



NABARD Research and Policy Series No. 11/2022



Sustainable Meat Value Chain and Enhanced Farmers' Income

Arup R. Sen

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M. Muthukumar





दृष्टि

ग्रामीण समृद्धि के लिए राष्ट्रीय विकास बैंक

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NABARD Research and Policy Series No. 11/2022

संधारणीय मांस मूल्य श्रृंखला और किसानों की आय में वृद्धि
Sustainable Meat Value Chain and Enhanced Farmers' Income

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Sustainable Meat Value Chain and Enhanced Farmers' Income

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पेपर में उद्धृत तथ्यों और व्यक्त विचारों के लिए राष्ट्रीय बैंक ज़िम्मेदार नहीं है।
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Chairman's Message



Academic research plays a crucial role in the policy formulation process. Studies and analyses done by researchers provide evidence based recommendations for addressing issues that are currently being faced by the target community. However, it is often seen that topics of research are confined to certain aspect of an issue, thereby limiting its scope for policy recommendations. Further, the research reports available may often be very technical and hence less communicative to the policymakers. To overcome the above limitations, NABARD had initiated one of its kind series titled “Research and Policy” to commission review papers that may help collate all the research findings on a given theme in a capsule form.

Under this series, eminent research scholars in different fields of agriculture research have been requested to document research in their field highlighting various issues, policy relevance and prescriptions, and suggestions for future research.

Already 10 research papers have been published and we intend to release more such papers on various topics ranging from ‘Changing Livelihoods’ to ‘Climate Change’ to ‘Credit Deposit Ratio’ in the coming months. The present paper on “Sustainable Meat Value Chain” which is 11th in the series is written by Dr. Arup R. Sen, an authority on the meat value chain. Dr. Naveena B. Maheswarappa and Dr. M. Muthukumar have co-authored the paper. I hope that the series will be beneficial to academicians, researchers and policymakers to solve the emerging challenges at the ground level.

My best wishes to the authors and the Department of Economic Analysis and Research (DEAR) of NABARD for initiating such a utilitarian and one of its kind series.

Shaji K. V.

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 and 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 eleventh publication in this series on “Sustainable Meat Value Chain” written by Dr. Arup R Sen, Dr. Naveena B. Maheswarappa and Dr. M. Muthukumar.

I wish this new series acts as a bridge between the researchers and policymakers.

P. V. S. Suryakumar

Deputy Managing Director

Preface



Indian agriculture showed impressive resilience during the pandemic times and became the primary driver of economic growth. Even though the sector was able to withstand the Covid-19 shock, there are still a number of structural problems that must be addressed if it is to continue to support sustainably the majority of the population that depends on it. In search of solutions to address various issues and constraints amidst uncertainties and climate change, agricultural research is what comes to my mind as one of the most powerful tools to eradicate extreme poverty, ensure food secure future and create agriculture as a sustainable livelihood to the ones who are dependent on it. Under the guidance of Shri P. V. S. Suryakumar, DMD and with the motivation to address the emerging challenges facing Indian agriculture through research and effective policy interventions, the Department of Economic Analysis and Research (DEAR), an in-house research wing of NABARD, initiated the Research and Policy Series.

The Research and Policy series is a glimpse of research findings in a capsule form thereby making it more effective and communicative to policy planners. This also distinguishes itself from opinionated articles and research available on the concerned topics of interest. For making these series a success, we approached eminent researchers in the field of agriculture, agricultural economics, as our purpose here was to get researcher's heart and their experience which they gained during their long passionate innings on paper highlighting various issues, policy relevance, prescription and suggestion for future papers on the themes of interest to NABARD.

Meat being a major export commodity in India's Agri-Export basket, the value chain on meat is an excellent area to investigate in order to ensure a stable market and higher returns for farmers. This will directly lead to the identification of issues in the domestic and export meat markets, as well as, in the long run, will help in doubling of farmers' income. In light of this, the current paper titled "Sustainable Meat Value Chain and Enhanced Farmers' Income", written by Dr. Arup R. Sen, Dr. Naveena B. Maheswarappa, Principal Scientists and Dr. M. Muthukumar, Senior Scientist, ICAR National Research Centre on Meat, Hyderabad, assumes importance. The authors have a distinguished academic background, with research interests in meat quality, meat

processing, climate change mitigation strategies for meat animal and meat production, etc.

The paper begins by outlining the sector's current state and contribution to the national economy. It also describes the constraints faced by the sector in terms of production and input supply. The paper goes on to examine the role played by various actors involved in the meat production and processing sector, as well as how technology induction and extension services can aid in realising the sector's potential. The authors then present the SWOT analysis of the sector as well as the current institutional environment available to the sector at various levels of administration. Finally, the authors discuss how meat industry can have a significant impact on doubling farmers' income and conclude by examining areas for future research and policy interventions, along with making recommendations to promote further growth in the sector.

In bringing this series as planned, we would like to express our sincere gratitude to Shri. Shaji K. V., Chairman, NABARD for his unstinted support and guidance. We wish to express our sincere thanks to Shri P. V. S. Suryakumar, DMD, for being the inspiration and the driving force behind the publication. 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.

I also acknowledge the contributions of the officers of DEAR, NABARD especially Dr. Vinod Kumar, GM; Dr. Ashutosh Kumar, DGM; Mrs. Balwinder Kaur, DGM; Mrs. Geeta Acharya, Manager; Ms Neha Gupta, Shri 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.

Dr. K C Badatya

Chief General Manager

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Abbreviations

AI	Artificial Insemination
APEDA	Agricultural and Processed Food Products Export Development Authority
CAGR	Compound Annual Growth Rate
CCPP	Contagious Caprine Pleuropneumonia
CIRG	Central Institute for Research on Goats
CPRs	Common Property Resources
CSWRI	Central Sheep and Wool Research Institute
DAHD	Department of Animal Husbandry and Dairying
ET	Enterotoxemia
FAO	Food and Agriculture Organization
FICCI	Federation of Indian Chambers of Commerce & Industry
FMD	Foot-and-Mouth Disease
GHG	Greenhouse Gas
GoI	Government of India
GVA	Gross Value Added
ICAR	Indian Council of Agricultural Research
ICDI	International Climate Development Institute
ICMR	Indian Council of Medical Research
IFAD	International Fund for Agricultural Development

(Contd.....)

Abbreviations *(Concluded)*

INAPH	Information Network for Animal Productivity and Health
NAAS	National Academy of Agricultural Sciences
NABARD	National Bank for Agriculture and Rural Development
NABCONS	NABARD Consultancy Services
NADCP	National Animal Disease Control Programme
NBAGR	National Bureau of Animal Genetic Resources
NDDB	National Dairy Development Board
NIN	National Institute of Nutrition
NIVEDI	National Institute of Veterinary Epidemiology and Disease Informatics
NLM	National Livestock Mission
NPBB&DD	National Programme for Bovine Breeding and Dairy Development
NSSO	National Sample Survey Office
PIB	Press Information Bureau
PPR	Peste des Petits Ruminants
SHG	Self-Help Group
SWOT	Strengths, Weaknesses, Opportunities and Threats
TSSGCFL	Telangana State Sheep & Goat Cooperative Federation Limited
USDA	United States Department of Agriculture
USGCF	Uttarakhand Sheep, Goat and Rabbit Farmers' Cooperative Federation
UTs	Union Territories
WBLDC	West Bengal Livestock Development Corporation

Executive Summary

In India, the livestock sector contributed 6.17% to the total gross value added (GVA) and 30.87% to the agriculture and allied sector's GVA in 2020-21. The country has vast livestock resources with 536.76 million heads. Among all the livestock, water buffaloes have emerged as a multipurpose animal owing to their contribution to milk, meat, draught and leather industry. Sheep and goat play a significant role in food and nutritional security, and have emerged as an important source of livelihood for millions of rural poor and pastoralists, especially in the rainfed regions where crop production is uncertain and rearing large ruminants is restricted due to acute scarcity of feed and fodder. Water buffaloes have become the preferred animal among all categories of farmers due to many advantages like efficient conversion of coarse feed, straws and crop residues to milk and meat, resilience and adaptability, wider acceptability of buffalo meat and milk, climate smart nature, and so on. The present system of production and marketing of buffalo milk and meat for domestic and export markets is endowed with multifarious challenges, and needs corrective actions at various levels. There are multiple stakeholders along the buffalo milk and meat value chain who operate in isolation, and there is a lack of information at various levels along the chain. The whole idea of value chain is to generate value for all the actors, while also analysing how different actors in the chain exchange knowledge to enter the market. Development of livestock value chain for local and external markets can be considered as a powerful tool for poverty reduction and to fight against the challenges of food security in developing countries like India. There are a number of stakeholders like farmers, traders, wholesalers, retailers, big retail chains and consumers, who are involved in the livestock commodity value chains, and the partitioning of gains among the stakeholders along the chain is often debated and analysed.

Though India is the largest milk and buffalo meat producer and the second largest goat meat producer, there are concerns like lower productivity due to non-availability of pure, superior indigenous germ plasm, shortage of dry fodder, concentrates and green fodder, poor animal health services and disease outbreaks, and so on. Major emphasis is required on improvement of well adapted indigenous breeds to harness the better adaptive traits developed through natural selection. Cross-breeding with high yielding exotic and other native breeds of goats must be considered. The feed and

fodder resources play a prominent role in profitable livestock farming, as it constitutes the major share of production cost. Hence, it is important to enhance the productivity of fodder per unit area and the utilisation of waste lands and newer non-conventional feed ingredients for goat production. Advances in animal health are expected to play a major role in the progress of livestock industry. Control of animal diseases assumes prime importance in the crucial time of shifting of animal agriculture from extensive to intensive and commercial system of management. Strategic control and eradication of economically important diseases can result in enhancing sheep and goat production in the country.

Production and marketing aspects of livestock produce are intertwined with each other. The value chain of buffalo meat production for the domestic market is very informal. Traders play a very active role in this value chain as an intermediary aggregators. Farmers have limited market access, and are isolated from major consumers due to logistical and transport costs. Sheep and goat value chain actors comprise of producers, primary traders, secondary traders, small butchers and urban butchers. Export oriented buffalo and sheep meat processing plants are sourcing buffaloes and sheep from the suppliers, who collect and bring the animals from different livestock markets of the neighbouring districts or from neighbouring states or even far away states where they are available.

There is no common slaughter policy in the country, as slaughter of animals is a state subject. Each state has its own slaughter policy detailed in the state animal preservation acts. The states have enacted the prevention of cow slaughter and animal preservation acts largely meant for regulating slaughter of cow and its progeny. However, a number of states have also included buffalo slaughter regulation provisions in the same acts which is affecting buffalo slaughter and export of buffalo meat. The slaughter policies need to be farmer oriented, as they have to continue with the enterprise for their livelihood, and are more aware of the performance of the animal and its worth for retaining. Majority of buffalo meat is processed in the Agricultural and Processed Food Products Export Development Authority (APEDA) approved export oriented abattoirs – most of them are integrated meat processing plants, and have adequate infrastructures to practice strict sanitary and phytosanitary measures. More than 90% of the buffalo meat produced in India is exported under frozen conditions. Sheep and goat are mainly slaughtered in municipal slaughterhouses, and hot carcasses are transported

to retail meat shops and sold fresh to consumers without any chilling. Most of the slaughterhouses lack basic facilities for efficient utilisation of by-products. Less than 2% of the sheep and goat meat undergoes processing in India. However, considering the growing demand for hygienically processed meat, there is a potential for value addition, packaging, branding and e-retailing of sheep and goat meat.

Extension of knowledge, technology and services through extension education to the grassroot level is of paramount importance for the growth of the livestock sector. The field level extension functionaries of the major sheep and goat rearing states need to be targeted during the coming decades, and regular training should be provided on the latest technological developments. Training of farmers, trainers and other targeted groups is one of the important aspects for dissemination of knowledge and information to end users. The sustainability of the value chain plays out simultaneously along three dimensions, namely, economic, social and environmental. There is a growing need for sustainability in meat supply chains to decrease the impact on environment, when a supply chain's economic and social needs are sought to be achieved. Environmental issues like methane emission, over grazing and soil erosion/pasture degradation, slaughterhouse effluents, disposal of carcasses, disposal of wool processing/dyeing waste, etc., need attention in planning and policy for protecting environment from pollution.

The Government of India has taken several initiatives for the overall growth and development of animal husbandry and dairy sector in the country, and state governments are also implementing different value chain strengthening programmes. The insurance of livestock is the best safeguard for minimising the risk of smallholder producers because of higher risk of loss of production and animals due to diseases and feed scarcity. There are many challenges and policy issues in livestock value chain that require attention in order to make this sector more vibrant. This policy paper comprehensively covers the buffalo, sheep and goat sector, inputs and value chain analysis, transportation and marketing structure, domestic and export meat production, processing and value addition, research and development (R & D) and technological innovations, and government schemes and initiatives make significant contributions for doubling farmer's income. Several issues and recommendations have been prescribed for improving the sector-specific value chain, which will help in achieving better profits and employment for the smallholders. A few researchable issues have also been recommended for effective value chain management and maximum income realisation for the farmers.

