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Ministry of Agriculture &
Farmers Welfare

Report of the Committee for Doubling Farmers' Income

Volume VIII

"Production Enhancement through Productivity Gains"

Production & Productivity is linked to Market Inputs, Field Inputs, Farming Practices and Directly Impacts on the Value Realised

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Department of Agriculture, Cooperation and Farmers' Welfare,
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Foreword

The country has witnessed a series of concerted discussions dealing with the subject of agriculture. In 1926, the Royal Commission of Agriculture was set up to examine and report the status of India's agricultural and rural economy. The Commission made comprehensive recommendations, in its report submitted in 1928, for the improvement of agrarian economy as the basis for the welfare and prosperity of India's rural population. The urban population was about 11 per cent of the whole, and demand from towns was small in comparison. The Commission notes, that communication and physical connectivity were sparse and most villages functioned as self-contained units. The Commission encompassed review of agriculture in areas which are now part of Pakistan, Bangladesh and Myanmar. The net sown area in erstwhile British India was reported as 91.85 million hectares and cattle including buffaloes numbered 151 million. Almost 75 per cent of the cultivated area was under cereals and pulses, with rice and wheat occupying 46 per cent of the net sown area. The area under fruits and vegetables was about 2.5 per cent and that under oilseeds and non-food crops was about 20 per cent. In the ensuing years, as well known, the country underwent vast changes in its political, economic and social spheres.

Almost 40 years later, free India appointed the National Commission on Agriculture in 1970, to review the progress of agriculture in the country and make recommendations for its improvement and modernisation. This Commission released its final report in 1976. It refers to agriculture as a comprehensive term, which includes crop production together with land and water management, animal husbandry, fishery and forestry. Agriculture, in 1970 provided employment to nearly 70 per cent of the working population. The role of agriculture in the country's economic development and the principle of growth with social justice, were core to the discussions. The country was then facing a high population growth rate. After impressive increase in agricultural production in the first two Five Year Plans, a period of stagnancy set in and the country suffered a food crisis in the mid-1960s. The report in fifteen parts, suggested ample focus on increased application of science and technology to enhance production.

Thirty years hence, the National Commission for Farmers was constituted in 2004 to suggest methods for faster and more inclusive growth for farmers. The Commission made comprehensive recommendations covering land reforms, soil testing, augmenting water availability, agriculture productivity, credit and insurance, food security and farmers competitiveness. In its final report of October 2006, the Commission noted upon ten major goals which included a minimum net income to farmers, mainstreaming the human and gender dimension, attention to sustainable livelihoods, fostering youth participation in farming and post-harvest activities, and brought focus on livelihood security of farmers. The need for a single market in India to promote farmer-friendly home markets was also emphasised.

The now constituted DFI (Doubling Farmers' Income) Committee besides all these broad sectoral aspects, invites farmers' income into the core of its deliberations and incorporates it as the fulcrum of its strategy. Agriculture in India today is described by a net sown area of 141 million hectares, with field crops continuing to dominate, as exemplified by 55 per cent of the area under cereals. However, agriculture has been diversifying over the decades. Horticulture now accounts for 16 per cent of net sown area. The nation's livestock population counts at more than 512 million. However, economic indicators do not show equitable and egalitarian growth in income of the farmers. The human factor behind agriculture, the farmers, remain in frequent distress, despite higher productivity and production. The demand for income growth from farming activity, has also translated into demand for government to procure and provide suitable returns. In a reorientation of the approach, this Committee suggests self-sustainable models empowered with improved market linkage as the basis for income growth of farmers.

India today is not only self-sufficient in respect of demand for food, but is also a net exporter of agri-products occupying seventh position globally. It is one of the top producers of cereals (wheat & rice), pulses, fruits, vegetables, milk, meat and marine fish. However, there remain some chinks in the production armoury, when evaluated against nutritional security that is so important from the perspective of harvesting the demographic dividend of the country. The country faces deficit of pulses & oilseeds. The availability of fruits & vegetables and milk & meat & fish has increased, thanks to production gains over the decades, but affordability to a vast majority, including large number of farmers too, remains a question mark.

The impressive agricultural growth and gains since 1947 stand as a tribute to the farmers' resilience to multiple challenges and to their grit & determination to serve and secure the nation's demand for food and raw material for its agro-industries.

It is an irony, that the very same farmer is now caught in the vortex of more serious challenges. The average income of an agricultural household during July 2012 to June 2013 was as low as Rs.6,426, as against its average monthly consumption expenditure of Rs.6,223. As many as 22.50 per cent of the farmers live below official poverty line. Large tracts of arable land have turned problem soils, becoming acidic, alkaline & saline physico-chemically. Another primary factor of production, namely, water is also under stress. Climate change is beginning to challenge the farmer's ability to adopt coping and adaptation measures that are warranted. Technology fatigue is manifesting in the form of yield plateaus. India's yield averages for most crops at global level do not compare favourably. The costs of cultivation are rising. The magnitude of food loss and food waste is alarming. The markets do not assure the farmer of remunerative returns on his produce. In short, sustainability of agricultural growth faces serious doubt, and agrarian challenge even in the midst of surpluses has emerged as a core concern.

Farmers own land. Land is a powerful asset. And, that such an asset owning class of citizens has remained poor is a paradox. They face the twin vulnerabilities of risks & uncertainties of production environment and unpredictability of market forces. Low and fluctuating incomes are a natural corollary of a farmer under such debilitating circumstances. While cultivation is boundarised by the land, market need not have such bounds.

Agriculture is the largest enterprise in the country. An enterprise can survive only if it can grow consistently. And, growth is incumbent upon savings & investment, both of which are a function of positive net returns from the enterprise. The net returns determine the level of income of an entrepreneur, farmer in this case.

This explains the rationale behind adopting income enhancement approach to farmers' welfare. It is hoped, that the answer to agrarian challenges and realisation of the aim of farmers' welfare lies in higher and steady incomes. It is in this context, that the Hon'ble Prime Minister shared the vision of doubling farmers' income with the nation at his Bareilly address on 28th February, 2016. Further, recognizing the urgent need for a quick and time-bound transformation of the vision into reality, a time frame of six years (2016-17 to 2022-23) was delineated as the period for implementation of a new strategy.

At the basic level, agriculture when defined as an enterprise comprises two segments – production and post-production. The success of production as of now amounts to half success, and is therefore not sustainable. Recent agitations of farmers (June-July 2017) in certain parts of the country demanding higher prices on their produce following record output or scenes of farmers dumping tractor loads of tomatoes & onions onto the roads or emptying canisters of milk into drains exemplify neglect of other half segment of agriculture.

No nation can afford to compromise with its farming and farmers. And much less India, wherein the absolute number of households engaged in agriculture in 2011 (119 million) outpaced those in 1951 (70 million).Then, there are the landless agricultural labour who numbered 144.30 million in 2011 as against 27.30 million in 1951. The welfare of this elephantine size of India's population is predicated upon a robust agricultural growth strategy, that is guided by an income enhancement approach.

This Committee on Doubling Farmers' Income (DFI) draws its official members from various Ministries / Departments of Government of India, representing the panoply of the complexities that impact the agricultural system. Members drawn from the civil society with interest in agriculture and concern for the farmers were appointed by the Government as non-official members. The DFI Committee has co-opted more than 100 resource persons from across the country to help it in drafting the Report. These members hail from the world of research, academics, non-government organisations, farmers' organisations, professional associations, trade, industry, commerce, consultancy bodies, policy makers at central & state levels and many more of various domain strengths. Such a vast canvas as expected has brought in a kaleidoscope of knowledge, information, wisdom, experience, analysis and unconventionality to the treatment of the subject. The Committee over the last more than a year since its constitution vide Government O.M. No. 15-3/2016-FW dated 13th April, 2016 has held countless number of internal meetings, multiple stakeholder meetings, several conferences & workshops across the country and benefitted from many such deliberations organised by others, as also field visits. The call of the Hon'ble Prime Minister to double farmers' income has generated so much of positive buzz around the subject, that no day goes without someone calling on to make a presentation and share views on income doubling strategy. The Committee has been, therefore, lucky to be fed pro-bono service and advice. To help collage, analyse and interpret such a cornucopia of inputs, the Committee has adopted three institutes, namely, NIAP, NCAER and NCCD. The Committee recognizes the services of all these individuals, institutions & organisations and places on record their service.

Following the declaration of his vision, the Hon'ble Prime Minister also shaped it by articulating 'Seven Point Agenda', and these have offered the much needed hand holding to the DFI Committee.

The Committee has adopted a basic equation of Economics to draw up its strategy, which says that net return is a function of gross return minus the cost of production. This throws up three (3) variables, namely, productivity gains, reduction in cost of cultivation and remunerative price, on which the Committee has worked its strategy. In doing so, it has drawn lessons from the past and been influenced by the challenges of the present & the future.

In consequence, the strategy platform is built by the following four (4) concerns:

- Sustainability of production
- Monetisation of farmers' produce
- Re-strengthening of extension services
- Recognizing agriculture as an enterprise and enabling it to operate as such, by addressing various structural weaknesses.

Notwithstanding the many faces of challenges, India's agriculture has demonstrated remarkable progress. It has been principally a contribution of the biological scientists, supplemented by an incentivizing policy framework. This Committee recognizes their valuable service in the cause of the farmers. It is now time, and brooks no further delay, for the new breed of researchers & policy makers with expertise in post-production technology, organisation and management to take over the baton from the biological scientists, and let the pressure off them. This will free the resources, as also time for the biological scientists to focus on new science and technology, that will shift production onto a higher trajectory - one that is defined by benchmark productivities & sustainability. However, henceforth both production & marketing shall march together hand in hand, unlike in the past when their role was thought to be sequential.

This Report is structured through 14 volumes and the layout, as the readers will appreciate, is a break from the past. It prioritizes post-production interventions inclusive of agri-logistics (Vol. III) and agricultural marketing (Vol-IV), as also sustainability issues (Vol-V & VI) over production strategy (Vol. VIII).The readers will, for sure value the layout format as they study the Report with keenness and diligence. And all other volumes including the one on Extension and ICT (Vol. XI), that connect the source and sink of technology and knowledge have been positioned along a particular logic.

The Committee benefited immensely from the DFI Strategy Report of NITI Aayog. Prof. Ramesh Chand identified seven sources of growth and estimated the desired rates of growth to achieve the target by 2022-23. The DFI Committee has relied upon these recommendations in its Report.

There is so much to explain, that not even the license of prose can capture adequately, all that needs to be said about the complexity & challenges of agriculture and the nuances of an appropriate strategy for realising the vision of doubling farmers' income by the year of India's 75^{th} Independence Day celebrations.

The Committee remains grateful to the Government for trusting it with such an onerous responsibility. The Committee has been working as per the sound advice and counsel of the Hon'ble Minister for Agriculture and Farmers' Welfare, Shri Radha Mohan Singh and Dr. S.K. Pattanayak, IAS, Secretary of the Department of Agriculture, Cooperation and Farmers' Welfare. It also hopes, that the Report will serve the purpose for which it was constituted.

12^{th} August, 2017

Ashok Dalwai
Chairman, Committee on
Doubling Farmers' Income

About Volume VIII

The eighth volume of the Report of the Committee on Doubling Farmers' Income (DFI) examines productivity led production growth, keeping mindful that farmers must be able to benefit from technologies and practices that allow them to create value in a more optimal manner. Production enhancement, as a result of productivity gains, optimises on resources deployed, minimises ecological stresses and also reduces per unit cost of production.

This volume discusses these various aspects for the major agricultural sectors. Productivity on crops comes about from changed cultivation practices, i.e., selection of appropriate planting material, applying optimal inputs for soil and plant health, efficiencies during irrigation and tending phase, suitable staggering of sowing and harvest, inter-cropping and enhancing the cropping intensity on land. To achieve this, a wide variety of technology, information, tools and scientific practices are brought into use. In case of livestock and fisheries sectors, productivity enhancement can come from breeding, feeding, health care and other application of animal sciences. The result of such efforts is that the production is optimal to the effort and resources used.

Productivity enhancement not only adds to production, but can also contribute to release farmers' time, land and other resources, freeing these for other productive activities. Consequently this in turn, can offer the farming enterprise the option to diversify into other activities in the supply chain. Farm level productivity therefore, can bring additional gains by allowing the farmers' enterprise to partake in the marketing and other allied activities and capture value from a market led agricultural value system. These secondary, off-field or near-farm activities are also explained in Volume-III. The important aspects on input management are detailed in Volume-VII which also relate to sustainability, which is discussed earlier in Volumes V and VI. Productivity is therefore, intrinsically linked with the earlier volumes, and the consequent gains in production has to be directly co-related to marketing and monetisation.

This volume touches upon the selected agricultural sectors and examines aspects related to cereals, pulses, oilseeds, horticulture, livestock & fishery, sericulture and some commercial crops. The following Volume-IX will take the discussion forward on Secondary Agricultural activities.

Ashok Dalwai

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Doubling Farmers' Income

Volume VIII

"Production Enhancement through Productivity Gains"

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Setting the Context

Redesigning crop geometry & commodity matrix

Production is the final output resulted from the efforts of farmers. The produce is the fungible material that a farmer seeks to monetise, for generating returns on the efforts and costs undertaken. The value realised depends not only on the market demand but also on the productivity achieved in the course of production. Productivity allows for production at lower per unit cost, and is critical to farmers' income.

0.1. Background

Assets, tools, labour and capital are the key elements that take material inputs and convert into agricultural output. Land is the primary asset in case of all terrain-based farming, for field crops, orchards, plantations, aquaculture, livestock, etc. However, in case of marine fishing, the primary asset is the maritime ecosystem and the vessels that harvest the produce. The tools vary across sectors, from simpler hand held implements to industrial scale equipment and high technology systems like sonars, radar, humidity controllers and sensor based equipment.

Labour includes the individual enterprise dedicated to the core farming activities, by the farmer and the farming workers. Human capital in agriculture is involved in controls and decision making and as labour in the activities undertaken. The financial capital cuts across the operations and plays a critical role in the physical capacity to deploy appropriate tools and manpower, as well in the necessary inputs that go into farming. The inputs, such as planting material, water, fertilizer, animal feed, knowledge, etc. are linked to the initial capital available and the capital generated from monetising the output.

The drivers of income growth for farmers are diversification of farm activities towards high-value produce, technology up-gradation and modernisation, knowledge based enterprise development, irrigation (micro-irrigation), each having a multiplier effect in production and productivity. Value chain optimisation at every level in the integrated supply chain, in producing and moving the produce from farm to consumers, optimal price realisation for farmers through competitive markets and improvement in terms of trade are the other factors that ensure that the productivity at field translates into gainful productivity at income level.

The efficiencies achieved from the synergistic exploitation of all of above, is decisive in the productivity achieved at farm level. These efficiencies underpin the final cost of production, the total production achieved, and the reduced stress on man, assets and the ecology. From the farmers' perspective, the cost and volume produced are most critical, as this is the wealth that he/she creates. This wealth is thereafter available to the farmers, to be monetised at prices that are directly linked to demand. The exchange transacted is the final value realised by the farmer, and the productivity impacts on the net income achieved.

0.2. Mandate of Agriculture

At Independence, India's urban population was estimated at 6 crores, and by its 75th anniversary it is expected to be about 48 crores. With such urbanisation, the ratio of urban population in the total population has shifted from 15 per cent to nearly 35 per cent. The dependency load on the agricultural sector for food and other materials has, at a minimum, more than doubled. This has to happen from a fixed land area and depleting resources. Reports also indicate that by 2030 the urban population may touch 50 per cent. This only reflects that agriculture, is increasingly and acutely linked to the sustenance and survival of the urban population. However, this awareness is yet to be fully appreciated by the dependent population.

The globally accepted goal from agriculture, has been to produce more to assure food security. However, food that contains toxins is not food secure, neither is production that is harming the ecology sensible. It is time to go beyond the conventional terms of food security and ensure that food security includes not such quantity but quality of nutrition and quality of production system. Agriculture, in today's world, is not just with purpose to produce to sustain life; it has to produce more from less and in safe manner. In modern day context, the agricultural mandate needs redefining, entailing food and nutritional security, along with sustainability, thereby expanding upon the erstwhile production centric mandate.

i. Agriculture has the moral responsibility of meeting food and nutritional security in consonance with the agro ecological backdrop.
ii. It has to generate gainful employment resulting in income gains to make the farmers more economically secure.
iii. It has to generate raw material that will directly support agro-processing of food and non-food products to support secondary agriculture.
iv. It has to support agro-processing industry to produce primary and intermediate goods, which will feed the manufacturing sector.
v. Agricultural practices need to be on a sustainable basis.

Agriculture has to generate both food and raw material to meet the requirement of modern society for feed, fibre, fuel and other industrial uses, and in a manner that is sustainable.

0.3. Changing Farmers' Income from Seasonal to Perennial

Concentration on few cereal crops has reduced profitability, distracted investment, and dampened growth in the agricultural sector. Agricultural diversification can help to reverse these trends by making the sector more profitable as it becomes flexible in meeting the local and international demands and enables poor people to do something new and remunerative yet within their sphere of competencies and resources.

Diversification is considered a shift of resources from one crop (or livestock) to a larger mix of crops and livestock, keeping in view the varying nature of risks and expected returns from each crop/livestock activity and adjusting it in such a way that it leads to optimum portfolio of income. Diversified farming activities, instead of concentrating on crops alone, can ensure sustainable income. Agricultural diversification can reduce the risk exposure of farm households by optimizing income from a range of activities, more stable employment for farm workers and resources throughout the year.

Agricultural diversification in India is gradually picking momentum in favour of high value crops/livestock/fishery activities to augment incomes rather than a coping strategy to manage risk and uncertainty. In India, today nearly two-thirds of the total agriculture production today is high value (dairy, horticulture, fish, meat, poultry and spices). This has help farmers to shift to less water-intensive crops, reduce dependence on rain, and ensure that their livelihoods are more sustainable. However, this diversification has been largely driven by a few states like Andhra Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan, Maharashtra and West Bengal.

Diversification needs to be more geographically widespread and augmented through further thrust on processing of perishables. This highlights the importance of strong policy support for development of agricultural diversification in India so as to enable farmers to capitalize on the opportunities of diversification. Infrastructural bottlenecks remain a major obstacle for poor farmers to participate in and profit from agricultural diversification due to limited ability to get their produce to markets, limited ability to add value to their produce and also due to lack of market knowledge. Policies are needed to help theses growers by strengthening their marketing skills, providing market access, both on local and national levels and improving market and transport infrastructure.

Also the lack of resources in terms of credit, training and exposure are major constraints for farmers wanting to venture into new lines of production. Restructuring of existing extension systems toward more participatory methods and provision of small term loans in terms of micro-finance options has been found to be an effective means of strengthening the linkages between farmers and the research community. Also, cooperation with local NGOs and producer group with regards to extension work has proved very beneficial so as to fulfil the needs of women, small and marginal farmers.

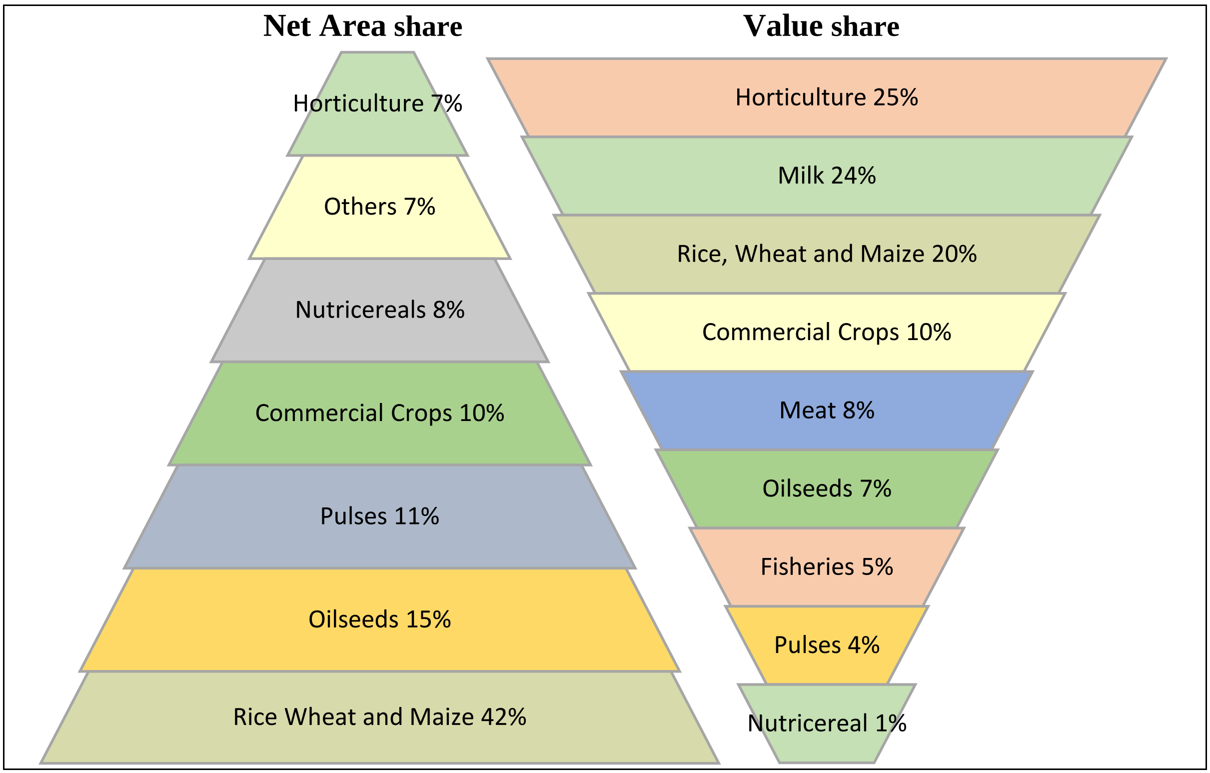
Regional and international networking and contractual research are considered important to quickly resolve a wide variety of constraints in diversification that differs from region to region. The training of farmers in new technologies and processes involved in diversification will improve their technical ability to engage in diversification. There is the need for enabling the establishment of fruitful corporations between native entrepreneurs and foreign businesses and by serving local businesses to upgrade their standards so as to conform to international quality requirements. But for all this to be successful farmers need assistance in acquiring the technical knowledge of these arrangements and assistance in accessing related markets.

0.4. Area and value pyramid

Farmers' income security is as important as nation's food and nutritional security. Agriculture has met the goal of food security with surplus foodgrain production; however, there is a need to assure the nutritional security, along with the gains in farmers' income. Value is important for generating high income of farmers, but as seen in DFI Volume I, no direct correlation among area and value is observed.

The value of any agricultural produce depends on a number of factors. In some cases, the factors include demand linked to administered and allocated values, and in some cases the terms of trade many not be so favourable, despite untapped demand, such as in case of nutri-cereals. It would be worthwhile to evaluate the relationship between acreage and value and use this to plan future actions, to make the most of agricultural assets, outputs and markets. Certainly, there is need to change the crop cafeteria to suit the ecology and the consumers' preference, hence ensuring that value is captured across all areas of concern.

Figure 0.1 Area and Value Pyramid



Source: DFI Committee

In case of field crops, it is observed that 42 per cent of the area is under major cereal crops (rice, wheat and maize) contributing only 20 per cent in the value of output, and just 7 per cent area is under horticultural crops but contributes 25 per cent to the value (Figure 0.1). Thus, a shift in area under cereals to other high value and nutritional commodities like horticulture, pulses, nutri-cereals as per the agro-climatic condition of the regions can may lead to demand fulfilment and income enhancement can also be achieved.

The DFI Committee felt the need for States to undertake comprehensive district level planning, to bring about a shift in area under cereals to other high value and nutritional commodities like horticulture, pulses, nutri-cereals as per the agro-climatic condition of regions, so that along with demand fulfilment, income enhancement can also be achieved.

Unless the concerns on profitability of crops are addressed immediately, it may be difficult to liberate agriculture from its current growth trends. The country has the ability to to meet the food and nutritional demands of its population. However, before initiating a shift in the crop geometry, there will be need to ensure that food security is not disrupted. This can happen through special focus on productivity enhancement.

Except wheat, productivity of other crops in the country is below world average and much lower than agriculturally advanced countries (Chand, 2017). Technology adoption, minimizing yield gaps, better and sustainable irrigation practices etc. are few areas that need attention for enhancing the productivity growth in crops.

0.5. Commodity matrix and Supply Demand balance

Owing to increasing population over the years, demand for food will naturally show an associated increase. Further, socio-economic changes will also influence the trends on overall demand for food. NCAP Vision 2050 and a study by Kumar et al 2016, showed that the demand for fruits and vegetables will surpass the demand for cereals in the years to come.

Table 0.1 Projected Demand for major food commodities in India

Commodity	Current Production (~mill tons)	Projected Demand (mill tons)		Growth in Demand between 2030 to 2050
		2030*	2050**	
Cereals	**250**	284	359	**26.4%**
Pulses	**22**	26.6	46	**72.9%**
Edible Oils	**8**	21.3	39	**83.1%**
Vegetables	**175**	192	342	**78.1%**
Fruits	**93**	103	305	**196.1%**
Milk	**160**	170.4	401	**135.3%**
Sugar	**20**	39.2	58	**48.0%**
Meat	**7**	9.2	14	**52.2%**
Egg	**4**	5.8	10	**72.4%**
Fish	**11**	11.1	22	**98.2%**

Source : **Kumar et al. (2016) for projected demand in 2030*
***NCAP Vision 2050 for projected demand in 2050*

To meet this variation in demand, there will be need to **diversify and shift existing areas into crops where demand is expected to grow at a higher pace**. Looking at the food grain production scenario, country is self-sufficient or rather surplus in food grain requirement thus; we need to assess whether India needs this much of foodgrains? There is a possibility to shift some area to other crops which are high in both nutrition and in value. This will necessitate undertaking important changes in the current agriculture scenario and offers high potential in achieving doubling of farmers' income.

Farmers' income is directly related to both production and the marketing of the produce. There is need to grasp the gains in form of income enhancement along with maintaining the production balance in commodity status. Moreover, moving to sync with changes in the consumer preference for specific commodities and for better quality will also foster trade across the nation, which will further increase the share from farming income and allied activities.

Following table provides an insight from productivity gains from major food commodities and resultant production in 2022-23.

Table 0.2 Current and Projected Output of Agriculture Sector

Crop/ Livestock category	**Production, 2015-16 (million tonnes)**	**Projected Production, 2022-23 (million tonnes)**		
		Business as Usual Based on output growth between 2000-15 (% growth)	Accelerated growth scenario	Assumptions
Cereals	235.2	275.7 (2.29)	295.8	No area change, based on productivity growth of 3.1%
Pulses	16.3	20.8 (3.50)	21.9	No area change, based on productivity growth of 3.1%
Oilseeds	25.3	32.9 (3.88)	35.1	No area change, based on productivity growth of 3.1%
Horticulture	286.2	425.3 (5.80)	451.5	Area growth of 2.8%, productivity growth of 3.1%
Milk	151.0	204.0 (5.36)	205.6	Based on output growth of 4.5%
Meat	7.0	14.6 (11.02)	14.6	Based on output growth of 11%

Source: DFI Committee Estimates

It can be clearly noticed that despite no change in acreage under crops, an enhancement in productivity by 3.1 per cent will not only realise desired gains to the farmers in 2022-23 but also increase the nutritional availability. The country faces a deficit in pulses & oilseeds.

It is to note that current outputs can easily outpace the requirements in some sectors. One can naturally expect that the rising food demand will be accompanied by increasing demand for its safety and quality owing to rising health consciousness. Thus, the main challenge will be to develop technologies, practices, varieties and breeds that are high yielding as well as safe to human health. This will need to be accompanied with safe and secure post-harvest management and delivery systems. Together, this will make India's agricultural sectors future ready.

It has also assessed that irrigation management can be a game changer in productivity enhancement by bringing substantial growth in output. It has been established that micro-irrigation can bring substantial increase in productivity and result in water saving (Government of India, 2009). The average productivity of fruits and vegetables has increased about 42.3 and 52.8 per cent, respectively mainly because of judicious use of water. This was met with equal consumer demand and the overall benefits from the micro irrigation system are reflected in the income enhancement of these farmers. In addition to productivity increase and resource conservation, a major advantage of micro-irrigation in the rain-fed areas is to help reduce fluctuations in output under deficit rainfall conditions and hence reduce vulnerability.

Apart from above mentioned indicators for diversifying and to take a productivity approach, major requirement will be to evaluate and sync with the agro-climatic conditions. The crop matrix should be developed in agro-ecological consonance. An overall shift from being production centric to productivity centric approach is the need of the hour to overcome both nutritional requirement and value gains.

0.6. Yield gaps

India is largest producer of pulses in the world whereas the second largest producer of paddy, wheat and sugarcane. India is also an important producer of commercial crops like cotton, sugarcane and tobacco. But in most of the cases the productivity of various crops in India are lower than those in the US, Europe and China, because in most of these countries crops are largely grown in high input management conditions with considerably long growing periods. A measure of the degree of crop yield potential, the attainable yield and the corresponding yield gap (the difference between attainable yield and actual yields) is crucial so as to suggest appropriate policy measures.

There always exists a gap between what is projected as the potential yield of any crop variety at a research station, and what is produced by the farmers themselves. Several factors are responsible for theses yield gaps such as physical, biological, socio-economic and institutional constraints which can be effectively improved through participatory research and government attention. Thus, it is important to revisit yield gaps in various production systems in India to estimate existing yield potential across various agro-climatic zones in India.

