support services, to invest in on-farm infrastructures, and to establish strong linkages with the value chain actors to improve their access to remunerative markets. Without any facilitation, it would be challenging for them to adjust their production systems to the emerging market and non-market forces. Hence, the extent to which the smallholder farmers would participate in the expanding market of animal-source foods would be contingent upon how the governments, livestock-based industries and financial institutions facilitate the adjustment process through appropriate policies, investment, institutions and regulations.

This study begins with looking into the opportunities for the growth of the livestock sector through the lens of consumer preferences and future demand for animal-source foods. Section 3 discusses the recent structural changes in India's livestock production systems, and section 4 examines their contributions to the growth of the agricultural sector and farmers' income. The role of livestock in improving rural income distribution and reducing poverty is discussed in section 5, and towards reducing gender disparities and improving human capital in section 6. Section 7 discusses the negative and positive externalities associated with its synergistic relationship with crop production. The challenges to the livestock development are discussed in section 8. Section 9 identifies the research and policy gap, followed by a discussion on the strategies that can sustain the current trends in the livestock sector. The paper ends by presenting certain concluding remarks.

2. Opportunities for Livestock Sector Growth

Multifunctionality of livestock is an opportunity as well as a challenge in exploiting their potential for higher, sustainable and inclusive growth, improving food and nutrition security and human health, reducing poverty and gender disparities,

and enhancing ecosystem services. Nevertheless, a gradual shift in their functions in favour of food production offers a significant opportunity for smallholder farmers to improve upon their income and livelihood and escape from poverty through the livestock route. In this section, we examine the past trends in food consumption patterns in India and also prospects for future growth in the demand for animal-source foods in the domestic as well as international markets.

2.1 Domestic Market for Animal-Source Foods

Over the past three decades, the Indian economy has experienced robust and sustainable growth. It was accompanied by strong urbanisation trends, and liberalisation of domestic markets for private investment in agri-food marketing systems, rural infrastructure, agro-processing and supply chain logistics. Since 1990-91, the economy has been growing at an annual rate of around 7%. The urban population has grown at a rate of 2.64% compared to the total population growth rate of 1.57%. At present, more than one-third of the country's population lives in cities and towns.

Influenced by these factors, there has been a gradual shift in India's food basket away from the staple cereals to the high-value commodities of both plant and animal origin. Table 1 shows the changes that have taken place in the consumption pattern over the past two decades. Between 1993-94 and 2011-12, the per capita urban consumption of milk and milk products increased by 10%, eggs by 13%, and meat and fish by 25%. In rural areas too, the consumption of milk and milk products, and meat and fish increased almost at a similar rate. However, the rural consumption of eggs increased at a much faster rate.

Table 1: Per Capita Food Consumption in India During 1993-94 to 2011-12

(Kg/Month)

Product	Rural			Urban		
	1993-94	2011-12	% Change	1993-94	2011-12	% Change
Cereals	13.4	11.2	-19.6	10.6	9.3	-12.3
Pulses	0.8	0.7	-14.3	0.9	0.8	-11.1
Edible oils	0.4	0.7	42.9	0.6	0.9	50.0
Sugar	0.8	0.8	0.0	1.0	0.9	-10.0
Fruits, vegetables & nuts	5.8	5.9	1.7	10.1	9.0	-10.9
Milk & milk products	4.0	4.4	9.1	5.0	5.5	10.0
Eggs (no.)	0.6	1.1	45.5	1.5	1.7	13.3
Meat, fish etc.	0.3	0.4	25.0	0.4	0.5	25.0

Source: Kumar and Joshi (2016).

Milk is the most preferred animal-source food in India. It is consumed regularly as raw or its value-added products such as ghee, butter and curd. Meat, eggs and fish are consumed occasionally (Kumar and Birthal 2004) and in lower quantities. The per capita consumption of food grains including cereals and pulses declined in both urban and rural areas; the decline being more in the rural areas.

The differences in the consumption levels of animal-source foods along the rural and urban landscapes and the economic strata could be due to several economic, socio-cultural and religious factors. More than one-fifth of India's population is poor, living on less than US$ 1.9 per day, who cannot afford to include the costlier nutrient-rich foods in their regular diets. Further, the majority Hindu population avoids consuming non-vegetarian foods due to religious sentiments.

Nevertheless, as compared to the staple food grains, the consumption of animal-source foods is more responsive to the income and price changes (Kumar and Birthal 2004; Kumar *et al.* 2011). Kumar *et al.* (2011) estimated an expenditure elasticity of 0.43 for milk and 0.67 for non-milk animal-source foods, which is significantly larger than for the plant-based foods including high-value fruits and vegetables. Furthermore, they have also estimated expenditure elasticity of animal-source foods for the rural and urban, and the poor and rich consumers (Kumar *et al.* 2011), and found it larger for the rural and poor consumers. Kumar and Birthal (2004) and Kumar and Joshi (2016) have reported that although the level of consumption of animal-source foods is low among the poor households, their consumption has increased faster for them than for the rich households. This means that as their incomes increase, the poor and rural consumers will spend more of their food budgets on nutrient-rich animal-source foods.

The economic and demographic factors underlying the changes in the food basket have been quite robust in the recent past, and these are unlikely to subside in the foreseeable future. By 2050, India's population is likely to cross the 1.6 billion mark with approximately half of them living in cities and towns. Importantly, they will be more affluent than ever. This implies a faster increase in the future demand for animal-source foods. The projections indicate that if the past economic and demographic trends were to continue, in the immediate future, that is, by 2030, the demand for milk will increase to 185 mt, meat to 9.3 mt, eggs to 5.8 mt, and fish to 11.2 mt (Table 2). Their demand will be higher if the per capita income were to grow

Table 2: Demand for Livestock Products in 2030

(In Million Tons)

Product	2011-12	2030	% Increase
Milk	112	185	65.2
Meat	5.3	9.3	75.5
Eggs	3.5	5.8	65.7
Fish	6.4	11.2	75.0

Source: Kumar and Joshi (2016).

at a faster rate. In the long run, the demand for animal-source foods will be large. Hamshere *et al.* (2014) have shown that even under the business-as-usual scenario, India's demand for animal-source foods in 2050 will be more than double that in 2009, and larger than the demand for other food commodities including fruits and vegetables.

2.2 Global Market for Animal-Source Foods and International Trade

The global market for animal-source foods has also been expanding fast. The per capita consumption of all types of animal-source foods has increased throughout the world, more so, at a faster rate in the developing and emerging economies of Asia and South America (Table 3). This is an opportunity for India to explore the possibilities of exporting animal-source foods. Currently, India is not a significant player in the international trade of animal-source foods – its share is less than 1% in global dairy exports and 3% in global meat exports.

India's livestock exports comprise mainly of bovine meat, that is, buffalo meat or carabeef[1]. Carabeef accounts for over 85% of the total export earnings from livestock and livestock products. In 2018-19, India exported an average of 1.1 mt of carabeef a

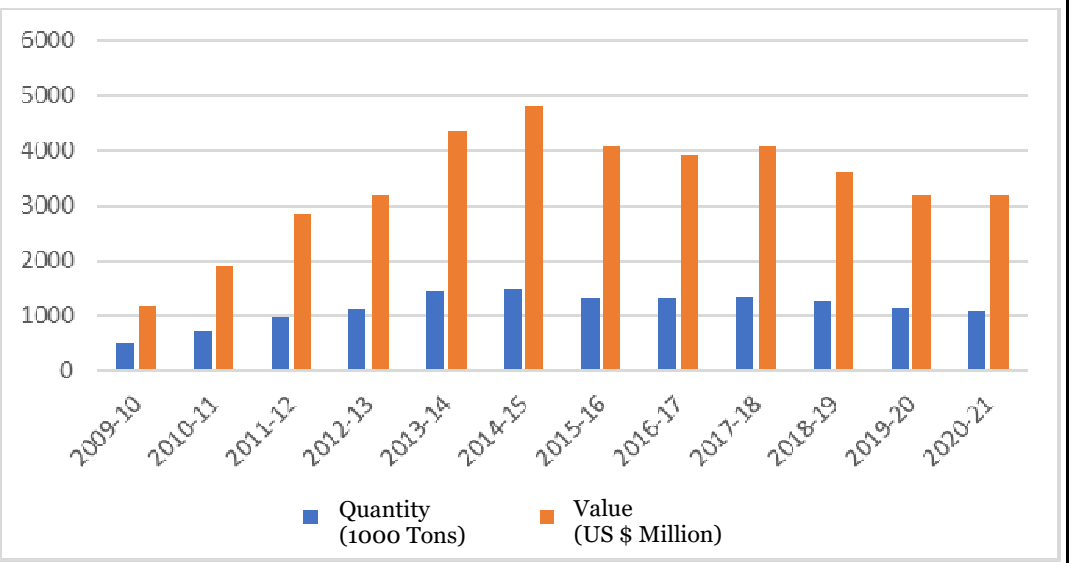
Table 3: Global Consumption of Animal Food Products

(Kg/Capita/Annum)

Region	Milk		Meat		Eggs	
	2001	2018	2001	2018	2001	2018
World	78.82	95.12	37.23	42.87	8.12	9.68
Africa	38.51	33.2	15.27	17.83	2.14	2.36
North America	254.70	298.74	119.00	115.11	14.34	16.09
South America	115.81	129.06	65.65	78.38	7.01	11.08
Asia	41.39	66.50	24.59	32.61	7.93	10.08
Europe	209.75	286.70	71.14	76.19	12.33	13.01
Oceania	183.11	270.40	101.23	103.94	6.23	8.46

Source: FAO-FAOSTAT (https://www.fao.org/faostat/en/#data).