Sustainable Meat Value Chain and Enhanced Farmers' Income

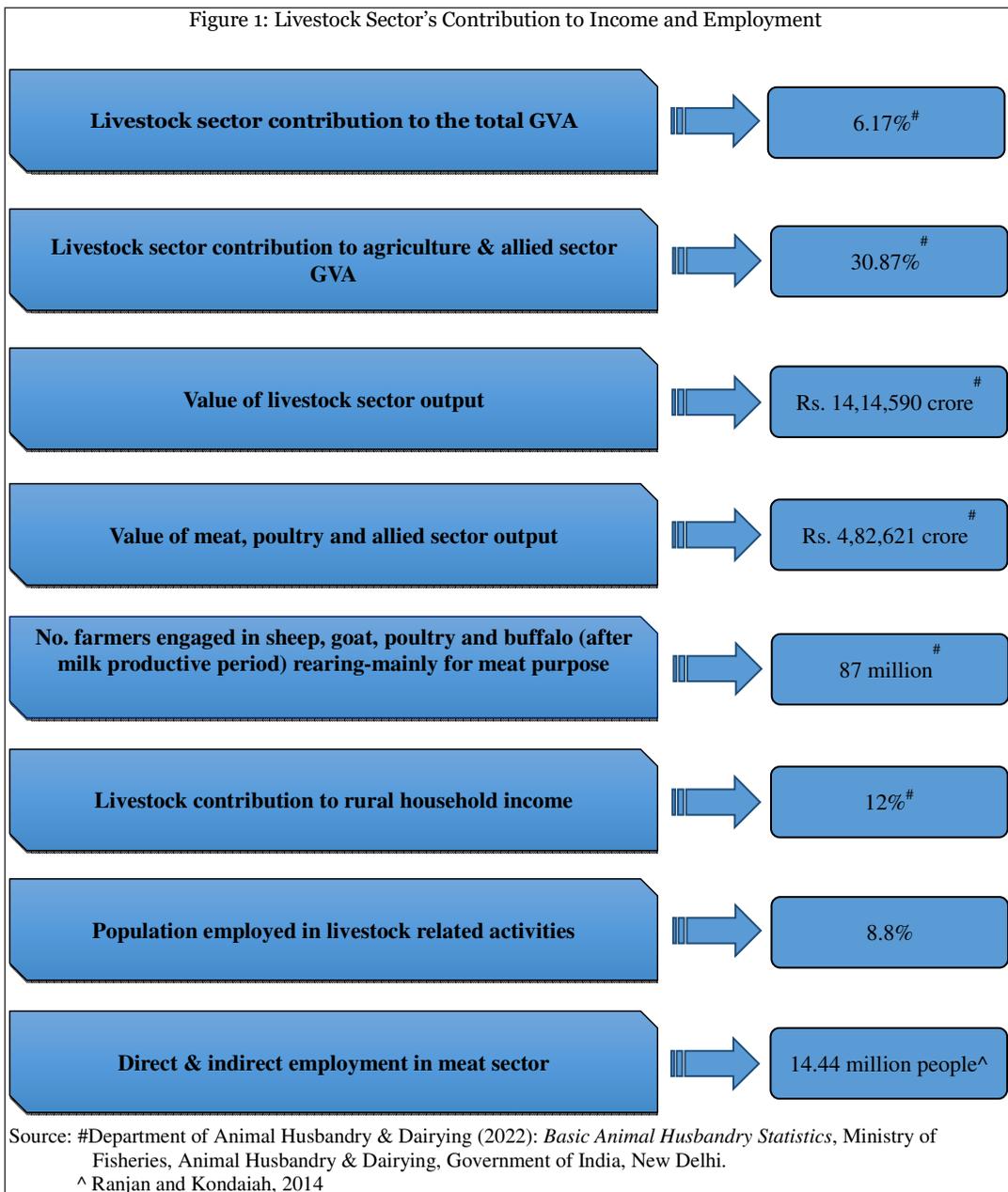
1. Introduction

Agriculture and animal husbandry are culturally, socially and economically intertwined with the intricate fabric of human society, as mixed farming and livestock rearing are a vital element of rural life (Dagar, 2017). In 2020-21, the livestock sector has grown at the rate of 7.93%, and is ahead among all sub-sectors of agriculture. Therefore, diversification towards livestock, poultry and non-farm sector activities is considered ideal, especially for small holders who do not possess adequate land to generate enough income for the family (Satyasai and Mehrotra, 2016). Further, as the livestock is mostly owned by the resource poor and impoverished population, inclusiveness in growth and development and empowerment is possible at a faster pace mainly through livestock and poultry (National Academy of Agricultural Sciences, 2016). About 20.5 million people depend upon livestock for their livelihood, and this sector provides employment to about 8.8% of the population. India has vast livestock resources numbering 536.76 million in total. The livestock sector contributes 6.17% to the total gross value added (GVA) and 30.87% to the agriculture and allied sectors GVA. The contribution of livestock to the total agriculture and allied sector GVA (at constant prices) has increased to 30.87% in 2020-21 from 24.38% in 2014-15 (Department of Animal Husbandry and Dairying, 2022). Livestock income has become an important secondary source of income for rural families and has assumed a key role in realising the goal of doubling farmers' income.

An overview of the livestock sector's contribution is presented in Figure 1. Water buffaloes have emerged as a quadruple function animal, owing to their contribution in milk, meat, draught and leather industry. In 2020-21, livestock and poultry sectors have contributed Rs. 14,14,590 crore to national GVA (Department of Animal Husbandry and Dairying, 2022). The sector employs 8.8% of the population by providing livelihood support to 20.6 million people (Department of Animal Husbandry and Dairying, 2018). Within the livestock sector, the Indian water buffalo contributes roughly around Rs. 3,10,531 crore, which is 27.93% of the total livestock sector output. Sheep and goats play a significant role in food and nutritional security of the rural poor, especially in the rainfed regions, where crop

production is uncertain and rearing large ruminants is restricted due to the acute scarcity of feed and fodder. Small ruminants contribute 15% to 27% of the family income of small holders' and provide gainful employment of 180 man days to 330 man days per annum, depending on the size of the flock. The sheep and goat sec-

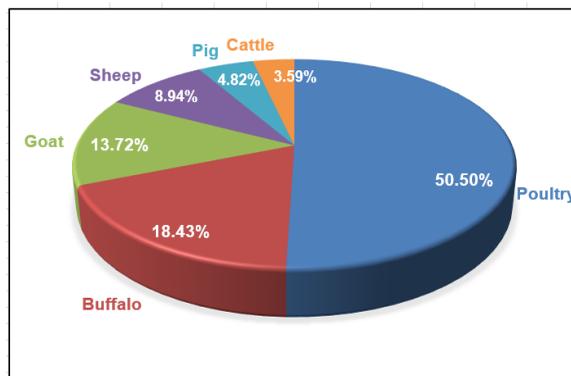
Figure 1: Livestock Sector's Contribution to Income and Employment



tor has contributed Rs. 89,768 crore to the country's GVA in 2020-21, and has the potential to contribute over Rs. 1,50,000 crore. India has 44 registered sheep and 34 registered goat breeds (ICAR-National Bureau of Animal Genetic Resources, 2021), and holds 3rd and 2nd position in the world for sheep (74.26 million) and goat (148.88 million) population in 2019-20, producing 0.678 million tons and 1.097 million tons of meat, respectively. The development of the goat sector alone has the potential to impact the livelihoods of 20 million goat rearers (NSSO, 2013), belonging to resource poor and socially backward segments of the society living in ecologically vulnerable areas.

Rising per capita income, growing urbanisation and unfolding globalisation are boosting the demand for high-value commodities including meat and poultry products (Birthal and Joshi, 2006). In 2021-21, the total meat production in the country was 8.6 million tons. Figure 2 maps out the contribution of different species to the total meat production in the country. Towards 2050, it is expected that the population in India would increase by 34%. In order to fulfil the dietary recommended levels of the livestock products by the Indian Council for Medical Research (ICMR) for a population of 1.7 billion people, the livestock sector should produce 186.2 million tons of milk, 18.7 million tons of meat and 306 billion eggs per annum (ICMR-National Institute of Animal Nutrition and Physiology, 2013). However, in spite of the huge contribution in terms of economy, livelihood and nutritional security the sheep and goat sector are still unorganised with several gaps along

Figure 2: Contribution of Different Meat Animal Species to the Total Meat Production



Source: Department of Animal Husbandry & Dairying (2022): *Basic Animal Husbandry Statistics*, Ministry of Fisheries, Animal Husbandry & Dairying, Government of India, New Delhi.

the supply chain including lack of meat breeds, animal marketing, transportation, hygienic slaughter, waste management, processing, cold-chain logistics and modern retailing facilities. Although the retail landscape has changed in the recent years due to the entry of e-commerce platforms, the slaughter and processing of sheep and goat is still unorganised. There are a number of stakeholders involved in the livestock commodity value chains, and the partitioning of gains among the stakeholders along the chain is often debated and analysed. Any value chain must address the issues of quality input supply, technology induction, optimisation of input costs, productivity enhancement, postharvest management, primary and secondary processing, storage and transport logistics, distribution network, and ultimate supply to the consumer. Various actors are involved in small ruminants and buffalo meat value chain right from rearing to marketing.

In order to meet the burgeoning demand for meat and meat products, the sector (buffalo, sheep and goat) specific approaches including evaluation of the existing situation, challenges, policy and regulatory guidelines along the value chain must be developed. However, very few studies are conducted in buffalo, sheep and goat value chain, and no efforts are made to analyse gaps in the development of the meat sector, understand the potential of livestock sector, strategise promotion of meat exports and revisit slaughter policies, and suggest measures for sustainability of buffalo, sheep and goat meat value chain. Very few sporadic studies in meat value chain were conducted at the district level in a couple of states (Life Academy of Vocational Studies, 2017; Intercooperation Social Development India, 2016, 2020), and through these studies, it is not possible to present a true overall picture of the sector in a vast country like India where production system and distribution, marketing of livestock and products varies from region to region and are specific to a particular species. It is, therefore, essential to review the buffalo, sheep and goat sector inputs, transportation and marketing structure, domestic and export meat production, processing and value addition, technological innovations, government schemes, and initiatives. Several issues and recommendations have been prescribed for improving the sector-specific value chain that will help in augmenting farmers' income, improving nutritional security and providing employment opportunities. Researchable issues and way forward have also been recommended to build a safe, resilient and sustainable buffalo, sheep and goat meat value chain in India.

1.1 Sectoral Importance

1.1.1 Buffalo

Buffaloes have become the preferred animal for all categories of farmers due to their advantages like efficient conversion of coarse feed, straw and crop residues to high quality milk and meat, adaptability, lower maintenance, disease resistance, and demand for lean and healthier buffalo meat and leather (Nanda and Nakao, 2003). The population of buffaloes has increased from 44.90 million (14.8% of the total livestock) in 1951 to 109.85 million (20.5% of the total livestock) in 2019 (Table 1). Indian buffaloes comprise about 58% of the total world population, and contribute more than 45% of the total milk production and 30% of the meat production in India. The average holding of milch buffaloes was estimated to be in the order of 1.42, 2.83 and 5.72, for small, medium and large herds, respectively. The average consumption of green fodder of small, medium and large herd per day per herd (day/herd) was reported to be 11.12 kg, 5.98 kg and 5.24 kg, respectively. Feed cost was the major item in buffalo production and accounted for Rs. 234/day/herd. The feed cost accounts for more than 50% of the total cost, followed by fixed cost (18%), labour cost (13%), which mainly consists of family labour, and recurring cost and veterinary expenses (10%) (Dikshit *et al.*, 2006).

The country's milk production has increased from 28.50 million metric tonnes (MT) in 1977 to the current production of more than 209.96 million MT, accounting

Table 1: Species-wise Distribution of Livestock (in %)

Livestock Species	Census years										Change in 2019 over 1951
	1951	1961	1972	1982	1992	1997	2003	2007	2012	2019	
Cattle	53.04	52.36	50.42	45.87	43.45	40.97	38.18	37.58	37.28	35.93	-17.11
Buffalo	14.82	15.27	16.23	16.63	17.88	18.52	20.19	19.89	21.23	20.50	+5.68
Sheep	13.35	11.99	11.31	11.62	10.79	11.85	12.67	13.50	12.71	13.86	+0.51
Goat	16.12	18.16	19.10	22.70	24.48	25.28	25.64	26.53	26.40	27.79	+11.67
Pig	1.50	1.55	1.95	2.40	2.72	2.74	2.79	2.10	2.01	1.69	+0.19
Others	1.17	0.67	0.99	0.76	0.68	0.64	0.53	0.32	0.37	0.23	-0.94
Total livestock	100	100	100	100	100	100	100	100	100	100	

Source: Department of Animal Husbandry & Dairying (2020): *Basic Animal Husbandry Statistics*, Ministry of Fisheries, Animal Husbandry & Dairying, Government of India, New Delhi.

for 23% of the global milk production. Further, the per capita milk availability in the country has also increased from meager 125 gram per day in 1977 to 427 gram per day in 2021. In addition to meeting the domestic demand, India exported 39,397.62 tonnes of dairy products worth of Rs. 1,492 crore (that is, \$201.4 million) in 2020-21 (Agricultural and Processed Food Export Development Authority, 2022).

Over the last few decades, the meat function of buffaloes has increased with surging exports due to the organised development of buffalo meat export industry. Though the buffalo meat is a by-products of the dairy industry, there is a rising demand for India's buffalo meat exports and due adherence to stringent safety and health norms in the value chain. Buffalo meat with lower intramuscular fat, cholesterol and calories, higher units of essential amino acids, biological value, iron content, and residue free status would make it one among the healthiest meats for consumption. The country has exported 1.09 million MT of buffalo meat worth of \$3.17 billion in 2021-22 (Agricultural and Processed Food Export Development Authority, 2022). Further, buffaloes contribute about 40% of the total leather from all species. The export of leather and leather goods fetched \$3.3 billion and \$3.68 billion, respectively, in 2020-21.

1.1.2 Sheep and Goat

As per the 20th *Livestock Census*, the total sheep population in the country was estimated at 74.26 million (13.8% to the total livestock population), which increased by 14.1% over the previous census, and this sector contributed nearly 8% (0.678 million tons) of the total meat production (8.1 million ton) and employed nearly six million people in the country (Department of Animal Husbandry and Dairying, 2019). Sheep with its multi-facet utility for wool, meat, milk, skin and manure form an important component of the rural economy particularly in the arid, semi-arid and mountainous areas of the country. It provides a dependable source of income to the shepherds and pastoralists through sale of wool and animals. Sheep rearing contributes around 8.5% of the total value of output from the livestock agrarian economy, especially in the arid and semi-arid and mountainous area – regions considered not economical for crops and dairy farming (Wodeyar and Kadam, 2018). Sheep rearing in India is an inseparable component of mixed farming system in view of the prevailing socio-economic conditions in the country, where per capita land holdings is hardly 0.2 hectares (Ministry of Agriculture and

Farmers Welfare, 2020). Landholdings in general have a negative association with sheep and goat rearing. Because of scanty suitable grazing lands in most of the states, the shepherds keep on migrating their flocks over extensive areas within or even in the neighbouring states. Sheep and goat farming has been undertaken by people across the income and social group during the last few decades. However, large size (50 to 300 animals) herd/flocks have been reduced due to the gradual shrinking of grazing land in almost all the regions.

Development of the goat sector has the potential to impact the livelihoods of 20 million goat rearers (NSSO, 2013), belonging to resource poor and socially backward segments of the society living in ecologically vulnerable areas. Goat farmers could earn 250% to 300% higher incomes from goat rearing only by adopting scientific norms of goat management (Deo and Hegde, 2013). The potential to earn is still higher by improving herd size and engaging in goat rearing as an enterprise by rural households. The system of goat management is mostly a function of social acceptance of the community to goats, availability of land, pasture, human resource, capital and economic dependence on livestock in general and goats in particular, etc. Depending upon these factors, the systems of goat management vary from place to place. The systems of goat management are of different types; village system, extensive system, semi-extensive system, intensive system and very intensive system, etc. These systems involve varying types of goat rearing (Devendra and Burns, 1983). The sheep and goat are mainly dependent on common property resources (CPRs) for meeting their feed and fodder requirements. The CPRs comprise barren and uncultivable lands, cultivable wastes, permanent pastures, and other grazing land and land under miscellaneous trees, crops and other fallow land. In spite of their critical role in the livelihood security of the rural poor, the CPRs are declining continuously (Murthy and Patra, 2011). Family labour and common grazing resources were observed to be the critical and major inputs used in the goat production system. Scarcity of feed and fodder are the major constraints in the existing small ruminant production system, and better management of common feed resources is crucially important for improved fodder supplies in rainfed areas. Due to its good economic prospects, goat rearing under intensive and semi-intensive systems for commercial production has been gaining momentum for the past couple of years. The implementation of goat husbandry technologies in farmers' flock provided average employment ranging from 80 to 140 man-days in a year.