The clear objective is to ensure that the maximum potential of any crop variety is harvested at the farmers' field. Significant yield gaps exist across various crops through different states as well as within states. Bridging these yield gaps will not only increase crop production but also helps to improve the efficiency of land and labour use, reduce production cost and add to food security. The current yield gaps show a lack of transfer of technology, adoption and knowhow to farmers.

Improving farm yields is important as it can also release land for other productive uses, such as diversifying into added high value commodities and allow farmers to scale up integrated farming practices. If a farmer can generate the current output, of say wheat, from lesser share of his land, some of the same land can be used to take up horticulture or add mushroom, sericulture, beekeeping or other secondary agricultural activities.

Productivity enhancement requires yield gap minimization between district to state, state to state and state to nation. These variations in crop yields are related to market accessibility, purchasing power/income, agricultural work force, and terrain factors, besides water and fertilizer management. However, closing yield gaps will enhance food self-sufficiency and enable food security at local, regional, and global scales.

There is immense yield potential at every level which needs to be assessed to minimise these yield leakages through better technology adoption, increased participation in FLD (front line demonstration), better irrigation practices, soil health card and other schemes.

Table 0.3 presents the yield gaps across major states producing cereals crops in India. Yield for rice ranges from a maximum of 3.8 tonnes per hectare in Punjab to lowest of 2.0 in case of Odisha, indicating a yield gap of more than 47 percent. The information highlights that crop yields vary across regions, even within the same climatic zones.

Table 0.3 Cereals- Inter-state and Intra-state Yield Gap (2014-15)

Interstate Yield Gap			**Intrastate Yield Gap**				
State	Yield of Major States (ton/Ha)	Percentage Yield Gap with Maximum Yield State	Best Yield District (ton/Ha)	Lowest Yield District (ton/Ha)	Yield range within State (ton/Ha)	Gap in max yield district and Min yield district (%)	Gap in State Avg Yield and Min Yield district (%)
Rice	Best Yield Punjab 3.8						
West Bengal	2.7	28.9	Maldah (3.5)	Darjeeling (2.1)	1.4	40.0	22.2
Uttar Pradesh	2.1	44.7	Auraiya (3.2)	Lalitpur (0.8)	2.4	75.0	61.9
Punjab	3.8	0.0	Sangrur (4.7)	Pathankot (2.5)	2.2	46.8	34.2
Odisha	2.0	47.4	Sonepur (3.4)	Jharsuguda (1.4)	2.0	57.9	29.0
Andhra Pradesh	3.0	21.1	SPSR Nellore (4.0)	Visakhapatanam (1.7)	2.3	57.5	43.3
All India	***2.4***	***36.8***					
Wheat	Best Yield Punjab 4.3						
Uttar Pradesh	2.3	46.5	Baghpat (3.4)	Banda (0.9)	2.5	73.5	60.9
Madhya Pradesh	2.9	32.6	Hoshangabad (4.8)	Dindori (1.3)	3.5	72.9	55.2
Punjab	4.3	0.0	Faridkot (4.8)	Pathankot (2.7)	2.1	43.8	37.2
Haryana	4.0	7.0	*				
Rajasthan	3.0	30.2	Jhunjhunu (4)	Jaisalmer (1)	3.1	75	66.7
All India	***2.8***	***34.9***					
Maize	Best Yield Tamil Nadu 6.4						
Karnataka	3.2	50.0	Kodagu (5.1)	Bidar (1.8)	3.3	64.7	43.8
Madhya Pradesh	1.9	70.3	Seoni (3.6)	Sidhi (1.3)	2.3	63.9	31.6
Bihar	3.3	48.4	Katihar (6.5)	Kaimur (Bhabua) (1.2)	5.3	81.5	63.6
Tamil Nadu	6.4	0.0	Perambalur (11.0)	Tuticorin (5.2)	5.8	52.7	18.8
Telangana	3.3	48.4	Karimnagar (5.0)	Medak (1.8)	3.2	64.0	45.5
All India	***2.6***	***59.4***					

Source: DFI Committee Estimates based on data compiled from DACNET

*District -wise data not available for the year 2014-15

In case of wheat, the yield varies from a high of 4.3 tonnes per hectare in Punjab to a low of 2.3 in Uttar Pradesh. The yield gap in case of major cereals is maximum in case of maize where more than 70 percent difference is seen between the states having the lowest and the highest yield. The table also highlighted large yield gap among the districts in specific states, thus there is considerable yield gap within states, indicating the scope to increase the yield in future, in the districts having comparatively lower yields.

Considerable yield gap also exist between major states producing coarse cereals like Jowar and Bajra where it is more than 64 per cent and as much as 68 per cent respectively.

Table 0.4 Coarse Cereals: inter-state and intra-state Yield Gap (2014-15)

Interstate Yield Gap			**Intrastate Yield Gap**					
State	Yield of Major States (ton/Ha)	Percentage Yield Gap with Maximum Yield State	Best Yield District (ton/Ha)	Lowest Yield District (ton/Ha)	Yield Range within State (ton/Ha)	Gap in Max yield district and Min yield district (%)	Gap in Max District Yield and Avg State Yield (%)	Gap in State Avg Yield and Min Yield district (%)
Jowar	**Jowar: Best Yield Madhya Pradesh 1.7**							
Maharashtra	0.6	64.7	*					
Karnataka	1.1	35.3	Davangere (2.1)	Chamarajanagar (0.4)	1.7	81.0	47.6	63.6
Tamil Nadu	1.5	11.8	Tirunelveli (4.7)	Tiruppur (0.3)	4.4	93.6	68.1	80.0
Rajasthan	0.8	52.9	Rajsamand (2.1)	Jaisalmer (0.1)	2.0	95.2	61.9	87.5
Madhya Pradesh	1.7	0.0	Barwani (3.3)	Rewa (0.9)	2.4	72.7	48.5	47.1
All India	***0.9***	***47.1***						
Bajra	**Best Yield Uttar Pradesh 1.9**							
Rajasthan	1.1	42.1	Dholpur (2.1)	Jaisalmer (0.1)	2.0	95.2	47.6	90.9
Uttar Pradesh	1.9	0.0	Kasganj (3.3)	Allahabad (0.7)	2.6	78.8	42.4	63.2
Gujarat	1.7	10.5	*					
Haryana	1.7	10.5	*					
Maharashtra	0.6	68.4	Jalgaon (1.2)	Parbhani (0.1)	1.1	91.8	50.8	83.3
All India	***1.3***	***31.6***						

Source: DFI Committee Estimates based on data compiled from DACNET

*District -wise data not available for the year 2014-15

District wise yield gap in maximum in Rajasthan both in case of Jowar and Bajra where it is around 88 percent in case of Jowar and more than 90 percent in Bajra. Thus there are serious gaps both at the state level and at the district level which highlights the importance of increasing yield potential, which if addressed properly could help in achieving the target of increasing farmers income.

There exists significant yield gap in case of pulse also, for example in case of Tur (Arhar) the yield ranges from a high of 1.1 (tonnes/hectare) to a low of 0.6 in case of Maharashtra. Same is the case with Gram and Lentil (Masur) where the yield gap is considerable with more than 36 percent in case of Gram and around 50 percent in case of Lentil (Masur).

Table 0.5 Pulses- Inter-state and Intra-state Yield Gap (2014-15)

Interstate Yield Gap			Intrastate Yield Gap					
State	Yield of Major States (ton/ Ha)	Percentage Yield Gap with Maximum Yield State	Best Yield District (ton/Ha)	Lowest Yield District (ton/Ha)	Yield Range within State (ton/ Ha)	Gap in Max yield district and Min yield district (%)	Gap in Max District Yield and Avg State Yield (%)	Gap in State Avg Yield and Min Yield district (%)
Tur (Arhar)	**Best Yield Gujarat 1.1**							
Maharashtra	0.6	45.5	Jalgaon (0.5)	Beed (0.2)	0.3	60.0	40.0	33.3
Madhya Pradesh	1.0	0.0	Damoh (1.5)	Khargone (0.5)	1.0	66.7	33.3	50.0
Karnataka	0.7	0.0	Hassan (1.5)	Tumkur (0.2)	1.3	86.7	53.3	71.4
Gujarat	1.1	0.0	*					
Jharkhand	1.0	0.0	*					
All-India	***0.7***	***0.0***						
Gram	**Best Yield Uttar Pradesh 1.1**							
Madhya Pradesh	1.0	9.1	Shajapur (1.8)	tikamgarh (0.4)	1.4	77.8	44.4	60.0
Maharashtra	0.8	27.3	Hingoli (2.9)	Jalna (0.3)	2.6	89.7	72.4	62.5
Rajasthan	0.7	36.4	Sawaimadhopur (1.4)	Churu (0.3)	1.1	78.6	50.0	57.1
Karnataka	0.7	36.4	Hassan (1.0)	Haveri (0.5)	0.5	50.0	30.0	28.6
Andhra Pradesh	1.1	0.0	Guntur (2.3)	Anantapur (0.1)	0.6	95.7	52.2	90.9
All-India	***0.9***	***18.2***						
Lentil (Masur)	**Best Yield West Bihar1.0**							
Madhya Pradesh	0.7	30.0	Ratlam (1.0)	Shivpuri (0.3)	0.7	70.0	30.0	57.1
Uttar Pradesh	0.5	50.0	Budaun (1.1)	Banda (0.1)	1.0	90.9	54.5	80.0
Bihar	1.0	0.0	Kaimur (Bhabua) (2.6)	Sitamarhi (0.2)	2.5	93.6	62.0	83.1
West Bengal	1.0	0.0	Medinipur west (1.8)	Coochbehar (0.5)	0.5	70.6	44.9	46.6
Rajasthan	1.0	0.0	Pratapgarh (1.2)	Bhilwara (0.6)	0.6	50.0	16.7	40.0
All-India	***0.71***	***29.5***						

Source: DFI Committee Estimates based on data compiled from DACNET

*District -wise data not available for the year 2014-15

Even at district level across different states, there exists huge yield gap mainly due to different cropping systems, biophysical situations and other attributes of farming systems. This highlights the need for taking up adaptive research based technology generation and dissemination in case of major pulses producing states.

In last few years India has emerged as the major importer of food oil and pulses in the world. So by increasing the yield of oilseeds we can restrict the additional burden on state exchequer. In case of oilseeds yield gap across major states is maximum (78.6 percent) in case of Groundnut while it is minimum in case of Rapeseed & Mustard. Significant intrastate yield gaps exist. Thus, there is considerable scope for increasing yield for oilseeds in the country.

Table 0.6 Oilseeds - Inter-state and Intra-state Yield Gap (2014-15)

Interstate Yield Gap			**Intrastate Yield Gap**					
	Yield of Major States (ton/Ha)	Percentage Yield Gap with Maximum Yield State	Best Yield District (ton/Ha)	Lowest Yield District (ton/Ha)	Yield Range within State (ton/ Ha)	Gap in Max yield district and Min yield district (%)	Gap in Max District Yield and Avg State Yield (%)	Gap in State Avg Yield and Min Yield district (%)
Rapeseed & Mustard		**Best Yield Haryana 1.4**						
Rajasthan	1.2	14.3	Hanumangarh (1.5)	Jaisalmer (0.6)	0.9	60.0	20.0	50.0
Madhya Pradesh	1.0	28.6	Mandsaur (2.1)	Umaria (0.4)	1.7	81.0	52.4	60.0
Haryana	1.4	0.0	*					
Uttar Pradesh	0.9	35.7	Mainpuri (1.8)	Banda (0.1)	1.7	95.4	48.6	91.1
West Bengal	1.1	21.4	Paraganas north (1.3)	Darjeeling (0.3)	1.0	77.5	19.7	72.0
All-India	***1.1***	***21.4***						
Groundnut	**Best Yield Tamil Nadu 2.8**							
Gujarat*	2.2	21.4	*					
Rajasthan	2.0	28.6	Bikaner (2.4)	Rajsamand (0.8)	1.6	66.7	16.7	60.0
Tamil Nadu	2.8	0.0	Thiruvarur (4.9)	Nilgiris (1.0)	3.9	79.6	44.9	63.0
Karnataka	0.8	71.4	Udupi (2.0)	Bidar (0.3)	1.8	87.2	62.0	66.2
Andhra Pradesh	0.6	78.6	Guntur (4.5)	Anantapur (0.3)	4.2	93.2	87.6	45.6
All-India	***1.6***	***42.9***						
Soyabean	**Best Yield Madhya Pradesh 1.1**							
Madhya Pradesh	1.1	0.0	Betul (2.1)	Burhanpur (0.6)	1.5	71.4	47.6	45.5
Maharashtra	0.7	36.4	Kolhapur (2.2)	Hingoli (0.3)	1.9	86.4	68.2	57.1
Rajasthan	1.0	9.1	Sawai Madhopur (1.4)	Banswara (0.8)	0.6	42.9	28.6	20.0
Karnataka	0.7	36.4	Dharwad (1.0)	Bidar (0.6)	0.5	44.4	27.9	22.8
All-India	***1.0***	***9.1***						

Source: DFI Committee Estimates based on data compiled from DACNET

*District -wise data not available for the year 2014-15

Table 0.7 presents the yield gap across major commercial crops in India. As can be seen from the table, there exists huge yield gap both across different states and within the same state as well. Several spatial and temporal factors are responsible for such variation in productivity across major states. A thorough understanding and quantification of these factors is needed to estimate the scope to increase productivity in various states.

Table 0.7 Commercial Crops - Inter-state and Intra-state Yield Gap (2014-15)

Interstate Yield Gap			**Intrastate Yield Gap**					
	Yield of Major States (ton/Ha)	Percentage Yield Gap with Max Yield State	Best Yield District (ton/Ha)	Lowest Yield District (ton/Ha)	Yield Range within State (ton/Ha)	Gap in Max yield district and Min yield district (%)	Gap in Max District Yield and Avg State Yield (%)	Gap in State Avg Yield and Min Yield district (%)
Cotton	**Best Yield Gujrat 0.6**							
Gujrat	0.6	0.0	Solapur (0.3)	Beed (0.1)	0.2	66.7	51.6	31.1
Maharashtra	0.3	50.0	Khammam (0.5)	Nizamabad (0.2)	0.3	60.0	20.0	50.0
Telangana	0.4	33.3	Guntur (0.9)	Anantapur (0.2)	0.7	77.4	32.3	66.7
Andhra	0.6	0.0	Gulbarga (0.7)	Chamarajanagar (0.2)	0.5	71.4	42.9	50.0
Karnataka	0.5	16.7						
All-India	***0.5***	***16.7***						
Sugarcane	**Best Yield Tamil Nadu 106.8**							
Uttar Pradesh	62.2	41.8	Shamli (78.8)	Lalitpur (40.4)	38.4	48.7	21.1	35.0
Maharashtra	82.2	23.0	Sangli (108.8)	Washim (29.0)	79.8	73.3	24.4	64.7
Karnataka	91.2	14.6	Davangere (128.3)	Ramanagara (65.6)	62.7	48.9	28.9	28.1
Tamil Nadu	106.8	0.0	Namakkal (126.1)	Tirunelveli (78.0)	48.1	38.1	15.3	27.0
Gujarat	68.9	35.5	*					
All-India	***71.5***	***33.1***						
Tobacco	**Best Yield Uttar Pradesh 4.3**							
Andhra	2.6	39.5	Krishna (6.2)	Anantapur (1.9)	4.3	69.4	58.1	26.9
Gujarat	1.4	67.4	*					
Karnataka	0.7	83.7	Belgaum (1.3)	Mysore (0.6)	0.7	53.8	46.2	14.3
Uttar Pradesh	4.3	0.0	Etah (4.7)	Hardoi (2.5)	2.2	46.8	8.5	41.9
Bihar	1.8	58.1	Khagaria (2.0)	Siwan (1.8)	0.2	10.0	10.0	0.0
All-India	***1.6***	***62.8***						

Source: DFI Committee Estimates based on data compiled from DACNET

*District -wise data not available for the year 2014-15

India is the largest milk producer in the world, milk and other dairy products account for around two thirds of the value of the Indian livestock sector and support the livelihoods of nearly half of India's rural households. Table 0.8 shows the yield gap in milk production. Application for yield gap analyses in dairy sector is significant in context of fact that livestock farming is an important component of smallholder farming systems.

Punjab tops the list for yield across the most categories in the dairy sector owing to various socio-economic reasons. Considerable yield gaps are seen, both across different states and within the states as well.

Table 0.8 Interstate Yield Gap across Major Milk Production States (T.E 2014-15)

Major States	Average daily Productivity (Kg/ Day)	Yield Gap with Maximum Yield State (%)	Major States	Average daily Productivity (Kg/ Day)	Yield Gap with Maximum Yield State (%)
Crossbred	**Best yield Punjab (11.1)**		**Indigenous**	**Best yield Punjab (6.6)**	
Punjab	11.1	0.0	Punjab	6.6	0.0
Chandigarh	9.0	18.4	Haryana	5.2	21.4
Meghalaya	9.0	19.2	Gujarat	4.1	38.7
Gujarat	8.9	19.3	Delhi	4.0	40.2
Kerala	8.8	21.0	Rajasthan	3.7	44.2
All India	***7.0***	***37.0***	***All India***	***2.5***	***62.9***
Buffaloes	**Best yield Punjab (8.7)**		**Goats**	**Best yield Punjab (8.7)**	
Punjab	8.7	0.0	Daman & Diu	1.7	0.0
Haryana	7.6	13.0	Punjab	1.4	18.0
Chandigarh	6.1	29.3	Haryana	0.9	48.9
Jharkhand	5.8	33.2	Uttar Pradesh	0.8	56.2
Delhi	5.8	33.4	Kerala	0.7	62.0
All India	***5.0***	***43.0***	***All India***	***0.4***	***74.3***

Source: Basic Animal Husbandry & Fisheries Statistics 2015, Ministry of Agriculture & Farmers Welfare Department

The dairy sector is only one reflection of India's livestock sector, one of the largest in the world. The socio-economic development and changing lifestyle has resulted in a change in the dietary patterns in India. There has been increased consumption of meat, including poultry and animal-based products.

Also over the last few years, a steep rise in export of bovine meat (carabeef) and this industry has emerged to be significant for providing income and employment in the agricultural sector.

The major states with buffalo meat production centres are Uttar Pradesh, Andhra Pradesh, Maharashtra and Punjab. A significant component of the rural labour force is employed in rearing the livestock and related occupations. There has been sharp rise in the production of animal meat across various states in India but there exists significant yield gap across major meat producing states in India. Table 0.9 provides the yield gap across major meat producing states.

Table 0.9 Interstate Yield Gap across major Meat producing States (2015-16)

States	Productivity (Kg/animal)	Yield Gap with Maximum Yield State (%)	States	Productivity (Kg/animal)	Yield Gap with Maximum Yield State (%)
Cattle-Adult: Best yield A&N Islands (214.3)			**Cattle-Young: Best yield Kerala (90.1)**		
A&N Islands	214.3	0.0	Kerala	90.1	0.0
Tamil Nadu	147.3	31.3	Tamil Nadu	72.1	19.9
West Bengal	130.8	39.0	Arunachal Pradesh	70.1	22.2
Maharashtra	130.5	39.1	Assam	57.3	36.4
Sikkim	128.4	40.1	Manipur	43.1	52.1
Total	**110.6**	**48.4**	**Total**	**51.0**	**43.3**
Buffalo-Adult: Best yield A&N Islands (240.0)			**Buffalo-Young: Best yield Nagaland (104.7)**		
A&N Islands	240.0	0.0	Nagaland	104.7	0.0
Nagaland	187.4	21.9	Kerala	92.0	12.1
Maharashtra	186.7	22.2	Madhya Pradesh	82.7	21.0
Jammu & Kashmir	168.4	29.8	Maharashtra	81.4	22.2
Delhi	159.9	33.4	Andhra Pradesh	74.4	28.9
Total	**133.9**	**44.2**	**Total**	**63.5**	**39.3**
Sheep-Adult: Best yield Haryana (20.0)			**Sheep-young: Best yield Andhra Pr. (10.7)**		
Haryana	20.0	0.0	Andhra Pradesh	10.7	0.0
Himachal Pradesh	19.3	3.8	Jammu & Kashmir	10.6	1.1
Jammu & Kashmir	16.9	15.7	Rajasthan	10.4	3.2
Karnataka	16.6	17.3	Madhya Pradesh	10.1	5.9
Rajasthan	15.5	22.5	Haryana	9.3	13.6
Total	**13.8**	**31.1**	**Total**	**9.9**	**7.2**
Goat-Adult: Best yield Himachal Pr. (20.2)			**Goat-Young :Best yield Madhya Pr. (12.1)**		
Himachal Pradesh	20.2	0.0	Madhya Pradesh	12.1	0.0
Haryana	19.4	4.0	Jammu & Kashmir	10.7	12.1
Jammu & Kashmir	16.7	17.2	Andhra Pradesh	10.5	13.2
Uttar Pradesh	16.6	17.7	Rajasthan	10.2	16.2

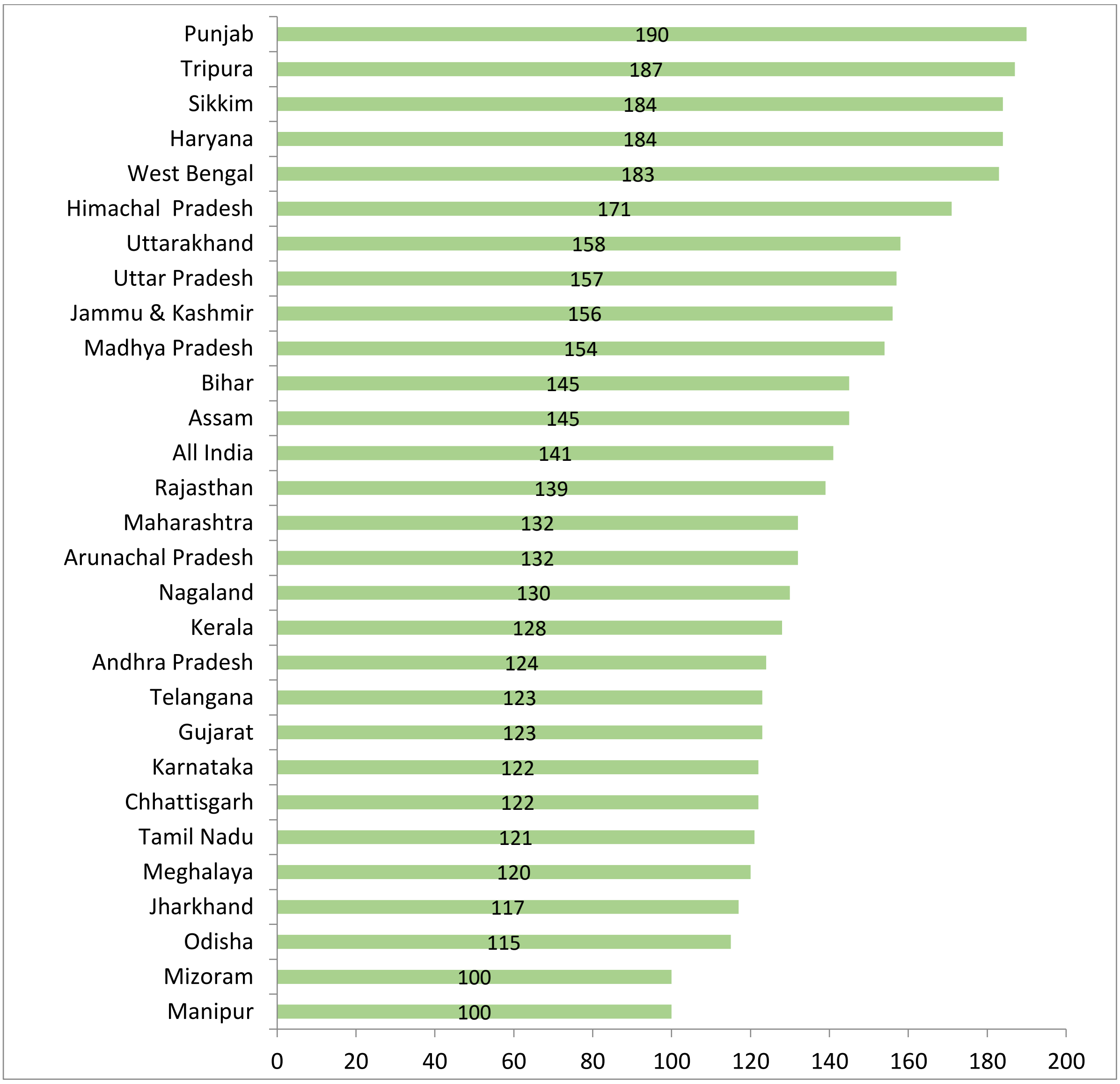
States	Productivity (Kg/animal)	Yield Gap with Maximum Yield State (%)	States	Productivity (Kg/animal)	Yield Gap with Maximum Yield State (%)
Madhya Pradesh	16.6	18.0	Kerala	9.0	26.2
Total	**11.2**	**44.4**	**Total**	**8.9**	**26.3**
Pig-Adult: Best yield Mizoram (86.9)			**Poultry: Best yield Lakshadweep (3.2)**		
Mizoram	86.9	0.0	Lakshadweep	3.2	0.0
Nagaland	79.4	8.6	Sikkim	2.5	21.1
Kerala	75.0	13.6	West Bengal	2.0	36.7
Rajasthan	60.4	30.5	Manipur	2.0	37.0
Arunachal Pradesh	60.0	30.9	Mizoram	1.9	40.5
Total	**38.0**	**56.3**	**Total**	**1.4**	**57.4**

Source: Basic Animal Husbandry & Fisheries Statistics 2015, Ministry of Agriculture & Farmers Welfare.

0.7. Cropping Intensity

According to the latest available data triennium 2014-15, the index of intensity of cropping for the country as a whole is 141 per cent. It shows great spatial variations with 'higher levels in northern plains and lower levels are found in dry, rain-fed regions of Rajasthan, Gujarat, Maharashtra and Karnataka. Punjab has the highest cropping intensity of 190 per cent, followed by north eastern states of Tripura and Sikkim and Haryana (184 per cent).

Figure 0.2 State-wise cropping intensity (T.E. 2014-15)



Source: DFI Committee - estimates based on data compiled from DACNET.

To fulfil the increasing food demand, intensifying cropping over the existing area is the only viable option we had today. Higher cropping intensity implies higher productivity per unit of arable land during one agricultural year.

The level of cropping intensity is determined by several factors. The most important factor is the availability of water from natural or man-made sources for irrigation purpose. However, the scope for year round cropping activities in most states of India is severely constrained by the seasonal distribution of rainfall.

So long as this natural constraint is mitigated, by developing irrigation facilities, the level of multiple cropping cannot be improved. Volume I of the DFI reports provides insight on how micro irrigation can benefit famers' income growth.

0.8. The Crop Geometry

Shifting little area from staple to high value in the suitable region (basis agro-climatic condition and availability) can lead to a sizable increase in the returns for farmers. This can be clubbed with crop planning matrix to understand the potential location for area and crop shifting. Diversification towards high value crop needs current attention (NITI Aayog Policy Paper and Volume I and Volume II of DFI Committee Report). High value crops offer comparatively better growth in terms of value of output contribution as compared to the staple crops. Birthal, *et al.* (2013) has also noted that diversification into production of fruits and vegetables, in general, and vegetables, in particular, is likely to benefit the small and marginal farmers more than the medium and large farmers.

Table 0.10 provides the existing crop geometry and shows that in the majority of states, maximum area is occupied under foodgrains, followed by oilseeds. Area under nutri-cereals and horticultural crops is lower despite its potential to generate higher returns.

Table 0.10 Existing crop geometry across states (area share to GCA %)

States	**GCA (000 ha)**	Rice	Wheat	Maize	Nutri cereals	Total Pulses	Total Oilseed	Total Food-grain	Horticultural Crops
Andhra Pr	**7909**	29.7	0.1	4.0	3.1	14.7	17.5	51.6	13.7
Arunachal P	**293**	43.8	1.1	16.2	8.1	3.5	11.4	72.7	9.3
Assam	**4086**	60.6	0.7	0.6	0.1	3.6	7.5	65.7	12.8
Bihar	**7725**	41.8	27.5	9.2	0.3	6.9	1.6	85.7	6.0
Chhattisgarh	**5705**	66.6	1.8	2.0	2.4	15.6	5.1	88.4	2.6
Gujarat	**12620**	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.8
Haryana	**6461**	19.2	39.2	0.1	7.7	2.1	8.5	68.3	1.1
Himachal Pr	**941**	7.9	8.0	8.1	3.1	8.2	8.4	8.5	14.2
J & K	**1162**	23.2	25.9	26.1	3.5	2.2	5.4	80.9	8.8
Jharkhand	**1628**	65.0	4.2	6.0	0.9	10.2	4.1	88.0	7.4
Karnataka	**12087**	10.9	1.7	11.1	17.5	19.5	11.6	60.7	8.8
Madhya Pr	**23662**	8.4	23.5	4.0	3.1	22.8	31.5	61.9	3.1
Maharashtra	**22915**	6.9	4.3	4.2	17.9	15.5	17.7	48.7	5.5
Manipur	**356**	53.3	0.6	6.7	0.0	8.5	11.0	69.2	14.9
Meghalaya	**342**	32.1	0.1	5.2	0.0	1.4	3.7	39.6	47.5
Mizoram	**125**	24.1		4.7	0.0	3.0	1.7	31.8	65.4
Nagaland	**496**	38.2	0.6	13.9	2.1	7.7	13.1	62.5	20.1
Odisha	**5136**	79.5	0.0	1.7	0.6	14.6	3.7	95.8	0.1
Punjab	**7858**	36.4	44.7	1.6	0.2	0.7	0.6	83.6	2.3
Rajasthan	**24769**	0.6	12.4	3.8	20.8	14.5	19.7	52.0	4.0
Sikkim	**142**	8.0	0.3	28.1	5.7	4.4	5.7	40.8	48.5
Tamil Nadu	**5677**	29.4		5.6	8.4	13.0	7.1	56.4	12.2
Telangana	**5801**	27.3	0.0	11.6	2.0	9.1	8.0	50.0	4.5
Tripura	**477**	53.5	0.1	0.9	0.0	2.3	1.4	56.7	26.7

States	GCA (000 ha)	Rice	Wheat	Maize	Nutri cereals	Total Pulses	Total Oilseed	Total Food-grain	Horticultural Crops
Uttarakhand	**1107**	23.4	31.7	2.3	18.6	5.8	2.9	81.9	5.4
Uttar Pradesh	**25955**	22.8	37.8	2.9	4.9	9.0	4.3	77.3	4.6
West Bengal	**9589**	56.8	3.4	1.3	0.2	2.6	7.9	64.3	18.0
All India	**197852**	**22.1**	**15.5**	**4.5**	**8.1**	**12.1**	**13.5**	**62.4**	**6.6**

Source: DFI Committee Estimates based on data compiled from DACNET.