Figure 1: Trends in Buffalo Meat Exports



Source: Agricultural and Processed Food Products Export Development Authority, Government of India (https://apeda.gov.in/apedawebsite).

year, valued at US$ 3918 million (Figure 1), which is equal to 7% of the total exports of agricultural commodities. India exports over 70% of its carabeef production. With a share of approximately 8% in the global bovine meat exports, India is the third-largest exporter after Brazil and the United States. India's main export destinations are Vietnam, Malaysia, Hong Kong, Egypt, Indonesia, Iraq, Saudi Arabia, Philippines, United Arab Emirates and Oman. These countries together account for 85% of India's exports of carabeef.

Several factors have contributed to the rise of India as one of the largest exporters of bovine meat (Landes *et al.* 2016). One, until recently the Southeast Asian countries, which are now the main importers of carabeef from India, had relied on the European Union for sourcing their domestic demand for bovine meat, that is, beef. However, under the pressure of World Trade Organisation (WTO), the European countries were compelled to reduce subsidy support for the production and export of beef, leading to a rise in the cost of beef production and its price. On the contrary, the international prices of carabeef have always been much lower than that of beef. Two, carabeef is as lean as beef, and it blends well with other value-added products. These factors attracted several of the poor Southeast Asian countries to diversify their import

sources of bovine meat, with India emerging as the main source. Three, India is closer to most of its export destinations; hence, lower cost of transportation. Four, India has bilateral trade agreements with several Southeast Asian countries that facilitated easy access to markets in these countries (Mandal and Sirohi 2018). And, five, India also exports carabeef to the Middle-east Islamic countries that have a preference for *halal* meat, and India has the capacity to produce and supply *halal* meat. Notably, the Middle East countries have also a sizeable number of Indian migrants.

India has considerable potential to export carabeef beyond the Southeast Asia and Middle East, on account of several factors other than its price competitiveness in the international market. The carabeef is low in fat and cholesterol and is free from radiation. India does not use hormones, antibiotics and chemicals for fattening animals and in manufacturing of meat and meat products. On the supply side, India utilises mainly male buffaloes for meat manufacturing. The utility of male buffaloes as a source of draught power has declined considerably, and unlike cattle, there are no religious sentiments attached to the use of buffalo for meat production. However, the main barriers in exploiting the potential of buffaloes for meat production are the lack of incentives for farmers to raise buffalo calves to optimum slaughter age[2], and the poor institutional arrangements, like contract farming, that link farmers to the actors, such as traders, processors and exporters, in the downstream the meat value chains.

India's exports of dairy products are also competitive in the international market (Landes *et al.* 2017). The country now appears to be having surplus milk, and it is also competitive in production compared to the major dairy products exporters. The need is to process the surplus milk into value-added products conforming to the quality standards prevalent in the international market. Buffalo milk is considered ideal for manufacturing mozzarella cheese, which is high in demand in the international food market.

3. Structural Changes in Livestock Production Systems

3.1 Livestock Resources

India has a huge livestock population, comprising diverse species. In 2019, it housed 193 million cattle, 110 million buffaloes, 149 million goats, 74 million sheep, 9 million pigs and 885 million poultry birds (Table 4). The demography of livestock,

Table 4: Livestock Population in India

(In Million)

Year	Cattle	Buffa-loes	Sheep	Goats	Horses & Ponies	Camels	Pigs	Mules	Don-keys	Yaks	Poul-try
1992	204.6 (7.4)	84.2	50.8 (4.7)	115.3	0.82	1.03	12.8 (14.5)	0.19	0.97	0.06	307.1 (32.8)
2003	185.2	97.9	61.5	124.4	0.75	0.63	13.5	0.18	0.65	0.06	489.0
2012	190.9	108.7	65.1	135.2	0.63	0.40	10.3	0.20	0.32	0.08	729.2
2019	193.5 (26.5)	109.9	74.3 (5.5)	148.9	0.34	0.25	9.1 (21.0)	0.08	0.12	0.06	885.2 (62.8)

Note: Figures in parentheses are as percentage to crossbred or improved population.
Source: Government of India, *Livestock Census*, Various Issues.

however, has undergone a gradual change in terms of the relative abundance of species and their economic and social functions. Between 2003 and 2019, the population of cattle, buffaloes and small ruminants (goats and sheep) increased, while that of pigs, horses and ponies, mules, donkeys and camels declined considerably. Notably, the increase in the population of cattle and buffalo was driven by an increase in the number of their females, with a simultaneous decline in the number of their males. During this period, the poultry population grew exponentially and almost doubled.

Several factors contributed to the demographic shift in the livestock population. On the supply side, the shrinking landholding size, the intensification and mechanisation of agriculture, and the development of modern means of transportation rendered the males of both cattle and buffalo less relevant as a source of draught power. The average size of landholding in India has declined drastically, from 2.8 hectares in 1970-71 to 1.08 hectares in 2015-16 (Rajakumar *et al.* 2021). Birthal and Taneja (2006) have noted a significant increase in the tractor density, a concomitant decline in the density of draught animals. It is important to note that the indigenous cow in India has traditionally been valued more for breeding males for the use as a source of draught power for agricultural operations, and milk as an adjunct. On the other hand, the ever-expanding market for animal-source foods has strengthened its utility as a source of nutritious food.

Urbanisation is considered an important driver of demand for animal-source foods, however, the growing urbanisation has not caused any major shift in livestock production closer to the demand centres, that is, cities and towns because of the lower cost of trade. Currently, approximately 4.5% of the bovines (cattle and buffaloes), 4.3% of goats, 2.7% of sheep, 9.7% of pigs and 4.7% of poultry birds are raised in urban or

Table 5: Trend in Urban Livestock Population

Species	1992		2019	
	Urban (million)	% Share in Total	Urban (million)	% Share in Total
Cattle	8.70	4.3	8.19	4.2
Buffalo	4.29	5.1	5.02	4.6
Sheep	1.92	3.8	2.03	2.7
Goat	5.92	5.1	6.44	4.3
Pig	1.54	12.0	0.88	9.7
Poultry	24.40	8.0	39.61	4.7

Source: Government of India, *Livestock Census*, Various Issues.

peri-urban areas (Table 5). Thus, the share of urban livestock has not changed much over the years, despite the faster pace of urbanisation.

The constricted growth of urban livestock production systems is ostensibly due to the land constraint on animal housing and fodder production, and scarcity of labour. Higher land prices and wages raise the cost of livestock production in or around urban areas. Thus, the advantage of lower trade costs due to the urban proximity is eroded by the higher cost of animal maintenance and production.

A notable development that has taken place in India's livestock production systems is the introduction of high-merit exotic germplasm for artificial insemination of the low-producing indigenous cows. Although the efforts towards crossbreeding of cows are traced in the first half of the 20th century, these could not succeed due to the non-adaptability of the exotic/crossbred animals to India's tropical climate, and also their greater requirements of feeds, fodders, health care and management. However, the growing domestic demand for animal-source foods compelled a re-look into this issue, and the concerted efforts to promote crossbreeding technology were made during the 1960s and 1970s. Since then, the animal breeding research has evolved several crossbred strains of cattle, sheep, pigs and poultry.

The share of crossbreds in the total cattle population increased more than three-fold, from 7.4% in 1992 to 26.5% in 2019. The share of crossbreds of sheep and pigs too increased. In 2019, approximately 5.5% of the sheep and 21% of the pigs were crossbreds. Notably, there has been a drastic genetic shift in the poultry; the high-yielding commercial poultry birds now comprise over 63% of the total poultry population.

Table 6: Share of Crossbreds in Rural and Urban Livestock Population, 2019
(As Percentage to the Respective Population)

Species	Rural	Urban	Total
Cattle	25.8	44.1	26.5
Sheep	5.4	7.9	5.5
Pig	20.0	30.7	21.0

Source: Government of India, *Livestock Census*, Various Issues.

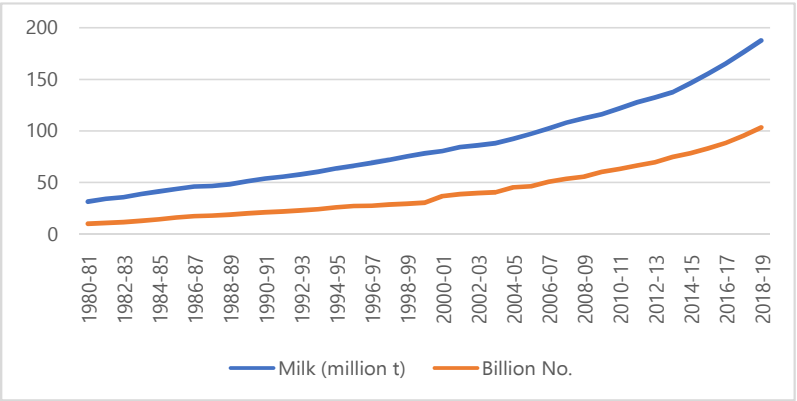
Nonetheless, a technological dualism persists. The crossbreds have a larger share in the urban livestock, ostensibly due to its commercial orientation (Table 6). In the urban areas, 44% of the cattle are crossbreds compared to 26% in the rural areas. There are also significant regional disparities in the adoption of crossbreeding technology. The share of crossbred cattle in the total cattle population is much higher in Kerala, Punjab and Tamil Nadu, compared to that in Assam, Chhattisgarh, Madhya Pradesh and Jharkhand (Appendix Table 1).