Lack of veterinary health services in remote and ecologically vulnerable areas and the absence of good production practices are resulting in disease outbreaks among sheep and goat. The *Peste des Petits Ruminants* (PPR) or goat plague is the most important disease of sheep and goats, causing an economic loss to the tune of Rs. 1,800 million per annum. The foot-and-mouth disease (FMD) is the most important infectious disease of cattle and buffaloes, causing an economic loss of Rs. 20,000 crore per annum (Saxena *et al.*, 2017). The ICAR-Central Institute for Research on Goats (CIRG) is working on improving the productivity and genetic potential of indigenous goats through supply of superior germ plasm from institute to the state animal husbandry departments, other developmental agencies and goat farmers (ICAR-Central Institute for Research on Goats, 2020). The Institute has developed health technologies, and diagnostics are being developed regularly for the benefit of goat as well as goat keepers. Over the past few decades, the research institutes including ICAR-Central Sheep & Wool Research Institute (CSWRI) are working on this sector, offering a number of technological options that could raise the productivity of different species. These include genetic enhancement of indigenous breeds through crossbreeding with exotic breeds, improvement of nutritive quality of feed and fodder through biological and chemical treatments, development of vaccines against animal diseases, improved livestock management practices, and postharvest management.

High demand for goat and its products with potential of good economic returns have been driving many progressive farmers, businessmen, professionals, ex-servicemen and educated youths to take up the goat enterprise on a commercial scale (Kumar, 2007). Goats provide food and nutritional security to the millions of marginal and small farmers and agricultural labourers. However, the productivity of goats under the prevailing traditional production system is very low (Singh and Kumar, 2007). It is because they are maintained under the extensive system on natural vegetation on degraded common grazing lands and tree lopping. The chevon (goat meat) is the most preferred and widely consumed meat in the country. Goat milk is recommended for infants, old and convalescent people (Pal *et al.*, 2011). Adoption of improved production technologies and management practices in the farmers' flock is very low. Thus, rearing of goats under intensive and semi-intensive system using improved technologies for commercial production has become imperative, not only for realising their full potential but also to meet the increasing demand of chevon in the domestic and international markets.

2. Production and Input Supply to Buffalo, Sheep & Goat Value Chain

2.1 Availability and Supply of Breeding Stock

India has 17 registered water buffalo breeds, which are predominant in different regions or areas of the country (ICAR-National Bureau of Animal Genetic Resources, 2021). The buffaloes in India belongs to indigenous germplasm and most of the animals are Murrah or Murrah type (44.4%). The important breeds include Murrah, Nili Ravi, Jaffarabadi, Surti, Mehsana, Bhadawari, Nagpuri and Pandarpuri. As per Department of Animal Husbandry and Dairying (2013), five buffalo breeds are confined to a single state, whereas, rest of the breeds are distributed across two or more states and union territories (UTs). The buffalo breeds having larger area of distribution include Murrah (22 states/UTs), Jaffarabadi (12 states/UTs), Surti (12 states/UTs), and Mehsana (10 states/UTs). Different breeds vary in their body weight, shape and texture of the skin (Deo and Hegde, 2013).

Though India is the world's highest milk producer and the second largest goat meat producer, the availability is limited owing to low livestock productivity due to diseases and short supply in terms of dry fodder, concentrates and green fodder (ISDI, 2020). Improvement of breeds may be performed through either crossbreeding or upgrading. But there are many challenges in improving the breeds, like the availability of elite bull and lack of awareness among the farmers about the scientific breeding practices. Another challenge is the adoption rate of artificial insemination (AI), because it is still only 24.5% of the full adoption potential (Rathod *et al.*, 2016). Possible interventions can be the raising of awareness among the farmers about the scientific breeding practices, doorstep AI services, use of progeny tested semen for AI, use of embryo transfer technology, etc. (National Dairy Development Board, 2018). There is a need to invoke "foresight technology" to seek the perspective from the future rather than extending the present (National Academy of Agricultural Sciences, 2016). Nondescript low producing buffaloes are to be crossed and upgraded with the semen of the best descript or defined breed in terms of the trait of interest – Murrah for milk and Jaffarabadi for fat and body weight (National Academy of Agricultural Sciences, 2016; Madan and Prakash, 2007).

The sheep breeds in India have been classified on the basis of agro-ecological regions like North temperate region, North-Western arid and semi-arid region, South-

ern peninsular region and Eastern region. India possesses a vast diversity in sheep genetic resources in the form of 44 well established breeds and 34 goat breeds, which are spread in different agro-climatic zones of the country (ICAR-National Bureau of Animal Genetic Resources, 2021). These breeds have evolved through natural selection and selective breeding by rearers for adaptation to specific agro-ecological conditions (Mandal *et al.* 2014). However, intermixing of nearby breeds, introduction of exotic breeds and change in the farming system have resulted in a decline in the purebred population. Breeding policy for sheep and goat must focus on efforts to improve growth, body weight, reproductive efficiency, meat and wool quality and quantity, and to reduce mortality. An area specific approach should be adopted to improve quality and quantity of coarse wool and fine wool. Main focus should be to produce and distribute good quality rams and bucks from indigenous breeds, which can thrive in different agro-climatic conditions.

Goats in India consist of a number of varieties, and are distributed across all agro-climatic regions of the country. Some varieties produce only fiber, whereas some are reared for meat and milk and few for meat only. Production of breeding males having high genetic potential should be an essential element of the breeding policy for each species and breed. Formation of breed associations by involving farmers for improvement of indigenous breeds of various species and identification and registration of animals having good genetic potential must be promoted by providing financial, technical and organisational assistance. In the case of buffaloes, the semen of the high genetic merit bulls should be made easily available to the farmers to improve productivity. There is a problem of availability of adequate number of elite males to opt for genetic improvement of goats by natural service under field conditions. A majority of the goat population in India is nondescript having lower production potential. In goat breeding practices, completely unplanned breeding by the 'stray buck' is in practice throughout India. Hence, a breeding policy should be followed with marker assisted or gene assisted selection, where yield and product quality are taken into consideration for consistent and uniform quality with health benefits to the consumers. Major emphasis is required on improvement of well adapted indigenous breeds to harness the better adaptive traits developed through natural selection. Cross-breeding with high yielding exotic and other native breeds of goats must be considered (National Livestock Policy, 2013). For example, selective breeding of Black Bengal goats, and withdrawal of old buck and introduction of new buck of distant genetic relation is one approach.

2.2 Feed Supply and Nutritional Availability

Poor livestock nutrition is one of the major production constraints in smallholder systems. The feed and fodder resources play a prominent role in profitable livestock farming, as it constitutes the major share of rearing expenses. Food and feeds contribute almost 60% to 70% of the overall recurring expenditure, so profitability of the farm can be improved by economic feeding of livestock. The key issue is feed scarcity, low nutritional quality feeds and imbalance in feeding. Feeding the balanced ration to dairy animals increases efficiency and reduces the cost of feeding (Singh *et al.*, 2019). Presently, the country faces a net shortfall of 35.6% green fodder, 10.5% dry crop leftovers, and 44% concentrate feed ingredients. The option for increasing land area under fodder cultivation is very limited. Hence, it is big challenge to utilise the available meagre land wisely with its fullest potential to produce the fodders for the animals (Singh *et al.*, 2022). By 2025, the deficit in green fodder and dry fodder will be 65% and 25%, respectively. Only 5% of the cropped area is utilised for fodder production. There is a need for restructuring the land use strategy to elevate the overall percentage of cultivable lands for fodder production to not less than 10% (Planning Commission, 2019).

Management of feed and fodder resources is crucial for the future development of goat production in the country. It is important to enhance the productivity of fodder per unit area and utilisation of the waste lands and newer nonconventional feed ingredients for goat production. Meeting the requirement of feed and fodder for sheep under the prevailing scenario of gradually diminishing grazing lands is one of the major challenges. Shrinking areas under community pasture land is a major limitation, and would adversely affect the sheep husbandry in future (ICAR-Central Sheep and Wool Research Institute, 2013). A majority of the goat keepers have been letting out animals for grazing on village common lands and community pastures, apart from feeding crop residues. However, during recent years, lack of community land development has reduced the forage production significantly. The lands reserved for grazing have been reducing due to diversion for other purposes and encroachments (Deo and Hegde, 2013). The availability of crop residues has also reduced significantly, as many large farmers have shifted from traditional food crops to cash crops and high yielding varieties of food crops, which produce lower quantity of forage. This has been affecting the growth of goats. By nature, goat can easily survive on available grass, shrubs and trees (Bhattacharya, 1988). Most of the goat keepers do not consider

supplementary feeding to be economical. Small-ruminant fattening in general is a profitable business proposition. The constraints faced are not structural or systemic but are more technical, such as access to feed, capital and technical knowledge. Extensive data were generated on carcass characteristics of finisher lambs maintained under intensive feeding (Karim, 1999). The growth response is found to be similar in kids maintained on *ad lib* concentrate and khejri or pala leaves (Sen *et al.*, 2002). Sen *et al.* (2000) concluded that concentrate supplementation beyond 2% of body weight was not desirable for the meat programme due to a higher body fat accretion. It is realised that manipulation of present production system by advocating grazing with supplementation is a better alternative for optimum production compared to intensive feeding. There are also prospects for using novel feeds from various sources to provide alternative sources of protein and energy, such as plantation crops and crops like maize, sorghum, millet and groundnut (National Dairy Development Board, 2012). The fact remains that if feed availability cannot be ensured in a well-designed breeding programme, no genetic gains can be obtained as a result of selection (National Academy of Agricultural Sciences, 2016).

Buffaloes are usually reared in India under different production systems such as:

- i. Extensive or grazing: Prevalent among economically weaker class of landless rural families and migratory families.
- ii. Semi-intensive or grazing supplemented with stall feeding: This is a widely practiced system, wherein animals are taken for 6-10 hours for grazing and additionally fed with crop residues, green fodders, agro by-products, which are area and season specific.
- iii. Intensive or stall feeding: Generally followed by medium and large farmers with adequate land holdings and producing enough dry and green fodders for feeding the buffaloes.
- iv. Peri-urban adjunct: Due to urbanisation, population settling in periphery of bigger towns and cities follow this type of buffalo rearing.
- v. Peri-urban enterprise: Commercial dairy enterprises run by traditional animal keepers maintain a herd size varying from 40-200 lactating units, which are intensively managed.

- vi. Urban intensive: Buffaloes reared under stall feeding in the city areas.
- vii. Corporate farming: Cost-intensive industrial type ventures of rich farmers or industrial houses, invariably as adjunct to large milk plants and processing units.

2.3 Animal Health Care

The occurrence of diseases is an important factor, which influences the productivity and economy of animal farming. Disease acts as a negative influence on the livestock production system, thus, setting off a cascading affect of low production, low income and subsistent livelihood. Govindaraj *et al.* (2021) revealed that there was variation in loss levels between species and among the states due to variation in disease incidence and severity levels, productive capacity of the animals, animal health infrastructure in the respective states, etc., in cattle and buffalo. There is need for timely vaccination with effective vaccines to mitigate the mortality, morbidity and consequent loss to farmers and other stakeholders in the entire livestock economy in different states in India. In this regard, there is a need for sustained active surveillance programmes and development and use of novel diagnostics for early detection of the diseases in buffalo so as pre-empt their adverse impact at the earliest.

Goats suffer from many diseases; some of these are common with other livestock species, while a few are specific to goats only. Diseases in goats result in mortality and morbidity losses, resulting in low productivity of animals (Singh and Prasad, 2008). The diseases like PPR, Enterotoxemia (ET) and goat pox are more common, and PPR has been the cause of high rate of mortality. The increasing trend in economic losses was noticed with PPR, sheep and goat pox and ET, and a decreasing trend with fascioliasis or distomatosis, anthrax and contagious caprine pleuropneumonia (CCPP). Diseases in goats result in mortality which ranges from 5% to 25% in adults and 10% to 40% in kids. India has world's lowest yield for goats (<10.0 kg carcass weight) due to endemic diseases (FMD, PPR and Blue Tongue) and poor access to preventive and curative health care resulting in 15%-40% mortality (Singh *et al.*, 2018). In addition, morbidity losses result in low productivity of the animals. Poor health care has also been affecting the productivity to a great extent (Hegde and Deo, 2015). Existing veterinary services for prevention and control of diseases in sheep and goats in the rural areas are inadequate. Because of the increased vulnerability of diseased animals,

preventive care becomes more important, particularly in small ruminants. Buffaloes can be affected by the same diseases and parasites as cattle, however, buffaloes have a higher degree of resistance and tolerance than cattle against many diseases. Buffalo breeds have varying degrees of tick resistance, however, FMD, tuberculosis, brucellosis, leptospirosis, bovine viral diarrhoea, fasciolosis, and protozoal infections have significant economic impacts on the water buffalo industry depending on the region and production system. Control of animal diseases assumes prime importance in the crucial time of shifting of animal agriculture from extensive to intensive and commercial system of management. Strategic control and eradication of economically important diseases will result in enhancing sheep and goat production in the country. Most of these diseases could be prevented through timely vaccination and good husbandry practices. Despite the Government of India initiatives, the estimated annual loss on account of PPR was Rs. 1,204 billion in small ruminants and Rs. 23.19 billion due to FMD (ICAR-National Institute of Veterinary Epidemiology and Disease Informatics, 2016).

3. Live Animal Transport and Marketing

3.1 Transportation

The value chain for buffalo meat production in the domestic market is informal. Traders play a very active role in this value chain as intermediary aggregators. Farmers (primary producers) have limited market access, and are isolated from major consumers due to logistical and transport costs. Farmers often avoid these costs directly by selling to intermediary aggregators. Traders buy the animals from various farmers and pool them for further marketing or haul purchased animals to municipal slaughterhouses. Farmers are able to sell buffaloes at better prices in livestock markets. Most animals are transported to the livestock market by tempos or vans, but a few animals are brought to market on the hoof from nearby villages (Federation of Indian Chamber of Commerce and Industry, 2013). Given the regional distribution of farmers and distances to market, transport cost is a major component of the value chain. Animal welfare has become an integral part of the Indian livestock production system with established rules on cruelty to animals and transportation. There is a concern over rising prices of buffalo and inland transportation costs, which increase the overall cost of the value chain.