With appropriate infrastructural and logistic support, a chunk of area can be shifted to high value commodities for generating higher returns to farmers.

The change in this existing crop geometry will require investing in tandem to develop strong structural support for these highly perishable produce types. Both central and state assistant is required to build the necessary infrastructural facilities. The current e-NAM scheme can also prove beneficial by providing a trading platform for these commodities.

0.8.1. Changing Crop Geometry

Tables 0.11 provide us a glimpse about future requirement for wheat in India (projected demand based on actual consumption in NSS Family Budget Survey plus average export of wheat for last ten years) based on two scenarios i.e. business as usual and accelerated growth scenario; thus, approximately 2.5 million hectares can be released from wheat cultivation and can be shifted to more required and remunerative crops.

Table 0.11 Estimated land which can be released from Wheat Crop

		Output (Million Tonnes)	Projected Demand (Million Tonnes)	Surplus (Million Tonnes)	Productivity (Tonnes/ Hectare)	*Land to be released (Million Hectare)
2016-17	Existing Status	98.4	91.0	7.4	3.0	2.5
2021-22	#Business as usual	105.0	100.6	4.4	3.5	1.3
2021-23	@Accelerated growth scenario	112.0	100.6	11.4	3.7	3.1

Source: DFI Committee Estimates

Output projected using the productivity growth of 1.9 % per year (last 10 year growth) with area constant at 30.2 Million ha at 2015-16 level.
@Output projected using the productivity growth of 3.1 % per year as given in NITI Policy Paper with area constant at 30.2 Million ha at 2015-16 level.
*Calculated by dividing surplus production divided by the wheat productivity

Many parts of northern India, especially Punjab is facing severe water crisis because of a complicated mix of economic, geographic, and political factors. In global comparison, India also uses almost twice the amount of water to grow crops as compared to China and United States (Table 0.12). In the past half century, majority of the growth to net irrigated area has come through the assurance of continuous supply of ground water. The primary cause of over-exploitation of ground water has been the rising demand from agricultural sector. In most of the cases, decisions such as cropping pattern and cropping intensity are primarily driven by continuous supply of ground water without caring about negative environmental impact.

Table 0.12 Water use for crop production in different countries (in cubic metres/tonne)

Crops and Crop Products	**Average Amount of Water Needed to Grow Crops in**			
	Brazil	**India**	**China**	**United States**
Rice	3,082	2,800	1,321	1,275
Sugarcane	155	159	117	103
Wheat	1,616	1,654	690	849
Cotton	2,777	8,264	1,419	2,535

Source: R. Suhag, Overview of Groundwater in India, Tech. Rep. 2016.

Policy measures like power subsidies for agriculture have played a major role in the decline of water levels especially in the northern part of India. Also, even though Minimum Support Prices (MSPs) are currently announced for number of crops, growers of sugarcane, wheat and rice are largely benefitted from this policy. These issues have created highly skewed incentive structures in favor of water intensive crops. Water-intensive crops like sugarcane and paddy are mostly grown in the naturally water-starved areas of the country for instance paddy in Punjab and Sugarcane in Maharashtra with Maharashtra being the second largest grower of sugarcane in India and Punjab being the third largest grower of rice (Agricultural Statistics at a glance 2016). Central Ground Water Board (CGWB, Ministry of Water Resources) used to measure ground water resources in the country at different scales at different time interval at state level and within districts, such as blocks/mandals/talukas/watersheds. Ground water development is a ratio of the annual ground water extraction to the net annual ground water availability. It specifies the quantity of ground water available for use. Table 1.13 illustrates the level of ground water development in the country over the past two decades.

Table 0.13 Ground Water Situation in India (Past 20 Years)

Level of ground water development	**Explanation**	**% of districts in 1995**	**% of districts in 2004**	**% of districts in 2009**	**% of districts in 2011**
0-70% (Safe)	Areas which have ground water potential for development	92	73	72	71
70-90% (Semicritical)	Areas where cautious ground water development is recommended	4	9	10	10
90-100% (Critical)	Areas which need intensive monitoring and evaluation for ground water development	1	4	4	4
>100% (Overexploited)	Areas where future ground water development is linked with water conservation measures	3	14	14	15

Source: R. Suhag, Overview of Groundwater in India, Tech. Rep. 2016.

0.8.2. Different scenarios of staple foodgrains production

From 1960-61 to 2015-16, rice production increased from around 34 million tonnes to around 44 million tonnes and wheat production increased from 10.4 million tonnes to around 92.0 million tonnes. The yield improved from around 1.0 tonnes per hectare to around 2.4 tonnes per hectare in case of rice and fourfold in case of wheat, from 0.8 to 3.0 tonnes per hectare. Nonetheless, the area under rice cultivation has increased only marginally; it was around 40 million ha in 1980-81 and 44 million ha in the year 2015-16.

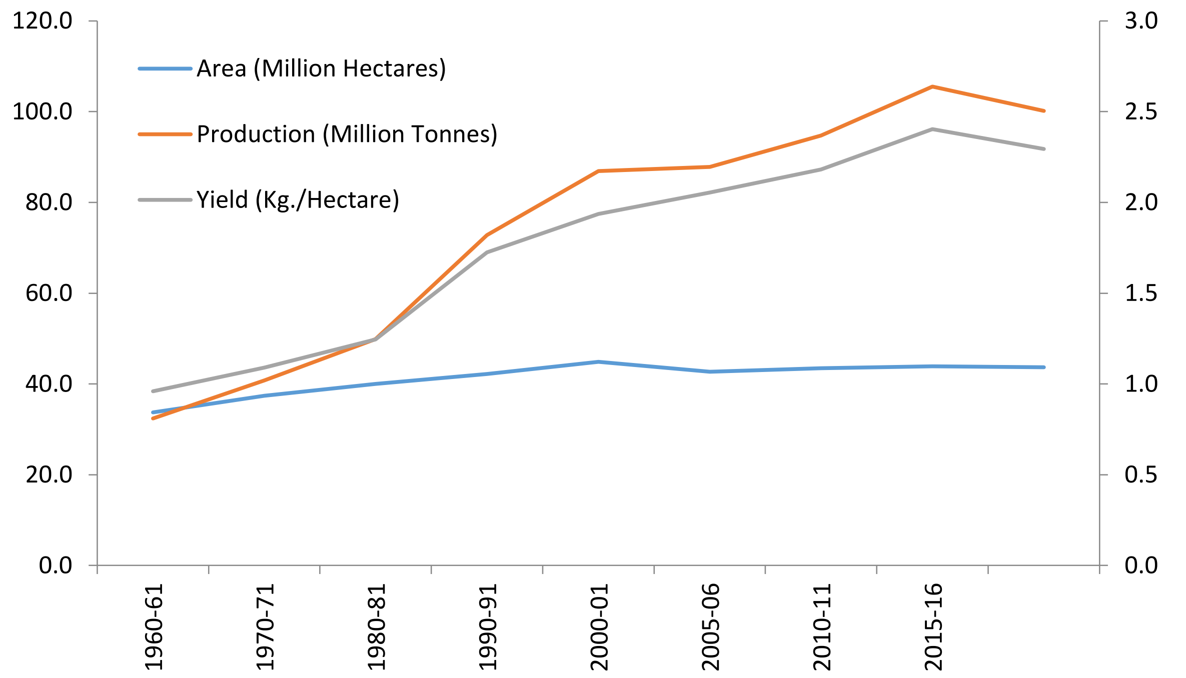
Table 0.14 Rice and Wheat (Area, Production and Yield)

	Rice			Wheat		
Year	Area (mill Hectares)	Production (mill tonnes)	Yield (ton/Ha)	Area (mill Hectares)	Production (mill tonnes)	Yield (ton/Ha)
T.E. 1960-61	33.7	32.4	1.0	13.0	10.4	0.8
T.E. 1970-71	37.4	40.8	1.1	20.6	38.8	1.7
T.E. 1980-81	40.0	49.9	1.2	22.4	34.6	1.5
T.E. 1990-91	42.2	72.8	1.7	23.9	53.0	2.2
T.E. 2000-01	44.9	86.9	1.9	26.9	72.4	2.7
T.E. 2005-06	42.7	87.8	2.1	26.5	70.1	2.6
T.E 2010-11	43.4	94.8	2.2	28.4	82.8	2.9
T.E.2015-16	43.9	105.5	2.4	30.7	92.0	3.0

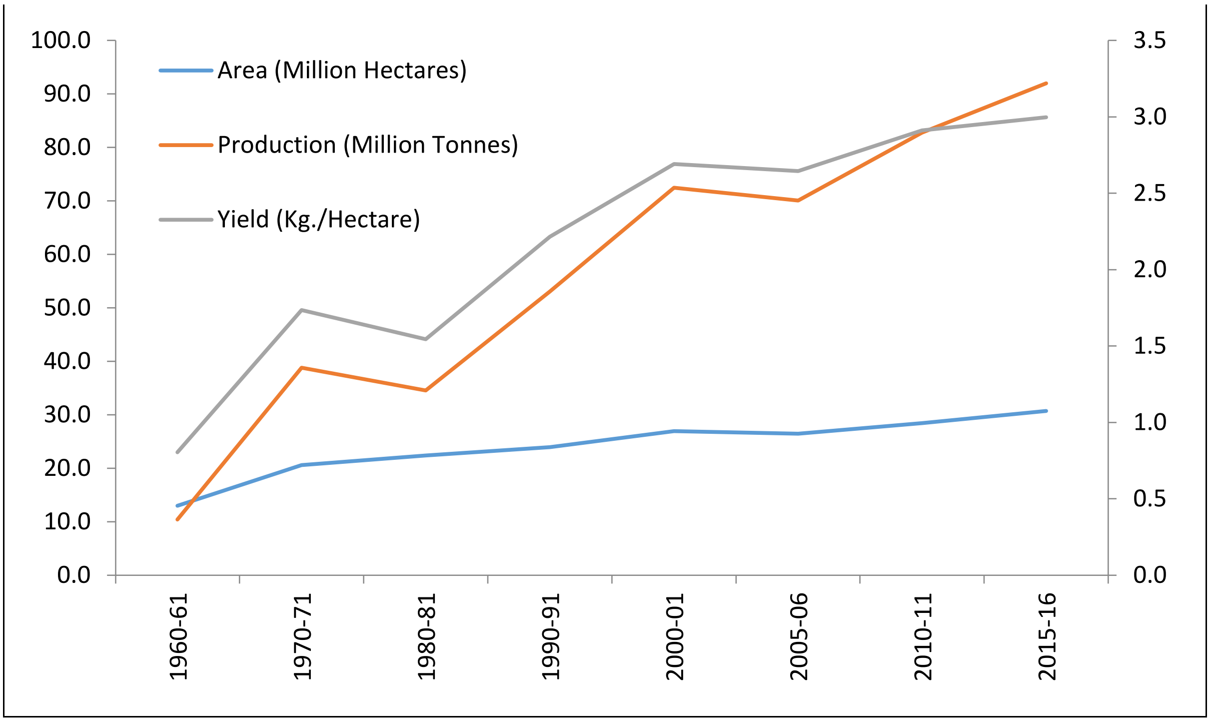
Source: DFI Committee Estimates based on data available in Agricultural Statistics at a Glance

Figure 0.3 Trends in Area, Production and Yield of Rice and Wheat in India

Rice



Wheat



The trends show that future production of rice may face some stagnation. Various agencies had suggested different growth rate for production of various commodities in India as shown in Table 0.15.

Table 0.15 Average Annual Growth Rate of Production of Selected Food Commodities in India as suggested by different agencies

	Actual Growth Rate	FAO/ OECD	USDA	FAPRI	IGC	NCAER	
						India stand-alone Cosimo Model	Econom-etric Model
	2004-14	**2013-23**	**2013-23**	**2013-21**	**2013-19**	**2015-24**	**2015-23**
Wheat	3.6	1.5	0.8	1.1	1.0	1.2	1.6
Rice	2.0	1.5	0.8	NA	1.9	1.5	2.5
Coarse grains	2.1	1.8	2.3	1.9	1.8	1.5	2.6
Pulses	3.8						1.3
Total oilseeds	1.0	2.6	2.1	0.6	1.3	1.5	4.9

Source: *State of Indian Agriculture 2015-16*

Scenario A: Business as Usual

In the last five years since 2011-12 to 2015-16, in case of rice, the area is almost stagnant at 44 million hectare whereas the production is increasing at a slow rate. Average growth rate for the area between the last ten years (2006-07 to 2015-16) is -0.01 per cent and average growth rate for production comes out as 1.42 per cent.

Table 0.16 Projected Area, Yield and Production for rice and wheat

	Rice*	Wheat#	Demand Supply Projections[1]				
Year	Production-(million tonnes)	Production-(million tonnes)	Commodities	Year	Supply Projection	Demand Projection	Demand supply gap
2016-17	106	96	Rice	2020	108.1	111.8	-3.7
2017-18	107	100		2030	122.1	122.4	-0.3
2018-19	109	103	Wheat	2020	104.2	98.3	5.9
2019-20	110	106		2030	128.8	114.6	14.2
2020-21	112	109					
2021-22	113	113					
2022-23	115	116					

Source: DFI Committee Estimates based on data available in Agricultural Statistics at a Glance

* (Area constant at 43.4 hectares at 2015-16 level and annual production grows at rate of 1.4 percent per year)
# (Area constant at 30.23 hectares at 2015-16 level and annual production grows at rate of 3.2 percent per year)

Using area constant at 43.4 million hectares at 2015-16 level and average annual production growth rate of 1.4, the rice production is projected at 115 million tonnes in 2022-23. In case of wheat average growth rate for the area between the last ten years (2006-07 to 2015-16) is 1.36 whereas average growth rate for production is 3.19. Using the area constant for wheat at 30.23 hectares at 2015-16 level and average production growth rate of 3.19 per cent, wheat production is projected at 116 million tonnes for the year 2022-23.

Scenario B: Optimistic Approach

In this scenario, keeping area under rice constant at 43.4 million hectares, a higher annual growth rate of production at 2.5 per cent is used.

Table 0.17 Optimistic scenario for rice and wheat production

Year	Rice Area (mill Hectares)	Rice Production (mill tonnes)	Wheat Area (mill Hectares)	Wheat Production (mill tonnes)
2015-16	43.4	104.3	30.2	93.5
2016-17	43.4	106.9	30.2	96.8
2017-18	43.4	109.6	30.2	100.2
2018-19	43.4	112.3	30.2	103.7
2019-20	43.4	115.1	30.2	107.3
2020-21	43.4	118.0	30.2	111.0
2021-22	43.4	121.0	30.2	114.9
2022-23	43.4	124.0	30.2	119.0

Source: DFI Committee Estimates based on data available in Agricultural Statistics at a Glance

[1] Adapted from Kumar P. et al (2016)

In this case, with higher yield from same area, total supply of rice will be 124 million tonnes in 2022-23. Using the same criteria for wheat with area fixed at 30.23 hectares at 2015-16 level, and a higher annual growth rate of 3.5 per cent, the wheat production will be 119.0 million tonnes in 2022-23.

0.8.3. Specific Case of Punjab

Over 97% of the cultivated area in Punjab is irrigated, the highest in the country though only 25% of the area benefits from canal irrigation the remaining 75% is irrigated using groundwater. Average annual decline in groundwater table in the central Punjab was about 17 cm during the 1980s and about 25 cm during the 1990s, it was alarmingly high at 91 cm per annum during 2000–2005.

Table 0.18 District-Wise Ground Water Assessment for Punjab (as on 31.03.2011)

Area	Total Irrigated Area (Hectares)	Wheat (Hectares)	Percentage of Total Irrigated Area	Level of Exploitation of Groundwater	Yield (Tonnes/ Hectare)
Amritsar	414392	188233	45.42	Over exploited	3.91
Barnala	248570	113785	45.78	Over exploited	4.62
Bathinda	556800	253581	45.54	Semi-Critical	4.80
Faridkot	247996	115607	46.62	Over exploited	4.81
Fatehgarh Sahib	191061	84411	44.18	Over exploited	4.05
Fazilka	475007	206201	43.41	Critical	4.43
Firozepur	415567	188220	45.29	Over exploited	4.66
Gurdaspur	413016	183010	44.31	Critical	3.35
Hoshiarpur	322489	142345	44.14	Semi-Critical	3.60
Jalandhar	412947	167475	40.56	Over exploited	4.10
Kapurthala	267159	110234	41.26	Over exploited	3.90
Ludhiana	592502	252702	42.65	Over exploited	4.46
Mansa	357668	165382	46.24	Over exploited	4.47
Moga	381307	175067	45.91	Over exploited	4.54
Muktsar	446362	208148	46.63	Safe	4.36
Nawanshahr	179612	75234	41.89	Semi-Critical	3.71
Pathankot	55440	22909	41.32	Safe	2.74
Patiala	510722	233229	45.67	Over exploited	4.39
Rupnagar/ Ropar	134508	65673	48.82	Safe	4.03
S.A.S Nagar/ Mohali	104214	50022	48.00	Safe	3.96
Sangrur	635311	284263	44.74	Over exploited	4.81
Tarn Taran	394413	188215	47.72	Over exploited	4.13
Total	7757063	3473946	44.78		4.29

Source: Dynamic Ground Water Resources of Punjab State, Central Ground Water Board, 2013 and Agricultural Statistics at a Glance 2016.

In 22 districts of Punjab water table is declining in 110 blocks due to over-extraction of water than recharge. By 2023, the water table depth in central Punjab is projected to fall below 70 feet in 66% area, below 100 feet in 34% area and below 130 feet in 7% area (Central Ground Water Board 2014-15).

There are districts like Amritsar, Fatehgarh Sahib, Jalandhar, Kapurthala and Tarn Taran, all these districts fall under the over exploited category also their productivity level is low as compared to other districts. Because of the depletion of the groundwater, irrigation cost for wheat crop has increased significantly in these areas; this has resulted in more adverse effect relatively on the small and marginal farmers who lack necessary resources to finance such investments.

This has further contributed to increasing incidence of farmers' indebtedness as a result of increasing cost of well deepening and pump replacement. Thus, these districts may be targeted to release the area from wheat and some other crops may be grown there which are more remunerative.

Similarly, there are several other districts in different states, which have low water table and are struggling with irrigation issues, but traditionally are growing water intensive crops like paddy and sugarcane. These should be marked and specific tailor made policies/programmes should be designed for these districts so as to encourage them to grow crops, which are less water intensive at the same providing higher returns.

The need of the hour is to shift from water guzzling crops of rice, wheat and sugarcane towards less water consuming crops like pulses, coarse cereals, vegetables and fruits. But, it needs several policy measures for encouraging the farmers to make a shift from wheat-rice cycle to other cereals and pulses. Since wheat and rice coupled with other crops are backed by minimum support prices (MSP) and input subsidy (whether water, fertilizer or power) regime, there is a huge enticement for the farmers in some parts of the country to grow these crops.

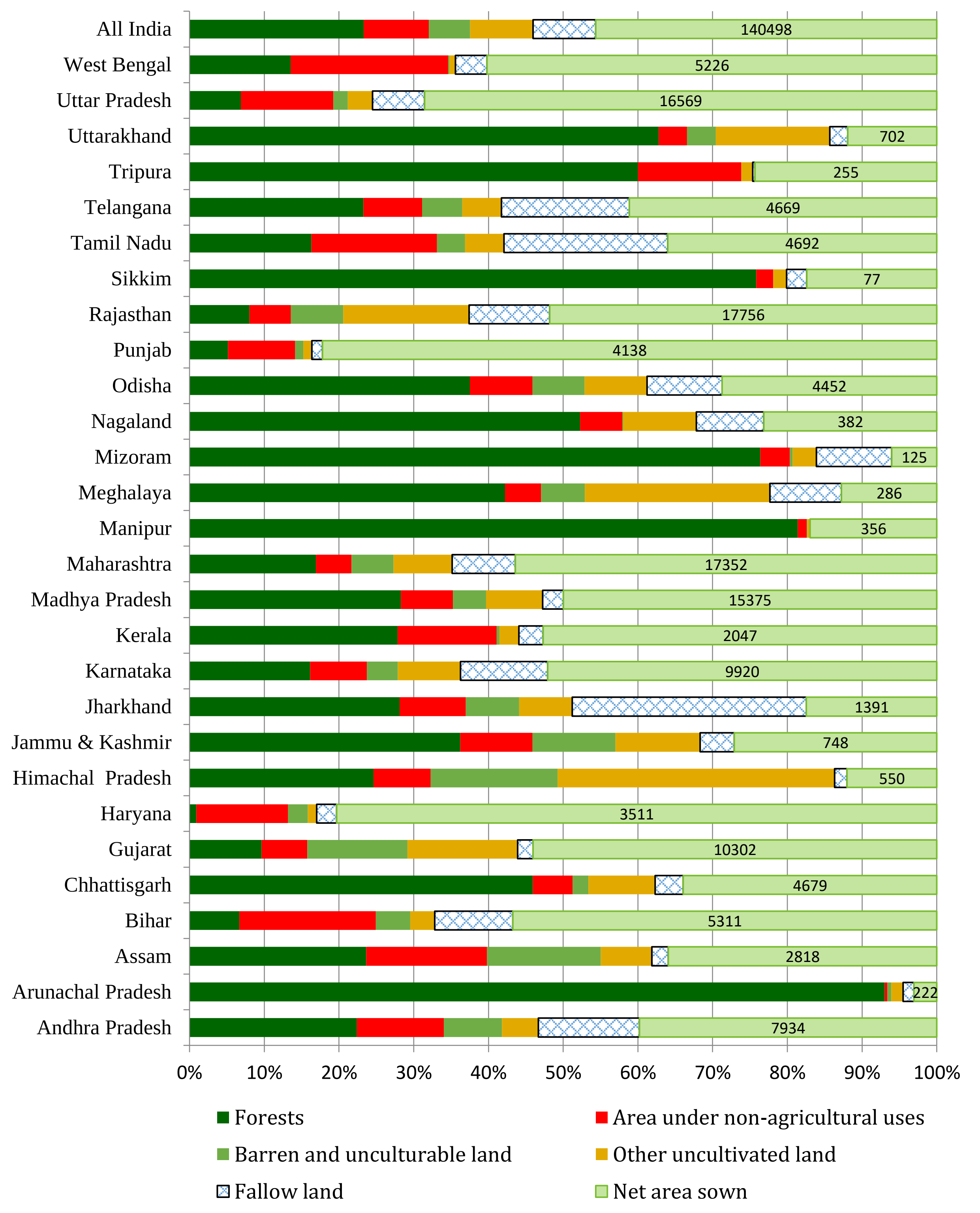
Most of the time major policy response to is problem has always been to disincentivise farmers from growing these crops by making meagre enhancements in the MSP. However, this alone is not sufficient, we need a complete package of agricultural practices that will help the farmers in growing alternative crops for that we required huge investment in public infrastructure. For instance, due to the rice milling industry in Haryana and Punjab, there is now a proper established market in place for different varieties of rice.

Until such a marketplace is available for other crops, farmers are unlikely to make a shift to other crops like pulses. In such a scenario, KVKs can play a key role in sensitizing the farmers towards environmental issues emerging because of consistent growing of crops which are consuming enormous amount of water and benefit of growing alternative crops like pulses, coarse cereals, vegetables and fruits.

0.9. State-wise land use pattern

India's land-use pattern shows total geographical area of 3.28 million square km. As per the land use statistics only 94 per cent of the total geographical area is available for utilisation.

Figure 0.4 State wise land use pattern in India ('000 Hectares, T.E 2014-15)



Source: DFI Committee Estimates based on data compiled from DACNET

Out of this, 45.5 per cent is net sown area, forest cover is 23 per cent, and 5 per cent is current fallow land (Table 0.15). This land-use pattern varies across states.

Every state in the country has significant area under culturable waste, and barren and unculturable land, which comprises 10 per cent as a whole for India. This area can be judiciously brought under cultivation following intense land management practices.

There is scope to bring culturable waste land under agriculture or by altering the area currently not fit for cultivation. The latter comprises of area under non-agricultural use, barren and unculturable land. This land area is unfit for cultivation due to problematic soil conditions like acidic soil, large treks and mainly is rainfed. Such land can be upgraded to support optimal crop production. There is need to follow proper land management practises.

In view of mounting pressure on land for numerous purposes, it is necessary to plan appropriate use of all the available land. This may be done by taking fitting measures to control soil erosion, desertification, improvements made on irrigation and water and soil conservation. Likewise, with the help of up-to-date and scientific methods of farming, productivity of land can also be amplified. All endeavours should be made to strike a balance amongst diverse use of land.

Nutri-cereals are typical to the dry land ecosystem, and play an important role in agricultural value system, the same as rice and wheat in irrigated areas. In the dry land parts of the country, nutri-cereals can play a significant role in doubling the farmers' income while also addressing concerns on nutrition.

Though income generation through enhancement in the productivity gains during green revolution has great significance, however, the dry land crops were not able to reap the same benefit as two staple cereals (rice and wheat).

In case of nutri-cereals productivity enhancement measures must be implemented along with demand enhancement through value addition so as to achieve objectives. Different policy measures are needed in order to enhance the productivity potential of millets in India. Developing innovative supply chain models as market linked value systems, will add to farmers' share in consumers' rupee and increase their income. Creation of farmgate level primary processing clusters for millets will increase the consumption of millets in the production zones. Creation of awareness about the health and environmental benefits associated with consumption of millets will aid demand creation for millets in the country.

Along with doubling farmers' income in various agro-ecological commodities and cropping systems the aspect of imparting nutritional security should also has to be considered.

Table 0.19 State wise land use pattern in India (thousand Hectares, T.E 2014-15)

State/ Union Territory/ Year	Geogra-phical Area	Reporting area for land utilisation statistics	Forests	Not available for cultivation		Other uncultivated land excluding Fallow Land			Fallow Lands		Net area Sown	Gross Cropped Area	Agri. Land (Culti-vable / Cultur-able /Arable)	Cultivated land	Un-cultivable land	Un-cultivated land
				Non-agricultural uses	Barren & unculturable land	Permanent pastures & other grazing lands	Land under misc. tree crops	Culturable waste land	Fallow other than current fallows	Current fallows						
Andhra Pradesh	19934	19934	4461	2324	1550	313	199	457	1087	1609	7934	9823	11285	9542	8649	10391
Arunachal Pradesh	8374	7241	6735	26	38	18	35	63	66	37	222	293	424	259	6817	6982
Assam	7844	7844	1854	1269	1193	170	223	144	86	87	2818	4086	3359	2906	4485	4938
Bihar	9416	9360	622	1711	432	15	247	45	121	856	5311	7677	6580	6167	2780	3192
Chhattisgarh	13519	13790	6333	738	289	877	1	353	259	261	4679	5705	5553	4941	8237	8849
Gujarat	19602	19069	1834	1171	2552	851	4	1960	16	379	10302	12620	12661	10681	6408	8388
Haryana	4421	4371	39	538	115	25	7	20	20	97	3511	6461	3655	3607	717	764
Himachal Pradesh	5567	4576	1126	350	777	1510	64	122	22	54	550	941	812	604	3764	3971
Jammu & Kashmir	22224	9339	1000	267	306	114	63	136	15	111	748	1162	1072	859	2955	3168
Jharkhand	7972	7970	2239	707	569	114	100	352	1074	1424	1391	1628	4341	2815	3630	5155
Karnataka	19179	19051	3073	1447	787	906	280	411	529	1698	9920	12087	12838	11618	6213	7433
Kerala	3886	3886	1082	515	14	0	3	98	56	71	2047	2611	2275	2118	1611	1768
Madhya Pradesh	30825	30756	8693	2146	1363	1293	20	1014	481	371	15375	23662	17261	15746	13495	15010
Maharashtra	30771	30758	5205	1466	1724	1245	250	917	1194	1406	17352	22915	21118	18758	9640	12000
Manipur	2233	2100		26	1	1	6	1	0	0	356	356	363	356	1737	1744
Meghalaya	2243	2242	946	109	131		165	390	155	60	286	342	1056	346	1186	1896

State/ Union Territory/ Year	Geogra-phical Area	Reporting area for land utilisation statistics	Forests	Not available for cultivation		Other uncultivated land excluding Fallow Land			Fallow Lands		Net area Sown	Gross Cropped Area	Agri. Land (Culti-vable / Cultur-able /Arable)	Cultivated land	Un-cultivable land	Un-cultivated land
				Non-agricultural uses	Barren & unculturable land	Permanent pastures & other grazing lands	Land under misc. tree crops	Culturable waste land	Fallow other than current fallows	Current fallows						
Mizoram	2108	2075	1585	82	8	7	52	7	161	48	125	125	393	173	1682	1902
Nagaland	1658	1652	863	93	2		93	69	99	50	382	496	694	432	958	1220
Odisha	15571	15495	5814	1301	1078	528	208	559	641	915	4452	5136	6775	5366	8721	10129
Punjab	5036	5033	259	453	53	5	8	46	6	65	4138	7858	4263	4203	769	829
Rajasthan	34224	34267	2749	1898	2400	1687	25	4064	1980	1709	17756	24769	25534	19465	8734	14802
Sikkim	710	443	336	10			4	4	5	7	77	142	97	84	346	358
Tamil Nadu	13006	13033	2125	2191	489	109	243	327	1716	1141	4692	5677	8119	5833	4914	7200
Telangana	11359	11346	2641	890	611	300	113	180	761	1180	4669	5801	6903	5849	4443	5497
Tripura	1049	1049	629	145		1	12	3	2	1	255	477	273	257	776	793
Uttarakhand	5348	5886	3695	222	228	192	389	316	86	55	702	1107	1548	757	4337	5129
Uttar Pradesh	24093	24170	1658	2988	468	65	327	413	528	1153	16569	25955	18990	17722	5180	6449
West Bengal	8875	8684	1173	1833	12	2	49	20	13	356	5226	9589	5664	5581	3020	3102
All India	328726	307702	71732	26767	17006	10257	3158	12500	10941	14844	140498	197852	181940	155342	125761	152360

Source: DFI Committee Estimates based on data compiled from DACNET

The measures to consider for increasing the production of millets would include bringing more fallow and waste lands under millet cultivation, bridging existing yield gaps and increasing the resource use efficiency. These steps will help in increasing the nationwide availability of nutri-cereals and supplement marginal dry land farmers' income. Development of value added products will help in growing the demand for millets in the country.