The crossbreds are not high-yielding in themselves. For better performance, they require quality feeds and fodders, and better housing, health care and management than do their indigenous counterparts. These are also more vulnerable to diseases and climatic stresses. In this context, Thomas *et al.* (2002) have argued that the indiscriminate introduction of crossbreeding technology in developing countries without due consideration of its suitability to the ecological conditions, and the requirements of support services (breeding and veterinary services) may not yield the desired outcomes, that is, higher milk yield and carcass weight. On analyzing the adoption of crossbreeding technology along the ecological landscape, Kumar and Singh (2008) have reported its higher adoption in favorable ecological conditions. Further, in the case of cows, the crossbreds have fewer lactations compared to the indigenous cows, which means that despite their higher yield the lifecycle productivity of crossbreds could be lower than that of indigenous species. This is, however, a matter of empirical investigation.

3.2 Livestock Production

Table 7 shows the trends in the production of animal-source foods. In the past five decades, the milk production increased tremendously from around 20 mt in the 1960s to 188 mt in 2018-19 (Figure 2). It may be noted that India's milk production surpassed that of the US in 1997, and since then, India has been the largest producer of milk in the world.

Figure 2: Trends in Milk and Egg Production in India



Source: Government of India (2020a).

Table 7: Livestock Production in India

(In Million Tons)

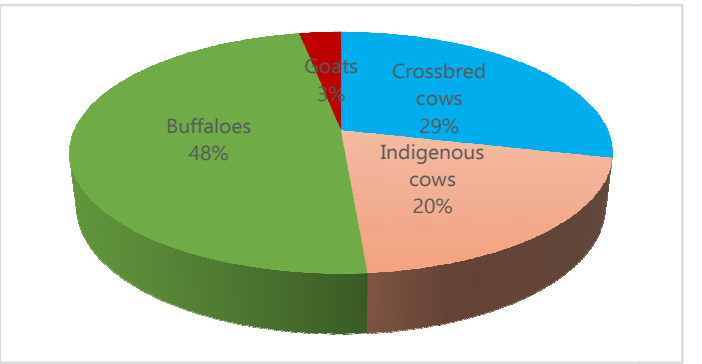
Year	Milk	Total Meat	Poultry Meat	Eggs (Billion Numbers)
1992-93	58.0	3.9	0.5	22.0
2002-03	86.2	4.7	1.1	39.8
2012-13	132.4	6.3	2.3	69.7
2018-19	187.7	8.1	3.8	103.3

Source: Government of India (2020a).

Figure 3 shows the contribution of different dairy species to the total milk production. The buffaloes contribute 48% to the total milk output, followed by the crossbred cows (29%) and the indigenous cows (20%). The share of the goat is estimated at about 3%. Notably, the share of crossbred cows in the total milk output has increased considerably. Many non-bovine species (sheep, camel, donkey and horse) also produce milk for human consumption, but their contributions have remained unquantified and also less appreciated in food consumption patterns. Nonetheless, it is worth mentioning here that their milk has several nutraceutical and therapeutic properties, which can be exploited for improving the nutrition status and health of the people.

The revolutionary progress in the dairy sector is often termed as the White Revolution, and in the development literature, it is as celebrated as the Green Revolution. The White Revolution was powered by the institution of cooperatives – a

Figure 3: Share of Different Species in Milk Production, 2019-20 (In %)



Source: Government of India (2020a).

three-tier structure with village dairy cooperatives (VDCs) at the bottom, federated as milk union at the district level and a federation of milk unions at the state level – that link rural dairy producers to urban markets. Over time, the number of VDCs has increased significantly from a little over 13,000 in 1980-81 to 1.41 lakh in 2012-13 and further to 1.91 lakh in 2018-19. Viewed differently, the dairy farmers in about 30% of the Indian villages have access to cooperatives for the disposal of milk. The quantum of milk procured by the VDCs also increased substantially from less than one mt in 1982-83 to 9.6 mt in 2012-13 and further to 18.5 mt in 2018-19, equalling to about 10% of the total milk production.

Until the late 1990s, the dairy cooperatives flourished in a protectionist environment. These were supported by the central and state governments through concessional finances, grants, subsidies and tax incentives. Besides, these were protected from the internal and external market competition. The dairy industry was protected from the cheap imports of dairy products through higher import tariffs. The competition in the domestic market was circumvented through a regulation 'Milk and Milk Products Order (MMPO)' that made the entry of private processors conditional upon developing their milk sheds and without encroaching upon the milk sheds of existing processors, including dairy cooperatives. However, with the economic liberalisation process starting in 1991, the dairy industry has gradually been deregulated to allow private investment in processing and value chain development. The private sector now procures as much milk as do the cooperatives (Birthal *et al.*

2016; Landes *et al.* 2017). The rural dairy producers retain almost half of the milk produced for consumption within the households, and the rest is sold in the market. The cooperatives and private processors together procure somewhere between 20% and 25% of the total milk production or 40%-50% of the marketed surplus. The rest of the milk is traded in the informal market, comprising milk vendors, sweet-makers and local consumers.

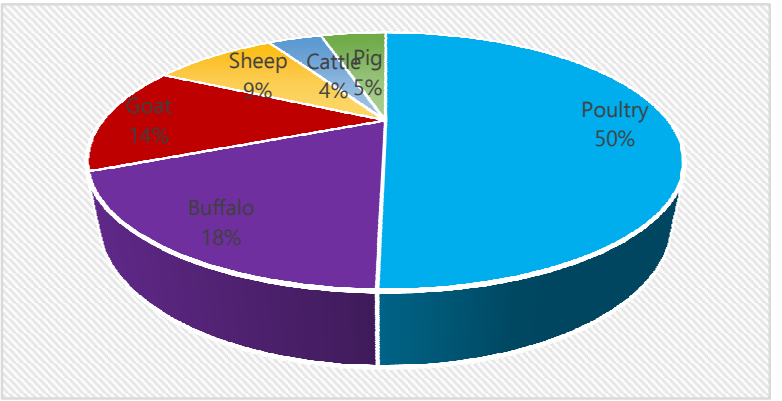
The outreach of the dairy cooperatives, however, has remained highly asymmetrical across states. In 2018-19, of the total milk procured by the dairy cooperatives, about 45% came from Gujarat and 15% from Karnataka, and thus these two states alone accounted for about 60% of the total. The eastern and northeastern states have been bypassed by the cooperatives. Together, these states contribute only 5.5% of the total milk procurement. The private investment in the dairy industry is also concentrated in advanced states like Punjab, Haryana and Maharashtra that have a greater production potential (Landes 2017; Birthal 2016). Such an unequal spread of the marketing and processing infrastructure calls for identifying factors, including production system characteristics, infrastructure, institutions and governance, that attracted cooperatives and private processors in some states and not in others. Birthal *et al.* (2019), in their supply response functions, noticed that milk production was more responsive to the technological change, availability of animal health and breeding services, feed and fodders and market institutions, and less responsive to milk prices.

Simultaneously, another revolution happened in the poultry sector. The number of eggs produced increased from 22 billion in 1992-93 to 70 billion in 2012-13 and further to 103 billion in 2018-19 (Table 7, Figure 2). Broiler meat production too increased considerably from 0.5 mt in 1992-93 to 2.3 mt in 2012-13 and further to 3.8 mt in 2019-20, raising its share in the total meat production to 50% (Figure 4). This revolutionary progress in the poultry sector was driven by the private investment in breeding for higher yield, feed manufacturing and development of integrated value chains through contract farming. Approximately two-thirds of the broilers and eggs in the country are now produced under contracts.

4. Livestock and Agricultural Growth

The agricultural sector, which used to dominate the Indian economy, has shrunk considerably with its share in the country's GVA falling to 14.8% in 2019-20 from

Figure 4: Share of Different Species in Meat Production, 2019-20 (in %)



Source: Government of India (2020a).

Table 8: Contribution of Livestock to Agricultural GVA

(in %)

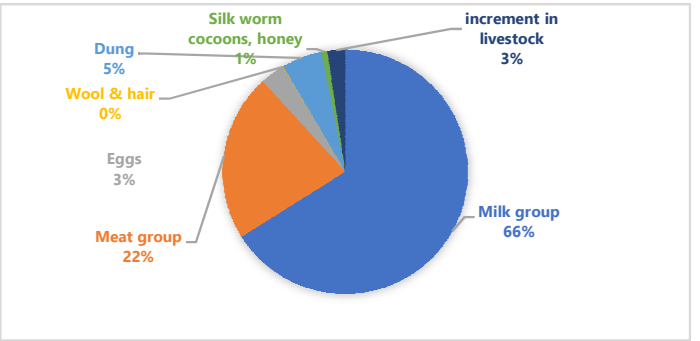
Sector	Percentage Share					% Annual Growth			
	1980-81	1990-91	2000-01	2010-11	2019-20	1980s	1990s	2000s	2010s
As % of the Agriculture GVA									
Crops	61.4	64.2	64.9	64.9	55.9	3.1	3.4	2.5	1.3
Livestock	17.4	18.3	18.5	21.6	29.4	3.1	3.4	4.2	7.6
Forestry	18.7	14.3	12.5	9.0	8.4	-0.3	1.0	-0.4	3.9
Fisheries	2.5	3.3	4.1	4.6	6.4	5.7	5.4	3.6	9.0
Agriculture GVA	100	100	100	100	100	3.0	3.3	2.6	3.5
As % of the Total GVA									
Agriculture GVA	44.7	35.7	26.5	18.2	14.8				
Livestock GVA	7.8	6.5	4.9	4.0	4.4				
Total GVA						5.2	6.1	6.9	6.7

Source: Government of India, *National Accounts Statistics*, Various Issues.