Sheep and goat value chain actors are producers, primary traders, secondary traders and small butchers, and urban butchers. Their marketing process involves sorting, loading on to trucks, transportation, weighing, driving etc. Sheep and goats are transported from the point of production to livestock markets and then to abattoirs for meat production (Figure 3). Transportation logistics is more or less similar across different states, and mostly sheep and goat are driven on hoof to livestock markets and from there they are transported by road or rail. The mode of transportation depends on volume and distance. Majority of sheep and goat transporters do not carry way bills and health certificate on board. Most of the transporters and secondary traders are unaware of animal transportation rules and consequences. Loading, unloading and weighing are some the most critical activities and lack of handling facilities like suitable ramps for loading and unloading and weighing balances, and ignorant and abusive stockmanship during transportation and marketing cause stress and injuries to animals. Efforts should be made to develop detachable and foldable ramp, which could be attached to the back door of the vehicle (Photo 1a). Similarly, movable platform type balances need to be designed for stress free weighing of animals (Photo 1b).

During transport, sheep and goat may be trucked together, but should not be mixed with cattle. Feed and water should be given at 3 or 4 hour intervals during transport of sheep and goat. Dung should be removed after every 8 hours (Naveena

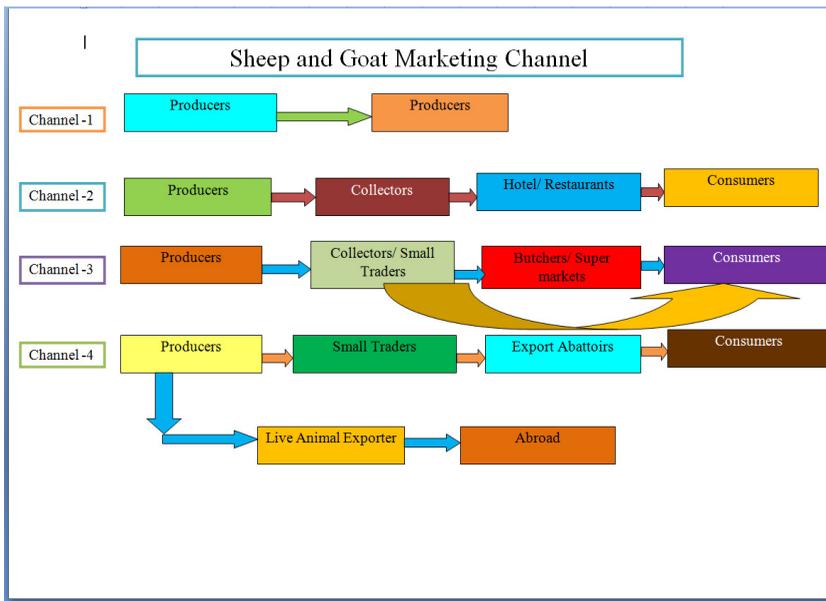
Photo 1a: Portable and Movable Weighing Balance



Photo b1: Detachable, Foldable and Portable Animal Loading and Unloading Ramp



Figure 3: Sheep and Goat Marketing Channels in India



Source: Muthukumar *et al.* 2018 and NABCONS, 2013.

et al., 2020). The provisions of the Central Motor Vehicle Rule 125 E-Special requirements of motor vehicles transporting livestock prescribe the conditions. The recent Motor Vehicle Act – Livestock Transportation (Amendment Rules) Notification, of 8th July 2015, stipulates transport of animals in accordance with the specifications of the Bureau of Indian Standards (BIS) as provided in IS-14904:2007, or IS-5238:2001, or IS-5236:1982. The notification that came into effect from January 1, 2016, required animal transport trucks to adhere to standards set by the BIS and to have permanent cages to ensure that it cannot transport more than the allowed number of animals like six buffaloes or 40 goats per truck. This type of strict regulations are practically not possible, and need a few amendments so that it can be implemented thoroughly.

3.2 Market Infrastructure

Production and marketing aspects of livestock produce are intertwined with each other. Market driven production rather than production propelled marketing is the order of the day. The market map is an analytical tool that helps in understanding policy issues that affect the functioning of the chain and also the institutions and

organisations providing the services (market information, quality standards) that the different actors need in order to make better informed decisions. Like other agricultural markets in India, those for livestock have also remained underdeveloped, in fact, much less developed in comparison to crop based commodities. There are about 2,000 markets for live animals, falling under the jurisdiction of state governments and managed by local bodies such as municipal corporations and gram panchayats. An overview of buffalo and sheep and goat market is presented in Photo 2 and Photo 3, respectively. Most of these markets lack transparency in transactions, and are short of basic infrastructure and marketing facilities.

Photo 2: Buffalo Market Facility

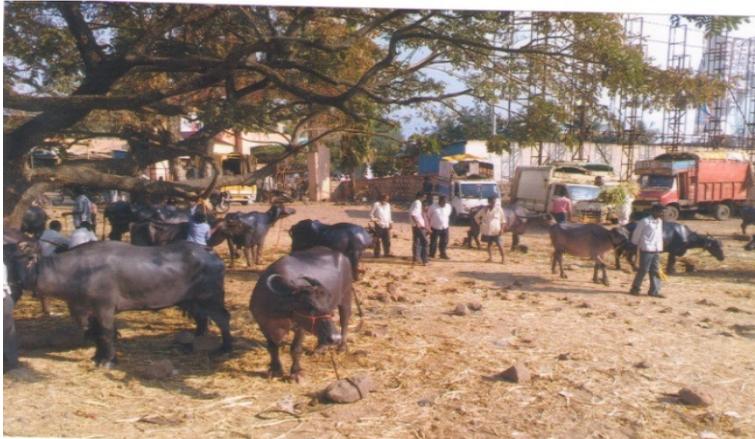


Photo 3: Sheep and Goat Marketing Facility with Different Amenities



Goat markets in India are highly unorganised and one of the most unexplored areas (Siddiky, 2017). The livestock markets are conventionally categorised into primary, secondary and end markets. The basis of this classification is mainly the number of animals that attend each market day and the number and types of market participants. Accordingly, a primary market is a market that has less than 500 heads of animals, the main sellers are the producers themselves, and the main buyers are local assemblers. A secondary market gathers 500 to 1,000 heads of animals, and in terms of market participants, the main sellers are local assemblers, while the main buyers are big traders. An end market holds more than 1,000 heads of animals, and in terms of market participants, traders are the main sellers, while butcherries, restaurant owners and export abattoirs are the main buyers. There are numerous agencies and middlemen involved in the selling, purchasing and transportation of buffaloes (Jadoun *et al.* 2014).

Different marketing channels for sheep and goat is explained below:

- Village or rural market: Village markets operate once or twice per week. They fall under the jurisdiction of gram panchayat, state jurisdiction or are managed by private players. Livestock markets are open spaces, badly managed without shelter and drinking water. Veterinary services are not available in these markets.
- Block and district market: These markets operate 2-3 days in a week. Most transactions take place between primary traders and butchers and few secondary traders who buy goats for terminal markets. These markets are located in a strategic location with high goat density
- Terminal markets: End markets are few in number operating 2-3 days in a week. Secondary traders bring goats from distant places to these markets

3.3 Participants in the Value Chain and Profit Margins

The market participants for sheep and goats are many, and include producers, brokers, small and large-scale traders, trading cooperatives, local abattoirs, individual consumers, feedlot operators, live animal exporters and meat exporters. Each of these market participants have different functions and constraints, such as the lack of feed and veterinary supplies, lack of market information and credit, recurrent droughts

and local clan conflicts, inconsistency in the quality and quantity of supplies, certification process and regulatory issues, etc. These are all critical constraints for market actors. Producers sell mainly in primary markets, while a few also sell in secondary markets. There are neither cooperatives nor producers directly linked to end markets.

- Primary traders: Located in villages, they have strong linkages with farmers and collect 1-2 sheeps and goats per day from the farmers. They travel 25-30 km per day using motorcycles to buy the animals and keep them for 2-5 days before selling in village or block markets.
- Secondary traders (block levels): Located in towns and cities, they buy sheep and goat from primary traders at the block level for butchers in cities and also send the animals to other cities and towns. They have strong communication with secondary traders at the district level, butchers in cities and traders in other markets.
- Secondary traders (district/city levels): Located in towns and cities, they buy sheep and goat from secondary traders at the block level to supply to butchers in cities and also send animals to other cities and towns. They have good communication links with secondary traders at the block level, butchers in cities and traders in other markets.
- National traders: These traders are active in the trade of sheep and goat all over the country. They collect sheep and goat from district traders and sell live animals in the national market mainly to the butchers/abattoirs.

There are very few exclusive markets for sheep and goat, and in these markets, fee collected from the agents and farmers are credited into the government account without benefitting the livestock sector. It is appropriate to use this revenue for improving veterinary health facilities, fodder supply for animals, shelter for stay, fresh water for animal drinking, etc., which are seldom visible in the market yards. Till now the livestock sector did not come under the ambit of regulatory framework for marketing, resulting in no proper database for livestock arrivals, prices along with no proper mechanism for price discovery through auction, etc. Absence of appropriate market infrastructure, lack of standards and standard operating procedures are resulting in high transaction losses due to too many intermediaries. For the buffalo value chain in the domestic market, animals are procured by aggregators and supplied by periurban

and urban dairies directly to abattoirs. The net margin is the highest for traders (retaining 57% of the total value added), and followed by retailers (accounting for 37% of the value added). In case of peri-urban and urban dairies, who sells directly to the abattoirs, the trader's share in value added is 63% (Bardhan *et al.*, 2019).

The export-oriented meat processing plants are sourcing buffaloes and sheep from the suppliers, who collect and bring the animals from different livestock markets of the neighbouring districts or from neighbouring states or even far away states where the animals are available. Immediately after arrival, the animals are examined, and those that found suffering from injuries or any painful conditions are immediately sent for emergency slaughter. The suspected animals are returned to the suppliers. Only healthy animals are sent to animal holding area or lairage after tagging their ears for identification of the supplier. The payment to animal suppliers is made on the basis of hot carcass weight. With regard to traceability, barcode is available on each meat pack for tracing it up to the factory in terms of the date and batch of production. However, animal identification is limited only to the supplier, and does not go back to the place of procurement and the primary producer (NABARD Consultancy Services, 2013). More business and export potential can be ensured if the traceability from the producer can be maintained and block chain technology can be used. Recently, the Government of India introduced Information Network for Animal Productivity and Health (INAPH), where all the information collected from each animal are made available to the farmers' and policy makers', and this helps in taking informed decisions and creating a robust database to accelerate the growth of the animal husbandry sector through mass tagging. The INAPH is general record activities of animal identification, traceability, milk recordings, general condition and health care for dairy animals. However, it would be more useful if it is integrated with the buffalo meat sector and export data, so that traceability can be maintained in the buffalo meat value chain. Thus, in order to assure quality of our food products and prevent economic and trade impediments, it is necessary to execute a proper traceability system in place (Rao *et al.* 2022).

4. Meat Production and Processing

In India, meat produced from sheep and goats are generally termed as mutton and chevon, respectively. Male sheep and goat (rams and bucks) are usually marketed for slaughtering at an average age of 12 to 14 months, and the live weight generally varies

from 20 to 25 kg. However, spent females and breeders of more than five years or very young lambs of 3 to 6 months age are also marketed for meat purpose based on the demand.

4.1 Slaughter Policy

There is no common slaughter policy in the country as slaughter of animals is a state subject. Each state has its own slaughter policy detailed in the state animal preservation acts. The states have enacted the state prevention of cow slaughter and animal preservation acts largely meant for regulating slaughter of cow and its progeny. However, a number of states have also included buffalo slaughter regulation provisions in the same acts. Some states have made laws restricting slaughter of buffalo calves (either with or without mention of age of calves) and productive buffaloes. Buffalo calves sacrifice is not permitted in the states of Bihar, Madhya Pradesh, Maharashtra and Andhra Pradesh. Some major states with large buffalo populations such as Uttar Pradesh, Rajasthan, Haryana and Punjab have no restrictions on buffalo slaughter. Uttar Pradesh has no restrictions on buffalo slaughter and has a large number of buffalo meat export plants. The slaughter policy of the country being state specific but with movement of animals from state to state without much restrictions on the movement of at least buffaloes, the effect of slaughter policy could be assessed not only on the productive buffalo population in states but also the country buffalo population.

The slaughter policies need to be farmers oriented; farmers have to continue with the enterprise for their livelihood, and they are more aware of the quality of the animal and its worth for retaining. Though buffalo slaughter policies are not controversial on account of religious reasons, there are restrictions in a number of states that limit their potential realisation. With increasing concerns of feed shortages, it would not be in the interest of the farmers to retain any unwanted buffalo showing lower production or surplus animals, which cannot be maintained with his resources. In such situations, there should not be any compulsion for retaining such animals, and the disposal should be facilitated as per the market demand.

Selection and culling are complimentary to each other for improving productivity. Culling is one of the complex decision making exercises, which is essential for a dynamic dairy enterprise. Based on the farmer's situation, culling is resorted in the best economic interest of the farmers. It is the farmers who should have the decision

making power on culling, and this should not be interfered with as it would adversely affect his returns (Nirala, 2011). The restrictions in some of the states on slaughter of buffalo calves, both male and female and adults up to 14 years and beyond, has no basis scientifically or legally, as it would result in retaining of defective, low producing and excess animals by the farmer against his resources and economics. Unreasonable restrictions would affect scientific and modern buffalo production. By banning slaughter completely, the worthless animals instead of being eliminated will multiply themselves and deprive the better part of the population of any chance of development. In addition to providing livelihood and huge revenue generation through export of buffalo meat from unproductive culled animals, effective culling of these unproductive buffaloes will help to reduce greenhouse gas (GHG) emissions to a larger extent. The environmental benefits of culling at the rate of 10% of unproductive female buffaloes are depicted in Box 1.

Box 1 Environmental Benefits of Culling Unproductive Female Buffaloes (Calculated Values)
<p>Effective culling of unproductive female buffaloes in India</p> <p>Average GHG Emission : 25kg CO₂ eq. GHG/Kg meat production</p> <p>Average buffalo carcass : 200kg (that is, 200 x 25=5000kg CO₂ eq./buffalo carcass)</p> <p>Roughly 10% of (110 million) buffaloes are slaughtered each year.</p> <p>That is, 11.92 million buffaloes x 5000 kg CO₂ eq./buffalo</p> <p>59 billion kg CO₂ eq.</p> <p>Or 0.059 billion tonnes</p> <p>Or 0.059 Gigatonnes CO₂ eq. emission is reduced each year</p>

4.2 Domestic Sector

Slaughter of animals is a state subject, and state legislatures have exclusive power in the matter as per Entry 15 of List II in the Seventh Schedule of the Constitution. Providing adequate facility for hygienic slaughter of animals and quality and safe meat to the consumers is the constitutional obligation of the state governments. Further, this is a pre-requisite for compliance with Food Safety and Standards Authority of India (FSSAI) regulations relating to establishment of small slaughterhouses {Section-V, Part IV of Schedule 4 of Food Safety and Standards (Licensing and Registration of Food Business) Amendment Regulations 2019}. For the domestic market, the local body of

the state government (municipality or corporation) provides a place for slaughter of permitted animals and collects service fees from the butchers and meat traders. The domestic value chain for buffalo meat production in India consists of a network of stakeholders, who work within specific stages from farm to plate. The chain integrates livestock producers, traders, butchers, wholesale meat dealers and retailers. Most meat consumed in India is produced in municipal slaughterhouses. The major consuming states of buffalo meat in India are Uttar Pradesh, undivided Andhra Pradesh, Kerala, West Bengal and Maharashtra. The rising slaughter of buffalo in these states is indicative of increasing consumer demand for buffalo meat. Slaughter of buffalo for domestic consumption is trending upward in some major meat producing states, which points to increasing domestic demand. The pattern of buffalo meat consumption in India may differ from state to state due to differences in consumer preference and religious taboos.