Volume VIII-A

Cereals: Staple Crops
Rice, Wheat and Maize
Nutri-Cereals, including Millets
Pulses & Oilseeds

Volume VIII-B

Commercial Crops: Cotton, Sugarcane

Volume VIII-C

Horticulture & Sericulture

Volume VIII-D

Animal Husbandry: Dairy, Livestock, Fishery

Dairy Sector

Chapter 1
Dairy Sector: Growth Dynamics

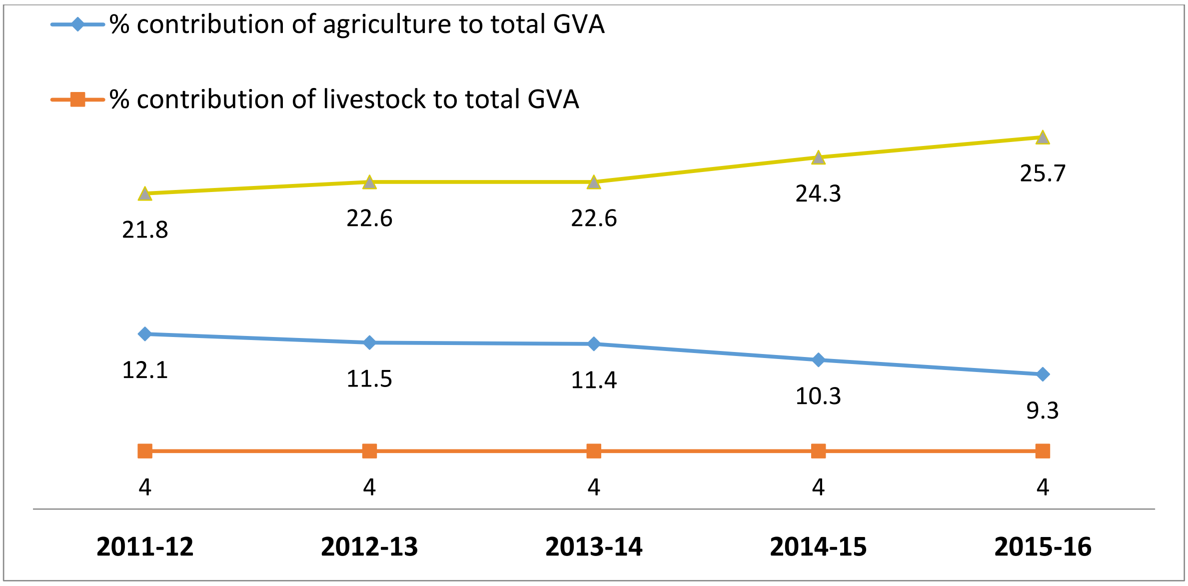
Dairying is one of the most important means of providing livelihood and nutritional security to the rural masses. Milk group has predominant share (67 per cent) in the value of output from livestock sector. In the span of past 75 years, the dairy sector has come a long way registering more than 9-fold increase in milk production, from 17 million tonnes in 1950-51 to 165 million tons in 2016-17. The decadal growth rates, ranging from of 3.5-5.0 per cent during the past seven decades, have been higher than the world average growth rate of about one per cent.

1.1. Role of Dairy in the Economy

Rural households keep livestock because of the wide spectrum of benefits such as income, food, manure, draft power and social status. In 2015-16 livestock generated output worth Rs.4,159.49 billion (at 2011-12 prices) which comprised 3.9 per cent of the total Gross Value Added (GVA) and 25.7 per cent of the agricultural GVA (GoI, 2017).

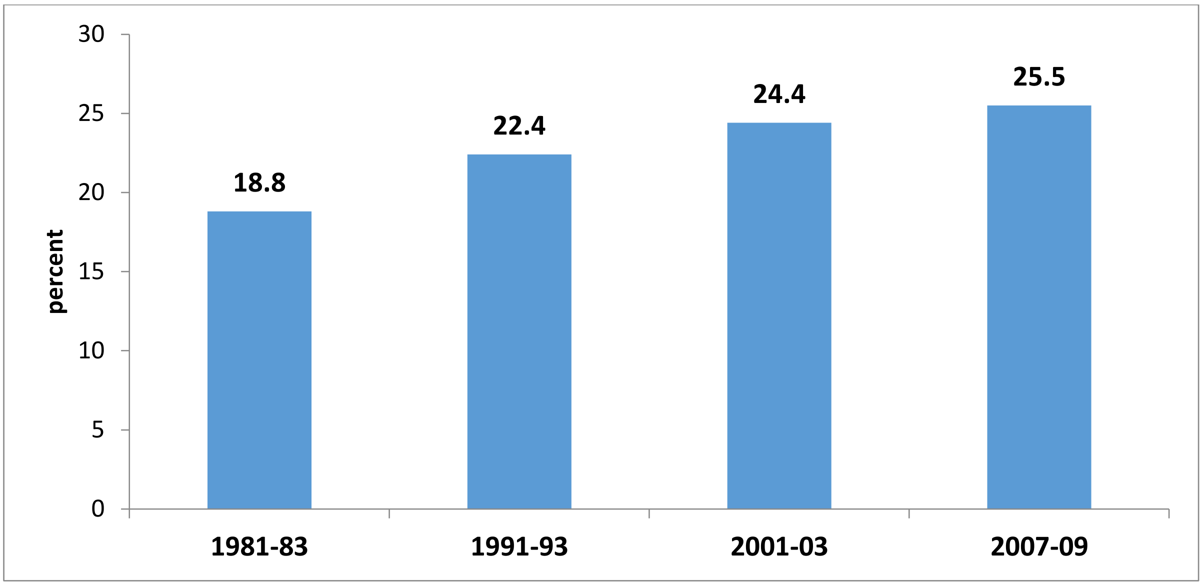
The development path of the Indian economy is manifest by various signs of change. The contribution of agriculture sector to total GVA at constant prices has seen a declining trend, while the contribution of livestock sector to the total GVA and agricultural GVA has increased (Figure 1.1).

Figure 1.1 Contribution of livestock to agriculture sector: recent trends



Long term trends bring out increasing importance of livestock in the agriculture and allied activities even more sharply. The contribution of livestock to the total output of the agriculture sector increased from 19 per cent in TE 1983 to 26 per cent in TE 2009 (Figure 1.2). Driving livestock growth, are changes in the utility of livestock for farmers and in food consumption pattern. Consumption of livestock products like eggs, milk and meat is increasing due to rise in the income of the booming middle class, both in urban and rural areas

Figure 1.2 Decadal trends in share of livestock in agriculture GDP (1999-2000 prices)



The value of output from milk group has been higher than the same for three major crops viz., paddy, wheat and sugarcane. Notably, while the output growth in these crops has been negligible (or even declining in case of sugarcane) as is indicated by near stagnant output value at constant prices (Table 1.1), there has been a consistent increase in milk output. Thus, in terms of the output, milk is the largest agricultural commodity in India.

Table 1.1 Trends in real value of output (2011-12 prices)

Item	2011-12	2012-13	2013-14	2014-15	2015-16
Paddy	170595	169773	172144	170369	168028
Wheat	118068	115884	119051	107828	114880
Sugarcane	60139	58614	56181	59464	54179
Milk group	327767	339240	352247	374269	396691

Dairying in rural India is a way of life; it has broader social and economic dimensions. As per the NSSO 70th round (2012-13) Land and Livestock, 34 million households reported ownership of adult female cattle and 24 million owned adult female buffalo. The distribution of animal holding has been found to be more equitable as compared to land holding. This is borne out by the fact, that 85 per cent of the Indian farmers, who are marginal, and small, own only 45 per cent of farm land but 75 per cent of bovines.

1.1.1. Contribution to Rural Income

According to NSSO Situation Assessment Survey (2012-13) estimates, agriculture sector contributes to around half of the income of farmers and more than one-tenth is being contributed by livestock sector, thus making contribution of agriculture and allied sector more than 60 per cent in the total income of farmers. The proportion of income from livestock sector is higher in case of economically disadvantaged groups - about 26 per cent in case of the poorest households and about 12 per cent in case of overall rural income. The share of farmers' income from cultivation rose from 45.8 per cent in 2002-03 to 47.9 per cent in 2012-13; the share of income from livestock/dairying was the one that grew the most, from 4.3 per cent to 11.9 per cent, while the contribution from both non-farm business and wages & salaries declined over the period. Further, unit level analysis of NSSO showed that the average farmers' income from dairying was around 84 per cent of the income from livestock.

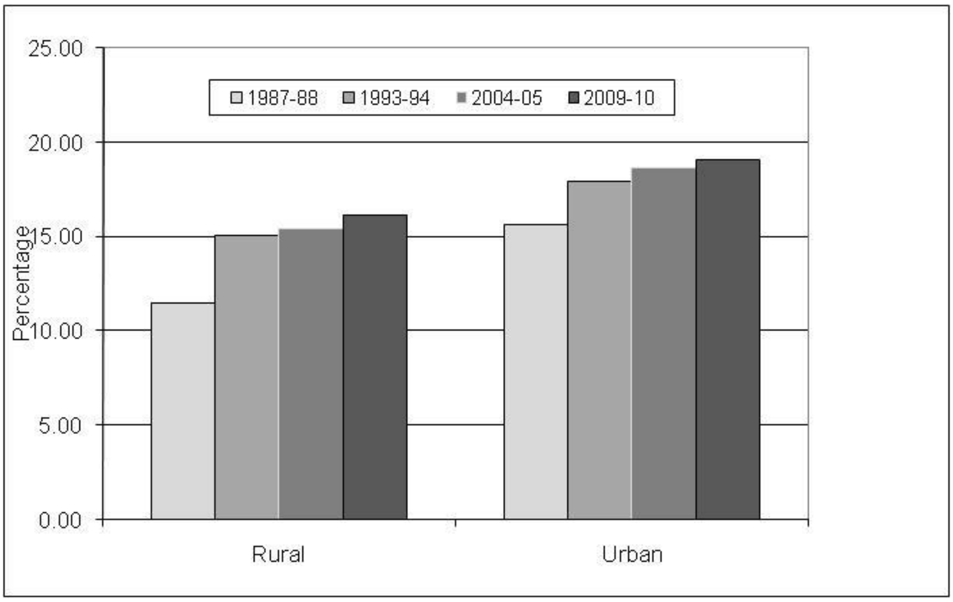
1.1.2. Contribution to Rural Employment

Livestock sector in general is predominantly labour intensive in nature. Women workforce plays a pivotal role in rearing the farm animals, especially dairy animals. The NSSO 68th round (2011-12) Employment survey estimates that 4 per cent of the usually working rural persons are engaged in animal production and other animal husbandry activities, either in principal or subsidiary status. In absolute terms it works out to be 30.9 million rural workers, about 1.5 times higher than the usual status employment of 19.97 million rural workers in livestock sector in 2004-05. The proportion is eight times higher for females (8.8 per cent) than males (1.0 per cent). Over the years, there has been a distinct trend towards feminization of livestock activities, with percentage of females in cattle, goat and poultry increasing from about 60, 40 and 40 percent, respectively in 1983-84 to nearly 70, 55 and 70 percent, respectively in 1999-00. The employment status of persons indicates that most of the workers in dairy are self employed, substantiating that dairying is instrumental in arresting casualization of rural labor force. However, a deeper look indicates that a very high percentage of the self employed workers are actually unpaid family labor and/or helpers that points towards high incidence of underemployment in dairy faming. The estimates of employment elasticity, during 1993/94-1999/00, were 0.4 in the livestock sector - higher than the same in agriculture sector, the primary sector as a whole, and even the aggregate employment elasticity indicating potential of demand-driven growth of labour in this sector. According to World Food Organization estimates, every rupee invested in livestock sector of India potentially yields 4 times its value. Therefore, it is pertinent to say that there are myriad opportunities in livestock sector to double the income of farmers by 2022.

1.1.3. Contribution to nutrition

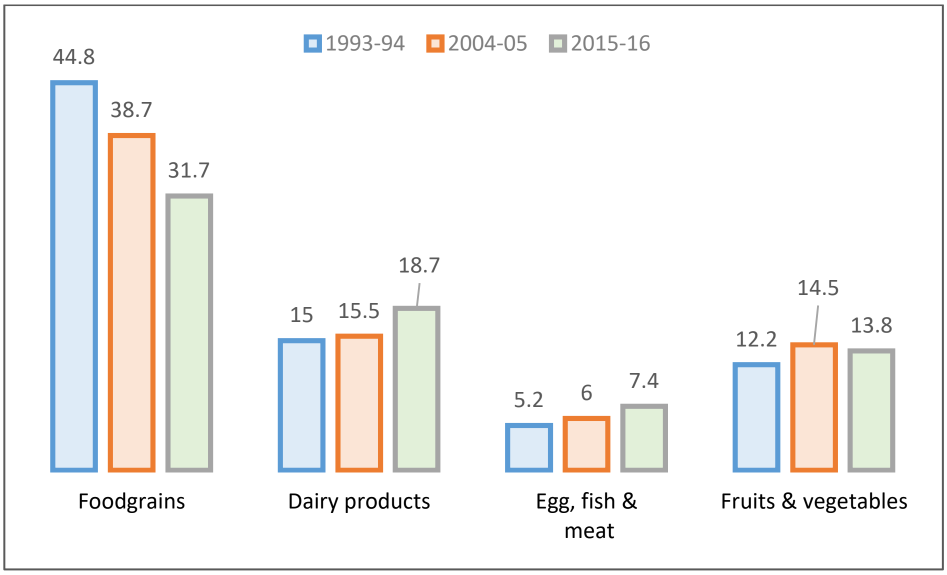
Besides being a source of income for rural households, milk also ensures nutritional security of the family, addressing issues like malnutrition. Studies show that households owning milch animals in rural areas consume almost three times more milk than the families which are not into dairying. Milk and milk products account for about 9 per cent of the monthly per capita expenditure in rural areas. There has been a constant increase in the share of food expenditure on milk and milk products in both, the rural and the urban areas (Fig. 1.3). In terms of quantity, in 2009-10, the per capita monthly liquid milk consumption (which includes milk converted into curds, butter, *ghee*, *paneer*, sweetmeat, etc. within the household, prior consumption) is 4.117 litres in rural and 5.358 litres in the urban areas; 29 per cent and 26 per cent higher, respectively, from the consumption level in 1987-88. Besides the consumption of liquid milk, the demand for value added dairy products, has increased very sharply in both rural and urban areas. In fact, India is projected as one of the fastest growing markets for cheese with annual growth pegged at 20 per cent (Ross, 2007).

Figure 1.3 Share of milk and milk products in monthly per capita food expenditure



Data Source: NSSO Consumption Expenditure Surveys, various rounds

Figure 1.4 Share (%) of food expenditure (Rural) - trend

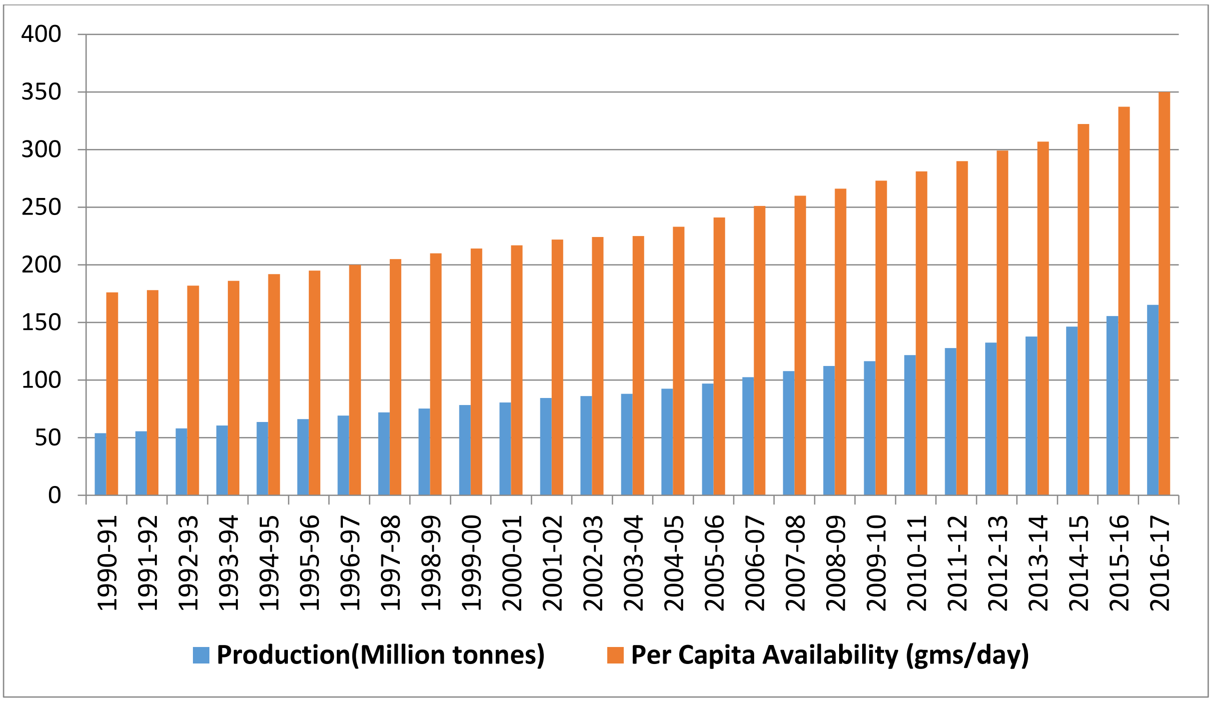


1.2. Current Status of Dairy Sector

India ranks first among the world's milk producing nations, with a sustained growth in the availability of milk and milk products for growing population. The annual milk production was 165.40 million tonnes during 2016-17 as compared to 155.49 million tonnes during 2015-16, thereby recording a growth rate of 6.37 per cent.

The Indian dairy sector is characterized more by 'production by masses' than 'mass production'. Unlike leading milk producing countries in the world, large proportion (95 per cent) of milk producers in the country hold 1 to 5 animals per household.

Figure 1.5 Trends in milk production and availability



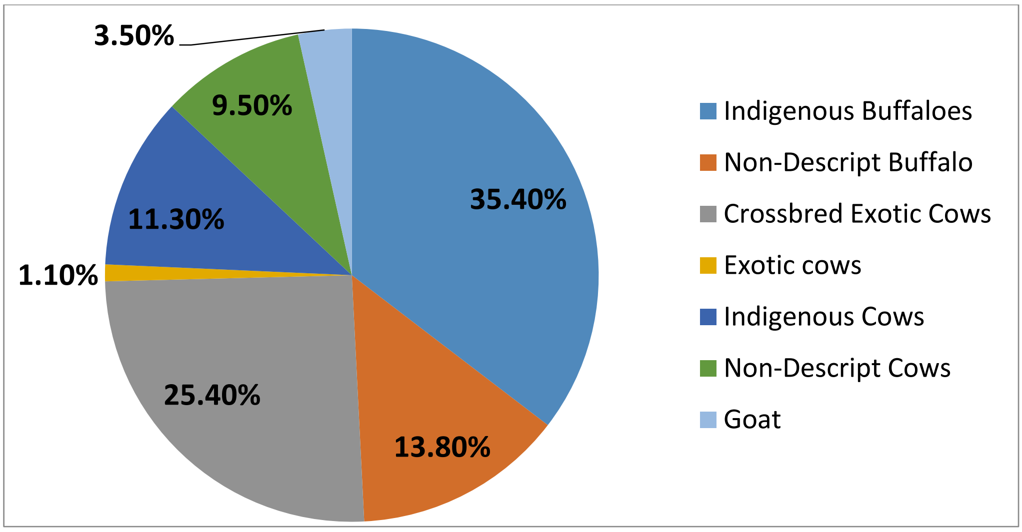
Milk Production*:* India, the top milk producing nation in the world contributes about 19 per cent to the global milk pool. In the ongoing decade (2010 onwards) the compound growth rate of milk production has been slightly more than 5.0 per cent per annum. Even during the global economic crisis in 2008-09, while there was a deceleration in the world milk production, the production of milk in the country recorded a steady growth. The turmoil in the feed input-milk output prices, a part and parcel of the then economic crisis, affected the milk production in the leading milk producing countries in the world. However, in India; the production of milk remained more or less resilient to these economic developments. Due to lower level of market orientation of dairy production system in the country, the responsiveness of milk production to price signals is in general weak.

The milk production has increased from 155.5 in 2015-16 to 165.4 million tonnes in 2016-17 registering a growth of 6.4 per cent. The per capita availability of milk was at 130 gm/day in 1950-51. There has been steady increase in per capita availability of milk since 1973-74 with a marginal fluctuation in the intermittent periods. However the per capita availability has sharply increased from 225 gm per day in 2003-04 to 355 gm per day in 2016-17.

Projections indicate that demand for milk will be in the range of 350 to 380 million tons by the year 2050. This will require small livestock owners to reorganaise themselves into producer groups to manage larger her sizes, and a greater spread of the organised milk supply chain.

The species-wise contribution of milk production (Fig. 1.6) shows that nearly 35.4 per cent of the milk production is contributed by indigenous buffaloes followed by 25.4 per cent by crossbred cattle. The indigenous cattle contribute 11.3 per cent of the total milk production in the country whereas non-descript cattle contribute 9.5 per cent milk production and non-descript buffaloes contribute 13.8 per cent milk production.

Figure 1.6 Species-wise contribution of milk production: 2016-17



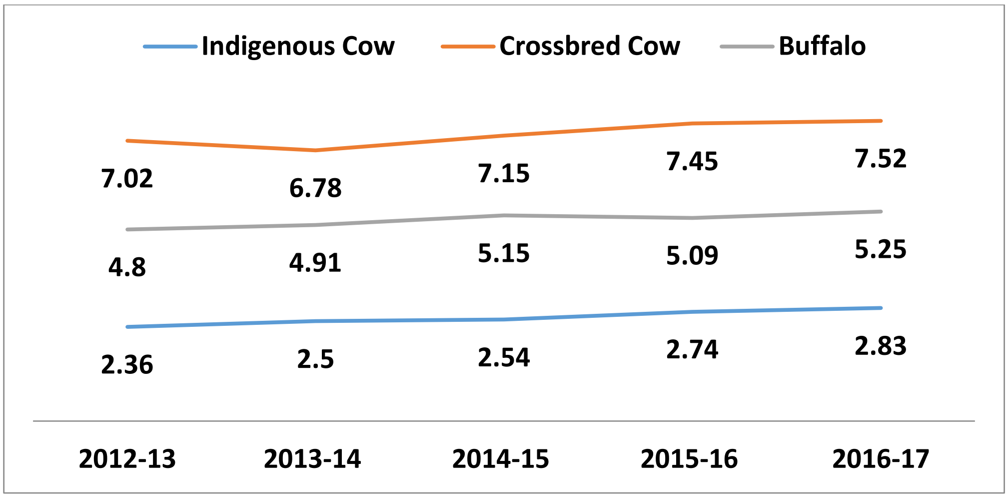
1.2.1. Scale of Milk Production

The low level of commercial orientation in milk production is reflected in the small scale of milk production for a majority of households. Empirical evidence provided by the researchers based on the large sample surveys indicate that level of milk production for 36 per cent households is only ≤500 litres/annum and for another 27 per cent between 500-1000 litres/annum. Such a tiny scale can provide some nutritional benefits to the family, but not enough surpluses for the market. Only 15 per cent households produce >2000 litres/annum and contribute 50 per cent to the total milk production. Interestingly, although the scale of dairy production is positively associated with land ownership, a considerable proportion of small landholders take up dairying as a commercial activity. Among the households producing more than 5000 litres of milk/annum, 54 per cent belong to marginal and small landholders, suggesting that with efficient input and output support services, dairying can be a vital economic activity for the economic upliftment of these small landholders.

1.2.2. Milk Productivity

Despite of holding the number one position in milk production in the world for nearly two decades, the milk productivity in the country remains one of the lowest as compared to many leading countries of the world. With about 17 per cent of the world dairy animal stock, India accounts for 19 per cent of the world milk production, while USA is producing 12.5 per cent of the total world milk from merely 6 per cent of the world cattle population. In India, the average milk productivity of crossbred cows, indigenous cows and buffaloes is only 7.53, 2.83 and 5.25 kg/day respectively. Over the years, there has been some growth in milk yield due to R&D interventions and sustained government efforts. For instance, in comparison to 2012-13, the productivity of indigenous cows is about 20 per cent higher in 2016-17 (Fig. 1.7). Similarly, the yield enhancement during this period for crossbred cows and buffaloes has been 7 and 9 per cent, respectively.

Figure 1.7 Productivity of dairy animals (kg./day)



1.2.3. Sources of growth in milk production

Despite of low productivity level, enhancement in productivity has been an important source of growth in milk production. During 2004/05-2013/14 more than half of the growth in milk production (60 per cent) has come from productivity enhancement (Table 1.2). The growth in milk yield has been particularly pronounced in case of local cows, although their share in milk production is the least (21 per cent) among the three types of dairy animals. The buffalo milk production which holds the predominant share in the total milk production (53 per cent) has increased at compound annual growth rate of 3.78 per cent during 2004/05-2013/14. The productivity growth in buffaloes has been slower than growth in number of in-milk animals. In case of crossbred cows, the contribution of growth in average productivity to total growth in milk production is quite small and the predominant growth in crossbred milk production has come from the increase in animal numbers.

Table 1.2 Species-wise sources of growth in milk production

Species	Total Milk Production(million tonnes): 2013-14	Compound Annual Growth Rate (per cent): 2004/05-2013/14	Share in growth (per cent)		
			In-milk animal	Average yield	Population-yield Interaction
Local cow	28.316 (21.34)	4.09	20.70	73.39	5.91
Crossbred	33.888 (25.55)	7.95	88.62	6.04	5.34
Buffalo	70.443 (53.11)	3.78	55.45	36.49	8.06
Total	132.637 (100.00)	4.79	26.40	59.99	13.61

Figures in parentheses are percentages of the total

Source: Basic Animal Husbandry Statistics, various years

1.2.4. Bovine Population Trends

India is home to about 57 per cent of world buffalo and 16 per cent of world cattle population. According to the Livestock Census 2012, the country has 133.2 million adult female cattle and buffalo and 88.35 million in-milk cattle and buffaloes. From 1961 to 2012, the total bovine population has grown at a slow rate of 0.57 per cent per annum largely because increase in female animal population has been accompanied by decrease in male animal stock due to widespread mechanisation of agricultural operations (Table 1.3).