44.7% in 1980-81 (Table 8). During this period, the livestock sector's share in overall GVA declined from 7.8% to 4.4%, but the sector's share in the Agricultural GVA increased by 12 percentage points from 17.4% in 1980-81 to 29.4% in 2019-20.

In the most recent decade, the GVA from the livestock sector grew at 7.6% per annum, which is marginally higher than overall economic growth, but twice the agricultural growth rate and larger than the growth rate of the dominant crop sector. Birthal and Negi (2012) have reported a rising contribution of livestock to agricultural growth rate from 31% in the 1990s to 36% in the 2000s. Given the faster growth in the 2010s, the livestock sector has increased its contribution to the overall agri-

Figure 5: Composition of the Value of Livestock Sector Output, 2017-18



Source: Government of India (2020b).

cultural growth rate to about 54%. These trends in the livestock sector, driven by increasing demand for animal-source foods, suggest that there is a considerable scope for sustaining the recent trends in the livestock sector in the future too.

Milk accounts for over two-thirds of the total value of the output of the livestock (Figure 5). Meat and eggs share about one-fourth of it, and the rest is accounted for by non-food products, such as, hides, skins, wool, hairs, dung and incremental stock. Milk is now the largest agricultural commodity. In 2017-18, its value was estimated at Rs. 7,076 billion (at current prices), which is 9% more than the value of food grains (Rs. 6,481 billion at current prices).

The contribution of livestock to farm household income has also increased significantly from 12.8% in 2012-13 to 15.5% in 2018-19 (Chandrashekhar and Mehrotra 2016; Government of India 2021). In fact, during the past two decades, animal farming has been the main source of growth in farmers' income. Given the growing importance of livestock in farm household economies, the Government of India has accorded a high priority to the development of dairying and animal husbandry in its efforts towards achieving the goal of doubling farmers' income by 2022-23.

5. Livestock, Inequality and Poverty

Over the past three decades, a large body of empirical studies has emerged demonstrating that in developing countries the agricultural growth has more significant effect on poverty reduction than does the growth in any other economic sector

(Ravallion and Datt 1996; Warr 2003; Christiaensen *et al.* 2006; Cervantes-Godoy and Dewbre 2010; Datt *et al.* 2016). Nevertheless, the pro-poor effects of agricultural growth have been tapering off (Datt *et al.* 2016), possibly due to the deceleration in the technological gains realised in the initial period of the Green Revolution, setting of the diminishing returns to additional input-use, increasing tendency of monoculture and declining landholdings size.

Can the livestock accelerate agricultural growth and arrest its declining contribution to poverty reduction? It may be recalled that the livestock contribute to poverty reduction through several channels. First, most livestock species produce a stream of outputs, at regular or shorter intervals, which can be sold for cash flow to meet the household consumption needs and other expenditures. Second, the livestock production is less vulnerable to climatic shocks – when crops fail to produce grains, their straws are still available as animal feed. Third, being a natural reproducible asset, the animals can be effortlessly multiplied to scale up production activity and accumulate wealth. Fourth, the integration of livestock in the agricultural production system allows smallholder farmers to benefit from scope economies and complementarities among the different components of the system. And, finally, the grazing on common lands, pastures and harvested fields allows smallholder farmers to derive private benefits at little or no cost. These characteristics of the livestock production imply a strengthening of the households' productive assets, cash flows, food and nutrition security, and a reduction in the cost of production.

Nevertheless, the extent to which the poor can benefit from the demand-driven growth of the livestock sector crucially depends on how the livestock resources are distributed across the population. Table 9 shows the distribution of different livestock species by landholding size. Livestock are raised by all types of rural households irrespective of their landholding sizes. However, they have a large concentration among the households at the bottom of the land distribution. The marginal farm households (possessing less than or equal to 1.0 hectares of land) comprise almost three-fourths of the rural households and share approximately 68% of the cattle, 57% of the buffaloes, 71% of the small ruminants, 73% of the pigs and 70% of the poultry birds, as against their share of 30% in the cultivated land. Notably, the landless households have little or extremely limited access to livestock resources, mainly

Table 9: Distribution of Land and Livestock Holdings in India, 2012-13

(In %)

	Landless (less than or equal to 0.002ha)	Marginal (0.002 to 1.0ha)	Small (1.0 to 2.0ha)	Semi-medium (2.0 to 4.0ha)	Medium (4.0 to 10.0 ha)	Large (more than 10.0ha)	Total
% of households	7.4	75.4	10.0	5.0	1.9	0.2	100
% share in the land	0.01	29.8	23.5	22.1	18.8	5.8	100
% share in livestock							
Cattle	3.4	68.0	14.7	8.5	4.4	1.0	100
Buffalo	12.4	56.9	13.9	10.5	5.4	1.0	100
Sheep and goat	4.5	70.7	10.5	5.7	8.0	0.6	100
Pig	0.0	72.9	18.9	7.1	1.0	0.1	100
Poultry	7.5	70.0	14.6	6.4	1.6	0.1	100

Source: Birthal and Jumrani (2019).

due to the land constraint on animal housing and fodder production. Moreover, given the guaranteed employment at fixed wages under the MGNREGA, they benefit more from participating in such programmes than from rearing one or two animals.

There are a few studies that have examined the equity and poverty implications of the distribution of livestock vis-à-vis land resources. Ali (2007) estimated the Gini coefficient in the distribution of livestock and land assets, and showed that livestock have a more egalitarian distribution than that of land. Akter *et al.* (2008) studied equity in terms of the contribution of livestock to the household income across income quintiles, and they observed that the households in the lowest quintile earn a higher share of their income from animal husbandry. On analysing the trends in the distribution of livestock resources across land classes, Birthal and Negi (2012) found that the landless households exited from the livestock production, and the marginal farm households consolidated their share in the livestock resources.

Given a more egalitarian distribution of livestock, the smallholder farmers are likely to benefit more from the demand-driven growth of the livestock sector. The empirical evidence on the relationship between the livestock sector growth and equity and poverty, however, is scarce. Birthal and Singh (1995) and Birthal *et al.* (2014) decomposed inequality in rural income by income source and concluded that livestock income had an equalising effect on rural income distribution. Other income sources, especially agriculture, had either an un-equalising effect or a small equalising effect on the rural income distribution.

A few studies have also investigated the effects of livestock sector growth on rural poverty. By plotting the state-level changes in the head count rural poverty rates against the growth rates in the value of outputs of livestock vis-a-vis crops, Birthal and Taneja (2006) had shown that although the growth in both the sectors had a beneficial impact on poverty reduction, it was livestock sector growth that had disproportionately a large effect on poverty reduction. Using the state-level data, Ali (2007) too observed a negative relationship between the share of livestock in agricultural GVA and the incidence of rural poverty. Bijla (2018) has reported livestock development as an important route for rural households to escape from poverty.

Some studies have relied on the household surveys to understand the role of livestock in poverty reduction. Ojha (2007), from an analysis of the household survey data in Uttar Pradesh, identified animal husbandry as an important path in escaping poverty for about one-fourth of the surveyed households. Likewise, from an analysis of the household survey data from Andhra Pradesh and Madhya Pradesh, Deshingkar *et al.* (2008) noticed the rearing of small ruminants being more pro-poor than the rearing of large ruminants. The larger pro-poor effect of small ruminants is attributed to their shorter gestation periods and lower costs of production because of their grazing on common lands. Using the data from a nationally representative survey of more than 50,000 farm households, Birthal and Negi (2012) regressed the poverty status of households (poor or not poor, and the poverty gap) on the income shares of livestock and crops after controlling for several other covariates, and they found a higher probability of escaping poverty through the livestock route. The marginal effect of livestock income was estimated at (-)0.36 compared to (-)0.25 of the crop income. Thus, the livestock sector has a 1.4 times larger effect on poverty reduction than the crop sector. Further, they also found the livestock income contributed to the narrowing down in poverty gap, that is, the difference between actual expenditure and poverty line expenditure. This evidence provides credence to an observation by Mellor (2004) that with a higher expenditure elasticity of demand for animal-source foods and a more egalitarian distribution of livestock resources, the livestock sector at a similar rate of growth would have a large effect on poverty reduction than the dominant crop sector.

6. Livestock, Women and Child Nutrition

There are three main aspects of the relationship among livestock, women and child nutrition: (i) livestock as a reproducible productive asset for women, (ii) role of

women in livestock production, and (iii) role of livestock in child nutrition mediated through women. Unlike the land, the livestock are the assets that are not bounded by any property rights, and therefore, these can be acquired with small start-up capital, and multiplied effortlessly to accumulate wealth and generate cash flows. Women comprise a sizeable proportion of the workforce in primary livestock production. In India, they meet over two-thirds of the labour requirement (Birthal and Taneja 2006; Jumrani and Birthal 2015). On the assumption that the women have greater participation in livestock rearing, they are also supposed to have a control on the livestock income, and hence a greater role in the decision-making within the household (Jumrani and Birthal 2015; Saxena *et al.* 2017). Thus, in the rural societies, where the land rights are biased towards male, the ownership of livestock by women can be an important means of reducing gender gap in income, nutrition and education.