Sheep and goat are mainly slaughtered in municipal slaughterhouses, and hot carcasses are transported to retail meat shops and sold fresh to consumers without any chilling. To a large extent, meat is sold in retail meat shops/butcher shops usually in small stalls that are mostly covered on all sides except front side of the shops. In a majority of cases, meat stalls are located away from residential area and not in close proximity with fruits or vegetable stalls. However, in areas surrounding municipal slaughterhouses, the edible by-products like liver, kidney, brain and tripe are sold in open spaces. Though there is no restriction of age in slaughtering of sheep and goat, it varies with the acceptability of the consumers' regions. In Tamil Nadu, most of the goats are slaughtered in less than one year of age with the average body weight of 14 to 15 kg and with a carcass weight of 6 to 7 kg. It indicates consumers' preference for tender meat over tougher meat from old animals (Karthik *et al.*, 2017). In some parts of rural and urban areas and small towns, sheep and goats are slaughtered behind the shop illegally, and meat is sold for local consumption. This type of road side illegal slaughter should be stopped for hygienic and clean meat production.

4.2.1 Abattoir

Sheep and goat meat are premium meats in India sold at approximately Rs. 800 to Rs 1,000 per kg across the country. Most of the edible offal or by-products produced from sheep and goat are also marketed and consumed in India. Hence, the wastage from this sector is minimal. However, major chunk of the sheep and goat meat is produced in domestic municipal slaughterhouses, which are in very poor condition

and realisation from inedible by-products is very less. Most of the by-products of sheep and goats like liver, heart, lungs, kidney, head, feet and gastrointestinal (GI) tract are utilised for edible purposes. One of the major inedible by-products, hide/skin which had greater demand in the past, is currently unutilised or under-utilised due to lack of market demand (Irshad and Sharma, 2015). Hence, efforts should be directed to utilise the skin for preparing high value products such as collagen powder, collagen sheets, gelatin, pet foods, etc., for increasing profit margins. Despite the fact that pollutants of the meat industry are of bio-degradable nature, their management is essential to prevent public health risks, meet the regulations and provide a positive image to the sector. Appropriate technology suitable for small and medium category, namely, biomethanation, bio-briquettes and composting, need to be standardised for disposal of waste in an economically viable manner and also for generating wealth through utilisation of waste. Using advanced and recent technologies, it is now possible to develop eco-friendly processes in addition to treatment of wastewater generated by slaughter houses (Ahmad and Ansari, 2012).

Hence, organised slaughtering in the sheep and goat sector will improve the returns to farmers. There is a vast scope for improving the infrastructure and facilities at the service abattoirs run by local bodies to ensure supply of wholesome meat to domestic consumers. Establishing abattoir with modern facilities with line system requires huge investments. On the other hand, huge modern abattoirs established in different cities based on online slaughter concept are lying unused. Hence, semi-modern abattoirs based on individual booth models with facility for cloak room, stunning, bleeding platform, overhead rail for evisceration, separate by-products processing, proper drainage, effluent treatment plant and composting/rendering unit, which require less monetary inputs and operational problems, are more suitable for the prevailing Indian situation.

4.2.2 Retail Meat Shops

Meat sector activities including retailing of meat play a substantive role and bring great value by supporting local economies and enriching livestock farmers and other stakeholders across the value chain. According to industry research, the size of India's meat market is close to \$30-\$35 billion, which is further growing at around 18% to 20% every year (*Business Line*, August 2019). About 25 to 40 million people rely on retail food markets, including meat retailing and informal food vendors for their live-

lihoods. The retail meat shops need to be upgraded with all the basic facilities like fly proof arrangements, knife sterilizer, hand washing unit, etc., required for hygienic handling of meat in an aesthetic manner.

Globally, food and meat retailing are undergoing a major shift driven by changing consumer needs and expectations, socio-economic development and technological advancements. In India, food retailing is in focus since new retail chains are giving competition to small stores, as these do not sell meat. According to many studies, more than 90% of meat is sold through the wet market in the raw fresh segment. These traditional meat shops are usually small outlets, with a platform on the side opposite to the entrance, cutting of meat is done on wooden logs and pieces is done by using knife. Unlike meat shops in developed countries or few outlets from organised retail chains, the majority of consumers' buy meat from a freshly slaughtered animal carcass displayed in front of the customer as to see and believe what they buy. The reason that Indian consumers prefer to buy fresh meat from open/wet markets is because of the perception that meat will be fresh and better in quality.

4.2.3 Supermarkets and e-Marketing

Indian retail is one of the fastest growing markets in the world and the fifth largest global destination in the retail space. In 2006, India had 500 supermarkets which increased to 8,500 in 2016. There are 15 million customary grocery shops/kirana shops across the country and about 25 to 40 million people rely on wet markets and informal food vendors for their livelihoods. Disruptions in the e-commerce business and meat delivery startups are re-evaluating their strategies to meet the changing market dynamics. With high retail rents, e-commerce presents a more profitable alternative to operating a physical store especially in metropolitan cities, however, considering shipping costs and other logistics traditional retail shops still finds some advantages. Unlike branded items for several commodities, the meat or fish are mostly produced by small scale and unorganised business ventures and, therefore, consumers prefer to buy them physically from local markets.

There is a huge opportunity for branded players and for the organised retail to grow and expand the market, because people have until now preferred fresh meat. Now-a-days people are becoming aware of the hygiene and quality of fresh and semi processed meat, and this segment is picking up and witnessing a huge surge

in demand, so there is a plenty of scope to expand the business of e-marketing of meat. Moreover, customers are shifting from buying meat from open market outlets to modern retail stores, including e-retailing, where products are handled in a more hygienic way and stored at the right temperature with adequate product information and prompt customer service. From a retail standpoint, there is an increased willingness of consumers to try chilled and frozen products, and they are accepting it as a healthy and quick option. It is expected that with rapid urbanisation across the country, wet meat markets will shrink and sale of fresh meat will be confined to niche markets. The online meat market in India has been growing rapidly and has been the strongest in recent years. With rising protein consumption in the country, this category is bound to grow by at least 25% in the foreseeable future.

4.3 Meat Export Sector

Agricultural and Processed Food Products Export Development Authority (APEDA), an apex body under Ministry of Commerce and Industry and owned by the Government of India provides license and conducts regular inspection of meat exporting plants in India. Most of the export-oriented abattoirs are integrated meat processing plants and have adequate infrastructures to enforce strict sanitary and phytosanitary measures as per International Animal Health code of O.I.E (Photo 4). These plants utilise all the slaughterhouse by-products for production of meat cum bone meal, tallow, etc., and also produce value added meat and by-products. Though a small number of buffaloes are slaughtered in the local body owned slaughterhouses for domestic consumption, a majority of the buffalo meat production is carried out in the export oriented integrated facilities. It is mandatory that all these meat export plants should have adequate facilities for meat animal handling, ante-mortem and post mortem inspection, hygienic slaughter, dressing and meat processing, by-products collection and processing, rendering effluent treatment and disposal to get approval and recognising the facility for registration as a meat export plant by APEDA. A major proportion of the buffalo meat and a small proportion of sheep meat is being exported to 68 different countries where they have gained an excellent reputation for over 39 years. Today India is recognised as the largest buffalo meat exporter in the world and the second largest meat exporter after Brazil.

In 2021, 1.24 million tons of buffalo meat was exported. It has been in the top three export items in the agriculture commodity basket for some time. The largest

Photo 4: Buffalo Meat Processing Followed in the State-of-the-Art Hygienic Meat Export Plants



Courtesy: Allansons Limited, Zaheerabad, Telangana State, and Aswini Agro Private Limited, Vijayawada, Andhra Pradesh

importers of Indian buffalo meat include Hong Kong, Vietnam, Malaysia, Egypt, Indonesia, Iraq, Saudi Arabia, Philippines and United Arab Emirates (UAE). India's buffalo meat exports have been growing at an average annual rate of nearly 14% since 2011. The United States Department of Agriculture (USDA) has forecast that Indian buffalo meat exports could increase in the coming years because of competitive pricing and quality. Although the Indian buffalo meat industry has several inherent strengths and has opened up multitude of avenues all across the value chain and export, the sector is grappling with few external as well as internal setbacks. Among the several bottlenecks, prevalence of FMD in the country is perturbing (Audarya, 2020), and this calls for prompt eradication measures to boost buffalo meat exports from India in the short term. Recognising the enormous contribution of the buffalo meat sector in assuring a decent livelihood to farmers, stabilising the rural economy, ensuring food security and providing employment to millions, a parliamentary committee has reviewed the meat export policy in 2018. India's global supremacy in buffalo meat production can well be translated into supremacy in exports, provided stringent policy initiatives are taken to promote export-oriented quality-controlled production and processing (Kaur *et al.* 2021).

4.4 Value Addition and Further Processing

Meat processing helps to produce value added, variety and convenience meat products to meet lifestyle requirements. For efficient use of tough meat from spent buffalo, many researchers have suggested the development of value added convenient meat products, wherein meat and other components are minced to reduce their particle size and other ingredients are incorporated to improve the processing quality and palatability (Anjaneyulu, 2007). Buffalo meat is basically used in the household for preparation of curries and Kebabs. The buffalo meat has great water holding and binding properties, and is, therefore, used for industrial purposes like in the production of sausages, patties, nuggets, corn beef, ham, etc., (Kumar *et al.*, 2018). The meat processing industry is of enormous significance for the country's economic development, because of the vital linkages and synergies that it promotes. Driven by the demand for new products with new innovative formulations, the meat industry has been forced to install flexible production lines that can generate large quantities of high quality meat products with nutritional benefits (Rufina and Dorothy, 2014). The market for meat based processed ready-to-eat products is rapidly increasing. The total market for non-vegetarian value-added products is about Rs. 300 to Rs. 350 crore, the dominant share of which are chicken-based products. The growth of processed meat sector assures the farmers a regular off-take of their produce at reasonable prices and provides a wider variety to the consumers'. This is more applicable in the poultry sector, where when the market prices fall due to excess supply, it can be processed and released in the market at an appropriate time to enable the farmers' to sustain his operations.

Processing meat to value added products will provide reasonable returns from meat animals to the farmers (Kondaiah, 2004). According to a report in 2014, 35% of dairy, 21% of meat, 11% of poultry meat, 8% of marine and 2.2% of fruits and vegetables have undergone processing (chilled, packaged, branded and marketed), and the remaining produce was marketed as natural, fresh and healthy produce (Naveena *et al.*, 2018). This is mainly because of buffalo meat in which around 90% of the total meat produced (approximately 1.5 MT) undergoes chilling, packaging, freezing and branding and which is then exported. Most of the buffalo meat is processed at around 82 state-of-the-art export slaughterhouses approved by the APEDA. These processing plants have all the facilities for solid and liquid waste management and to convert all the inedible waste and by-products into meat and bone meal, meat meal, blood meal

or fertilizer using the rendering or composting technique. Hence, wastage from the buffalo meat sector in India is rather limited.

Sheep and goat meat are premium meats in India and sold at around Rs. 800 to Rs. 1,000 per kg across the country. Most of the edible offal or by-products produced from sheep and goat are also marketed and consumed in India. Hence, the wastage from this sector is minimal. However, a major chunk of the sheep and goat meat in India is produced in local slaughter houses, which are in very poor condition and lack basic facilities resulting in improper disposal of inedible offals and liquid waste. Organised slaughtering in sheep and goat sector will improve the returns to farmers. Sale of fresh meat may yield a 4% to 5% margin, however, processing into value added meat products will result in 15% to 20% profit margin for meat processors. It has been estimated that about 7% to 15% of the gross income come from by-products utilisation by meat processors (Naveena *et al.*, 2018).