Table 1.3 Growth trends in bovine Population: 1961-2012

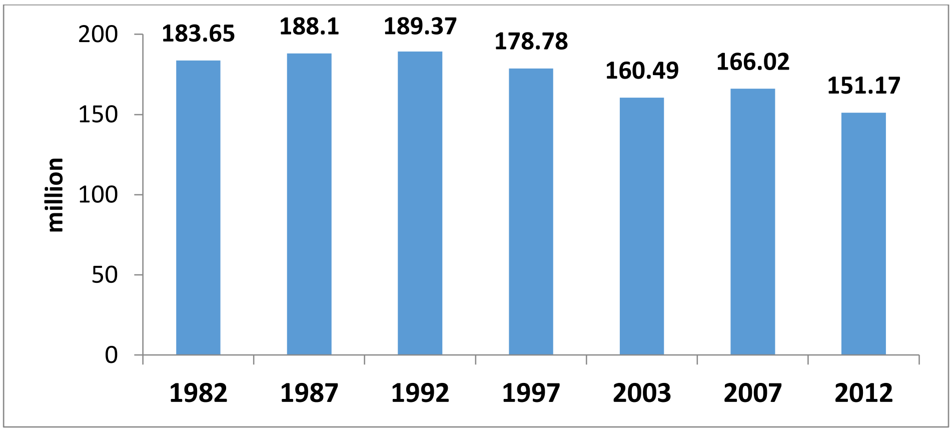
Type	Total	Buffalo	Cattle	Indigenous cattle *	Crossbred cattle*
Bovine Population	0.57	1.49	0.19	-0.61	5.06
Male	-0.52	0.25	-0.66	-1.00	1.81
Female	1.24	1.82	0.89	-0.23	6.53
Adult females	1.02	1.61	0.69	-0.36	6.54
In-milk animals	1.76	2.13	1.49	0.64	7.01
Unproductive adult female stock	1.25	2.39	0.76	-0.07	6.48
Wet-dry ratio	1.57	1.31	1.60	1.01	0.42

* Growth rate for indigenous and crossbred cattle pertains to the period 1982-2007

Source: Livestock Census, various years

There has been distinct shift in composition of dairy herd towards buffaloes. Among the adult female animals, the number of buffaloes has increased at a faster rate (1.6 per cent) than cattle (0.7 per cent). Out of the total buffalo population in the country (108.34 million) more than 50 per cent are breedable females, indicating preference of the farmers for rearing buffaloes for milk production. Among the states, Uttar Pradesh, Andhra Pradesh, Madhya Pradesh, Rajasthan and Punjab have the largest buffalo population and together they accounted for nearly 60 per cent buffalo population of the country in 2012. Eastern region has less than 10 per cent of the buffalo population with swamp buffalo being included. A major share of milch animals is located in drought prone areas.

Figure 1.8 Population trends of local (indigenous & non-descript) cattle



There is a large number of indigenous and non-descript cattle, though this population has declined from 183.65 million in 1982 to 151.17 million in 2012, which is a decline of 17.69 per cent (Fig. 1.8). Major decline was noted between 2007 and 2012 livestock census.

The adoption of crossbreeding technology in cows has led to high growth rate in female crossbred cattle, while the indigenous female stock has decreased. Total crossbred number grew from 8.80 million in 1982 to 39.73 million in 2012.

Another notable trend in the herd composition is the faster growth of in-milk animals vis-à-vis adult female stock, implying an improvement in the wet-dry ratio of all the three types of dairy animals. However, the number of unproductive adult females has increased as there is no official policy to cull the unproductive animals.

1.3. Annotation

Dairy farming has remained a very important component of the traditional farming system of the country, and is one of the most important means of providing livelihood and nutritional security to the vast majority of rural masses. The most prevalent dairy production system is under mixed farming system integrating crop and livestock production in a synergistic manner. India, with about 19 per cent share in global milk pool in 2016-17, continues to be the top milk producing nation in the world. With an impressive figure of growth rate of 6.4 per cent from previous year, the country has recorded 165.4 million tonnes production in 2016-17.

However the Indian dairy sector is characterized more by 'production by masses' than 'mass production'. Only 15 per cent households contribute 50 per cent to the total milk production in the country. Generally, the milk productivity in the country remains one of the lowest as compared to many leading countries of the world.

Despite of low productivity level, technology led productivity enhancement has been important in contributing to the growth in milk production. The growth in milk yield has been particularly pronounced in case of local cows among the three types of dairy animals. Therefore, due attention on the productivity enhancement of the indigenous cows will be a win-win strategy for enhancing farmers' income, as indigenous cows have good adaptation potential to climate stress compared to buffaloes and crossbreds.

The genetic and technological intervention over the time has also significantly imparted growth in milk production through shift in the herd composition towards more in-milk animals. Besides, crossbreeding strategy has led to the faster growth of highly productive crossbred females. However, considering the resource position of the farmers, which is by and large poor, it is important that breeds are developed for high milk production that can be reared under the rugged Indian conditions where fodder scarcity, heat and humidity are a reality.

Artificial insemination (AI) coverage is estimated at 30 per cent of adult-female cattle and buffalos, with additional requirement of 64 million frozen semen straws (male germplasm). At the moment there are about 42 registered breeds of cattle (with 59 per cent animals reported as non-descript) and 14 registered breeds of buffalo (including 43 per cent non-descript).

It is estimated that nationally about 46 per cent of milk output is consumed by producers themselves and 54 per cent is marketed. The unorganised sector with about 80 per cent share in total milk production predominates the marketing and processing of milk. In the interest of economic well-being of the milk producers, it is essential to provide them with greater access to the organised sector. This would not only ensure remunerative prices to farmers for their produce but will also encourage more farmers to adopt dairying as a source of livelihood.

The dairy sector needs to be transformed from population friven to technology driven, from subsistence type to robust economic models, to progress livestock farmers into the status where they function as livestock economic units.

Key Extracts

- Rearing of dairy animals is an important source of income, employment and nutrition for the farmers, which makes for technical, infrastructural and policy interventions in dairy vital for doubling the farmers' income.
- Milk production has shown a steady growth, thus increasing the per capita milk availability despite of increasing population.
- Notwithstanding of low productivity levels, the trends in productivity growth have been positive particularly for the local cows and buffaloes. In fact, productivity enhancement has been the major source of growth in milk production from local cattle.
- Composition of dairy herd has shifted towards buffalo population. Crossbred adoption levels have also gone up.
- Unorganised sector is the major player in handling the marketed surplus of milk.
- Dairy Cooperatives have much wider network than private dairy plants in terms of membership, but both cooperatives and private have an almost equal share in milk processing.
- It is important to increase the share of organized milk marketing to benefit farmers in terms of higher monetization.

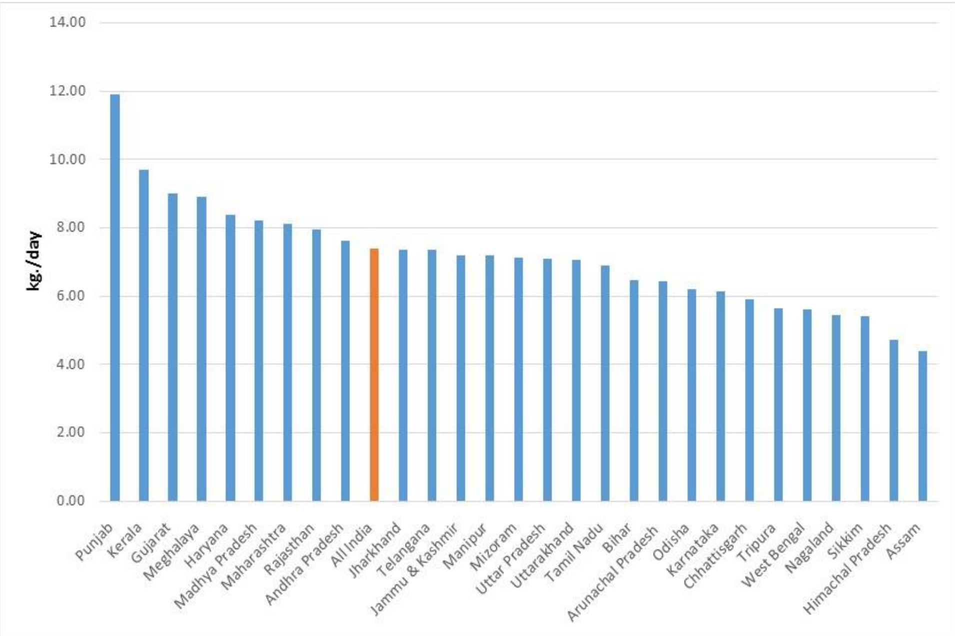
Chapter 2
Dairy: Yield Gap and Challenges

The income of the farmers can be enhanced by increasing the productivity of dairy animals. To achieve the targeted milk production of 254.5 million tons by 2021-22, the desired growth rate in productivity of lactating animals is 4.7 per cent (2016/17-2021/22) as against the existing growth rate of 2.3 per cent (2011/12-2015/16). It is a major challenge to bridge the yield gaps that exist at inter and intra-regional levels as well as across farms.

2.1. Milk Yield of Dairy Animals: Inter-state Variations

It is a well-established fact that the productivity potential of zebu cattle (*Bos Indicus*) originating in the Indian sub-continent is lower than that of *Bos Taurus* that are mostly reared in temperate countries. The former species comprises of primarily dual purpose breeds, traditionally catering to the draft power and milk requirement of farm households in India. Over the period of time, cross-breeding the low productivity cattle with superior germplasm enhanced their productivity potential, which is reflected in the higher milk yield of crossbred versus the local cows. However, this improvement in genetic potential of cattle is far from being uniform across states and there exist sharp inter-state variations in the yield of crossbred cows (Fig. 2.1).

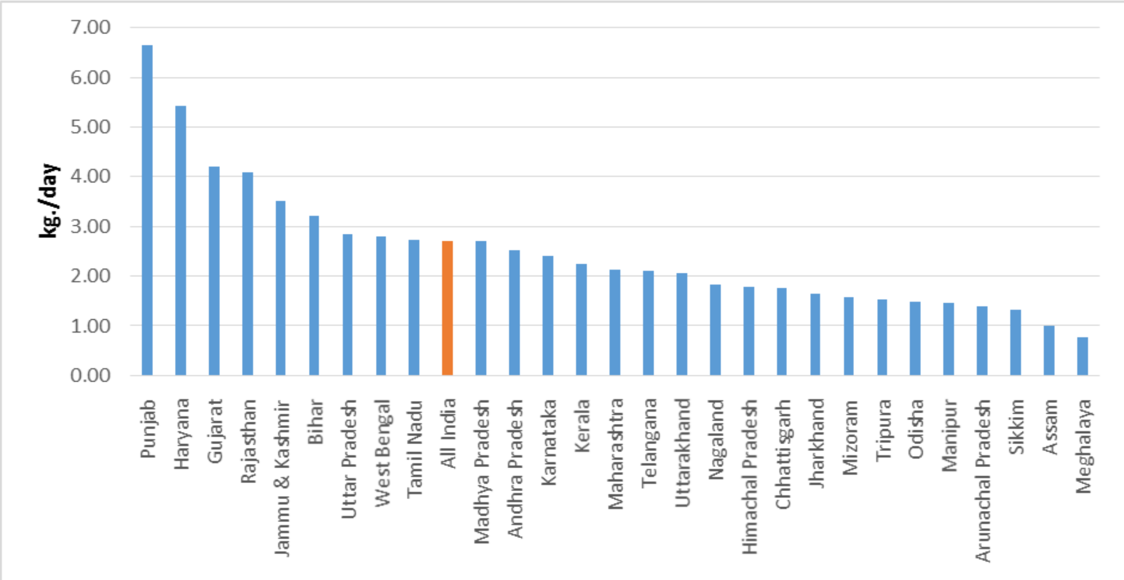
Figure 2.1 Inter-state Variations in Milk Productivity (TE 2016-17): Crossbred Cows



In TE 2016-17, the highest productivity (11.9 kg/day) of crossbred cows is reported in Punjab. The state of Kerala ranks second, followed by Gujarat. The crossbred adoption rate is over 92 per cent in Kerala but compared to Punjab the yield is more than 20 per cent lower. A number of major milk productivity states, such as Uttar Pradesh, Tamil Nadu and Karnataka, all have crossbred yield level lower than the all India average of 7.37 kg/day.

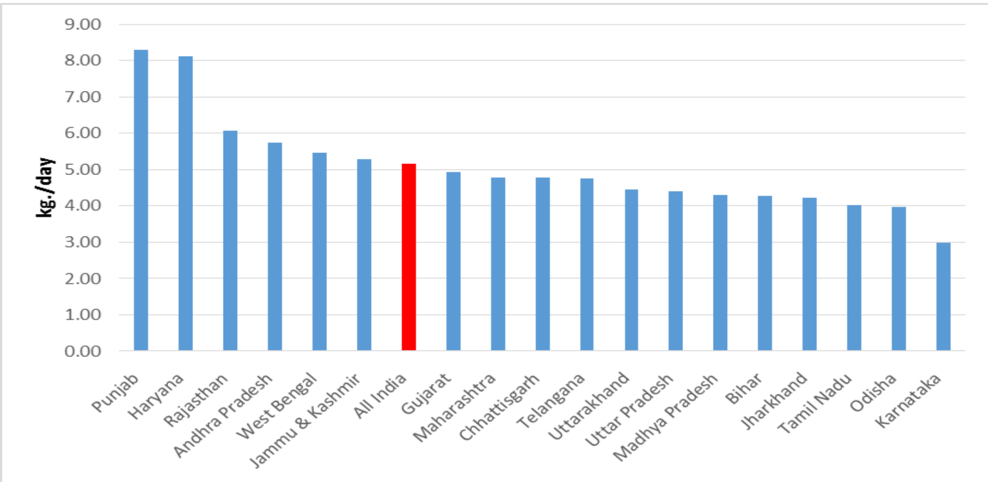
In case of local cows, the inter-state variations are even sharper (Fig 2.2). In only two states, i.e., Punjab and Haryana, the milk yield is about 5.5-6.5 kg/day. Most of the states have a yield gap of nearly 50 per cent in comparison to these two best performing states.

Figure 2.2 Inter-state Variations in Milk Productivity (TE 2016-17): Local Cows



India is not the native tract for high yielding breeds of cattle but certainly the home tract of world's best buffalo breeds such as Murrah, Mehsana, Bhadawari, etc. However, very sharp inter-state variations in yield are discernible in this case as well (Fig. 2.3). Once again, Punjab and Haryana are the top two states with over 8 kg/day average productivity in milk buffaloes. The two states of Rajasthan and Andhra, ranking third and fourth respectively, have a yield gap of around 2 kg/day in comparison to the top two states. In several other states with sizeable buffalo population, like Gujarat, Maharashtra, U.P, and M.P, the productivity is even below the all India average of 5.16 kg/day.

Figure 2.3 Inter-state Variations in Milk Productivity (TE 2016-17): Buffaloes



Thus, in general, higher milk productivity of all the three types of milk animals in agriculturally progressive states of Punjab and Haryana indicates that agricultural development is a precondition for improving milk productivity. In agriculturally underdeveloped states/regions, farmers are more and more dependent on livestock in general and dairy husbandry in particular, but the milk productivity is generally low. There were many states in which milk productivity was lower than the national average in case of local cow and buffalo and there is a need to work on improving the productivity of these animals, which account for a major share in the total milk production.

2.2. Dimensions of Yield-gap at District level

The inter-state variations in milk productivity are partly reflective of the differences in the emphasis given to the development of animal husbandry in the state by the respective state governments. However, there are also notable differences in the productivity levels across districts within a state. Taking one state from each of the four geographical regions of the country, the intra-state yield gaps have been shown in Table 2.1. In the most progressive state of Punjab, the difference in productivity of crossbred cows in Ludhiana and Roper is over 3 kg/day, which translates into a difference in the annual gross returns of about Rs. 27000/cow (considering price of milk as Rs. 30/kg and 300 day lactation length). Similar magnitude of yield gap is also observed for crossbred cows in Gujarat and Tamil Nadu. The intra-district variations in yield are less pronounced for buffaloes compared to crossbred in Punjab and Gujarat, the two buffalo dominant states. Odisha, which has a large population of local cows, has abysmally low productivity (<1 kg/day) in several districts, such as Sundargarh, Balangir, Kandhamal, Nabarangapur, Kendujhar, and Debagarh.

Table 2.1 Yield-gap at District Level in Selected States

Deviation from best producing district in the state	Local Cows	Crossbred	Buffalo
a. Northern India: Punjab			
< 1 kg/day		Muktsar	Tarn Taran, Barnala, Amritsar, Bathinda, Moga, Sangrur.
1-2 kg/day		Bathinda, Barnala, Gurdaspur, Sangrur, Patiala	SAS Nagar, Hoshiarpur, Jalandhar, Gurdaspur, Kapurthala, Patiala, Faridkot, Ludhiana, Mansa, Firozpur, SBS Nagar, Fatehgarh Sahib, Rupnagar
> 2 kg/day		Amritsar, Mansa, Firozpur, SAS Nagar,	

Deviation from best producing district in the state	Local Cows	Crossbred	Buffalo
		Moga, Faridkot, Rupnagar, Fatehgarh Sahib, Jalandhar, Tarn Taran, SBS Nagar, Kapurthala, Hoshiarpur	
Best producing district (kg/day)		**Ludhiana (13.153)**	**Muktsar (9.681)**
b. Western India: Gujarat			
< 1 kg/day	Patan, Junagadh, Gandhinagar, Rajkot, Porbandar, Amreli, Anand, Mehsana, Banaskantha, Surendranagar, Bhavnagar, Jamnagar, Sabarkantha, Kachchh	Patan, Banaskantha, Jamnagar, Amreli, Rajkot,	Mehsana, Porbandar, Junagadh, Banaskantha, Rajkot, Jamnagar, Amreli, Gandhinagar, Ahmedabad, Surendranagar, Sabarkantha, Anand, Kachchh
1-2 kg/day	Vadodara, Surat, Kheda, Bharuch, Navsari, Tapi, Narmada,	Gandhinagar, Surendranagar, Porbandar, Junagadh, Sabarkantha, Anand, Bhavnagar, Kheda, Kachchh, Ahmedabad,	Bhavnagar, Surat, Kheda, Valsad, Tapi, Navsari, Panchmahals, Bharuch, Vadodara, The Dangs, Narmada
> 2 kg/day	Panchmahals, Valsad, Dahod, The Dangs	Panchmahals, Dahod, Surat, Valsad, Navsari, Narmada, Vadodara, Tapi, The Dangs, Bharuch	Dahod
Best producing district (kg/day)	**Ahmedabad (4.952)**	**Mehsana (10.429)**	**Patan (5.699)**
c. Eastern India: Odhisha			
< 1 kg/day	Baleshwar, Koraput, Subarnapur, Malkangiri, Gajapati,	Sundargarh, Bhadrak, Mayurbhanj, Rayagada, Jajapur, Kendrapara, Puri, Dhenkanal, Koraput, Subarnapur, Baudh, Baleshwar, Ganjam,	Malkangiri, Bhadrak, Khordha, Jajapur, Mayurbhanj,

Deviation from best producing district in the state	Local Cows	Crossbred	Buffalo
		Kalahandi, Balangir, Malkangiri, Nuapada, Gajapati, Jagatsinghapur, Kandhamal, Cuttack	
1-2 kg/day	Jajapur, Kendrapara, Jagatsinghapur, Bhadrak, Kalahandi, Puri, Rayagada, Nayagarh, Cuttack, Baudh, Ganjam, Nuapada, Anugul, Dhenkanal, Khordha, Jharsuguda, Sambalpur, Mayurbhanj	Kendujhar, Nayagarh, Nabarangapur, Khordha, Debagarh, Bargarh, Jharsuguda, Anugul	Puri, Koraput, Ganjam, Debagarh, Anugul, Cuttack, Jagatsinghapur, Rayagada, Kendrapara, Subarnapur, Kalahandi, Sundargarh,
> 2 kg/day	Sundargarh, Balangir, Kandhamal, Nabarangapur, Kendujhar, Debagarh		Nuapada, Sambalpur, Dhenkanal, Gajapati, Jharsuguda, Kandhamal, Nabarangapur, Baleshwar, Nayagarh, Kendujhar, Baudh, Balangir
Best producing district (kg/day)	**Bargarh (3.06)**	**Sambalpur (6.86)**	**Bargarh (5.27)**
d. Southern India: Tamil Nadu			
< 1 kg/day	Namakkal	Kanniyakumari, Dharmapuri, Krishnagiri,	Krishnagiri, Namakkal , Pudukkottai, Virudhunagar, Nagapattinam, Thiruvallur, Thanjavur, Tiruchirappalli, Madurai, Tiruppur, Salem, Thiruvarur, Kancheepuram
1-2 kg/day	Cuddalore, Erode, Coimbatore, Kancheepuram, Thanjavur,	Namakkal, Salem, Coimbatore, Karur, Erode, Sivaganga, Tiruppur, Tiruvannamalai,	Viluppuram, Theni, Tirunelveli, Coimbatore, Cuddalore, Erode, The Nilgiris,

Deviation from best producing district in the state	Local Cows	Crossbred	Buffalo
	Thiruvallur, The Nilgiris	Ariyalur, Viluppuram,	Perambalur, Vellore, Thoothukkudi, Dindigul, Tiruvannamalai, Ariyalur, Kanniyakumari, Karur,
> 2 kg/day	Sivaganga, Tirunelveli, Tiruppur, Pudukkottai, Theni, Nagapattinam, Madurai, Dindigul, Kanniyakumari, Ramanathapuram, Viluppuram, Tiruchirappalli, Perambalur, Ariyalur, Dharmapuri, Krishnagiri, Vellore, Karur, Thiruvarur, Salem, Thoothukkudi, Virudhunagar	Pudukkottai, Thoothukkudi, Perambalur, Cuddalore , Theni, Dindigul,Thanjavur, Nagapattinam, Vellore, Tiruchirappalli, Tirunelveli , Thiruvallur , Virudhunagar, Thiruvarur, Madurai, Kancheepuram , Ramanathapuram	Dharmapuri, Ramanathapuram
Best producing district (kg/day)	**Tiruvannamalai (4.76)**	**The Nilgiris (8.74)**	**Sivaganga (5.41)**

2.3. Productivity Variations across farms

From the perspective of doubling farmers' income, it is particularly important to highlight the differences that exist in productivity of dairy animals across farm households and identify some of the important characteristics/practices of farms with higher average productivity.

Based on the primary survey of 560 dairy farms in dynamic (Punjab and Haryana) and transient (Odisha and West Bengal) dairy production system in the country, yield gaps were worked out for the two groups of farms: one that fed prepared Compound Cattle Feed (CCF) to dairy animals (Group 1) and the other that did not use the same (Group 2). The results showed that yield differentials were minor (6.4 per cent) for buffaloes, but fairly substantial for the crossbred cows (16.6 per cent) in dynamic region (Table 2.2).

In the transient region where there is acute shortage of green fodder, the feeding of CCF had important bearing for the milk productivity of the animals. The yield differential among the farmers feeding CCF and not feeding the same was as high as 62 per cent in crossbred cows.

Table 2.2 Inter-farm differentials in Feeding Pattern and Milk Productivity

Particulars	Dynamic Region				Transient Region	
	Buffalo		**Crossbred cows**		**Crossbred cows**	
	Group 1	**Group 2**	**Group 1**	**Group 2**	**Group 1**	**Group 2**
Average Milk Productivity (lit./day)	5.77	5.29	6.96	5.43	9.78	6.04
Average Qty. of dry fodder (kg./day)	7.29	8.31	5.99	6.36	8.76	7.67
Average Qty. of green fodder (kg./day)	21.05	22.48	18.66	18.28	3.27	2.36
Average Qty. of compound cattle feed (kg./day)	2.50	0.00	2.37	0.00	3.21	-
Average Qty. of home-prepared concentrate (kg./day)	0.86	1.15	0.63	1.36	2.73	3.05
Roughage : Concentrate	76:24	91:9	75:25	87:13	61:39	73:27

 # Note: Group 1: Animals fed with compound cattle Feed; Group2: Not fed with CCF

Source: Sirohi et al. (2016)

Other than the feeding pattern, variations in productivity have also been reported by several studies across herd size categories, with a direct relationship between size of herd and average productivity of animals, perhaps due to better management of animals by the larger farmers.

2.4. Scope of Yield Enhancement

In the absence of data on demonstration milk yield for different milch breeds, it is not possible to give reasonably accurate estimates of increase in milk production that can be attained by bridging the yield gap with respect to such a reference yield.

However, the information on the potential yield of some important cattle and buffalo breeds in the country (Box 2.1) shows that there exists vast scope of enhancing milk productivity.

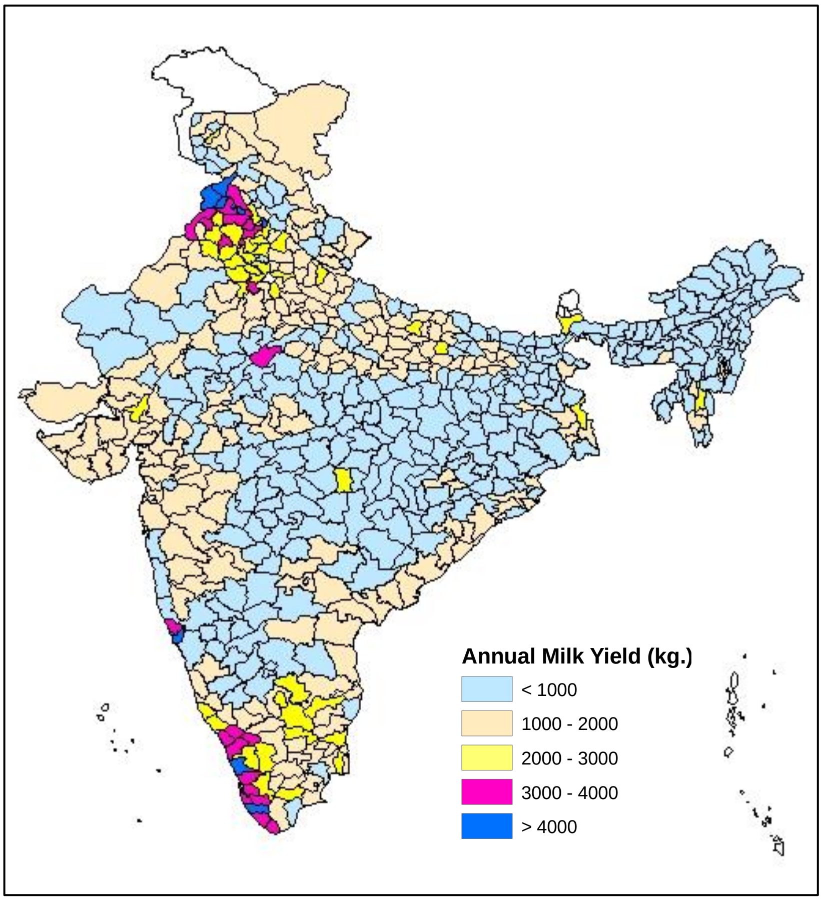
Box 2.1: Performance of Selected Cattle and Buffalo Breeds

Breed	**Lactation Production (kg)**	**Lactation length (days)**
Hariana	693-1,754 (Average: 996)	238-330 (Average: 272)
Sahiwal	1,600-2,750 (Average: 2,325)	285-375 (Average: 318)
Gir	1,835 - 2,950 (Average: 2,125)	302-329 (Average: 305)

Breed	Lactation Production (kg)	Lactation length (days)
Kankrej	1271-2232 (Average: 1954)	308-329 (Average: 314)
Jersey Crossbred	1,722-3,476	325-357
HF Crossbred	3,926-4,568	312-349
Murrah	1,586-1,929 (Average: 1,850)	263-316 (Average: 294)
Nili Ravi	1,003-2,057 (Average: 1,751)	269-337 (Average: 299)
Jaffarabadi	1,917 - 2,075 (Average: 1,967)	316 - 328 (Average: 325)
Mehsana	1,774 - 1,904 (Average: 1840)	312 - 327 (Average: 315)
Surti	1,399 - 1,955 (Average: 1699)	308 - 323 (Average: 310)

As against the average productivity potential of around 1800-200 kg. per lactation, in most parts of central, eastern and north-eastern India, the lactation yield of animals is less than 1000 kg.(Map 2.1), indicating that there is substantial potential to enhance the productivity in several parts of the country by appropriate interventions providing technological and support services. While comparing the milk yield from buffalo in neighbouring countries, in case of Murrah, it is 2133 kg per lactation in China as compared to 1850 kg per lactation in India, while in case of Nili-Rabi, it is 1825 kg in Pakistan and 2262 kg in China as compared to 1751 kg in India.

Figure 2.4 Lactation Yield of Dairy Animals

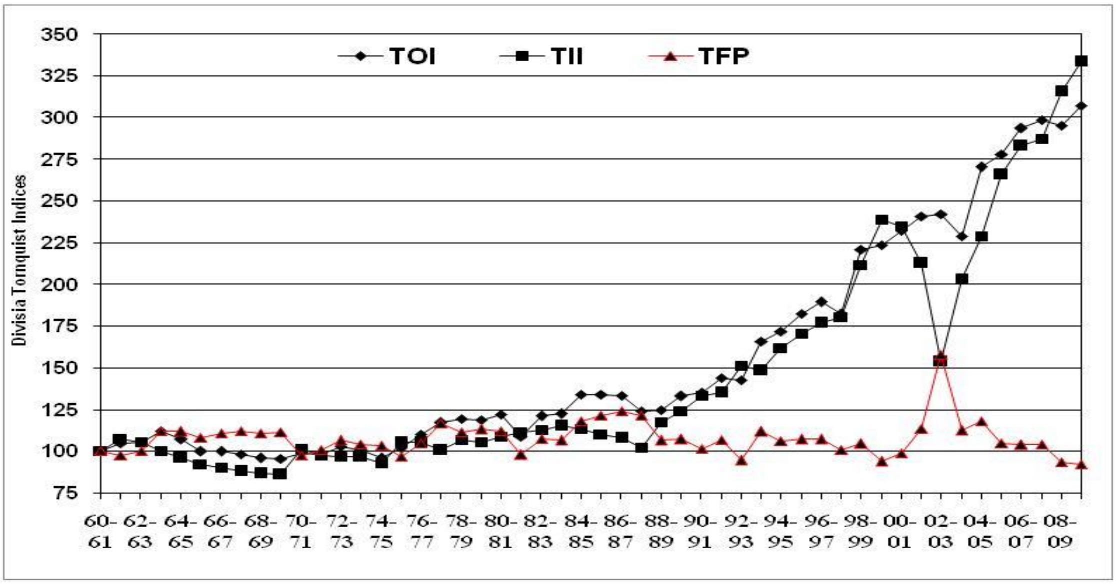


In a study conducted under NATP Project - V-PAGe (Chandel et al., 2012), it was found that total milk production can be increased by 41.24 per cent if yield gaps were removed among districts within a state, and this increase could go upto 95 per cent if yield gaps were removed among districts within each of the five milk production systems, identified as buffalo, buffalo-crossbred, crossbred, indigenous and mixed.