Livestock provide nutrient-rich foods, and they can impact a household's nutritional status *via* the family member who controls the livestock and livestock income. Within the household, the women are the primary caretakers of food and nutrition security, and with control over livestock income, they often allocate more of the household budget to the nutrition, health and education of children. The evidence from Africa shows that ownership of livestock by women is associated with more consumption of animal-source foods (Okike *et al.* 2005; Ayele and Peacock 2003). The income from the sale of animals and animal-source foods helps households improve their dietary diversity and children's health, nutrition and education. From an Ethiopian study, Hoddinott *et al.* (2014) reported that the ownership of a cow helped to improve children's milk consumption and reduce their stunting rates. Malapit *et al.* (2013) reported that in Nepal better maternal and child nutrition was associated with women's control over livestock income. Jumrani and Birthal (2015) also provide evidence of better child nutrition when women had a great role in primary livestock production. With this in view, they favour livestock-related interventions that contribute to women empowerment and human capital formation through the gender lens.

7. Livestock and Environment

In the mixed farming systems, as in India, the animals on small farms derive most of their energy requirement feeding on crop residues and by-products, and grazing on common lands and harvested fields; and they return the same energy in the form of food (milk, meat and eggs), draught power and dung (for manures and

domestic fuel). This process of energy exchange between crop and livestock production systems generates both negative and positive externalities to the environment. The negative externalities include the emission of greenhouse gases through enteric fermentation and manure management, degradation of common lands due to overgrazing and environmental pollution due to animal excreta. The positive externalities are (i) the prevention of carbon dioxide due to the use of animal energy in place of fossil fuels, (ii) savings of natural resources (land) by recycling of the crop residues and by-products as animal feed, and (iii) improvements in soil fertility due to dung manure in place of chemical fertilizers. The organic farming relies on dung manure, which means an improvement in the soil, environmental and human health. The dung is also used for the manufacturing of biogas for domestic use.

Livestock are one of the largest emitters of greenhouse gases. They emit methane through enteric fermentation and manure management. Globally, they account for 12.5% of the total methane emission (Steinfeld *et al.* 2013). Several studies have quantified the greenhouse gas emission from Indian livestock (Dikshit and Birthal 2016). According to these, the livestock emit around 10 mt of methane annually, and more than 90% of it is through enteric fermentation. This is equivalent to 18% of the greenhouse emission from all the sources and two-thirds of the agricultural emission.

The positive contributions of livestock to the environment, however, have not been much documented and appreciated in public policy. Livestock contribute to the conservation of the environment in several ways: (i) recycling of crop residues and by-products as feed, (ii) dung as manure and domestic fuel, and (iii) savings of fossil fuel due to the use of draught animal power. Dikshit and Birthal (2013) assessed these contributions empirically. Their estimates show that if the equivalent of the energy as derived from the crop residues and by-products as feed were to come from cultivated green fodders, the country would have required an additional 40 million hectares of land to produce that much energy. About a half of the dung produced in the country is utilised as domestic fuel, and if the equivalent thermal heat energy were to be obtained from fuelwood, the country would have needed to allocate 1.6 million hectares of land to fuelwood plantation. The rest of the dung is used as manure, adding 1.22 mt of nutrients (nitrogen, phosphorous and potassium, NPK) to the soils. Furthermore, India has about 55 million adult male cattle and buffaloes that are used to meet the draught power requirements of agriculture. Assuming that a tractor technically replaces 10 draught animals, the

potential demand for tractors is estimated at 5.5 million and their diesel requirement for agricultural purposes alone at 13 mt a year.

8. Challenges

Although livestock play multiple roles in the household economies, some of these have not been documented and appreciated in public policy. As a result, the livestock development efforts continue to face several constraints, including the problem of surplus cattle, scarcity of feeds and fodders, poor delivery of breeding and health services, and inadequate marketing arrangements.

8.1 Low Level of Productivity

Table 10 presents the key demographic and biological characteristics of the dairy species that dominate India's livestock production system, in terms of both population and economic contribution. The females outnumber the males. They comprise over 90% of the crossbred cattle and buffaloes and 69% of the indigenous cattle. And, about half of the females of cattle as well as buffaloes are used for milk production, and at any point in time, approximately three-fourths of the buffaloes and crossbred cows are in lactation. The proportion of in-milk females is less in the case of indigenous cows.

Nonetheless, there are significant differences in the milk yields of cows and buffaloes. The average milk yield of indigenous cows is estimated at 3 kg/day, which is less than 40% of the yield of a crossbred cow and 54% of that of a buffalo. Notably,

Table 10: Structure of India's Dairy Production, 2018-19

Particulars	Crossbred Cattle	Indigenous Cattle	Total Cattle	Buffaloes
	Number in Million			
Total population	50.4	142.1	192.5	109.9
Female population	47.0	98.2	145.1	100.6
Milch population	25.7	48.5	74.2	51.2
In-milk population	20.0	32.0	52.0	38.2
	In Per cent			
Females in total population	93.1	69.1	75.4	91.6
Milch in the total female population	54.7	49.4	51.1	50.9
In-milk in milch population	77.9	65.9	70.1	74.6
	Kg/Day			
Milk yield	8.0	3.0	4.9	5.6

Source: Government of India (2020a).

Table 11: Average Growth Rate of Milk Production, In-milk Population and their Yield (2013-14 to 2018-19)

Particulars	Indigenous Cows	Crossbred Cows	Buffaloes
Production	6.67	8.47	5.33
Yield	4.06	2.99	2.56
In-milk population	2.55	5.27	2.71

Source: Government of India (2020a).

the milk yield of a cow in India is half of the global average, and much less than that in developed countries.

Importantly, the milk output of all the dairy species has increased significantly (Table 11). In the recent period, more than half of the growth in-milk output of buffaloes and indigenous cows came from improvements in their yields, while the growth in-milk output of crossbred cows was driven by an increase in their number. This is a reversal of the trend from a number-driven to a yield-driven growth, as observed earlier (Birthal and Taneja 2006).

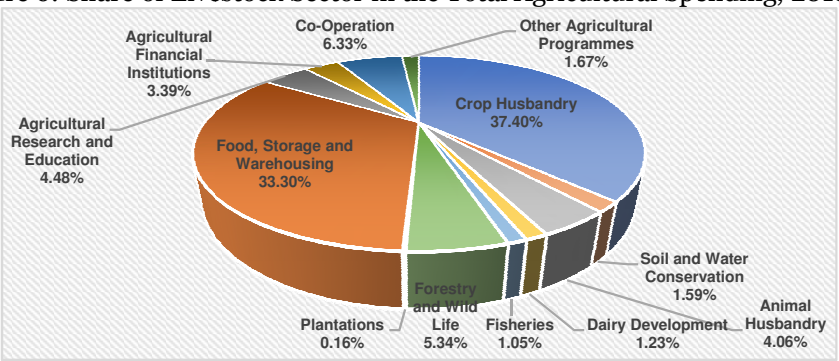
Although the crossbreeding of indigenous species through artificial insemination could result in higher milk yields, the success rate of artificial insemination has rarely exceeded 45%. This is mainly on account of the non-availability of quality semen and poor storage facilities and delivery systems. In 2018-19, the country had 54 semen stations, 235 frozen semen stations and 1,01,777 artificial insemination centres (Government of India 2020a). The low conception rate and poor delivery of breeding services, however, are a matter of concern. To enhance the efficiency of artificial insemination, there is a need to screen and use quality bulls for semen production and improve semen collection, storage infrastructure and its delivery mechanisms.

The changes in the livestock's functions in favour of food production and the increasing mechanisation of agriculture point towards the need for a greater focus of animal breeding research on reducing the number of males and improving the milk yields. The sexed-semen technology offers farmers a choice of selecting male or female offspring. The Government of India has been making efforts to promote this technology.

8.2 Underinvestment in the Livestock Sector

Figure 6 shows the share of the livestock sector (including animal husbandry and dairy development) in the total public spending (revenue and capital expenditure) on agriculture and allied activities (union and state governments). Its share is estimated

Figure 6: Share of Livestock Sector in the Total Agricultural Spending, 2018-19

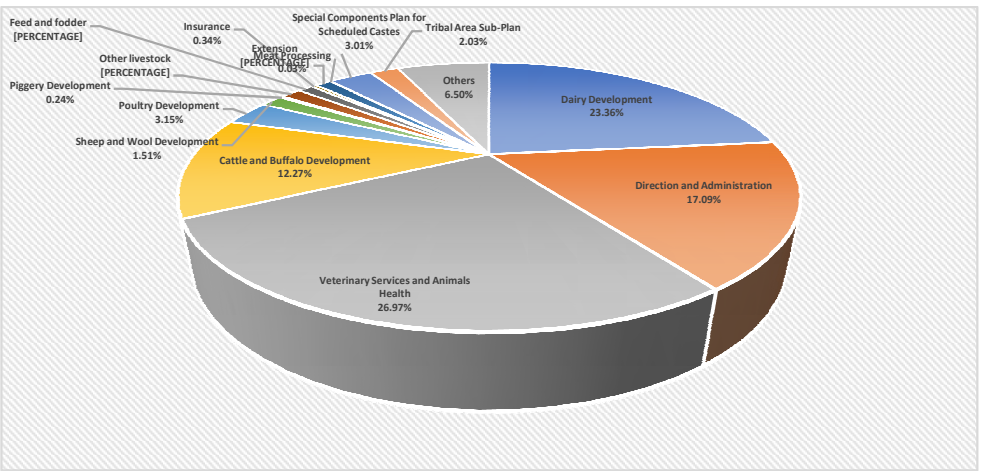


Source: Government of India (2021b).

at 5.2%, which is disproportionately low compared to the sector's contribution to the agriculture GVA. In fact, the share of livestock in the total agricultural spending has hardly exceeded 6% in the past two decades (Birthal and Taneja 2006; Birthal and Negi 2012; Birthal and Jumrani 2019). Rather, its share in the total agricultural spending has fallen in the recent decades from over 10% in the early 1990s (Birthal and Jumrani 2019).