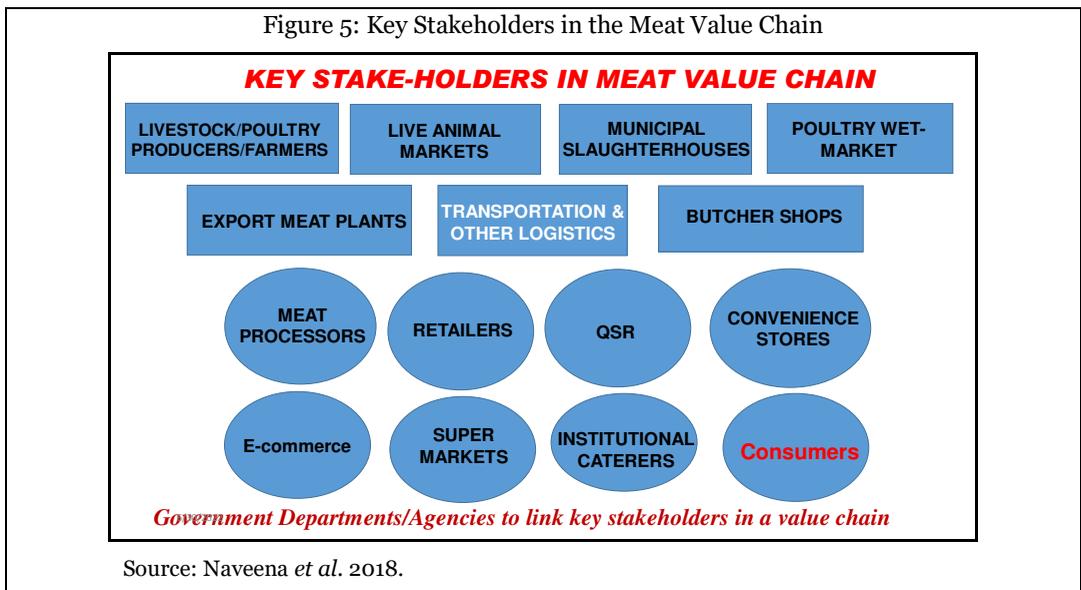
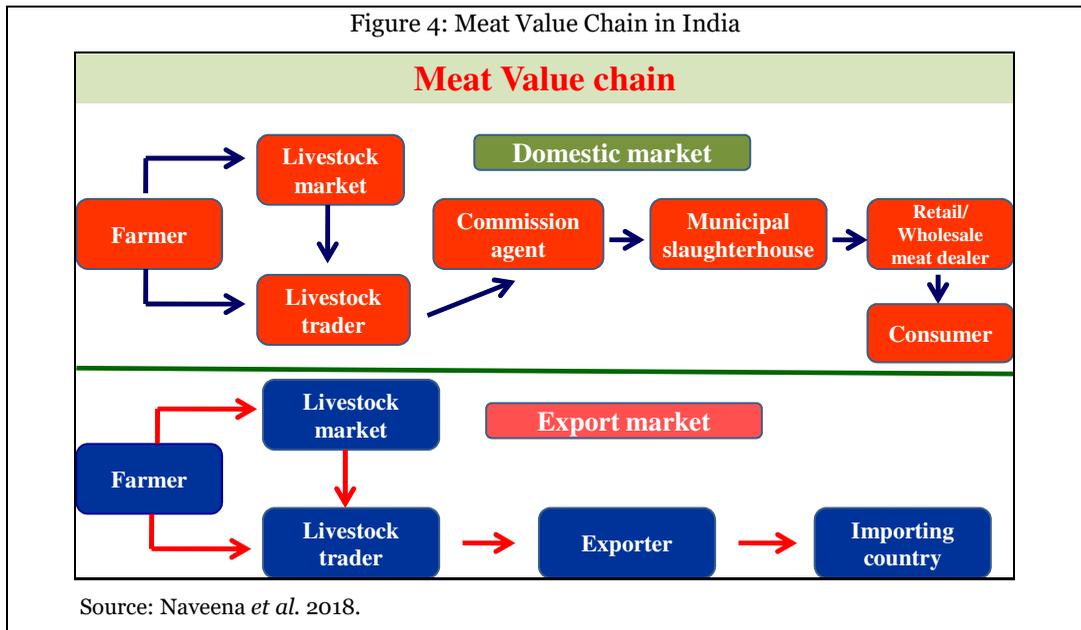
Hence, we need to focus on changing the demand for chilled meat; as long as hot meat consumption practice continues, it will encourage people to trade in fresh meat at wet markets. As the meat and poultry are highly perishable, and have a limited shelf life of 3 to 5 days under refrigeration temperature, it may not be possible for supermarkets to maintain the cold chain logistics throughout the production, processing, transportation and retailing chain. Hence, a dedicated and exclusive start up dealing with meat and poultry may provide a better alternative. However, complete integration or addressing the whole value chain is a key for startups to ensure consumer's safety. Especially sourcing of live animals and slaughtering of animals in their own slaughterhouses must be ensured. Startups need to address the entire meat value chain starting from procurement of live animals, slaughtering in hygienic slaughterhouses, processing, packaging, chilling, transportation and delivery.

5. Value Chain Analysis and Mapping

The value chain describes the sequence of related business activities or functions, from the supply of specific inputs for a particular product to primary production, sales, processing and distribution to final consumption (Kaplinsky and Morris, 2000). In other words, a value chain describes the full range of activities that are required to bring a product or service from conception, through the different phases of production and delivery to consumers and its final disposal after use (Weber *et al.*,

2018). The whole idea of a value chain is to generate value for all the actors while analyzing how the various actors in the chain exchange knowledge to enter the market. Growth and development of livestock value chains for local and external markets can be considered as a powerful tool for poverty reduction and to confront the challenge of food security in developing countries like India. This is especially true for India, where farmers are able to produce livestock products that have higher potential for value addition as compared to the conventional crops.

In the traditional value chains in India, farmers get almost 80% of the final consumer price, which is much higher as compared to other agricultural commodities. The scale of operations at every level in the value chain is very small (International Fund for Agricultural Development, 2018). Thus, any value chain must address the issues of quality input supply, technology induction, optimisation of input costs, productivity enhancement, postharvest management, primary as well as secondary processing, storage and transport logistics, distribution network and ultimate supply to consumer. Various actors are involved in small ruminants and buffalo meat value chain right from rearing to marketing. The value chain displays a number of points that are important in value chain analysis (Figure 4 and 5). Value chain analysis focuses on segmenting the different activities that add value in the production and sale of a product or service. It is expected that the involvement of the private sector will bring in greater efficiency, cost effectiveness and timeliness. The value addition in the value chain is expected to be client driven with the identification of critical missing links and bridging them through participation driven interventions. In the current marketing scenario, the agricultural produce has to go through a series of transfers or exchanges from one hand to another before it finally reaches the consumers. Since we have a tradition of rearing small ruminants as well as allied commercial activities, the time has come to think of value added activities. It is, therefore, imperative to understand the existing value chain, the way it operates, the impediments and other related issues. There are a number of stakeholders involved in the livestock commodity value chains and the partitioning of gains among the stake holders along the chain is often debated and analysed. Farmers, traders, wholesalers, retailers, big retail chains and consumers are the major actors of the value chain. A value chain is very different from a supply chain, which is simply the description of the physical flows of material from one enterprise to another. A value chain achieves vertical integration of the business through joint strategic planning, which requires transparency, trust and respect.



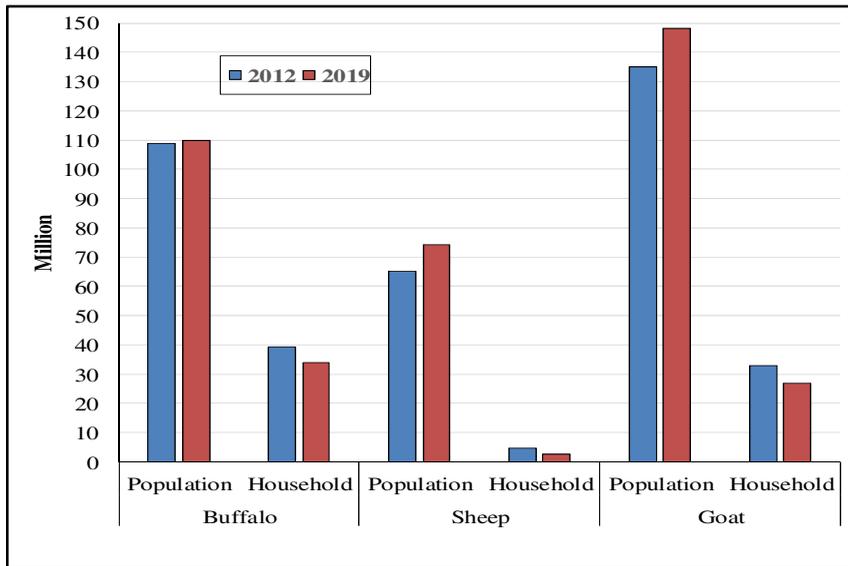
The availability and quality of domestic suppliers is a key determinant to participation in companies or private firms based value chains. The small rearers usually keep their goats in the extended portion of their dwelling houses and even in their kitchens. However, bigger flocks are kept in separate sheds along with other big ruminants. In such cases, as goats share sheds with other livestock, the cost of

shed for goat keeping is negligible. The main costs of goat rearing are the cost of the shed and feed costs, which vary largely according to intensive, semi-intensive, semi-extensive and extensive systems of goat management. In the intensive system, controlled feeding of goat is practiced and the animals are kept in total confinement, whereas in semi-intensive system, controlled and supervised grazing are practiced. The extensive system of goat management is mainly characterised by free grazing. But the intensive system of goat management is economically more feasible than the other two systems, whereas the semi-intensive system is better than the extensive one (Mandal *et al.* 2009). Small-ruminant fattening in general is a profitable business proposition, and that the constraints faced are not structural or systemic but are more technical such as access to feed, capital and technical knowledge (Kumar, 2007).

As buffaloes are reared primarily for milk, salvaging buffaloes for meat is typically a residual activity, not a planned farm business (Federation of Indian Chamber of Commerce and Industry, 2013). Buffalo meat is an adjunct; often, male calves and unproductive males and females are utilised for meat production. There is no systematic linkage among producers, traders and processors to respond to the changes in demand for meat. Hence, it is important to study the structure and governance of buffalo meat value chains. An efficient value chain management is crucial for delivering products in a safe and timely manner especially as developing-country demand grows for high value food commodities (Rich and Narrod 2005). Most of the literature on livestock value chains in India focuses on dairy value chains (Birthal *et al.* 2009; Sharma *et al.* 2009; Kumar 2010; Kumar *et al.* 2011; Wani *et al.* 2014; Birthal *et al.* 2017). There is hardly any systematic study on meat value chains, especially for buffaloes. Bardhan *et al.* (2019) found that aggregators constitute the main link between farmers and live animal markets and account for 72% of the total flow of buffaloes to livestock markets. Sub-traders/traders ship the bulk of the flow (94%) from markets to abattoirs. Of the total meat produced, 71% is shipped directly to importing countries and the rest to local markets; retailers account for 87% and restaurants 13%. Of the total value added, traders in the domestic value chains and export-oriented units capture a significant share.

There are 26.41 lakh households and 2.67 crore household enterprises in India, who reared sheeps and goats for their livelihood during 2019. However, the number of households rearing these animals has declined by 41.96% and 19.06%, respectively, for

Figure 6: Livestock Population and Number of Household and Household Enterprises Rearing Buffalo, Sheep and Goat



Source: Department of Animal Husbandry and Dairying (2019): *20th Livestock Census*, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India, New Delhi.

sheep and goat between 2012 and 2019 (Department of Animal Husbandry and Dairy, 2022). Similarly, the number of households rearing buffaloes have come down from 3.91 crore to 3.40 crore, resulting in 13.17% decline. On the contrary, buffalo, sheep and goat population has increased by 1%, 14.1% and 10.1%, respectively, during the same period (Figure 6). This suggests changes in the value chain dynamics, and this disparity may be due to a large number of entrepreneurs and startups who ventured into sheep and goat rearing through medium and large scale business replacing small scale farmers. Different state governments and sheep and goat development boards have also initiated various sheep and goat distribution schemes and programmes, resulting in a large scale inter-state movement of animals affecting household demographics and population figures.

6. Technology Induction and Extension Services

Extension of knowledge, technology and service through extension education to the grass root level is of paramount importance for the growth of the livestock sector (Joshi, 2017). The following institutions and organisations are exclusively involved in

research and development (R&D), extension, trainings and outreach programmes to support various sheep and goat sectors' stakeholders.

- ICAR-Central Sheep and Wool Research Institute, Avikanagar, Rajasthan.
- ICAR-Central Institute for Research on Goat, Mukhdoom, Uttar Pradesh.
- Nimbakar Agricultural Research Institute, Phaltan, Maharashtra.
- Sanjevani Goats, West Bengal.
- The Goat Trust, Lucknow, Uttar Pradesh.
- Ahmednagar Goat Co-op Federation Ltd., Maharashtra.
- Urmul Trust, Bikaner, Rajasthan.
- Goatwala Farm, Bhopal, Madhya Pradesh.

Some of these institutes are doing basic and applied research in all disciplines of sheep and goat production and product utilisation and to transfer technologies for improving quantity and quality of meat, milk and fibre production. However, in the absence of suitable infrastructure and skilled human resources, most of these technologies could not be transferred to needy farmers. Lack of efficient coordination between research institutions, line departments and extension network to provide inputs to the needy farmers has also been another problem. The livestock extension network is very poor or almost absent since only 5.1% of households have access to livestock related information. There is no exclusive livestock extension programme, and most services are animal health focused, not extension focused (Kumar *et al.*, 2020). Since the ICAR institutes and state universities cannot directly supply the superior germ plasm and animal health technology to the farmers' the state governments have to play a major role in livestock improvement. Lack of good quality breeding stock is a major constraint in commercialisation of goat production. The farms managed on scientific lines should be encouraged to become the centres of production of superior quality breeding animals. States have to develop multiple breeding farms with sufficient infrastructure and human resources, or else private participation is another alternative. The state governments in conjunction with research institutions need to play a major role in ensuring that livestock development programmes related

to breed development and providing health services enable the livestock owners to tap the full potential. The symbiotic roles of the public and private sectors in livestock extension service delivery and management systems by blending improved technologies with indigenous knowledge and practices and the development of public-private partnerships need to be accelerated. This needs to be backed with enhanced access to rural financial and marketing systems in an endeavour to enhance farmers' income from livestock (Saxena *et al.* 2019).

Increased participation of experts will be required in the future for identifying problems of marketing, identifying factors impeding production and in planning, execution and impact assessment of technologies in the field. Training of farmers, trainers and other targeted groups is one of the important aspects for dissemination of knowledge and information to end users. Farmers must be trained and retrained to develop their management skills for proper feeding including fodder development and conservation, proper breeding skills, disease control and prevention, basic on-farm processing methods to add value to their goat farming, simple record-keeping and the exploitation of synergies between livestock and crops. Skills for selecting the animals exclusively for meat, milk or wool and adopting modern technologies to grade the meat animals and ensuring the supply of hygienic meat with consistent quality must be developed.

7. Sustainable Meat Value Chain

The sustainability of the value chain plays out simultaneously along three dimensions – economic, social and environmental. The economic and social issues have already been discussed, and the following section covers the environmental issues, which are related to climate change, water and energy use, water pollution, soil degradation, land use change and biodiversity loss. On the environmental dimension, sustainability is determined largely by the ability of value chain actors to ensure little or no negative impact on the natural environment from their value adding activities; where possible, they should show a positive impact (Food and Agriculture Organisation, 2014).

The Indian food basket has become increasingly diversified, and consumption of high value agricultural commodities such as milk, eggs, meat and fish, and value added food has increased. Moreover, the consumer also needs quality products at afford-

able prices. This requires a sustainable meat value chain based on modern technology and diversified value added products. Small and marginal farmers play a major role in the buffalo husbandry. An analysis of survey results shows that there is a need to build long term sustainable measures for buffalo production system. Steps are needed to curb mortality of male buffalo calves in different parts of the country, as these calves could otherwise be salvaged for providing quality meat for export and domestic consumption (Federation of Indian Chamber of Commerce and Industry, 2013).

Livestock supply chains accounts for 14.5% of GHG emission while providing 34% protein. Improved management practices could reduce GHG emissions from livestock by about 30% (Food and Agriculture Organisation, 2014). Livestock production in India contributes to sustainability through:

- Use of uncultivable land for food production.
- Conversion of energy and protein sources that cannot be used by humans into highly nutritious animal sourced food.
- Reduction of environmental pollution with agro-industrial by-products.
- Generation of income and supporting livelihoods of millions of people.

Hence, there is a need to understand the ‘diversity of livestock production system’ in the country. Minimal meat processing as evident from lower value addition, traditional meat production practices without much automation, consumption of freshly produced hot meat, prevailing wet markets, local production and consumption resulting in lower food miles are all contributing towards sustainable production, processing and consumption. However, poorly managed livestock systems may have adverse effects on the environment, as well as on human and animal health and welfare. Therefore, disease outbreaks, vaccination, indiscriminate use of antibiotics, animal market infrastructure, animal transportation, lack of hygienic slaughterhouses, waste disposal and poor wet market issues must be addressed to ensure sustainability.