The removal of state-level yield gaps seems to be more feasible as compared to the system-level yield gaps, because of similar agro-environmental conditions and resource endowments within a state. The maximum potential to increase milk production by covering yield gaps exists in indigenous and crossbred milk production systems.

Studies on livestock sector in India had shown that a notable swing in the output growth had taken place after the 1980s. The Total Factor Productivity (TFP) growth, that is growth in output that is not attributable to growth in inputs, during 1980-81 to 1995-96, was nearly 1.8 per cent in the livestock sector, implying that technology contributed about 45 per cent to the total output growth (Kumar and Pandey, 1999). Another study for the period 1981 to 2001, at the all-India level by Avila and Evenson (2004) also reported TFP growth of over 2.5 per cent per annum in livestock. The state specific studies have also indicated a positive trend in TFP growth in livestock sector. In Haryana, the livestock sector sustained 1.0 per cent per annum TFP growth rate during 1989-90 to 1998-99 (Elumalai and Pandey, 2004).

Figure 2.5 Trends in Input, Output and TFP indices of livestock production in Rajasthan 1960-61 to 2009-2010 (at 2004-05 prices)



Source: Chand and Sirohi (2015)

During 2004-05 to 2014-15, the real output index in Gujarat increased at the annual compound growth rate of 4.98 per cent and TFP growth rate was 5.32 per cent (Pushpa, 2017). The long term trends in Rajasthan show a strong positive growth in livestock output index (Fig 2.5) and TFP index of over 100 in most of the years, which shows higher output than input indices. However, during the previous decade (2000/01– 2009/10), the situation has been somewhat dismal as TFP growth was negative (-2.82 per cent), as the output growth was driven primarily by the increase in inputs.

2.5. Challenges in Yield Enhancement

Output growth can be achieved by provisioning of adequate quality inputs and services. The contribution of technology in enhancing yield is channelized through improvement in input quality and management practices. There are several region-specific dimensions of existing challenges for enhancing the milk productivity, but broadly, major issues centre around the following aspects:

2.5.1. Enhancing the Genetic Potential of Animals:

One of the key factors affecting milk productivity of animals is the genetic ability of an animal for milk production, which is an inherited character, while others provide an enabling environment. The cattle genetic resources of India are represented by only 41 recognized breeds that account for 20 per cent of the cattle population. Another 21 per cent cattle population is crossbred, that means 59 per cent of the cattle in Indian are non-descript. The stock of female breedable non-descript cattle is over 40 million, whose average age at first calving is 60 months, and produce about 500 Kgs in a lactation and have a calving interval between 20 to 24 months. In case of buffaloes also, about 43 per cent are non-descript animals with very low genetic potential. The identification of type of animals of local breeds is a critical challenge for breed improvement programs. There is need to prioritize cattle and buffalo breeds as per their economic importance. This will be helpful to farmers in order to increase their income through rearing of livestock and sale of milk, milk products and animals as well.

The breeding bull contributes significantly in enhancing the genetic potential of its progenies for economically important traits, like milk production, fertility, body conformation etc. Genetic improvement for a specific trait or group of traits largely depends on how effectively these traits are recorded and what accuracy of selection is obtained for production of bulls. Currently, about 3760 bulls are used at various Semen Stations for producing semen with replacement of about 940 bulls each year. AI is the preferred method for attaining genetic progress in milch animals. To accelerate the genetic progress, the proportion of milch animals bred through AI needs to be raised substantially.

Presently, about 30 per cent of the breedable animals are bred through AI and 70 per cent are bred through natural service. About 102.69 million doses are currently produced annually by 53 semen stations operating in the country. This is sufficient to inseminate 30 per cent of the breedable animals in the country. However, if at least 60 per cent of the breedable animals are to be inseminated by 2021-22 then an aggregate of about 209 million quality semen doses of the required breeds would need to be produced. Not only is the coverage low, but generally the quality of service provided is also poor.

The conception rates (CR) in most of the regions, by and large, range from 40-49 per cent in field conditions, although studies in some states show much lower rates. Even on the farm of the National Dairy Research Institute, the CR in cows (50 per cent) is not much higher than that achieved in the field. Further, the success rate of AI in buffaloes is about 10 per cent lower than that in cows, even on organised farms. Studies on factors affecting CR in cattle indicate that with 90 per cent or more efficiency in four important factors, cow fertility, estrous detection accuracy, semen fertility and AI technique, the CR can be between 65-70 per cent.

In Indian field conditions also, accurate detection of heat symptoms and stage of oestrus in animals are reported to be very critical factors affecting the CR in cattle and buffaloes. Every missed heat is directly related to increased service period which in turn leads to longer inter-calving interval. Timely heat detection is essential for getting one calf per year. A cow wrongly detected in heat and inseminated leads to heavy loss in terms of wasteful expenditure. In case of buffaloes, chances of missing heat are high in summer months. So, buffaloes require extra attention as compared to cattle regarding heat detection.

2.5.2. Shortage of Feed and Fodder:

Animal feed is the most crucial input in livestock production. Empirical studies in India have shown that enhancing quality and quantity of feed input has greater impact than breed improvement on increasing milk productivity. The shortage of feed and fodder is a serious constraint in increasing the productivity of livestock in India. The assessment of availability of feed resources in India brings out two important points: one, over a period of time, with increase in agricultural production the animal feed availability has also improved, and two, despite the increase, its supply falls short of the aggregate nutritional requirement of feed by livestock population.

Table 2.3 Supply, demand and gap of livestock feed and fodder across Rajasthan

Agro-climatic zones	ACU ('000s)	Feed and fodder (DMI in million tons)		Deficit (%)	Stocking Rate (ACU/ha of pasture and grazing land
		Demand	Availability		
Irrigated north-western plain	1635.20	4.18	5.98	43.25	422.75
Semi-arid eastern plain	3670.91	9.38	5.31	-43.43	16.46
Flood prone eastern plain	3258.72	8.33	6.71	-19.37	31.00
Southern plain and Aravali hills	4228.06	10.80	6.01	-44.39	11.83
Arid western plain	5177.14	13.23	13.96	5.57	10.01
Transitional plain	5057.68	12.92	8.20	-36.52	15.65
Southern and south-eastern plain	3823.62	9.77	5.36	-45.09	22.62
Rajasthan	**26851.33**	**68.61**	**51.54**	**-24.87**	**15.81**

Source: Chand, Sirohi and Sirohi (2013)

At the all-India level, the estimated deficit of dry fodder, green fodder and concentrates is 10, 33 and 35 per cent respectively, which is likely to be enhanced to 11 per cent, 35 per cent and 45 per cent by 2020 (GoI, 2012). In the next decade, the feed balance may worsen further as production of green fodder is projected to decline by 2030. In states like Rajasthan, where livestock contribute about 37 per cent of the agricultural output and in situation of drought, the contribution of livestock in household income even goes up to 60-65 per cent, the percentage gap between the feed demand and supply was estimated to the tune of 24.88 per cent (Table 2.3).

The deficiency is more acute in the southern and eastern part of the state. In case of drought, such as during 2002-03, when the rainfall departed from the normal year by -64 per cent, fodder availability reduced by 40-50 per cent in the drought-affected districts.

The structure of animal feed production in the country is dual in nature, with production being carried out in both the organised and unorganised sector. The compound animal feed industry in the organised sector comprises of commercial feed and integrators' feed. The unorganised sector includes the customary feed preparations made by the farmers themselves and the production in unregistered feed factories. Although the product of the unorganised sector suffers from many deficiencies and imbalances, it still accounts for nearly 80 per cent of all feeds consumed by the entire animal population in India. The shortage of concentrate feed and nutritionally poor quality of feed are two key problems that impinge on the productivity growth in livestock sector in the country.

India ranks at 5th position among 130 major prepared animal feed producing countries. As a result of the commercial boom in poultry sector, the share of poultry feed sector is dominant, while cattle feed production is only about 25 per cent (7.5 million tonnes). About half of this is produced by the dairy cooperatives and government sector and is sold to farmer members involved in milk production at subsidized rates.

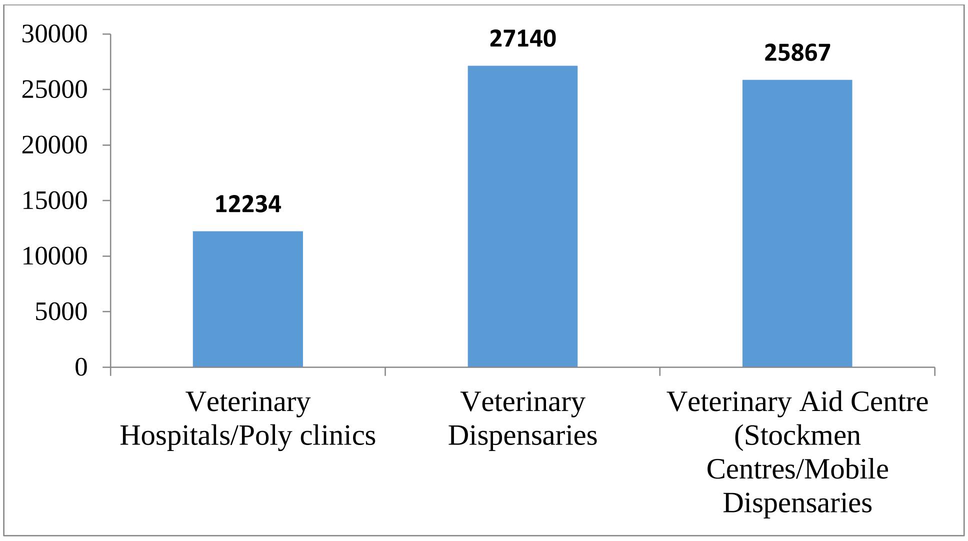
As per the enumeration by the Annual Survey of Industries (ASI), the number of animal feed manufacturing units in the factory sector have grown from just 76 in 1976-77 to 873 in 2012-13, registering a compound growth rate of 5.8 per cent per annum. Besides the number of factories enumerated by ASI, there are large number of unregistered feed manufacturing units. The major limitation of the industrially manufactured compound cattle feed in India is that it has proved its value only for high yielding animals but not for the low-yielder due to their genetic limitations.

2.5.3. Shortcomings in animal health care services:

The animal health services in the country are provided through a network of over 65000 veterinary hospitals/dispensaries and aid centres (comprising stockmen centres and mobile dispensaries) under the State Animal Husbandry departments (Fig.2.6). In addition, to a limited extent, some cooperatives, NGOs and private practitioners participate in the provision of these services. Despite the vast network of veterinary institutions, the incidence of diseases and epidemics is very high in the country that impinges on the productivity enhancement.

The poor status of animal health stems from the extremely limited attention paid to preventive health care services and inefficiencies in provision of curative health services. Most of the government dispensaries, hospitals and AI centres are stationary and are primarily engaged in providing curative health cover and breeding services. In the case of curative health services, a large gap also exists between the need and the availability of cow-side animal health service providers. As a result of this, most farmers resort to cheaper alternatives like engaging quacks, other untrained personnel or self-medication, which may, many a time, do more harm than provide a cure.

Figure 2.6 Veterinary Institutions in India: as on 31.03.2017



The veterinary services provided in the dispensaries/centres are limited to prescription by the veterinarians, the cost of medicines etc. have to be borne by the farmers themselves. An estimated 85 per cent of the annual non-plan state budgets are spent on salaries and other establishment cost, leaving little for drugs and vaccines. Therefore, despite the provision of service free of cost or at nominal price at the centre, the farmers spend substantial amounts of money for availing the service. Besides the cost of medicines and the transportation cost, the government veterinarians also charge their fees when they attend the cases at the farmers' door step.

2.5.4. Weak Extension Services:

The public extension services have played a major role in technology and knowledge transfer in the crop sector, but in the livestock sector extension service delivery has been very weak. The extension activities related to the livestock sector are by and large entrusted to the State Animal Husbandry Departments. The AHDs do not have the resources and expertise to conceive and operate technology transfer packages.

The institutional arrangement in the AHDs are mainly run by veterinarians who operate from veterinary dispensaries to treat animals rather than approaching farmers to educate and inform them about feed, fodder and animal health. Thus, the delivery of breeding and health services gradually came to be taken to be the sole extension support to the livestock sector and the evolution of a comprehensive nationwide extension service in the livestock sector has not been attempted.

There are, however, attempts by cooperatives, non-governmental/voluntary organizations, institutions under the National Agricultural Research System like the animal science institutes of the Indian Council for Agricultural Research, State Agricultural Universities, Krishi Vigyan Kendras (KVKs) etc. to provide some measure of extension support to livestock producers. But the coverage of, and access to, these agencies is limited, both in area and content and these do not measure up to a purposive national extension service comparable to the nationwide extension support available for crop production.

The National Sample Survey Organization (NSSO) in its survey of 55,000 farmer households conducted during 2003-04 found that only about 5 per cent of the households were able to access any information on animal husbandry compared with 40 per cent of households accessing information on modern technology for crop farming. The survey also revealed that public sector extension services are not the preferred option for accessing information on modern technologies on livestock production.

Private sources like media (print and electronic) and other progressive farmers play an important role in dissemination of information among the livestock farmers. The public sources of information, particularly the extension workers and the KVKs are virtually ineffective in rendering services in animal husbandry. The scope of the extension services is largely limited to providing information on animal health care and breeding, while the other important components of livestock production such as feeding and management are ignored. One and a half decades down the line, without any systematic focus on the livestock extension services, the situation is unlikely to change dramatically.

2.5.5. Low Public Investment in Livestock Sector:

Public investment by Central and the State governments is used to create production-enhancing and marketing support infrastructures in the livestock sector. Except during the Sixth Plan period, total outlay increased across all the Five-Year plan periods (Table 2.4), especially in the 12th Plan.

However, the share of allocation of funds for animal husbandry and dairy development has dropped from 1.1 per cent in the First Plan to 0.4 per cent in the Sixth Plan and then to 0.14 per cent in the most recent period. It is not commensurate with the contribution of the sector to the total GDP. This is in sharp contrast to the fact that the livestock sector has shown a high rate of growth of over 4.0 per cent per annum during the last decade and represents a growing proportion of agricultural GDP. Besides the low budgetary outlay, another area of concern is the gap between actual and planned expenditure, especially in case of animal husbandry. This gap suggests that more than shortage of funds it is the poor governance that is restricting the actual public investment in the sector.

Table 2.4 Public Expenditure on Animal Husbandry and Dairy Development

(Rs. Crore)

Plan	Animal Husbandry		Dairy Development		Total		AH&D to total agriculture outlay %	AH&D to total outlay %
	Planned	Actual	Planned	Actual	Planned	Actual		
First (1950-55)	14.2	8.2	7.8	7.8	22	16	6.2	1.1

Second (1955-60)	38.5	21.4	17.4	12.1	55.9	33.5	11.2	1.2
Third (1960-65)	54.4	43.4	36.1	33.6	90.5	77	8.3	1.1
Fourth (1967-72)	94.1	75.5	139	78.8	233.1	154.3	10	1.5
Fifth (1975-80)	NA	178.4	NA	NA	437.5	232.5	9	1.1
Sixth (1980-85)	60.5	39.1	336.1	298.3	396.6	337.4	7	0.4
Seventh (1985-90)	165.2	102.4	302.8	374.4	467.9	476.8	4.4	0.3
Eighth (1992-97)	400	305.4	900	818.1	1300	1123.5	5.8	0.3
Ninth (1997-2002)	1076.1	445.8	469.5	146.9	1545.6	592.7	3.6	0.3
Tenth (2002-07)	1384.0	1419.4	361.0	285.8	1745.0	1705.2	11.87	0.12
Eleventh (2007-12)	4871	2331	580.0	576	5447	2907		0.15
Twelfth (2012-2017)	7829	3675	3781	2840	11610	6515		0.14

2.6. Annotation

The crossbred cattle provide significantly higher yields as compared to the indigenous cattle and even buffaloes. The productivity of indigenous cattle is the lowest among the three major categories of large ruminants in the country. Therefore, crossbreeding has been a key genetic intervention for productivity enhancement of Indian cattle.

There is large inter-state as well as intra-state variation in productivity of dairy breeds. Besides, variations in productivity have also been reported across farms and herd size categories, with a direct relationship between size of herd and average productivity of animals. From the perspective of doubling farmers' income, it is particularly important to identify the reasons for the productivity differences even at farm household level for removal of the yield gaps. Adequate quality inputs and services are critical for yield growth of the lactating animals.

Bridging the state level yield gaps is more feasible as compared to the intra-state and system-level yield gaps because of similar agro-environmental conditions and resource endowments within a state. However, there exist region-specific dimensions of challenges for enhancing the milk productivity that need to be addressed at priority level.

Key Extracts

- There exists sharp inter-state variation in milk yield of lactating animals across the country. Majority of the Indian states lag behind the national average productivity of dairy breeds.
- The productivity potential of crossbreds is significantly higher among the large ruminants. Therefore crossbred adoption and crossbreeding of non-descript and low producing cattle is widely followed and practiced by farmers, though adoption rate is not uniform across the states.
- There exist wide yield gaps at district and even at farm level within state.
- Total milk production can be increased by 41.24 per cent if inter-district yield gaps within a state are removed.
- Bridging inter-state yield gaps is comparatively more feasible than system-level yield gaps within a state.
- The priority policy interventions for enhancing the productivity of dairy animals are: improving the genetic potential of animals, addressing shortage of feed and fodder, overcoming shortcomings in animal health care services, strengthening weak extension services and improving low public investment in livestock sector.

Chapter 3
Economics of Milk Production in India: A Review

The cost estimates of agri-based enterprises in agrarian economy of India are vital for improving the resource use efficiency of the farm inputs and ensuring remunerative prices to the farmers. Although dairy continues to be largely subsistence activity incidental to crop production but gradually a subtle trend towards commercialization of dairy enterprise is setting-in which would be reinforced in the times to come. The economics of milk production varies widely across the country depending on the type of production system, breed and market arrangements for sale of milk.

Dairying has traditionally been based on socio-economic and religious considerations in the country, being undertaken by the farmers as incidental to crop production, not as a commercial enterprise per se. Despite of largely subsistence nature of the activity, the rearing of dairy animals has cushioned the rural households from instability in crop production, serving as an important source of supplementary income for the farm families.

In past four decades, conditioned by the factors such as increase in the productivity of dairy animals, rapidly rising demand for milk in the urban areas and, greater monetary needs of rural households to fulfil their growing demand for non-agricultural commodities, improvement in milk procurement, road infrastructure, etc. there has been buoyancy in the marketed surplus of milk from the rural areas.

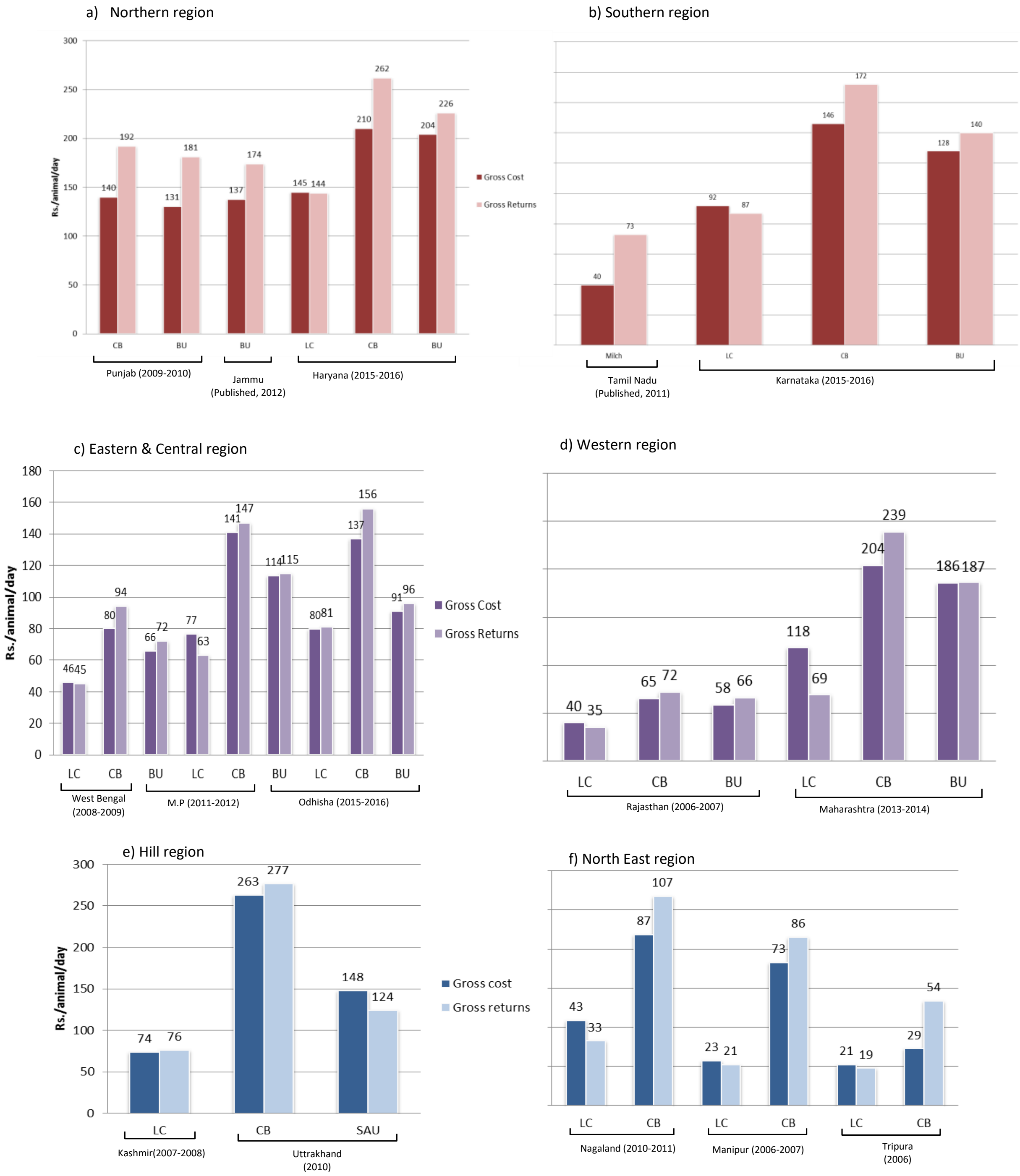
Another change that is gradually taking place is the increase shift from the maintenance of dairy animals on home grown feed inputs and public goods to purchased feed inputs, due to the decreasing size of land holding and shrinking common property resource base. The setting-in of a trend towards commercialisation of dairy enterprise, which would be reinforced in the times to come, has made today's dairy farmer vigilant about the economics of milk production, unlike his predecessor who was not very cautious about the net returns from dairying as several cost components did not involve out-of-pocket expenses for him.

Several studies have been carried out in various parts of the country on estimation of economics of milk production. Although, it is well understood that the economics of milk production is bound to be different with the variations in agro-climatic conditions and would also exhibit variation from season to season for different species of animals and within each species for different breeds of animals, yet, the studies do not follow a standardized methodology for cost estimation, thus, spatial and temporal comparisons of returns from dairying become very difficult. Nevertheless, a review of some studies, undertaken in past one decade or so, is given in this Chapter to highlight some important points on economic aspects of milk production in the country.

3.1. Cost and Returns in Milk Production: Regional Estimates

This section that presents the results of the work carried out by various researchers at different points of time using methodologies that may not be uniform across studies (Fig. 3.1).

Figure 3.1 Cost and Returns in Smallholder Milk Production System in India



However, the broad trends that emerges from the estimates of gross cost and gross returns are:

- Gross maintenance cost of crossbred cattle is the highest among all three types of milch animals, followed by buffaloes and local cows. This cost includes all the fixed and variable expenses and also the imputed value of unpaid family labour.

- In general, the variable cost accounted for about 80 per cent of the total maintenance cost and the expenditure on feed and fodder has been the dominant component of the variable cost.
- Gross returns are higher than gross cost in most cases indicating that dairying is a profitable enterprise in most parts of the country.
- Among the two types of native milch animals, viz. buffaloes and local cows, the former are economically viable in northern, western and parts of southern India.
- Local cows are sent for grazing in agriculturally less-developed regions like the north east, hill region and tribal region of central India and hence their maintenance cost is lower.
- Higher yielding animals are mostly stall fed on home grown feed and fodder. But due to decreasing size of land holding reliance on purchased feed inputs is increasing.
- In case of local cows, despite their lower maintenance cost than buffaloes and crossbreds, the net returns (difference between gross returns and gross cost) from milk production in case of local/ non-descript cows are either marginal or even negative in several areas.

3.2. Economic Viability of Dairy Farming in Different Production Environments[2]

A comprehensive study on cost of milk production sponsored by the DAHD&F was carried out simultaneously in nine geographical areas covering three types of dairy production environments that were characterized on the basis of milk yield, cropped area under fodder, milk production density and infrastructure status. In this study, methodology for working out the economics of milk production was standardised in consonance with international norms but adapted for dairy production system in India.

Dynamic Production Environment is defined as commercially oriented, well-endowed resource locations for feed and fodder with milch animals of good yield potential. The herd primarily comprises either buffaloes, buffaloes + crossbreds or only crossbreds. The study regions were Belt 1–Northern Plains (Moga & Bulandshahr), Belt 2–Gujarat (Anand & Mehsana), Belt 3–Tamil Nadu (Coimbatore & Trichy).

The gross cost of maintenance of crossbred cows is highest in Northern Plains (Table 3.1), largely on account of high capital costs. The price of animal is higher in the region as compared to the other two belts and hence, the capital costs are high. Cost of milk production is more or less same in Northern India and Gujarat (about Rs 28/litre) and much lower in Tamil Nadu due to higher yield of the crossbred cows. The cow milk is fetching much better prices in Gujarat than the other two regions. In Tamil Nadu, despite lower prices, the entrepreneur's profit worked out to be Rs 33.50 per animal per day (Rs 1.34/litre), while in Gujarat, the gross returns

[2] This section is based on the Sirohi et al. (2015)

from crossbred milk production are just sufficient to cover the operating and capital costs (Rs. 170.40/day), but not the opportunity cost of production (Rs.16.17/day). In Northern India, the profitability is worse, as only operating costs (Rs.112.18/day) can be covered by the farmers.

In Northern Plains and Gujarat, economic viability of buffalo milk production is not very encouraging. In Punjab and Western Uttar Pradesh, the economics of milk production is a study in contrast. Despite the productivity of buffaloes in two areas being similar (5-5-5-8 lit/day), the operating cost of maintaining a buffalo is nearly twice in Bulandshahr (Rs.162/day) as compared to Moga (Rs. 86/day). Due to higher gross cost, the cost of buffalo milk production was nearly Rs 14/litre higher in Western Uttar Pradesh (Rs.36.8/litre) than in Punjab (Rs.23.2/litre).

Western Uttar Pradesh is largely an unorganised milk market dominated by the vendors and middlemen. While they charge the consumers Rs 40/litre for buffalo milk, they pay just Rs 24 per litre to the farmer (60 per cent). In comparison, the cooperative and private sector organisations in Moga provide strong competition to vendors and middlemen and price paid to farmers is much higher. The net economic margin was Rs 3.50/litre in Moga as against a loss incurred by farmers in Bulandshahr. Despite cost of milk production being higher (Rs 39.70/litre) in Gujarat region than in Northern region, farmers got a much better price from the cooperatives and so were able to earn small net economic margin.

Table 3.1 Annual cost and returns from milk production in dynamic production environment.

Particulars	Belt 1: Northern Plains		Belt 2: Gujarat		Belt 3: Tamil Nadu
	Crossbred cows	**Buffaloes**	**Crossbred cows**	**Buffaloes**	**Crossbred cows**
Gross cost (Rs/day)	189.51	205.48	176.57	149.23	171.95
Gross returns (Rs/day)	140.36	151.01	172.50	150.34	183.80
Cost of milk production (Rs/litre)	28.49	33.93	28.08	39.66	18.27
Sale price of milk (Rs/litre)	19.57	23.95	27.42	39.69	19.61
Gross margin (Rs/litre)	4.56	0.95	7.70	11.63	6.18
Net margin (Rs/litre)	-5.77	-6.35	2.02	5.00	3.78
Net economic margin (Rs/litre)	-7.95	-9.82	-0.68	0.31	1.34

Note: All estimates at 2012-13 prices.

Underdeveloped Production Environment is basically the low-input and low-output locations characterised by subsistence holdings, resource poor locations with milch animals of low production potential and having poor infrastructural support system. There is predominance of indigenous cattle, maintained largely on common property resources. Three belts sampled under this were: Belt 1–Northeast (East Khasi Hill & Ri-bho), Belt 2–Chhattisgarh (Koriya & Surguja), Belt 3–Uttarakhand hills (Almora & Nainital). In the north-eastern belt, 30 per cent animals in the milch herd are crossbreds. In Chhattisgarh, besides local cows, 18 per cent of milch stock comprises buffaloes. Also, in hill region covered in the study, there was sizeable population of buffaloes, besides 11 per cent crossbred milch animals.