Until recently, investment in the livestock sector had concentrated on dairy development, mostly by the way of financial support to the dairy cooperatives (Birthal and Taneja 2006). Currently, the dairy development activities receive 23% of the total spending on the livestock sector (Figure 7). The animal health and veterinary services

Figure 7: Components of Livestock Spending, 2018-19



Source: Government of India (2021b).

account for about 27% of it. Small ruminants, pigs, fodder, and veterinary education, research and training receive a trivial amount. For instance, the extension activities receive only about 1% of the total spending on the livestock sector. The production of fodder, a key input in livestock production, also shares 1% of the total spending. Direction and Administration account for 17% of the total spending, and their share has increased over time (Birthal and Jumrani 2019).

8.3 Feed and Fodder Scarcity

The scarcity of feeds and fodders continues to be a major challenge in improving livestock productivity in the country. Feed supply has always remained short of the demand. The National Commission on Agriculture (1976) estimated a deficit of 49% in dry fodder, 53% in green fodder and 43% in concentrates in 1972-73. Over time, the deficit has reduced owing to an increase in the production of food-feed crops, mainly cereals. In 1991, the deficit was 31% in dry fodder and 23% in green fodder, but it was 47% in concentrate feeds (Singh and Muzumdar 1992). The recent estimates show a substantial reduction in the deficit of dry fodder to 8% and concentrates to 29%. The deficit in green fodder, however, remains almost unchanged (Table 12).

There are two main sources of green fodders, namely, the cultivated crops and the grasses gathered from cultivated fields, forests, pastures and common lands. The cultivated fodders account for half of the green fodder consumption (Dikshit and Birthal 2010). In the past two decades, the area under fodder crops has remained between 9 and 10 million hectares. The common grazing lands (permanent pastures and grazing lands, wastelands, and fallows excluding current fallows) occupy 16% of the geographical area. These, however, have been deteriorating quantitatively as well as qualitatively (Jodha 1992).

There are limitations on the methodology used for the estimation of demand for and supply of feeds and fodders. The estimates of demand for feed and fodders are derived

Table 12: Feed and Fodder Demand and Supply in India, 2002/03

(In Million Tons)

Feedstuff	Consumption	Requirement
Green fodder	491	648
Dry fodder	459	503
Concentrate feed	62	87

Source: Dikshit and Birthal (2010).

from the energy requirements of animals based on their age, weight and functions, and not from their actual consumption. Similarly, the supply estimates of dry fodder are derived using the grain-straw ratio of different crops and the area under these crops. Essentially, they treat the feed requirement as the demand, and the availability as the supply, which are not in the economic sense. Hardly there exists any official estimate of the feed demand and supply. Birthal *et al.* (2010) attempted to generate consumption rates of different types of feed for different animal species, which they used to estimate the demand (Table 12). They estimated the requirement of feeds and fodders and treated it as the potential demand. The difference between the total consumption and requirement is then considered as deficit or surplus, as the case may be.

There are several options to manage the feed deficit. It must be appreciated that the deficit is largely on account of the huge population of the low-producing animals. This suggests the need to optimise the livestock numbers matching the available feed resources, or vice versa. Given the restrictions on the slaughtering of animals, especially cattle, the optimisation of the population is a plausible option only in the long run. In the short run, the focus should be on augmenting the feed supplies by (i) bringing more area under green fodder crops, (ii) better management of grazing lands and pastures, and (iii) encouraging processing, storage and trade in feeds and fodders.

The feed deficit is seasonal and localised (Singh and Muzumdar 1992), and hence, there exists a scope to preserve and store surplus fodders during a good crop harvest for its use in the lean season. The need is to promote community fodder banks at the village level. In states like Punjab and Haryana, rice straw is considered inferior fodder and is often burnt. Such wastage can be avoided by its processing into pellets, and subsequently their transportation to the deficit regions. The deficit in the concentrate feeds can also be attributed to the huge exports of oilcake, especially soybean cake. India exports around 2 mt of soybean cake annually. Cultivation of green fodders is restricted to a few states (Appendix Table 1). Of the 10 million hectares of green fodder area, about 50% is in the states of Punjab, Haryana and Rajasthan. Efforts are needed to produce and disseminate the high-yielding fodder seeds and to rejuvenate and manage pastures and grazing lands. Besides, there are technologies such as urea treatment of straws, urea molasses mineral blocks and bypass protein that have the potential to improve the palatability of dry fodders, but these have not been adopted on a large scale.

8.4 Poor Delivery of Veterinary Services

Over time, there has been a significant improvement in animal health infrastructure and manpower. In 2018-19, the country had 65,815 veterinary institutions comprising 12,076 polyclinics and hospitals, 25,571 dispensaries and 28,168 veterinary aid centres like stockmen centres and mobile dispensaries (Government of India, 2020a). They engaged more than 49,030 veterinary professionals and over 62,316 para-veterinary professionals (World Organisation for Animal Health, 2019).

As per the recommendations of the National Commission on Agriculture (1976), one veterinarian is sufficient to serve 5,000 livestock units. Over time, the number of livestock units per veterinarian has reduced considerably (Birthal and Jumrani 2019), and it is now closer to the recommended level. Despite that, there are frequent outbreaks of the diseases like foot-and-mouth disease (FMD), black quarter (BQ), peste des petits ruminant (PPR) and influenza. What this implies is the need to improve the efficiency of the service delivery system and their re-orientation towards prophylactic management.

8.5 Underinvestment in Research, Education and Extension

Research, education and extension are crucial for the generation of innovative technologies and practices, and their dissemination, and improvements in professional capacities. These activities, however, have hardly received 3% of the total spending on the livestock sector (Birthal and Taneja 2006; Birthal and Negi 2012; Birthal and Jumrani 2019). It may be noted that the animal science research, in general, involves larger gestation periods, is capital-intensive and has a lower probability of success. It, therefore, requires more research resources for effecting the breakthroughs in different disciplines of animal science.

The gains from investment in research cannot be realised in the absence of strong institutional linkages between animal science research and extension systems. The livestock extension system or delivery of livestock information is extremely weak – only 7% of the farm households have access to livestock services (Government of India 2021a), which is two percentage points higher than in 2002-03 (Adhiguru *et al.* 2009). Farmers require information on several aspects of livestock production, ranging from animal breeding, health and nutrition, credit, markets, prices, international trade, and food safety regulations to overcome the challenges in harnessing the pro-poor

potential of livestock. It is, therefore, imperative to create a cadre of qualified livestock extension workers and promote public-private partnerships (PPP) for the delivery of information on technologies and management practices.

8.6 Underfinancing of Animal Husbandry

The poor livestock keepers need finances for acquisition of animals, construction of cattle sheds, purchase of feed, fodder and medicines, and so on. Unfortunately, animal husbandry has been neglected by financial institutions. Dairying and animal husbandry receive about 5% of the total advances to the agricultural sector (Birthal and Jumrani 2019). The inadequate financing of animal husbandry and dairying is rooted in the purpose for which the financial support is provided. The credit to animal husbandry is essentially seen as an investment credit, often advanced against tangible collateral, for purchasing animals and construction of cattle sheds. Although the poor can acquire animals through financial support and also scale up their herd through reproduction, they also need finances for purchasing inputs such as feeds, fodders and medicines. There is a strong case for extending the short-term credit support to farmers for animal husbandry and dairying. The production and maintenance cost of rearing a milch bovine (cow or buffalo) comprises 60%-70% of the total cost, which is almost equal to the operational cost of growing paddy or wheat in one hectare. If livestock development has to be poverty and nutrition-focused, the need for more credit to animal husbandry cannot be undermined. Let the financial institutions treat the animal as collateral and get it insured against the mortality and morbidity risks.

8.7 Inadequate Risk Management

Livestock are vulnerable to several diseases, and on occasions, these may cause huge morbidity and mortality losses (Singh and Prasad 2008; Birthal and Jha 2005; Bardhan *et al.* 2017; Bardhan *et al.* 2020). Besides, climate change has also emerged as a big threat to sustainable livestock production. To protect the livestock and livestock-based livelihoods from diseases and climate risks, the Government of India initiated a subsidised scheme for livestock insurance in 2008 in 100 districts restricted to five high-yielding (1,500 litres/lactation) cattle and buffaloes per household. The Government of India provides a premium subsidy of 50%. The scheme now covers all types of animals in all the districts. Nonetheless, the performance of

livestock insurance has not been encouraging. Hardly about 5% of the animal heads have been provided with insurance cover (Birthal and Jumrani 2019). There are also considerable regional disparities in animal insurance coverage – Andhra Pradesh and Kerala account for nearly one-third of the total animals insured in the country.