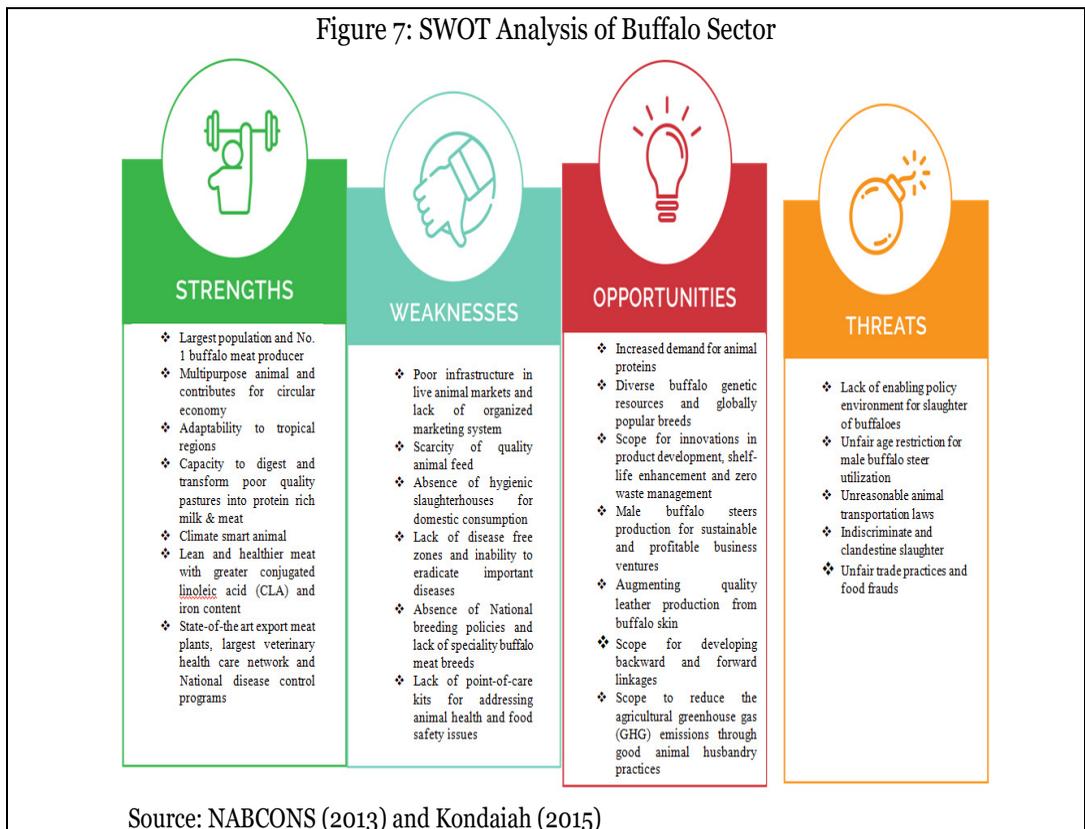
Environmental risk management through improved livestock productivity, population stabilisation, better feed, and manure use could reduce methane levels. Other possible interventions can be use of feed supplements for the animals, feed treatment of the poor quality roughages to increase the nutrient content, composting of

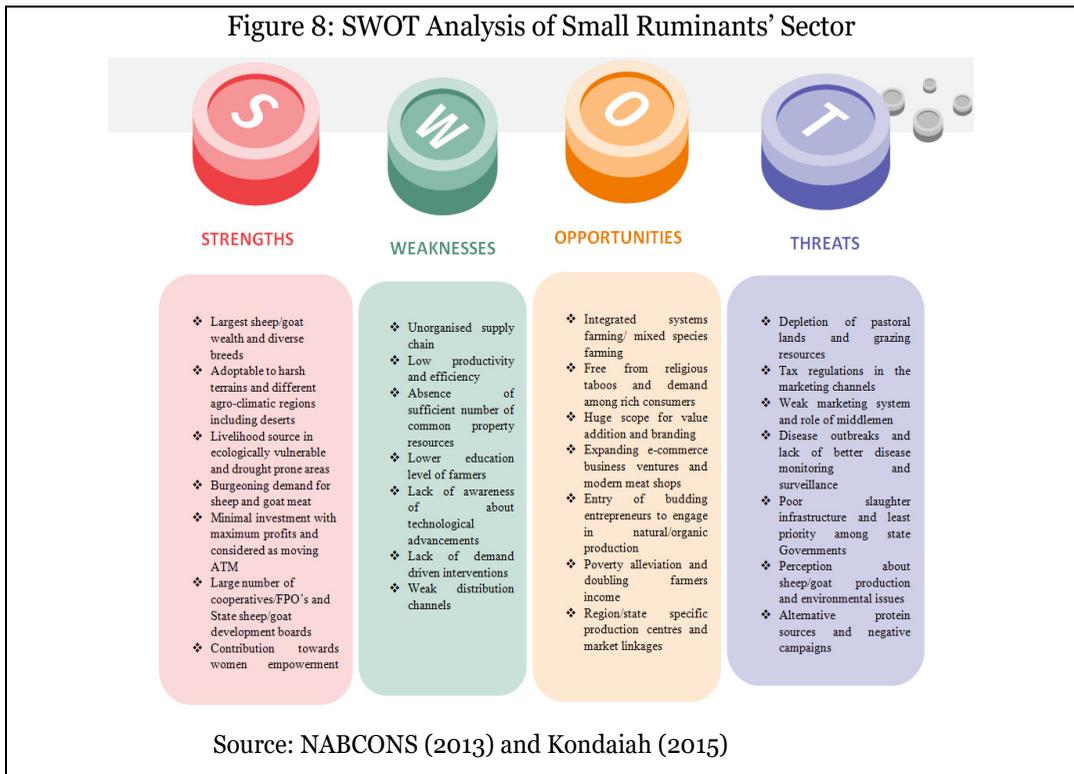
the animal waste products, and community biogas plants for the safe and income-generating disposal of the animal waste. Environmental issues like methane emission, over grazing and soil erosion/pasture degradation, slaughterhouse effluents, disposal of carcasses, disposal of wool processing/dyeing waste, etc., need planning and policy interventions for protecting the environment from pollution.

8. SWOT Analysis

Figure 7 presents a SWOT analysis of the buffalo meat sector that can help to strengthen the buffalo meat value chain to cater to both domestic and international markets, as well as enable farmers to benefit from the marketing gains. Significant weaknesses centred on the lack of policy and legislative measures for fattened buffalo meat production and slaughter policy.

Understanding the management practices adopted by the farmers is necessary to identify the strengths and weaknesses of the sheep and goat production system and





to formulate suitable intervention policies. Figure 8 depicts the SWOT analysis of the small ruminant sector in India.

9. Institutional Support Environment

9.1 Government of India Initiatives

The Government of India has taken several initiatives for the overall growth and development of the animal husbandry and dairy sector in the country. As in the case of agriculture, animal husbandry, dairying and fisheries are state subjects, and so the emphasis of the Department of Animal Husbandry, Dairying and Fisheries of the Government of India has been on supplementing the efforts of the state governments in the development of these sectors.

- The National Livestock Mission (NLM) has been launched during Twelfth Five Year Plan, with the main objective of achieving sustainable development of the sector by providing greater flexibility to states in formulating and implementing the schemes as per the local needs for the benefit of the farmers.

- The National Programme for Bovine Breeding and Dairy Development (NPBB and DD) was launched during 2013-14, by merging the four existing schemes of the department.
- The 'White Revolution – Rashtriya Pashudhan Yojana' comprising of 11 schemes is under operation. The e-pashuhaat portal, an E-market portal for bovine germplasm aims to connect breeders and farmers for ensuring the availability of bovine germplasm. The portal has been launched under the scheme 'National Mission on Bovine Productivity'. The e-Gopala app is India's first digital platform under the Aatmanirbhar Guapalak with a comprehensive animal system to enhance traceability, breed improvement, and animal health.
- The National Animal Disease Control Programme (NADCP) is a flagship scheme launched in 2019 for the control of FMD and brucellosis, by vaccinating 100% of the cattle, buffalo, sheep, goat and pig population for FMD and 100% bovine female calves of 4-8 months of age for brucellosis with a total outlay of Rs. 13,343 crore for five years (2019-20 to 2023-24).
- The Animal Husbandry Infrastructure Development Fund, launched recently, aims to increase milk production, boost exports, and increase employment by promoting micro, small and medium enterprises (MSMEs) and private companies through participation in processing and value addition in the animal husbandry sector with an outlay of Rs. 15,000 crore.
- A scheme under the Ministry of Food Processing Industries, Government of India, known as 'Mega Food Parks' was launched to provide a mechanism to link agricultural production to the market for ensure maximising value addition, minimising wastage, increasing farmers income and creating employment opportunities particularly in the rural sector.
- The National Bank for Agriculture and Rural Development (NABARD), has launched various schemes to promote sustainable and equitable agriculture and rural development through participative financial and non-financial interventions, innovations, technology and institutional development for securing prosperity.

9.2 State Governments Initiatives for Promoting Meat Value Chain

Several state governments are implementing subsidised livestock and poultry distribution schemes on a large scale aimed at facilitating not only the economic development of the rural farming community, but also production of sufficient milk, meat and egg to enhance the nutritional security in the states. A few success stories are highlighted below:

- Telangana State Sheep and Goat Cooperative Federation Limited (TSSGCFL) has supported over two lakh traditional shepherd families by providing 20+1 sheep per beneficiary at a 75% subsidy with a total project outlay of Rs. 12,000 crore.
- West Bengal Livestock Development Corporation (WBLDC) under the Department of Animal Resources Development has established the state-of-the-art sheep and goat slaughterhouses, refrigerated transport vehicles and modern retail chains, and has more than 211 Haringhata meat outlets across Kolkata city.
- Meat Products of India Limited, a public sector undertaking under Government of Kerala, has established Hi-tech Slaughterhouse at Edayar with a total outlay of Rs. 31 crore.
- Karnataka Sheep and Wool Development Corporation Limited has distributed 10+1 sheep per beneficiary, tents, kits for shepherds and constructed modern slaughterhouse, state-of-the-art animal marketing place, undertaken capacity building programs and distributed mobile meat processing vehicles.
- Uttarakhand Integrated Cooperative Development Program was implemented by the Uttarakhand Sheep, Goat and Rabbit Farmers' Cooperative Federation Limited (USGCF), and they successfully exported Himalayan goat meat bakraw in 2021.
- The Goat Trust, Lucknow, has created a goat bank, pashu sakhi, pashu bazaar and linked around 15,000 women goat rearers to market after launching the "ROUMASH" brand of meat in Uttar Pradesh.
- Ahmednagar Goat Co-op Federation Limited has established the state-of-the-art goat slaughterhouse and exported goat meat thus benefiting goat farmers.

9.3 Livestock Insurance

The insurance of livestock is the best safeguard for minimising the risk especially for smallholder producers. Its importance is paramount in case of small ruminants because of higher risk of loss of production and animals due to diseases and feed scarcity. Though the insurance companies have provision for insurance of animals throughout the country, only a very small share of small ruminants have been insured. In India, the insurance market especially in the agriculture sector is usually underdeveloped. The idea of livestock insurance emerged in India almost three decades back, yet it has not operated in significant way till date. Khan *et al.* (2013) suggested that most of the farmers are willing to participate in cattle and buffalo insurance. The low level of education of many dairy farmers have negatively influenced the decision to purchase livestock insurance. The Livestock Insurance Scheme, a centrally sponsored scheme, was implemented on a pilot basis during 2005-06 and 2006-07 of the 10th Five Year Plan. After introduction of NLM in 2014 the livestock insurance has gained importance, as risk management is well integrated into the needs of small livestock holders. The 'Risk Management and Insurance', as a Component IV of submission on livestock development of NLM, is to be implemented in all the districts. This component allows for the management of risk and uncertainties by providing a protection mechanism to the farmers against any eventual loss of their animals due to death, and to demonstrate the benefit of insurance of livestock to the people. The animal insurance schemes are implemented by the New India Insurance Company, Oriental Insurance Company, National Insurance Company and United India Insurance Company. The branches of these companies are located in almost all the districts. Most of the farmers are not willing to insure their livestock because of high premium rates and lack of awareness. When the animals are purchased with a bank loan, they are insured by the farmer, but the coverage is still very less. At the national level, only 6% of the animal heads (excluding poultry) have insurance cover (Bora, 2017). This is a matter of concern, as livestock is a security and poverty reduction instrument for the majority of the marginal and small farmers and the lack of insurance coverage makes them even more vulnerable in the event of unforeseen events (Chand *et al.* 2016). These researchers also suggested that government and other stakeholders' efforts need to be directed towards policies and programmes to create more awareness, assess the real demand of attributes preferred by farmers in the livestock insurance products and constant engagement with all stakeholders for designing and launching

any livestock insurance product. One aspect is knowledge enhancement and other is information dissemination, which will boost the insurance segment in the livestock sector. Kumar *et al.* (2018) have reported that motivation plays a central role in adoption of insurance among farmers. Further, the insurance institution should take measures like developing infrastructure, to reduce the premium and appoint proper staff to guide the farmers opting for the insurance (Singh *et al.* 2020).

10. Doubling Farmer's Income

Since Indian agriculture is dominated by small and marginal farmers who have small holdings, raising productivity is likely to be the single most important factor, if incomes of this group are to be doubled. The Government of India has a target to increase the average income of farmer household at current prices to Rs. 2,19,724 by 2022-23 from Rs. 96,703 in 2015-16 (Naveena *et al.*, 2018). The data of National Sample Survey Office (NSSO) and Central Statistical Organisation (CSO) for the years 2002-03 and 2012-13 revealed only a 34% increase in farmer's real per capita income. The dairy and animal husbandry sector have emerged as a primary source of income and the main component of agricultural activity for about 100 million rural households, mostly landless, small or marginal farmers. It is interesting to note that in the recent years, the economic contribution of the livestock is more than the food grain crops. It is so because traditionally, the crops were drivers of farm growth and food grain crops were the major part of it, and this was the reason that the government policy and programmes were focussed on crops. But slowly and gradually, the increased contribution of livestock is pointing to a structural shift in the agricultural sector. The policy makers are now recognising livestock as the engine of agriculture growth (Singh and Kumari, 2017), which led to the creation of separate Ministry of Fisheries, Animal Husbandry and Dairying, by the Government of India. The honourable Prime Minister recently noted that India produces milk worth Rs. 8.5 lakh crore annually, which is more than the turnover of wheat and rice, and underlined that the small farmers are the biggest beneficiaries of the dairy sector. Keeping in view the equitable distribution of livestock resources and the fact that contribution of livestock to farmer income is significantly increasing with the decline in farm size, there is a need for supporting allied activities to improve the cash flow of small and marginal farmers, and it can play a major role in our efforts for doubling of the farmers income by 2022 (National Bank for Agriculture and Rural Development, 2018). The com-

mittee on doubling farmer's income (Ministry of Agriculture and Farmers' Welfare, 2017) has emphasised small ruminants as important contributors to poverty alleviation, and this sectoral development is an important component of the National Rural Livelihood Mission (NRLM). Livestock owners should build a cheaper and a scientific shelter to protect the animals from the harsh weather, theft and for ensuring proper nutrition, etc. Improving the genetic material and the various breeding methods will help to enhance the productivity of the animals and ensure enhanced income. For profitable farming, detection of heat at right time and mating/breeding at an appropriate time is very much essential to increase the number of offspring per animal life cycle. Breed improvement, better feed and nutrition, animal health and better herd composition are important measures for raising livestock productivity (Chand, 2017).