The productivity of indigenous cattle was less than 2 litres/day in North-eastern region and the tribal areas of Chhattisgarh, while it was about 3.6 litres in the hill region of Uttarakhand. The cost of milk production was higher than the sale price of milk in Belt 1 and 2, but as the operating and capital costs were low, the net profit margin per litre of milk (returns over operating and capital expenses) was Rs 18-22 (Table 3.2). The animals were reared on common property resources substantially reducing the out-of-pocket expense for the farmers. If imputed value of feed and fodder from these resources was accounted, the net economic margin would be negative. In the hill region of Uttarakhand, animals gave better yield, thereby reducing the gross cost of milk production and the higher sale price of milk helped the farmer to generate a surplus.

Table 3.2 Annual cost and returns from milk production in underdeveloped production environment.

Particulars	Belt 1: North east	Belt 2: Chattisgarh	Belt 3: Uttarakhand
	Local Cows		
Gross cost (Rs/day)	56.20	70.06	82.66
Gross returns (Rs/day)	52.92	66.36	102.04
Cost of milk production (Rs/litre)	36.88	29.00	22.29
Sale price of milk (Rs/litre)	34.23	26.27	27.63
Gross margin (Rs/litre)	25.59	25.45	20.94
Net margin (Rs/litre)	22.04	18.58	16.57
Net economic margin (Rs/litre)	-2.67	-1.98	5.35
	Crossbred cows		
Gross cost (Rs/day)	174.07	132.40	102.52
Gross returns (Rs/day)	323.66	166.64	140.67
Cost of milk production (Rs/litre)	17.74	20.97	20.24
Sale price of milk (Rs/litre)	34.37	26.86	27.87
Gross margin (Rs/litre)	23.66	17.48	19.99
Net margin (Rs/litre)	21.74	11.41	15.64
Net economic margin (Rs/litre)	16.64	5.89	7.65
	Buffaloes		
Gross cost (Rs/day)		97.99	116.17
Gross returns (Rs/day)		98.12	217.94
Cost of milk production (Rs/litre)		29.12	16.72
Sale price of milk (Rs/litre)		29.22	31.38
Gross margin (Rs/litre)		22.04	24.36
Net margin (Rs/litre)		14.51	21.13
Net economic margin (Rs/litre)		0.05	14.84

Interestingly, the crossbred cows were very profitable in these belts. The feed and fodder expenses were not high and only family labour was employed for upkeep of the animals. In the north-eastern region, the productivity was even higher (9.0 litres/day) than that recorded in the dynamic milk region (6.0-8.8 litres), probably due to conducive climatic conditions. Even buffaloes were earning positive net returns in the underdeveloped region. In Chhattisgarh, their productivity was low, but on account of low feed cost, the net margin was reasonably good. In Uttarakhand, the higher yield makes the animals much more profitable.

Transient Production Environment reflects the transitory situation from the under-developed to dynamic which possesses the characteristics of above-mentioned production environments for selected parameters. All three types of milch animals were reared by the sample households from Belt 1–Malwa region (Indore & Ratlam), Belt 2–Western Maharashtra (Ahmednagar and Pune), Belt 3–Eastern Uttar Pradesh & Bihar (Patna & Gorakhpur).

The maintenance cost of local animal was least (Rs 124/animal/day) in Belt 3 (Eastern Uttar Pradesh and Bihar) and highest in Western Maharashtra (Rs 147/day). Except in Malwa region, the local cow was a loss making entity in other two belts of the transient production environment. The productivity was less than 3 litres/day and the gross returns were not even sufficient to cover the operating costs. These three belts were classified under Transient Production Environment as they have good adoption rate of crossbred cows. In the Malwa region of Madhya Pradesh and in Western Maharashtra, the net economic margin on crossbred milk production was quite substantial. The milk yield was good, especially in Western Maharashtra (10.45 litres) and hence, despite high daily maintenance cost, the farmers' profits were positive.

However, in Belt 3, the scenario was not as progressive. The gross cost was lower (Rs 171/day), but the average herd yield of crossbred cows was less than 5 litres and hence, the cost of production was about Rs 33/litre. Additionally, the farm gate prices of cow milk were very low (Rs 22/litre); although, farmers were able to cover their out of pocket expenses (operating costs) yet from the medium and long term perspective, profitability of crossbred animals is at stake.

In buffalo milk production, similar kind of trend is seen across the three belts. Lower productivity and lower price of buffalo milk has led to negative net margin in Belt 3, while in other two belts, net economic margin was positive, indicating the long term economic sustainability of buffaloes in Malwa region and Western Maharashtra.

Table 3.3: Annual cost and returns from milk production in transient production environment.

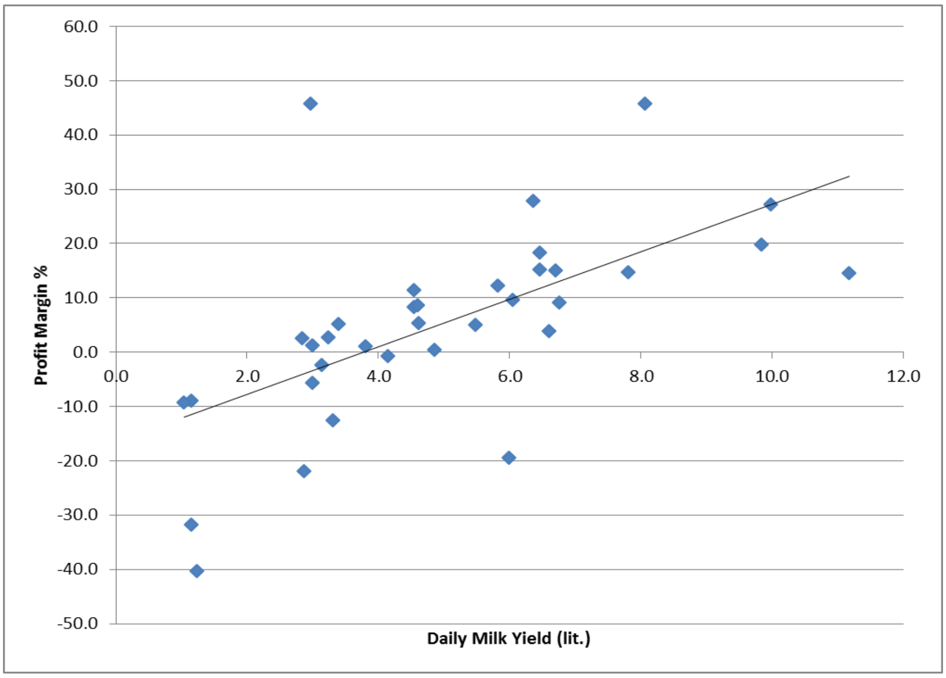
Particulars	Belt 1: Malwa Region	Belt 2: Western Maharashtra	Belt 3: Eastern Uttar Pradesh & Bihar
	Local cows		
Gross cost (Rs/day)	135.44	146.76	124.05
Gross returns (Rs/day)	139.36	93.89	71.67
Cost of milk production (Rs/litre)	23.30	46.64	39.19
Sale price of milk (Rs/litre)	24.11	28.07	21.10
Gross margin (Rs/litre)	13.97	-3.34	-5.05
Net margin (Rs/litre)	8.41	-11.63	-12.89
Net economic margin (Rs/litre)	0.75	-18.31	-18.00
	Crossbred cows		

Particulars	Belt 1: Malwa Region	Belt 2: Western Maharashtra	Belt 3: Eastern Uttar Pradesh & Bihar
Gross cost (Rs/day)	186.28	206.36	170.89
Gross returns (Rs/day)	201.72	311.01	120.60
Cost of milk production (Rs/litre)	22.85	19.45	33.33
Sale price of milk (Rs/litre)	24.91	29.48	22.22
Gross margin (Rs/litre)	15.79	18.71	4.69
Net margin (Rs/litre)	7.89	11.87	-6.77
Net economic margin (Rs/litre)	2.06	10.01	-10.32
		Buffaloes	
Gross cost (Rs/day)	153.90	220.77	153.09
Gross returns (Rs/day)	188.99	234.74	125.68
Cost of milk production (Rs/litre)	23.86	38.33	32.79
Sale price of milk (Rs/litre)	29.89	40.98	26.37
Gross margin (Rs/litre)	16.86	17.18	6.58
Net margin (Rs/litre)	12.18	6.96	-2.67
Net economic margin (Rs/litre)	6.07	2.62	-6.40

3.3. Profitability of Dairy Farming and Milk Yield

The daily maintenance cost of dairy animals does not increase proportionally with the productivity of animals. The direct relationship between profitability and productivity is fairly evident from the scatter plot between profit margin and milk yield (Fig. 3.2).

Figure 3.2 Increasing Profit Margin with Higher Milk Yield



For the productivity level upto 4.0 litres/day the profit margin is either negligible or negative, suggesting that yield improvement is must for enhancing the economic viability of dairy farming and making it instrumental in doubling farmers' income.

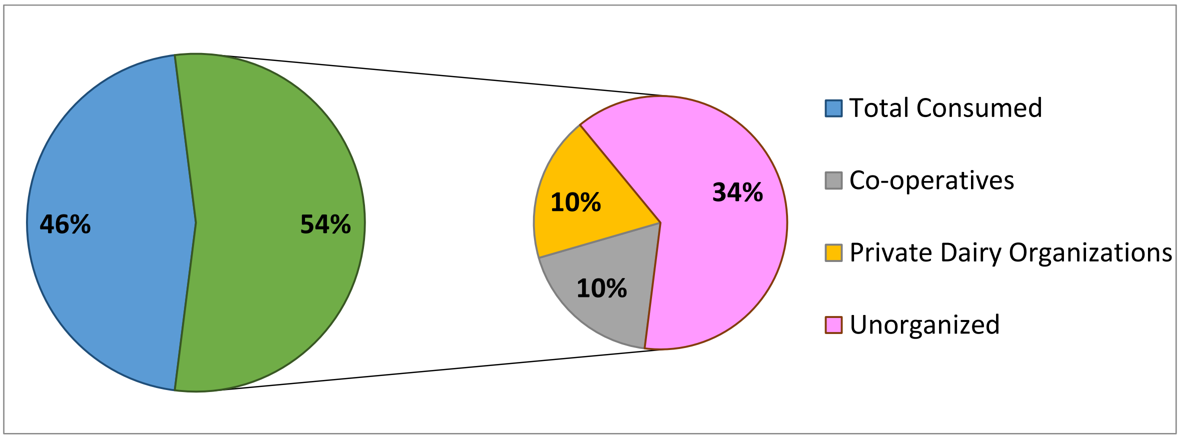
At the current input-output market prices, on an average the daily total cost of rearing milch crossbred and buffalo ranges from Rs.225-275 in dynamic and transient regions where animals are mostly stall-fed; the farmers can earn at least 10 per cent net economic margin if the average yield of crossbred is 8-9 litres and that of buffaloes 7-8 litres and average farm-gate prices are Rs 33 for cow and Rs.38 for buffalo milk.

3.4. Marketing and processing of milk

Currently, about 54 per cent of the milk produced in the country is surplus for domestic marketing, of which about 38 per cent is handled by the organised sector (i.e. about 20 per cent of total milk production), equally shared by Co-operatives and Private dairy organizations (Fig. 1.8). Almost 46 per cent of milk produced in India is retained by the households or sold to non-producers in the rural area. Unlike in most developed nations where 90 per cent of the surplus milk is processed through organised sector, in India it is the unorganised sector that predominates the marketing and processing of milk segment. In the interest of economic well-being of the milk producers, it is essential to provide rural milk producers with greater access to the organised sector. This would not only ensure remunerative prices to farmers for their produce but also encourage more farmers to adopt dairying as a source of livelihood.

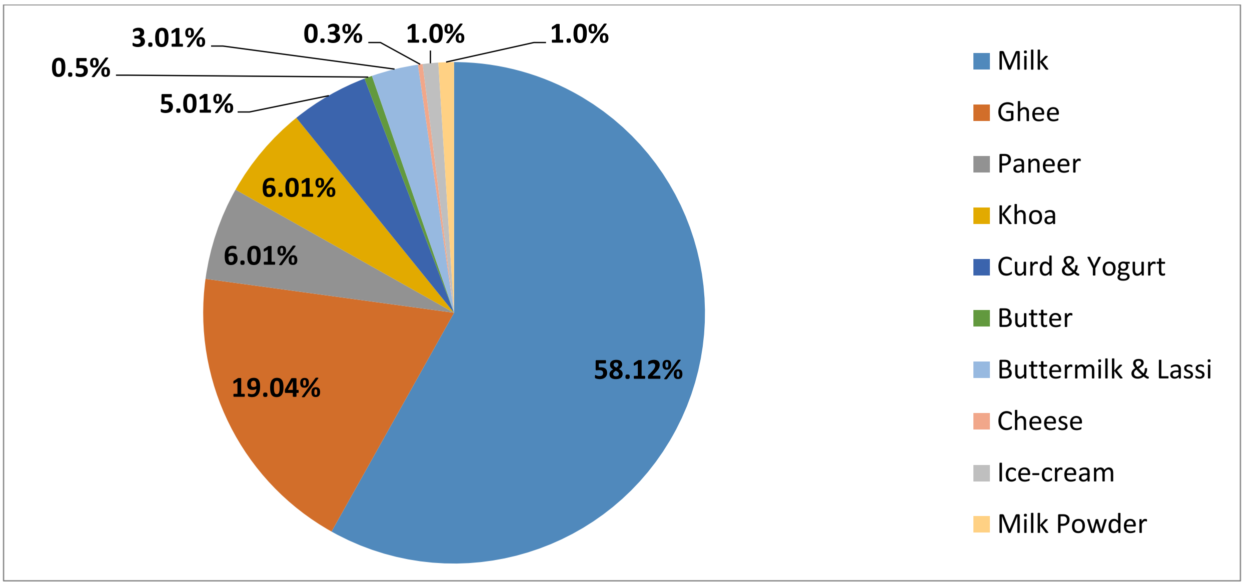
Co-operative sector plays a major role in supplying liquid milk in the domestic market. In 2015-16, a total of 155 lakh members (out of which 31 per cent were women) were covered under Dairy Co-operatives, and 53.5 lakh members were covered under Private dairy organizations. The total milk procured by Co-operatives in the same year was 440.7 lakh ltrs per day, and that procured by the Private dairy organizations was 450 lakh ltrs per day. The sale of liquid milk by the Cooperative Dairies reached 32 million litres/day during the year 2015-16 as compared to 31.24 million litres/day, registering a growth of 2.7 per cent over the previous year.

Figure 3.3 Marketed surplus and share of organised sector in milk procurement



The Indian dairy industry is estimated at around $70 billion in 2014-15, out of which the organised sector is valued at about $14 billion. The utilization pattern indicates that milk and ghee are the major products, followed by *paneer* and *khoa* (Fig. 1.9). However, a strong trend of diversification in the consumption basket is seen towards more value added dairy products, such as low-cholesterol ghee, low fat butter, yogurt, *paneer*, cheese, along with flavoured milks, ice-creams, UHT processed milk and shredded and liquid cheese, etc. During the last few years, the Indian cheese market has grown steadily at 15 to 20 per cent per annum. The Indian ice cream industry is currently estimated to be worth Rs. 2,100 crore, growing at a rate of approximately 12 per cent. Increase in demand of value added dairy products would lead to high growth and investment opportunities in the sector.

Figure 3.4 Composition of dairy products in India (2016-17)



3.5. Interventions for Higher Price Realisation

Besides higher yield and cost cutting, the prices that dairy farmers get for their produce is very vital from the perspective of increasing income. Broadly, three areas wherein interventions can be made to ensure more remunerative prices to the farmers are: i) expanding the organised milk marketing network to curtail the role of middlemen in milk marketing, ii) re-visiting the price fixation mechanism of milk by the cooperatives and iii) promoting small-scale value addition of milk by the farmers themselves.

3.5.1. Strengthening Supply Chain for Efficient Marketing

Milk is highly perishable product and has highly distributed production system located far from consumer markets. Milk moves from producers to consumers the supply chain that varies depending on whether it is direct to consumer or through the value chain of a processor, depending on the state and the production system.

Informal and semi-formal chains are generally short and primarily serve local markets, while formal chains are longer and link producers with local processors and onwards to distant consumers. It requires efficient logistics and processing along the supply chain - from production to consumption - to realise best value. In India, the role of downstream actors in the supply chain is even more critical since most milk producers are small, resource poor and often unable to establish their own linkage with markets, processors and consumers.

Empirical evidence shows that the milk producer's under the cooperative structure get more than 70 per cent share in the consumers' rupee, even without adding the additional gains they may get from re-distribution of organizational profits, while in case of traditional supply chain their share is 55-60 per cent, clearly emphasising the need to bring more and more dairy farmers under the ambit of organised milk marketing network.

Dairy co-operatives have played a significant role in production, marketing and processing of milk and dairy products, thereby contributing towards livelihood security of the millions of milk producers in the country. Besides ensuring better realisation of price paid by consumers, the areas in which the cooperative network is providing inputs/services to the dairy farmers such as fodder seed, compound cattle feed, mineral mixture, artificial insemination facilities, veterinary and health care, extension, training etc., the benefits to the farmers have been realised in terms of better yield of dairy animals, greater employment generation among the member households and greater technical efficiency in dairy farming. For instance, a comparative analysis of technical efficiency of cooperative member and non-member dairy farms in Gujarat indicated that member farmers (83.27 per cent) were more efficient than the non-member (75.31 per cent) farmers.

Women constitute the major workforce in dairy sector in large parts of the country. The institutional arrangements such as dairy cooperatives and SHGs have also been instrumental in empowering women farmers. However, their performance and impact of dairy co-operatives is not uniformly discernible across the entire length and breadth of the country, partly due to their skewed concentration in few states from west and south of the country and partly due to host of socio-economic-political factors.

In the recent past, some alternative models have emerged such as, contract farming, farmers' producer companies, progressive farmers' associations, etc. As the private sector emerged in milk processing and marketing segment, in order to compete with already established cooperatives, the private enterprises established physical facilities - such as, collection points, chilling and processing plants, chain governance mechanisms, system of price fixation and collection of milk, and provision of services to producers.

A few large private dairies, like Nestlé India in Punjab, have developed some variant of contract farming through which they get an assured supply of milk for their processing facilities. They also provide producers an assured market for milk, reduced price uncertainty, lower marketing and transaction costs, and easy access to inputs, technology, credit, and other services. It adapted many of the principles of cooperatives in its management of contract farming arrangements.

Key elements of the Nestle model

- Development of a comprehensive extension system and continuously adding new knowledge and technology; over 30,000 women in 550 villages have been covered by a special program because they perform most of the dairy activities;
- Providing high quality feeds and good quality fodder seeds at reasonable prices—about 10 percent of gross cropped area in Punjab is devoted to planted fodder, to which Nestlé contributed significantly;
- Providing breeding services free and veterinary services and drugs at cost;
- Helping farmers access bank loans and including mandatory insurance to cover risk;
- Collecting milk through commission agents and paying regularly in a transparent manner based on quality.

In Punjab, Progressive Farmers' Dairy Association (PDFA) has also been instrumental in strengthening the milk value chain by disseminating information on latest technologies, importing semen of high genetic potential cattle bulls from USA, providing better technical and medical support to the member farmers, providing loans to the dairy farmers on low interest rate by tie up with UCO Bank, providing better milk procurement price to the farmers through tie-up with MILKFED Punjab. On similar lines, PDFA has also been established in Tamil Nadu.

Milk Producer Companies has been coming up in a big way in various parts of the country. Unlike the cooperatives, these organizations have greater business orientation and are registered under the Companies Act. The success of Milk Producer companies from Rajasthan, Gujarat, and Andhra Pradesh in integrating the dairy farmer with the processor's value chain provides useful learning lessons and replicable models in other regions.

Currently, Dairy cooperative societies along with Producer Companies cover about 1.85 villages. There are about 3.2 lakh villages which have milk production above 200 KgPD (estimated based on the village wise In-milk population as per LC 2012 and In-milk animal productivity as per TCD 2015). Thus, there are about 1.35 villages which have potential for dairying and are yet to be covered by Dairy Cooperatives or Producer Companies. Therefore, there is need to expand coverage of cooperatives to new uncovered areas so as to bring more milk producers under the fold of organised sector, thereby providing rural milk producers with greater access to organised milk processing sector. In states like Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Orissa, West Bengal, Bihar, Chhattisgarh and Jharkhand where the dairy cooperative coverage is moderate or low, a separate set of strategies need to be devised for increasing milk procurement by dairy cooperatives.

For expanding the coverage of organised milk supply chain, effective implementation and sustainability of organised supply chain following interventions are required:

- Development of feasible business plans: Minimizing the overhead costs towards formation and operation of producer companies and co-operatives so that greater share of the profit reaches the producer farmers and their interest in the activity can be sustained.
- While the benefits of producer organizations are clear, there is not much clarity in terms of choosing the most appropriate structure of the FPOs. Research efforts are required to guide the farmers on choosing the appropriate legal entity for their producer organization.
- For upscaling and replication of existing success stories of group dynamics in various parts of the country, development of the local persons to provide the leadership roles is necessary. The producer farmers must have greater say in the management of such institutions and these agencies must also be galvanized to compete with the local vendors and run their activity professionally as a profit making entity. In this direction, Small farmers Agribusiness Consortia Platform recently launched by ICAR should collaborate with development agencies in the private and public sector. for capacity building of small famers.
- Cooperatives need reforms to enable capital accumulation and representative governance for improving their sustainability and profitability. Ensuring greater role of women in various capacities is the key to efficient management of the cooperatives
- The cooperatives and SHGs need to secure forward linkages to cover marketing risk faced by the members farmers.
- Encouraging formulation of FPO through simplification of the process of registering a FPO, capacity building of government officials concerned with FPOs and establishment of a State level coordination forum of FPOs where information about FPO productive potential and produce should be aggregated and leveraged with various market players. Issues of sourcing inputs, credit, technology and market linkages should be addressed by the forum. The forum should also look at solutions to HR, financing, capacity building, regulatory compliance and related challenges.

> One of the major reasons that unorganized sector continues to dominate the liquid milk market is lack of awareness among consumers regarding benefits of consuming pasteurised packed milk.
>
> Public at large perceive loose milk as "fresh" as opposed to the packed milk. Majority of liquid milk consumers remain largely ignorant about hazards of consuming loose milk which is prone to adulteration and contamination. The mind-set of the consumers can be changed through a nationwide awareness campaign for consumers regarding health and nutritive benefits of pasteurised milk.

- Investment in cold chain to maintain the quality of processed milk & milk products delivered from the dairy plant.
- Consumer centric strategies and intervention will also be crucial in enhancing the coverage of organised sector in milk marketing and thus benefiting the producers in a big way. To improve the consumer perception on consumption of branded safe milk supplied

by organised sector, there is a need to undertake brand building and sales promotion efforts thereby enhancing share of organised sector in the market.

3.5.2. Price Fixation of Raw Milk

With rising purchasing power and increasing health consciousness among people, there exists wide scope to drive growth of the Indian dairy market through organised sector. With increasing demand for milk and milk products, technological advancements for product differentiation and value added products (VAPs) will be crucial in passing on maximum share of consumer rupee to the producers. Therefore, focus is required for tapping VAP potential of consumer market along with liquid milk marketing.

3.5.3. Milk Pricing

Remunerative prices to the dairy farmers is the most important incentive for expansion of dairy sector as an enterprise. At present, the procurement price of milk is determined based on fat and SNF content of the milk. The two key issues in price fixation that are often a subject of intense discontentment among the dairy farmers are: i) hidden losses to farmers in present two-axis pricing policy and ii) not accounting for cost of milk production while fixing procurement prices.

Although the unorganised sector accounts for the lions share in procuring milk from the dairy farmers, yet the prices paid by them are not completely de-linked with the procurement prices paid by the dairy cooperatives. The dairy farmers contend that under the prevailing 60:40 two axis price fixation formulae of milk, the milk producers supplying pure cow or buffalo milk get 20-30 per cent less than actually due prices, while those who sell mixed cow and buffalo milk and/or dilute it with water are able to fetch higher prices. Digital hydro-analysis of milk purchase transactions of MILKFED Punjab for the month of December 2017 indicated hidden losses of Rs. 7.61/kg to the dairy plant only due to dilution of milk with water or mixing cow and buffalo milk. Capacity building efforts among the milk procurement staff are required to avoid such losses and pass on the benefits of loss avoidance to the dairy farmers.

Regarding linking the procurement price to the cost of milk production there are alternative view points. Bulk line cost is the method to fix price on the basis of cost of milk production which reckons that price should cover cost of milk production of 85 percentile farmers. The approach is contradicted on various accounts such as cost of milk production differs significantly among regions, seasons and breeds, non-availability of data on cost of milk production based on standard methodologies, and complexities inherent to dairy sector like frequent sale and purchase of animal, life time production, etc. Cost based pricing may bring in inefficiencies as it does not encourage the farmers and researcher to reduce the cost which goes against the overall welfare of the society in the long run. However, it is important to keep a track of the cost of milk production to keep a close watch on the profitability of the enterprise. Hence the suggested policy intervention in this direction is to initiate the estimation of cost and returns from milk production as a regular scheme by the Government, wherein the estimates are made as per the standardised methodology at least once in three years.

3.5.4. Small-scale Value Addition

Urban consumption in India is going up day by day, one of the prime reasons being that affluent urban consumers consume more value-added products. Value added products bring in higher profits than liquid milk and this allows for returning higher margin to the farmers. Therefore, focus should also be given for tapping value added products segment along with liquid milk marketing. There are several success stories that can be replicated by providing appropriate training and hand-holding support to the entrepreneurs.

The Business Planning and Development (BPD) Unit of National Dairy Research Institute, Karnal is carrying out exemplary work in this direction. Village level small scale milk processing units were strengthened by the establishment of quality testing and milk processing facility by procuring the processing equipments. The unit has now facility of bulk milk cooler (BMC), khoa making machine, steam jacketed kettles, paneer press, curd incubator, deep freezers and milk testing equipments. The women collect about 250 l of milk daily and process into value added products. The average income of these women SHG member is about Rs.10000/- per month/per member. The intervention has also enabled minimization of stakeholders in milk supply chain and milk producers are getting remunerative price (Rs. 34-40/l).

More of such organizations like BPD are required in other parts of the country and the existing once need to be strengthened for larger outreach.

3.6. Annotation

Field surveys in various parts of the country bring out some very important points related to economics of dairy farming. The rearing of local cows for milk production is by and large unviable, except where the input costs are low and common property resources are available.

However, in the dairy production system, based on grazing and/or crop by-residues for animal feeding, and family labour for maintenance of animals; as the out-of-pocket expenses of farmers are low, from the farmers' perspective, local cow is not really a loss making entity. Besides, it also provides dung and draft animals which are still essential inputs in agricultural operations in several regions.

The efforts of the Government to promote and conserve Indian cattle breeds can bear fruits only with the effective participation of cattle keepers that can be forthcoming only if directly quantifiable economic incentives of rearing local cows can be demonstrated to them. Besides yield improvement of local cows, better prices for their products and by-products can be an important option for increasing the income of millions of farmers rearing local cows.

In case of crossbred animals and buffaloes, although the gross margin is positive in most parts of the country; indicating their short run economically viability. There is need to improve the productivity of these animals for positive net economic margin and to meet the future rise in feed and fodder costs. Thus, for the economic sustainability of small-holder dairy farmers, it is imperative that R&D support is provided to maintain crossbreds with lactation yield of over 2700 litres and buffaloes producing over 2300 litres in a lactation.

A study on commercial dairy farms in Haryana, showed that the large dairy farmers with milch herd of about 150 animals have better bargaining power, therefore, on one hand, they can economize on cost and on the other, get more remunerative price for their produce. With moderately lower average herd productivity of 7.5 litres for crossbred cows, the farm can earn handsome profits (18 per cent net economic margin) suggesting that strengthening the group dynamics of smallholder farmers can have far reaching economic benefits.

Key Extracts

- The economics of milk production varies across agro-climatic conditions, seasons and even breeds within each species of dairy animals.
- Gross maintenance cost of crossbred cattle is the highest among all three types of milch animals, followed by buffaloes and local cows.
- Higher yielding animals are mostly stall fed on home grown feed and fodder. But due to decreasing size of land holding reliance on purchased feed inputs is increasing.
- In general, the variable cost accounted for about 80 per cent of the total maintenance cost and the expenditure on feed and fodder has been the dominant component of the variable cost.
- Among the two types of native milch animals, viz. buffaloes and local cows, the former are economically viable in northern, western and parts of southern India.
- The efforts of the Government to promote and conserve Indian cattle breeds can bear fruits only with the effective participation of cattle keepers that can be forthcoming only if directly quantifiable economic incentives of rearing local cows can be demonstrated to them.
- Yield improvement is must for enhancing the economic viability of dairy farming and making it instrumental in doubling farmers' income.
- For the economic sustainability of small-holder dairy farmers, it is imperative that R&D support is provided to maintain crossbreds with lactation yield of over 2700 litres and buffaloes producing over 2300 litres in a lactation.

Chapter 4
Maximising Income from Buffalo Rearing

Of the large ruminants, cattle and buffalo constitute two important domestic animals reared for milk in India. The country's dairy industry has achieved major progress putting India at the top globally with respect to milk production. However, within the country the prices of milk have been fluctuating to the disadvantage of farmers. This needs to be addressed.

4.1. Introduction

India is host to a large population of cattle and buffaloes. As per Livestock Census, 2012, the population of cattle stands at 190.90 million and that of buffaloes at 108.70 million.