8.8 Underdeveloped Markets and Value Chains

The animal-source foods are perishable and require immediate transportation to the demand centres or conversion into some value-added products and their refrigeration to avoid post-production losses. Besides the poor institutional support (extension, credit and insurance), the lack of access to remunerative markets is an important barrier to scaling up the smallholder livestock production systems. Except for poultry and to some extent for milk, the markets for livestock products are mostly informal and dominated by itinerary traders who often indulge in several malpractices exploitative of the farmers (Birthal *et al.* 2018; Kumar 2018). In the case of milk, over half of it enters the market, and of it, approximately 60% is procured by informal buyers, including local vendors and commission agents. For smallholders, selling small quantities in distant urban markets is not remunerative because of the higher marketing and transaction costs that are often invariant to scale (Birthal 2008).

As a part of the economic reforms process initiated in 1991, the Government of India liberalised the dairy industry for private sector participation, and this attracted considerable investment in dairy value chains. Assuming that dairy cooperatives and private processors procure milk in the proportion of their processing capacity, about 15% of the milk produced is procured by the private processors (Birthal *et al.* 2016). Most private processors procure milk from dairy farmers through informal contracts. Contract farming has been reported to reduce price uncertainty, marketing and transaction costs, and provide farmers with easy access to inputs, technology, credit and services (Birthal and Joshi 2009; Vandeplas *et al.* 2013).

Markets for live animals are weak, and they lack basic infrastructure and amenities for livestock and livestock sellers and buyers (Birthal 2016). Slaughtering facilities are also inadequate. More than half of the total meat output comes from unregistered slaughterhouses that often lack safety and hygiene.

Although the dairy cooperatives have played an important role in improving farmers' access to markets, their spread remains highly unequal across states. As

noted elsewhere, Gujarat and Karnataka together account for 60% of the total milk procurement. Eastern and north-eastern states have been bypassed by the cooperatives. Likewise, close to 90% of the processing capacity of private processors is concentrated in states like Uttar Pradesh, Maharashtra, Andhra Pradesh, Punjab, Haryana, Tamil Nadu, Madhya Pradesh and Rajasthan.

Contract farming has been quite successful in poultry sector. By providing farmers assured access to markets, the contractual arrangements reduce market and price risks and also motivate farmers to scale up their production (Birthal 2008). The expanding market for animal-source foods is an opportunity for agribusiness firms to improve their outreach through such institutional arrangements, particularly in regions that have considerable potential for production but remain underexploited due to the poor transportation infrastructure and markets.

Value addition to livestock products remains low. Only about 6% of the poultry meat, 21% of the buffalo meat and 35% of the milk undergo value addition (22% in the organised sector). The bulk of the poultry and buffalo meat is processed in the organised sector, and this sector accounts for 63% of the total milk processed.

9. Research and Policy Gap

India's large livestock sector, despite its significant potential for enhancing agricultural growth and reducing poverty, has remained understudied by social scientists and less appreciated in public policy, partly because of the lack of public data. There are significant data gaps in the areas of demand for and supply of feed, the economics of livestock production, output and input prices, adoption of technologies, and utilisation of livestock products and by-products. The following topics merit the attention in social science research:

Structural transformation: India's livestock sector has undergone a structural transformation over the past few decades in terms of changes in the herd structure and functions of livestock. Our understanding of the dynamics of livestock demographics and factors underlying them is limited. Studies are required to analyse the effects of technological change in crop production, agrarian structure, climate change, income growth, urbanisation, infrastructure and institutions on population dynamics and demographic changes in different livestock species, especially bovines. In other words, there is a need to estimate supply response functions for different live-

stock species. There is hardly any empirical study on this issue, except that by Birthal *et al.* (2019) on supply response of dairying.

Livestock and carrying capacity of natural resources: India has a huge population of different livestock species but limited resources to support it. The debate on surplus cattle, which began in the 1970s, remains inconclusive. It is, therefore, imperative to assess the carrying capacity of natural resources in order to optimize the population of different livestock species. In doing so, it is important to take into consideration the potential of technological changes happening in animal sciences, especially in sexed semen and embryo transfer technologies, and nutrition-enhancement technologies, and crop sciences with a due focus on high-yielding fodder seeds.

Urban livestock production: The rural and the urban livestock production systems have different characteristics and socio-economic and environ-mental impacts. Studies are required to bring out the differences between the two production systems in terms of herd structure, breeding efficiency, the scale of production, adoption of technologies, cost of production, markets for live animals and their products and by-products, and their socio-economic and environmental implications.

Lifecycle productivity of different species: The crossbred cows are high-yielding, but their genetic potential also deteriorates faster. Often, they exhaust their potential after four or five lactations, as compared to 8 to 10 lacta-tions in the case of indigenous cows and buffaloes. There is also a significant difference in the maintenance and production costs of crossbreds compared to their indigenous counterparts. This suggests the need to empirically investigate the lifecycle productivity of different dairy species and its implications for animal breeding policies.

Losses in livestock production: Livestock suffers from several problems of breeding, health and nutrition that reduce their production potential. Yet there is hardly any study done on the losses in animal productivity due to such factors (Birthal and Jha 2005). Studies are required on identifying different constraints, their severity and probability, and assessing the associated output loss.

Climate change and livestock: While climate change is emerging as a big threat to the sustainable development of livestock production systems, there is little empirical work on its impact on animal farming and the adaptations required to

mitigate the impact. Climate change may lessen the production potential of livestock through several channels directly and indirectly by reducing the availability of basic production inputs like feed and water, qualitative degradation of common grazing lands and pastures, and by altering the pattern of pests and diseases. Studies are required on how droughts, heat waves, cyclones and floods affect livestock production, and how livestock producers adapt to such risks ex-ante or ex-post.

Adoption and impact of technologies: Animal science research has generated several new technologies, but little is known about their adoption and impact, except that of crossbreeding technology in cattle. Economic studies are required on the adoption and impacts of different technologies on raising the productivity of livestock and reducing production losses. There is hardly any empirical evidence on the total factor productivity of the livestock sector (Birthal *et al.* 1999; Lal and Chandel 2017), and returns on investment in animal science research and extension (Kumar *et al.* 2004).

Efficiency and equity of livestock services: While there has been a significant expansion of animal health infrastructure and manpower, the understanding of their efficiency in delivering veterinary services remains weak. It is equally important to understand the efficiency of preventive versus curative health services.

Price determination and price discovery: What determines the prices of live animals and their products? In India, it is not the cost of production that determines output prices. For example, milk is priced using a two-axis formula, namely, the fat and solid non-fat in it. Can cost of production make a difference to it? Prices of adult female bovines should be decided based on their age, lactation order, yield, colour, appearance and sex of offspring, but it is done arbitrarily. Prices of young stocks and small ruminants are determined arbitrarily based on body weight and sex. There is an acute lack of studies on the pricing of live animals, and their products and by-products.

Value chains of livestock products and by-products: Livestock provides several products and by-products. While there is a fair understanding of the value chains of the main products, little is known about the value chains of their by-products, such as dung, hides and skins. Mapping value chains of livestock products and by-products remains a grey area for research.

Investment and subsidies: Although some studies have documented the trends and composition of investment in the livestock sector, yet the need to estimate returns on investment in the livestock sector as a whole and on the components of the investment cannot be undermined. Another related issue that merits attention in empirical research is the quantum of subsidies going to the livestock sector.

Cost of livestock production: Estimates of the actual demand and supply of feeds and fodders is essential on several counts. They will help in the efforts towards the optimization of livestock numbers commensurate with available feed resources, improving feed-fodder supply, promoting inter-region trade in feed and fodders, and managing pastures and grazing lands. Feed expenditure comprises a sizeable share of the cost of production, and the studies on feed consumption will help to understand the economics of different livestock enterprises, their comparative advantage and price determination.

10. Strategies For Sustainable Growth

Over the past four decades, India's livestock sector has traversed an impressive growth trajectory, turning the country self-sufficient in animal-source foods from their acute scarcity observed in the 1960s and 1970s. Nevertheless, the need to produce more remain as urgent as in the past. By 2050, India's demand for almost all types of animal-source foods is expected to increase substantially. Nevertheless, there exists a huge untapped potential for livestock production which can be harnessed through designing contemporary policies and programmes and their implementation to address various constraints that livestock producers confront.

Enhance the public spending on livestock: The livestock sector, despite its increasing contribution to agricultural growth and higher potential for reducing undernutrition and poverty, has remained underinvested. In the past two decades, its share in the public spending on agriculture and allied activities has hardly ever touched 5%. Although anecdotal, the economic and social rates of returns on public spending on the livestock sector are likely to be much higher than on other components of agriculture. Therefore, sustaining rapid and inclusive growth in the livestock sector requires raising its share in agricultural investment substantially from its current level.

Manage the feed and nutrition: While there has been a significant improvement in feed and fodder production, the feed deficit, especially in green fodder and concentrates, continues to be a major constraint to raising livestock productivity. To

manage the feed deficit, there is a need to (i) bring more area under high-yielding green fodder and food-feed crops, especially in deficit regions, (ii) arrest quantitative and qualitative degradation of common grazing lands and pastures, (iii) develop community fodder banks, (iv) promote inter-regional trade in dry fodders and concentrates, and (v) push up adoption of nutrition-enhancing technologies such as urea treatment of dry fodders, bypass protein and mineral mixtures.