India can easily double its meat production through buffalo veal production. It is estimated that about 10 to 12 million male buffalo calves are eliminated from the production system due to the non-remunerative cost of raising them in the earlier years. Due to the profitability of meat production in India, farmers now have an incentive to salvage and sell the buffalo male calves which were neglected and left to die. Salvaging these calves from early death and growing them to the larger weights of 250 kg live weight would result in production of one million MT of boneless buffalo meat of high quality, which can be exported at a premium price. Meat from such animals is tender, lean and juicy. Export oriented slaughterhouses should establish backward integration with farmers for raising these animals by providing health, feeding and extension management services at the farmers doorsteps. The meat plant should then buy back them at remunerative prices.

Presently, a buffalo farmer is earning around Rs. 15,000 to Rs. 25,000 per unproductive female buffalo, when he sells his aged animal after it stops producing the milk. Similarly, if a farmer can rear his male buffalo calf for up to 12-14 months to attain a body weight of 250-300 kg, he can easily earn another Rs. 25,000 per buffalo steer which will greatly enhance his income. As per the available data, 14 million male buffalo calves perish annually. If 70% can be salvaged, reared and processed at 175 kgs per head including edible offals when reared, they could yield 1.72 million tonnes of additional meat per annum. The country can earn an additional Rs. 25,000 crore per annum through export of male buffalo steer meat. However, this would require exclusive government schemes to support these activities and state governments must amend the existing rules to slaughter male buffalo steers.

In Afghanistan, around 70% to 80% mortality was reported among goat rearers due to haemorrhagic septicaemia. However, proper vaccination and health care has reduced the mortality to 0.5% to 1.0% resulting in increased income (International Fund for Agricultural Development, 2018). Hence, in order to ensure better income through the sheep/goat sector in India, it is important to ensure adoption of good management practices along with value chain development. Regular training, imparting skills and creating awareness among the livestock rearers will augment the income. Connecting producers, input suppliers, service providers, financial institutions, export and import companies will help to upgrade the existing value chain, thereby, minimise the risk for producers, and help raise incomes.

11. Strategic Policy Interventions and Recommendations

Focusing only on milk will not ensure sustainability of the livestock sector, nor it is economically viable. Contributions from meat, poultry, egg and allied sectors like leather, wool etc., will enormously augment the farmers income, besides providing huge employment opportunities and ensure the nutritional security of millions of people. Government schemes must be targeted to address every actor in the value chain to ensure inclusive growth. A comprehensive livestock sector policy should be aimed at enhancing buffalo, sheep and goat productivity and include all actions intended to facilitate farmers' access to animal health services, credit, and information and output markets, meat production, distribution and global recognition to bring profitability in the value chain. A produce a lot to get little approach will exert pressure on the environment, so increasing the productivity of the animals by following scientific methods of breeding, feeding, health care and management without numerically increasing the number of animals is the right approach to increase the meat production in the country. The following recommendations are derived based on the improved access to input supply, market infrastructure, market information, linkage and coordination, access to financial and insurance coverage, enabling environment, and meat production and processing:

Sheep/Goat

- Departments of Animal Husbandry and Dairying of the Government of India and state governments should evolve schemes to support and handhold entrepreneurs, who can develop high quality breeding stocks or import the best suitable breeds and multiply in lakh and distribute them among farmers.

- A region-wise breeding policy and preservation of indigenous germ plasm is required. Genetic improvement of identified indigenous descript breeds of sheep through selective breeding in their respective breeding tracts is needed for better yielding breed stock for meat, milk and wool.
- Selective breeding and withdrawal of old buck and introduction of new buck of distant genetic relation is the need of the present era. Further, a breeding policy should be followed with marker assisted or gene assisted selection, where yield and product quality is taken into consideration for consistent and uniform quality with health benefits to the consumers.
- Efforts should be made to attract private investment and encouraging entrepreneurs in large-scale production and distribution of breeding stocks to augment productivity.
- Promotion of entrepreneurs who could procure young lambs/kids from farmers and add value exclusively through fattening units and supply uniform, high yielding animals for meat production.
- Considering the fact that the migratory system of rearing of small ruminants is on the decline and traditional communities involved in this occupation have diversified, it would be prudent to slowly promote stall feeding, and at the same time, focus on providing the necessary support systems to farmers who continue to depend on rearing of these animals for their subsistence.
- Shelter management, rearing system, climate-resilient technologies and integrated production system for local ecology should be followed with creation of farmers' awareness.
- Robust live animal disease monitoring and surveillance and regular vaccination to effectively control animal diseases assumes prime importance at the crucial time of shifting of animal agriculture from extensive to intensive and commercial system of management.
- National policy is required for providing insurance to small and large ruminants and promoting index-based livestock insurance.

- Capacity building at all levels in the value chain: training to farmers, producers' organisation, service providers on scientific animal husbandry practices and training on value chain development.
- Provision of funds and access to credit are required, and there is also a need for encouraging livestock co-operatives and SHGs models at the village and block level who can effectively obtain funds, clearances and permissions from regulatory bodies and government agencies as compared to individual entrepreneurs.
- Build infrastructure and the digitisation of supply chain processes, and ensure the livestock traceability as a critical enabler to ensure efficiency and compliance with global quality standards to integrate livestock products into the global value chain.
- State governments must consider establishing hygienic slaughterhouses as a priority to ensure clean and safe meat to the public. This should be a part of a smart city plan.
- State governments have to create positive business environment for establishment of state-of-the-art slaughterhouses, modern retail meat shops and strengthening distribution channels including cold chain facilities, refrigerated vehicles and e-commerce platforms, etc. This will help millions of farmers to realise better prices, and the organised meat sector will help in better waste management, assured food safety, nutritional security, employment generation and export earnings.

Buffalo

- Upgrade and/or establish semen production centres, frozen semen banks, liquid nitrogen storage plants and AI centres, which will cater for buffalo reproduction and strengthen the existing buffalo breeding farms. These breeding farms could serve as loci for breed improvement, and as nucleus and multiplication centres.
- Streamline the animal preservation acts in the country to promote scientific practices of meat animal production, rejuvenate the scheme on salvaging and rearing of male buffalo steers for meat production and implementation of

integrated and inclusive contract farming system for buffalo meat production and promoting export for better earnings for farmers.

- Renovate and upgrade existing municipal slaughterhouses and traditional meat shops, improve business standards, and offer an alternative to closure.
- The markets for livestock and livestock products are underdeveloped, irregular, uncertain and lack transparency. Further, these are often dominated by informal market intermediaries who exploit the producers. It is important to have integrated market places and exclusive market infrastructure for perishable commodities like meat, poultry and fish with cold chain logistics including refrigerated vehicles.
- Meat processing and value addition are key to the prosperity of the meat industry. Buffalo meat exporters must be encouraged to develop various value added buffalo meat products and export them to developed countries for better profits.
- Indian buffaloes are considered climate smart and multipurpose utility animals, and have no religious significance. Unproductive female buffaloes which stop producing milk after a certain age will fetch Rs. 15,000 to Rs. 25,000 to poor farmers, and time and again, it was proven that no farmer will sell their milk productive buffaloes. State governments should differentiate buffaloes from cow/bullocks and cow protection act must be suitably amended to remove buffaloes from within the bovine preservation act. Transportation, slaughtering and export of buffalo meat must be promoted, and all support should be given to different stakeholders along the buffalo value chain to ensure higher export earnings while providing better returns to farmers. Promoting startup business ventures and private entrepreneurs to establish male buffalo steer farms and export their meat and leathers will create huge business opportunities.

12. Researchable Issues/Areas

- Carry out quantitative and qualitative gender and social inclusion analysis in livestock production to understand all gender roles, and impact of increased investment on women and marginal communities.

Box 2

Recommendation for Sheep and Goat Sector

- State governments must consider establishing hygienic slaughterhouses as a priority to ensure clean and safe meat to the public. This should be a part of a smart city plan.
- State governments have to create positive business environment for establishment of state-of-the-art slaughterhouses, modern retail meat shops and strengthen distribution channels including cold chain facilities, refrigerated vehicles and e-commerce platforms, etc. This will help the millions of farmers to realise better prices, and an organised meat sector will also help in better waste management, assured food safety, nutritional security, employment generation and export earnings.
- It is proposed to fix an approximate age limit of 10-12 months with an average body weight of 20 to 25 kg for sheep and goat for optimal meat quality and better returns to farmers.

- Study the supply of inputs, net income and price realisation per livestock in various parts of the country under different production systems.
- Economic model analysis with reference to profitability, both in small holders and commercial system of production.
- Region- and species-specific animal production practices as significant variation exists in breeds, farmer's practices, marketing and utilisation of finished products.
- Availability of feed resources (grazing/fodder) in small holder livestock production system and development of alternate feeds.
- Disruptive technologies for value chain analysis for understanding the livestock market.
- Evolving live animal grades and value based marketing tools for sheep, goat and buffaloes.

Box 3**Recommendation for Buffalo Sector**

- Streamlining the animal preservation acts in the country to promote scientific practices of meat animal production, rejuvenate the scheme for salvaging and rearing of male buffalo steers for meat production and implementation of integrated and inclusive contract farming system for buffalo meat production and promoting export for better earnings for farmers.
 - Indian buffaloes are considered climate smart and multipurpose utility animals, and have no religious significance. Unproductive female buffaloes, which stop producing milk after a certain age, will fetch Rs. 15,000 to Rs. 25,000 to poor farmer, and time and again it was proven that no farmer will sell their milk productive buffaloes. State governments should differentiate buffaloes from cow/bullocks and the cow protection act must be suitably amended to remove buffaloes from within the bovine preservation act.
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- Evaluation of real time farm economics in sheep, goat and buffalo meat value chain.
 - Development of novel, value added buffalo meat products and exploring the potential of meat processing and value addition for export.
 - By-product and waste utilisation models for efficient utilisation in small, medium and large abattoir waste disposal systems.
 - Study the energy and water consumption in small-holder livestock production system and their impact on the environment.
 - Understanding the sustainability of meat production, processing and consumption.
 - Study the role of meat value chain in income and employment generation.
 - Development of technological backstopping and role of extension services in meat value chain.

13. Conclusions

Livestock sector development has excellent potential for providing sustainable livelihood to millions of poor, marginal and small farmers, tribals and people living in disadvantaged areas in the country. However, there is a need for coordinated efforts to introduce various technologies leading to good husbandry practices and development of suitable forward and backward linkages to form an efficient value chain. A strong action plan with specific roles and responsibilities, investment by various stakeholders along with targeted approach will guide the implementation of the policy. The government interventions should create an enabling environment for the development of the sector with focus on investment in basic infrastructure, developing policies and providing a regulatory framework, along with incentives and support for private sector investment. Investment by private entrepreneurs will provide support to the growth of the sector by providing the required services along with marketing of products. There is an ample scope for further the development of buffalo meat sector, which warrants an even more enhanced proactive role from various development agencies.

Enhancing the production potential of food animals, improving infrastructure facilities for meat animal traceability and marketing, hygienic meat production, value addition, marketing and quality assurance are the need of the hour for the organised meat sector development in India and profitability in the value chain. Scientific interventions and pragmatic policies on meat production and marketing are going to play key roles in sustainability of livestock production and development of the meat sector. The success of integrated mode of poultry farming has to be extended to other animals to narrow down the gap between the demand and availability of quality meat at a competitive rate. The sheep and goat sector can come up similar to the poultry sector and can contribute significantly to livestock sector output with proper interventions and enhanced farmers' income. Understanding the market and preparing itself to respond to emerging market trends would be the prime instrument for enhancing the domestic livelihood opportunities in the small ruminant sector. Meat processing and retailing are very often described as places with poor animal handling, unhygienic slaughtering of animals that raises health concerns. However, over the years, it was discovered that lack of policy support and uniform and pragmatic guidelines for meat processing and retailing is inhibiting them from realising their full potential. Different studies have revealed the shortcomings and infrastructure gap in the meat value chain, and demonstrated that only those markets and commodities which received strong public policy support fared better.

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About The Authors



Dr. Arup Ratan Sen has contributed to integrated farming system and sustainable meat production, advanced processing technology, value addition and quality control of meat and meat products. He has handled 5 extramural research projects funded by World Bank and Government of India. He has ensured more than 25 memorandums of understandings (MoUs) for technical know-how, consultancy and contract research, and has successfully completed several sponsored research projects funded by industries. Dr. Sen has published more than 80 research papers and many books. He is vice president of Indian Meat Science Association, and has been conferred with several fellowships and other national and scientific society awards.

Dr. Naveena B. Maheswarappa has established the proteomics laboratory at Indian Council of Agricultural Research – National Research Centre on Meat, Hyderabad, and contributed to the understanding of muscle food quality, lipid-protein interaction and identified the protein biomarkers for meat colour and texture. Dr. Naveena has collaborated with industries for development, validation and commercialisation of antioxidant, packaging, slaughtering and meat processing technologies, besides ensuring more than 25 memorandums of understandings (MOUs) with entrepreneurs for technical know-how of value-added meat products. He has published more than 100 peer-reviewed journal articles, 6 books and 7 book chapters, and holds 4 patents. He is involved in developing Food Safety and Standards Authority of India (FSSAI) standards for meat and poultry products.



Dr. M. Muthukumar has 20 years of research, extension and teaching experience. His research areas include sustainable meat animal production and value chain, chemical safety of meat, value added meat products processing and entrepreneurship development. He is instrumental in establishing ISO 22000 certified experimental abattoir and poultry processing unit, agri-business incubation (ABI) centre, nutrients and chemical residues lab at National Research Centre (NRC) on Meat, Hyderabad. He has 76 research articles to his credit, authored 5 books and prepared 20 videos. He is serving as Secretary of Indian Meat Science Association (IMSA). He is also served as treasurer of IMSA and associate editor for Journal of Meat Science. He is accredited ISO 17025 and 22000 auditor and Trainer's Trainer of Food Safety Authority of India.



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