Improve the delivery of veterinary services: The delivery of animal health services remains poor despite a significant improvement in the veterinary health infrastructure and manpower. A two-pronged strategy involving the organisation of animal health campaigns for the diagnosis and treatment of diseases, and door-step delivery of veterinary services through mobile dispensaries may be adopted. Greater emphasis should be laid on preventive treatment.

Improve the efficiency of breeding services: India has a huge population of low-producing animals partly due to lack of quality semen, its poor storage and timely insemination. The success rate of artificial insemination hardly exceeds 45%, which is a demotivation to adopt artificial insemination. There is a need to improve infrastructure for semen production, storage and its delivery.

Improve livestock extension system: To produce more amidst the growing challenges, farmers need diverse and extensive information on animal breeding, feed and nutrition, animal health, weather, credit, insurance, markets, prices and consumer preferences. In future, they would require intensive animal farming knowledge, skill and information. The livestock extension system is almost absent, and farmers confront several informational constraints in managing the challenges. There is a need to evolve an extension system either using existing veterinary and para-veterinary professionals by redefining their responsibilities, or by creating a separate cadre of extension workers exclusively for animal husbandry.

Extend livestock insurance to all animals: Livestock are prone to several production risks including climate extremes and diseases. The current livestock policy covers only mortality losses and not losses due to morbidity. Health insurance needs to be extended to all types of animals irrespective of age and sex.

Investment in value chain development: Value chains are essential to improving farmers' access to markets and reducing transaction costs. The value

chains except for poultry and, to some extent, milk are almost non-existent. Even for milk, there are significant regional disparities in the value chain development. There is a need to develop value chains for small ruminants and pigs through institutional arrangements like cooperatives and contract farming. There is also a need to create awareness about food safety standards and regulations and the measures to comply with these.

Enhance the flow of short-term institutional credit: Farmers need credit for scaling up animal farming. Animals are a reproducible asset and can be easily multiplied at the farm level, but farmers need funds for the construction of animal sheds, purchase of feeds and other requirements. The credit policy treats advances to animal husbandry as investment credit. Recently, the government has made provisions to issue Kisan credit cards to Animal Husbandry farmers and Fisheries for meeting their short-term financial requirements.

Optimize the livestock population: India has a huge population of different livestock species, but limited resources to support it. The debate on surplus cattle, which started in the 1970s, remains inconclusive. Increasing mechanisation of agricultural operations has rendered male cattle and buffaloes redundant as draught animals. In view of the changing functions of livestock, it is imperative to optimise the population of cattle and buffaloes. The sexed-semen technology is a potential path towards population optimisation.

Enhance investment in the animal science research: For sustainable improvements in livestock productivity, it is essential to increase investment in animal science research. The animal science research involves a large gestation period, and is capital-intensive. Besides, the animal science research agenda needs to be reoriented taking into consideration the changing functions of livestock, climate change and emerging diseases including zoonotic diseases.

Prioritise livestock investment: Allocation of resources to different activities within the livestock sector appears biased in favour of activities that kick-start the markets (for instance, assistance to dairy cooperatives and animal health services), but tended to ignore activities that provide farmers with access to basic inputs (such as feed and water) and protect livestock against natural disasters and diseases (insurance), sustain productivity growth and enable farmers to improve

their competitiveness in the changing market environment (research and extension). And, over time, proportional allocations of resources to different activities have not changed much. This suggests a need to prioritise livestock development agenda based on feedback from different stakeholders, including livestock producers, service providers and processors, and accordingly, strike a balance in the resource allocation across different activities.

These strategies are generic in nature, and can be modified as per the requirements of the stakeholders. In the lagging states, it is the strategies that are basic to animal husbandry that need greater attention, while in the advanced states, the strategies that promote commercialisation and sustainability of the production system are more important.

11. Concluding Remarks

India continues to experience a demand-driven revolution in the livestock sector. Between 2010-11 and 2019-20, the sector recorded an unprecedented annual growth rate of 7.6%, which is comparable to the overall economic growth, but twice the agricultural growth rate, and five times the growth in the dominant crop sector. In fact, the livestock sector has now emerged as an engine of agricultural growth, raising its share close to 30% in the agricultural GVA and above 50% in the agricultural growth.

The distribution of livestock resources and income is more egalitarian than that of land, and thus, the animal husbandry is a more pro-poor activity. At a similar rate of growth, the livestock sector has a 1.4 times larger impact on poverty reduction than does the crop sector. Livestock engages about 8% of the agricultural workforce, and more than 70% of it are women, and thus, growth in the livestock sector contributes to women empowerment. And, when the women have control over livestock income, they allocate a large share of the household budget to the children's nutrition, health and education. In mixed farming systems, the livestock, by deriving their energy requirement from crop residues and providing draught power and dung, also save natural resources and foreign exchange.

Nevertheless, the available evidence indicates the existence of a considerable scope to exploit the untapped potential of livestock for higher, sustainable and inclusive agricultural growth through designing the contemporary livestock development strategies and their effective implementation. These include (i) an assessment

of livestock carrying capacity of the natural resources, and accordingly, the optimisation of the population of different livestock species, (ii) improving feed and fodder supplies, and breeding and health services, (iii) provision of institutional credit and insurance, (iv) development of markets and evolving value chains for live animals and their products and by-products, (v) investment in animal science research and extension, (vi) harmonisation of agriculture and livestock development policies, (vii) increase in public spending on livestock, and (viii) prioritisation of the development agenda.

It may be noted that India's huge livestock sector has remained understudied, and there is enormous scope to improve the understanding of the sector's potential contributions to the socio-economic development and conservation of the environment. One of the primary reasons often cited for such a state of affairs is the lack of public data on the use of inputs, cost of production, marketing and prices of outputs and inputs, and adoption of technologies related to animal breeding, nutrition and health. The immediate need is to strengthen institutional mechanisms for the collection, compilation and collation of data on various aspects of livestock production systems.

Notes

1 Slaughtering of cattle and exports of live cattle and beef are banned in India. It is mostly the buffalo meat that is exported.

2. Most slaughtered buffalo males are of less than one year of age.

Appendix Table 1: Key Indicators of Livestock Sector Across States

	Live-stock	Poultry	Area Under Fodder Crops	Area Under Permanent Pastures & Grazing Lands	Veteri-nary Hos-pitals/ Poly-clinics	Veteri-nary Dispen-saries	Veteri-nary Aid Centres	No. of Veteri-narians	No. of Para Veteri-narians	No. of AI Centres	% Cattle Cross-breds
	(000)	(000)	(000ha)	(000ha)							
Andhra Pradesh	34045	107863	64	214	337	1576	1275	2006	2263	6053	50.7
Arunachal Pradesh	1161	1600	0	18	15	180	305	175	630	50	2.1
Assam	18040	46712	4	167	21	435	767	812	2151	2078	7.2
Bihar	36454	16525	20	15	39	1098	1595	1045	518	4714	27.7
Chhattisgarh	15863	18712	0	887	340	809	403	546	1447	43	2.8
Goa	132	350	0	1	5	25	49	43	113	106	49.2
Gujarat	26871	21773	850	851	34	702	1057	655	880	8982	37.0
Haryana	6938	46295	420	25	1029	1817	22	826	2663	2839	57.6
Himachal Pradesh	4411	1342	9	1510	444	1767	1251	451	2519	3088	59.2
J&K	8319	7366	53	112	20	503	1301	444	1750	1354	59.0
Jharkhand	23580	24833	0	114	35	424	433	562	285	1698	5.8
Karnataka	29003	59494	28	904	695	2135	1382	2339	4764	7281	48.5
Kerala	2899	29772	6	0	278	868	20	1500	2723	3252	99.8
Madhya Pradesh	40622	16660	367	1303	1063	1583	65	1163	3272	5982	9.5
Maharashtra	33013	74298	969	1249	201	1740	2906	2214	702	4847	33.8
Manipur	550	5898	0	1	56	109	34	151	381	257	9.3
Meghalaya	2038	5380	0	0	4	114	122	233	471	65	3.8
Mizoram	358	2048	0	11	5	35	103	105	105	70	65.6
Nagaland	552	2839	0	0	11	55	100	185	295	6	25.6
Odisha	18143	27439	0	524	541	3239	314	931	2399	5404	16.5
Punjab	6992	17650	498	5	1389	1489	20	1147	1701	2878	90.3
Rajasthan	56775	14623	4928	1674	2530	198	5169	1952	7009	6241	17.6
Sikkim	273	581	0	0	18	61	54	78	497	1822	80.3
Tamil Nadu	24451	120781	91	108	177	2701	831	2345	1538	3704	90.9
Telangana	32626	79999	27	299	108	909	1201	1030	1019	4944	14.8
Tripura	1303	4168	0	1	16	60	458	170	314	11	18.4
Uttar Pradesh	67785	12516	767	65	2208	267	3396	1733	3892	5043	33.9
Uttarakhand	4422	5019	32	192	329	10	778	397	876	8022	33.7
West Bengal	37427	77323	3	2	112	612	2657	1173	1447	2556	18.2
All India	535829	851810	9138	10257	12076	25571	28168	26547	49030	98139	26.7

Source: Government of India: *Livestock Census*, Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry and Dairying, New Delhi, Various Issues.

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