Table 4.1 India's livestock population (nos in million)

SN.	Type	Livestock Census 2012	ePashuhaat Current
1	Cattle	190.90	188.19
2	Buffaloes	108.70	100.24
3	Goat	135.17	146.45
4	Sheep	65.07	62.11
5	Pigs	10.29	10.74
6	Camels	0.40	0.40
7	Mithun & Yaks	0.35	0.38
8	Horses & Ponies	0.63	
9	Donkeys & Mules	0.52	
	Total	**512.06**	

Source: Livestock Census, 2012 and 2018 estimates ePashuhaat portal

Further, the estimated world bovine stock as of April, 2018 is as in Table 4.2.

Table 4.2 Estimated bovine stock as on April, 2018

SN	Country	Nos. (in million)
1	India	305.00
2	Brazil	232.35
3	China	96.85
4	US	94.39
5	European Union	88.45
6	Argentina	53.76
7	Australia	25.50
8	Russia	18.38
9	Mexico	16.58
10	Turkey	14.50
11	Uruguay	11.75
	Total	**1001.84***

*Includes other countries.

Source: US Department of Agriculture

As seen from Table 4.2, India is estimated to have the highest bovine population in the world. Cattle and buffaloes together have led the white revolution in the country, and with an output of more than 165 million tons of milk (2017-18), India tops the ranking. While several measures have been taken to further increase the production and productivity, the price realization of the output will be critical in incentivizing the dairy farmers to adopt new technologies and make necessary investments. Unfortunately, the dairy industry is going through challenges with procurement prices of milk for farmers falling by 25-30 per cent over the last one year (2017-18). Price support for milk procurement is emerging as one of the important demands from the farmers from across the country. It may be difficult all the time to provide additional price support to check market fall and a sustainable option would be to strengthen post-production environment, which includes processing, agri-logistics and marketing *per se*.

An important aspect of agriculture in the context of small and marginal farmers is, that a single source of income is not adequate to cover all the expenses. Any strategy for enhancing the farmers' income needs to tap alternate sources of income, so that the cumulative income of the farmer increases and supports his welfare.

4.2. Promoting Buffalo Meat Industry

In India, the advantage of buffalo is that it can contribute to the farmers' income by way of both milk and meat. Buffalo meat is in effect a by-product of the milk industry as buffaloes are raised mainly for milk purpose. Farmers rear buffalo till they reach an unproductive age and thereafter sell them either to traders or at the livestock market. Production of meat in India increased from 1.9 million MT in 1988-89 to 7.4 million MT in 2016-17. In 2009-10, next to poultry, goat accounted for the greatest share (17 per cent) of total meat production, while buffalo's share stood at 14 per cent. However, the share of buffalo meat increased to 19 per cent in 2016-17, while that of goat decreased to about 14 per cent. This provides some indications in respect of the increasing demand for buffalo meat in the country. Of the agri-exports from India, buffalo meat is one of the major items.

India's annual foreign exchange earnings from buffalo meat export went up from Rs. 3,500 crore in 2007-08 to Rs. 27, 000 crore in 2015-16. It is estimated that this sector has the potential to reach a target of Rs. 40, 000 crore as foreign exchange earnings in the next five years. Buffalo meat export has experienced a phenomenal growth since the year 2000, when India accounted for about 5 per cent of the total global trade. By 2015, India emerged as the largest exporter in the world comprising 21 per cent of the world's carabeef export.

It is estimated that as high as Rs.26,685 crore, which is 60 per cent of total value of carabeef export in 2015-16 went to farmers as payouts. It is possible to double this by 2022-23 with appropriate policy interventions. The importance of promoting the trade in buffalo meat including exports is, that it can provide an additional income to the buffalo farmers by enabling them to earn 30-40 per cent of the cost of their animal as terminal value once the active lactation/reproductive age is complete. This lump-sum that the farmers may get can be used for procuring a new dairy buffalo.

Uttar Pradesh was the highest meat producer among all the states in India, as in 2016-17. Other major meat producing states in the country are Maharashtra, West Bengal and Andhra Pradesh. The State of Uttar Pradesh which is India's largest milk producer is home to more than half of the country's 80 numbers of standalone and integrated abattoirs approved by the Agricultural & Processed Food Products Export Development Authority (APEDA). The State of Uttar Pradesh accounts for two-thirds of the frozen buffalo meat exports from the country. Interestingly, most of this meat processing infrastructure in the country has been a private sector initiative, demonstrating the financial viability of this enterprise.

Integrating the buffalo meat supply chain linkages by eliminating the unnecessary intermediaries will go a long way in ensuring better remuneration to the farmers. By-products obtained during slaughter remain unutilised or underutilised causing environmental problems. The by-products may act as raw materials for allied sectors, like hides for the leather industry, processed offals for the pharmaceutical & pet food industries, and the inedible by-products for the poultry feed & lubricant industries. Mainstreaming both the primary produce and meat by-products value systems, will help farmers to capture optimal value from all of types of output.

There is need for developing and modernising municipal abattoirs and retail outlets for slaughter and sale of buffalo meat. The Ministry of Food Processing Industries (MOFPI) has launched a scheme for 'Setting up of new/modernisation of existing Abattoirs' with a view to ensure scientific and hygienic slaughtering of the animals and supply of quality meat and meat products. However, the scheme has not been successful throughout the country, especially in regions with lower throughput which does not justify large investment in modernising the slaughter houses. For such regions, low-cost model of modern slaughter houses can be adopted. In states like Uttar Pradesh, meat retail outlets - which were earlier needed to get operating license from the local municipal authority - are now required to obtain the same from FSDA as per the FSSAI standards. As such, there has been significant increase in the hygienic and food safety standards in the buffalo meat retail outlets in such states. There is need for further intensification and sustaining of implementation of these standards.

There exist disparities in various livestock markets and also the slaughtering fees charged at abattoirs in various states. In spite of collection of fees for transactions at livestock market by the local bodies or agricultural marketing committees, these fees are not channelled to develop infrastructure and improve facilities at these markets. Keeping in view the immense benefit of such markets, basic amenities for trouble-free marketing should be provided to livestock traders and farmers. There is need for developing livestock markets on modern lines, with areas for loading & unloading of animal, space for tying and resting of animals, proper washing & weighing facilities. It has also been found that in some markets the mandate of compulsory checking of animals for their healthiness, before they are sold, is not followed diligently. There is also need for a market intelligence system where the farmer gets to know the fair price prevalent in various markets.

4.3. Supporting Export of Buffalo Meat

Indian buffalo meat is currently exported to about 70 countries. By region, India exports the highest share of carabeef to Asia, followed by Middle-east and Africa. As in 2015, Vietnam was the biggest importer of carabeef from India. Other major importers of Indian buffalo meat were Egypt, Malaysia, Thailand and Saudi Arabia. This implies that India is yet to gain a foothold in the domestic market of developed countries in the west, like EU & USA and also in other countries in Asia and Africa, where buffalo-meat is in great demand. The market access to the buffalo meat exporters can be further strengthened by suitable interventions. For example, although India exports the highest share of carabeef to Vietnam, a major share of the buffalo meat imported from India by Vietnam makes its way to China. Governmental efforts in helping Indian farmers/exports to gain access to wet (fresh meat) markets in China, Iran, Philippines and Russia will bring higher gain from export and transfer better returns to the farmers in contrast to sales made to the processors.

Another major intervention needed is to enable easy export of good quality buffalo hide by reducing the export duty. The state-of-the-art abattoirs are able to produce quality hide that is freshly flayed, fleshed, salted and folded for supply to the leather industry. Since there is as high as 60 per cent duty on export of raw salted hides produced at even APEDA-approved abattoir, the products are not able to compete in the world market, and the producers are forced to sell in the domestic markets. The domestic tanneries and leather product manufacturers who benefit from this are also permitted to import raw hides and skins duty free at two-thirds of the international price. This, while benefitting the domestic leather industry, is proving to be unfair to the buffalo farmers. This needs to be addressed appropriately, keeping in mind the viability of buffalo based dairy farming and the interests of the dairy farmers.

The third aspect relating to promotion of exports relates to controlling Foot and Mouth Disease (FMD). This is the most important infectious disease of cattle and buffaloes causing an economic loss within the range of Rs. 12,000-14,000 crore /annum in India (Singh et al., 2013). The government has made intensive efforts over the years to control the outbreak of this disease through production of FMD vaccine and launching extensive vaccination campaigns through public private partnership. If these efforts are further intensified, many states in the country (except some states in the northern, eastern and north-eastern states) can be declared free from FMD in the next few years. Freedom from FMD in such states along with establishment of a robust traceability system will help India gain access to markets in yet unexplored countries.

It is also pertinent that the Government revives and strengthens 'Salvaging and Rearing of Male Buffalo Calves' Scheme which was earlier launched under the 'National Livestock Mission'. However, there have been few takers for this scheme. The Federation of Indian Chamber of Commerce and Industries (FICCI) based on a study carried out in 2013 has shown that only 2 per cent of the farmers surveyed were aware of this scheme. A large number of buffalo calves coming into the system every year are abandoned and not properly taken care of. It is estimated that 14 million of the male buffalo calves (below the age of 6 months) die annually due to improper care. It is further estimated that if these numbers of buffalo calves are salvaged, buffalo meat export may go up to 18.5 lakh metric tonnes, fetching an export value of Rs. 38,000 crore by 2022-23. The farmers can be incentivised to rear the buffaloes properly till they attain the age of 23-24 months and are ready for sale to abattoirs. The Department of Animal Husbandry may therefore examine to revive this scheme. The non-banking financing corporations (NBFC'S) may also explore the feasibility of providing credit for the purpose. NABARD may route subsidy to famers by refinancing the loan for them. This would encourage farmers to consider raising male buffalo calves as a remunerative activity.

It can be recommended with certainty, that offer of a comprehensive policy support to buffalo meat industry would help in strengthening dairy industry and contribute to realisation of higher incomes by the buffalo dairy farmers.

4.4. Annotation

Buffalo rearing requires farmer's care in managing animal health and fodder, and marketing of the live animals, of milk as the primary produce and of buffalo meat as the terminal produce. Various by-products such as leather, offal, extracts, etc. are also consumers an income opportunity for the farmers. To fully support growth in the dairy sector, there is also need to strengthen the linked meat and by-products industries so that there is an organised market for all aspects and output from buffalo farming.

While milk is a primary dairy product from buffaloes, it would be useful from the income perspective to enable the farmer to capture the terminal value of the animal after its productive life from the animal's sale for meat purpose. This calls for an efficient marketing system of live animals and well established buffalo meat industry.

Key Extracts

- Buffalo rearing provides farmers a market opportunity in the trade of livestock, semen and other genetic material. The regular income is also provided through sale of the primary produce, buffalo milk.
- Buffalo meat market is also a substantial opportunity for farmers, and India is maintaining the mantle of the world's largest exporter of buffalo meat. However, the trade in buffalo meat has not been fully tapped to its full potential.
- Millions of male buffalo calves are lost for want of proper care. Farmers may be incentivised to salvage this loss, linked to demand from abattoirs and thereby increase supply to meat industry.
- The trade in the by-products of the meat industry, especially hide, is not in farmer's favour. A revisit to export and import of leather is needed.
- A comprehensive Trade Policy to strengthen and support the buffalo meat industry needs to be formulated, which in turn will support the economics of dairy farmers and contribute to realisation of higher income of buffalo farmers.

Chapter 5
Fodder Development for Dairy

Availability of good quality feed and fodder is critical in animal management. The country faces huge deficit of fodder, and quality of available fodder is also a concern. There is always a trade-off between cultivating for human food and animal fodder, in using the small parcel of land, that dominate India's farm landscape. There exists a challenge in encouraging fodder cultivation on farms and on community lands, as also waste lands.

In India, production potential of livestock is not realized fully because of constraints related to feeding, breeding, health and management practices. Deficiency of feed and fodder (50.2 per cent) accounts for half of the total loss, followed by the problems of breeding and reproduction (21.1 per cent), diseases (17.9 per cent) and management (10.5 per cent) in animal management. In fact, availability and quality of feed and fodder are increasingly becoming a challenge due to urbanisation and shrinking base of natural resources.

The current deficit level of green fodder and concentrates are around of 35 and 44 per cent, respectively. Further, there is a supply-demand gap in respect of quality forage seeds as well. The government has launched 'Accelerated Fodder Development Program' and a sub-mission 'Feed and Fodder Development' to correct this situation. The emphasis is on research & development (R&D), with a view to enhancing fodder productivity and availability by adopting multi–cropping systems and improved farming technologies.

5.1. Adoption of Promising Forages and Varieties for different Regions

The area under forage crops is 8.5 m ha and a wide array of forage crops/species is grown in different regions of the country. There is great diversity in forage crops & varieties across varied regions and different growing seasons – including a large basket of perennial grasses, range legumes, cultivated forage cereals & legumes. Notwithstanding the stiff competition from food & other commercial crops, forage varieties with tolerance to drought/water scarcity situations hold promise and can fit well in existing farming systems. These varieties can be very well adopted and promoted in suitable growing regions (Table 5.1).

Table 5.1 Promising drought tolerating varieties of cultivated fodder and grasses/legumes

Crop	Varieties	Forage production potential (greens t/ha)	Adaptable region	Suitable for existing production systems
Sorghum	Pusa Chari-1, CO-27, SSG 59-3 (Meethi Sudan), CSH-20MF (UPMCH- 1101), PAC 981, CSV–15	35-45	Whole country except temperate hills	Food-forage cropping system/sole forage

Crop	Varieties	Forage production potential (greens t/ha)	Adaptable region	Suitable for existing production systems
Bajra	Avika Bajra Chari (AVKB-19), Raj Bajra Chari-2, CO-8, APFB-2, PCB-164	30-40	Whole country except temperate hills	Food-forage cropping system/sole forage
Maize	Pratap Makka Chari 6	40-50	Whole country	Sole forage/silage (milkshed areas)
Sudan grass	Meethi Sudan, Sweet Sudan Grass, Punjab Sudex Chari-1 (LY-250)	45-65	Whole country except temperate hills	Sole forage/silage (milkshed areas)
Oat	FOS-1/29, Bundel Jai-822, Bundel Jai 992 (JHO 99-2), JHO-2009-1	35-45	North, central & north western hill region	Sole forage/silage (milkshed areas)
Cowpea	Bundel Lobia-1, Bundel Lobia-2 , S 450	20-25	Whole country	Food-forage cropping system/sole forage
Guar	Durgajay, Durgapura Safed, HFG-119, Bundel Guar- 1, Bundel Guar- 2, Bundel Guar- 3	20-25	Whole country except temperate hills	Food-forage cropping system/sole forage
Sem	Bundel Sem-1	20-22	Whole country except temperate hills	Food-forage cropping system/sole forage
NB hybrid	CO-1, NB-37	150-180	Whole country except temperate hills	Round the year forage system, on farm boundaries, horti-pasture
Guinea grass	Bundel Guinea-1 (JHGG-96-5), Bundel Guinea-2 (JHGG 04 –01)	120-150	Whole country except temperate hills (very high altitude)	Round the year forage system, on farm boundaries, horti-pasture
Dinanath grass	Bundel-1, Bundel-2, COD-1	35-45	Whole country except temperate hills	Silvi-pasture, forest fringes, degraded lands/watersheds, community lands
Anjan grass	Bundel Anjan-1, CO-1 , Bundel Anjan-3	25-35	Whole country	Silvi-pasture/Horti-pasture, forest

Crop	Varieties	Forage production potential (greens t/ha)	Adaptable region	Suitable for existing production systems
				fringes, degraded lands/watersheds, community lands
Motha dhaman grass	CAZRI-76, Marwar Dhaman (CAZRI-175)	25-35	Central, western & dry arid region	Silvi-pasture, forest fringes, degraded lands/watersheds, community lands
Black spear grass	Bundel Lampa Ghas -1	25-30	Whole country (arid & semiarid region)	Silvi-pasture, forest fringes, degraded lands/watersheds, community lands
Stylosanthes sp.	*S. hamata, S. seabrana & S. scabra*	25-30	Whole country (semiarid region)	Silvi-pasture/horti-pasture , forest fringes, degraded lands/watersheds, community lands
Clovers	White & red clovers	20-25	Temperate/sub-temperate region	Horti-pasture/Silvi-pasture, forest fringes, degraded lands/watersheds, community lands

5.2. Round the Year Forage Production from Arable Lands

There is need for a strategy that achieves higher forage production per unit area and encourages forage production in mixed crop-livestock framing systems. Perennial availability of green fodder would help in improving the nutritional quality of livestock feed. For round the year fodder supply, fodder production systems have been developed for irrigated and rainfed situations which need to be promoted. The systems developed are as in the box below.

Box 5.1: Round the year fodder production systems

Technology I: Round the year fodder production system (Irrigated situation)

Hybrid Napier based cropping system [hybrid napier + (cowpea – berseem) + mustard] has green fodder production potential of 273 t/ha; and dry fodder potential of 44.3 t/ha per year under assured water supply (water requirement 1090 mm). It can supply round the year good quality fodder (cereal: legume, 67:33) which can sustain 8-10 ACU per ha (1 ACU= 350 kg body weight).	
The system is suitable for large scale dairy farmers in peri-urban and milkshed areas of whole of India except for tropical region. The cost of production is Rs 29 per quintal of green fodder and the net return is Rs 1,93,000 per ha with a BC (benefit:cost) ratio of 2.41.	Perennial based : N-B hybrid + cowpea
Technology II: Round the year fodder production system (rainfed situation)	
The system comprising subabul + tri-specific hybrid - fodder sorghum + pigeonpea is suitable for rainfed conditions. It has green fodder production potential of 53.3 t/ha and 13.28t dry fodder. It can sustain 2-3 ACUs with quality fodder. It provides nutrient rich pulse for human consumption and fuel wood; and is also capable of prolonging the fodder availability upto the month of May (dry period).	
The system is suitable for small and medium farmers of semi arid region (upto 500 mm rainfall). The cost of production is Rs 38 per quintal of green fodder and the net return is Rs 52,500 per ha with a BC ratio of 2.59.	Perenial based: subabul + trispecific hybrid - sorghum (fodder) + pigeon pea (grain)
Technology III: Fodder on field boundary/bunds/channels: Non-competitive land use	
Among different perennial cultivated grasses, napier- bajra hybrid is most suitable for bunds of irrigated areas; and tri-specific hybrid (TSH), guinea grass, anjan grass and nandi grass are suitable under rainfed conditions. It can produce 1.75 to 2.50 kg of green fodder per meter per cut, and on an average of 4 cuttings in a year 7.0-11.0 quintal of green fodder per 100 metre bund length is possible. The cost of production is Rs. 35 per quintal of green fodder and the net return is Rs. 1800 per bund area of 1 ha with a BC ratio of 1.8.	 NB hybrid on Field boundary at farmers field, Datia (M.P.)
All categories of farmers, specially marginal and small farmers in different agro-climatic regions of India. If 10 per cent of all the field boundaries are utilized, 17.8 MT of green fodder production/year can be produced additionally in the country.	

5.3. Forages from Degraded Lands

In rainfed/ arid regions of the country, large number of livestock are dependent on forage produced in rangelands. A design with a combination of different trees and grasses was tested to demonstrate creation of space for forage, which depending on the design of the system, can grow at rates comparable to open pasture. Silvi-pasture models are suitable for highly degraded/ waste lands under rainfed situation in semi-arid region of India (rainfall 400-700 mm). The establishment cost of the system ranges from Rs.25,000-30,000/ha and B:C ratio was 1.5-2 over the period of 10 years. Under conditions of poor soil, deficient water and nutrient status, where crop cultivation is not possible, silvi-pasture systems can serve the purposes of forage and firewood production and eco-system conservation.

Box 5.2: Silvo-pasture model for highly degraded/ waste lands

***i.* Ficus based silvi-pasture** Zone: Tropical &Semi arid Rainfall: 600-700 mm/annum Forage: 12.3 DM/ha (tonnes of dry matter/ha) ACU: 3 – 4/ha Grass- *Chrysopogon fulvus, Cenchrus ciliaris* and *Panicum maximum* Legume- *Clitoria ternatea* and *Stylosanthes seabrana* **Fodder availability** From grasses and legume- July to December (65-70 per cent) Tree leaves- March to June (30-35 per cent)	 Ficus infectoria with grasses and legumes species
***ii.* Hardwickia based silvi-pasture** Zone: Semi arid Rainfall: 600-700 mm/annum Forage: 7.4 t DM/ha ACU: 2- 2.5/ha Grass- *Chrysopogon fulvus, Cenchrus ciliaris* and *Panicum maximum* Legume- *Stylosanthes seabrana* **Fodder availability** From grasses and legume- July to December (85-90 per cent) Tree leaves- March to June (10-15 per cent)	 Hardwickia binata with grasses and legume species
***iii.* Morus based silvi-pasture** Zone: Semi arid Rainfall: 600-700 mm/annum Forage: 12.5 t DM/ha ACU: 3-4/ha Grass- *Chrysopogon fulvus, Cenchrus ciliaris* and *Panicum maximum* Legume- *Clitoria ternatea* and *Stylosanthes seabrana* **Fodder availability** From grasses and legume- July to December (65-70 per cent) Tree leaves- March to June and September to November (30-35 per cent)	 Morus alba with grass and legume species

***iv.* Acacia based silvi-pasture** Zone: Semi arid Rainfall: 600-700 mm/annum Forage: 10.4 t DM/ha (tonnes of drymatter/ha) ACU: 2.5-3/ha Grass- *Chrysopogon fulvus*, *Cenchrus ciliaris* and *Panicum maximum* Legume- *Clitoria ternatea* and *Stylosanthes seabrana* **Fodder availability** From grasses and legume - July to December (92-95 per cent) Tree leaves- November to December (5-8 per cent)	 Acacia nilotica with grass and legume species

5.4. Forages from Community Lands

Indian subcontinent is characterized by tropical monsoon climate. Accordingly, the active growth of grasses in grazing lands occurs only during monsoon season. Moreover, the grazing intensity in the country is as high as 12.6 ACU/ha compared with 0.8 ACU/ha in developed countries, which leads to degradation of lands and needs revitalization.

Box 5.3: Community pasture-land development

Combination of range grasses and legumes : *Cenchrus ciliaris*, *Cenchrus setigerus*, *Chrysopogan fulvus*, *Sehima nervosum*, *Heteropogon contortus*, *Dichanthium annulatum*, *Bothriochloa intermedia* , *Stylosenthes seabrana*, *Clitoria ternatea*, *Macroptilium atropurpureum.* **Target area:** Degraded land, community land and forest land available across the country. **Establishment cost of the system:** Rs.25,000-30,000/ha. **Benefit:Cost (B:C) ratio over the period of 10 years**:1.5-2 **Impact:** Productivity- 7.3 t dry mater (DM) per ha; carrying capacity : 2 ACU/ha, availability period of fodder from July to December.	 Model grassland in highly degraded land with fodder trees, shrubs and grasses **Rainfall: 600-700 mm/annum**  Pasture land site at Soda, Rajasthan with fodder trees, shrubs, grasses and legumes (70 ha) **Rainfall: 400-600 mm/annum**

5.5. Forages from Existing Orchards

Horti-pasture system integrates pasture (grass and /or legumes) and fruit trees to fulfill the gap between demand and supply of fruit, fodder and fuel wood through utilizing moderately degraded land. Indian Grassland Fodder Research Institute (IGFRI), Ranchi, has developed Aonla and Guava based horti-pasture systems for higher productivity. The range grasses used in the system are *Cenchrus ciliaris*, *Stylosanthes seabrana* and *Stylosanthes hamata*. During a period of 10 years it yields a B:C ratio of 4-6 and supports 2-3 ACU in a year.

Box 5.4: Technology I: Horti-pastoral model for higher income in rainfed ecosystem (semi-arid region)

<table>
<tr><td rowspan="2">Dimension:
Target area: Well suited to poor soils with a depth of 80-150 cm and annual rainfall of 700-800 mm.
Establishment cost of the system: Rs.40,000-50,000/ha.
B:C ratio: over the period of 10 years:4-6</td><td></td></tr>
<tr><td>Aonla with Cenchrus ciliaris and Stylosanthes hamata</td></tr>
<tr><td colspan="2">Technology II: Fodder production in mango orchards (Tropical/coastal region)</td></tr>
<tr><td rowspan="2">In mango (prime fruiting stage, above 4 years) based farming system in Karnataka, Maharashtra, Andhra Pradesh, Uttar Pradesh, West Bengal, Bihar etc., the common planting distance followed is 10 m by 10 m giving a minimum 7-8 m inter-space for introducing fodder crops.
Cost of production and returns (per ha):
Irrigated system with propagation by root slips
Cost: Rs.29,400.00 Returns: Rs.1,75,200.00
Rainfed system with propagation by seeds
Cost: Rs.12,500 Returns: Rs.72,000
It can provide green fodder of 146 t/ha/year with the gross value of Rs.1,75,200. Besides it resulted in indirect economic benefits like saving cost of feed by 47 per cent, increase in milk yield by 0.93 litres/ACU and labour saving by 0.91 mandays.</td><td></td></tr>
<tr><td>Farmer at Mango orchard in Dharwad, Karnataka</td></tr>
</table>

5.6. Exploring Non-conventional Fodder Resources

There exists scope for improving the basket of feed resources by relying upon non-conventional/under-utilized feed resources like cactus, lathyrus, sugar beet, moringa etc. These can be incorporated in unutilized lands/marginal soils/degraded areas along with other existing options of forages/grasses.

Box 5.5: Non-conventional fodder resources from unutilised lands/marginal/degraded lands

Target area: Cactus is well suited to degraded lands, pasture/nalla bunds & field boundaries, and thrives well in drought prone/scanty rainy areas. It is well suited to arid and semi-arid regions. Moringa & sugar beet can be incorporated well for energy/protein rich feed supplements in milk shed areas.

Establishment cost of the system: Rs. 20,000-25,000/ha.

B:C ratio over the period of 5 years:1.2-1.8

Fodder beats and turnips (intensive management system) – Protein: Root- 4 to 6 per cent & fresh leaves- 12 to 14 per cent, Yield potential: 600-800 q/ha.

Cactus (degraded lands): Protein- 4 to 7 per cent, Moisture content- 88 to 94 per cent.

Grass pea (Lathyrus) forage (semi arid condition):Protein- 14 to 15 per cent; Low ODAP- 0.07 to 0.20 per cent.

5.7. Azolla- A Feed Supplement

Azolla farming, in general, is inexpensive and it can be multiplied in natural water bodies for production of bio-mass. Bio-mass productivity is dependent on time and relative growth rate and efficiency of the species. Azolla is very rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B12, Beta Carotene), and minerals including calcium, phosphorous, potassium, ferrous, copper, magnesium. On a dry weight basis, Azolla possesses 25-35 per cent protein, 10-15 per cent mineral content, and 7-10 per cent comprising a combination of amino acids, bio-active substances and bio-polymers. During lean/ drought period it provides sufficient quantity of nutrients and serves as a feed resource.

Box 5.6: Azolla as supplement feed for livestock

It can successfully be grown round the year in southern states like Karnataka, Kerala, Goa, Tamil Nadu and Maharashtra and during monsoon and summer months in states of Punjab, Haryana, Delhi, U.P., Bihar, M.P., Rajasthan, Gujarat, and Chhattisgarh. In hilly states where winter is pronounced, Azolla can be grown in monsoon and summer months. Azolla is a highly productive plant. It doubles its bio-mass in 3–10 days, depending on conditions and it can yield upto 37.8 t fresh weight/ha (2.78 t DM/ha). **Per unit cost:** The cost of producing *Azolla* at farmer's level will be Rs1.0 to 1.5 per kilogram.	 Azolla demonstration at farmers fields in Jharkhand

5.8. Hydroponic Fodder Production: Water Saving Technology

In hydroponics, water consumption comes down sharply by 98 per cent when compared to conventional cultivation practices, and further the used water is recycled. Hydroponics fodder is more nutritious than the conventionally grown green fodder. In low water situations where fodders cannot be profusely grown, farmers can produce hydroponics based green fodder for their animals. The locally assembled/fabricated hydroponics has a low initial cost (Rs.4-5 lakh) and operational cost (approx Rs. 2/kg green fodder), which supplies fodder for 7-8 months/year. This is suitable for hot and humid regions. Branded fabricated hydroponics are costly (Rs.18-27 lakhs) with an operational cost of Rs.4-7/kg of green fodder, and suitable for whole year fodder production. It requires continuous power supply and hence a connection of 5-7 KVA would be needed.

In a study by Anand Agricultural University (AAU), Gujarat, it has been observed that production cost of hydroponics green fodder from white maize (Rs.4) was lower than yellow maize (Rs.5). In comparison to conventional green fodders, hydroponics based green fodders contained more crude protein (13.6 per cent vs 10.7 per cent) and less crude fibre (14.1 per cent vs 25.9 per cent). Intake of hydroponics green fodder by dairy animals was upto 24 kg/animal/day.

5.9. Silage from Surplus Fodder

Silage is the fodder which is conserved by reducing pH through natural anaerobic fermentation, and is used for feeding during scarcity period affected by drought or flood and a means of utilizing surplus forage. The suitable crops are sorghum, maize and oat etc. During lean periods, feeding of silage acts as a green fodder and maintains livestock productivity.

In general two lean periods are encountered when it can be fed. These include i) November-December; and ii) April-June (2+3 = 5 months). All areas (sorghum and maize growing states

& in rabi season, oat growing states), where farmers face a challenge in providing round the year fodder to the animals, surplus fodder can be preserved as silage.

Box 5.7: Silage for sustenance of livestock production

It can **s**ustain/increase the livestock production by 10-15 per cent during the scarcity of green fodder and suitable for all categories of farmers, having excess fodder over daily need.

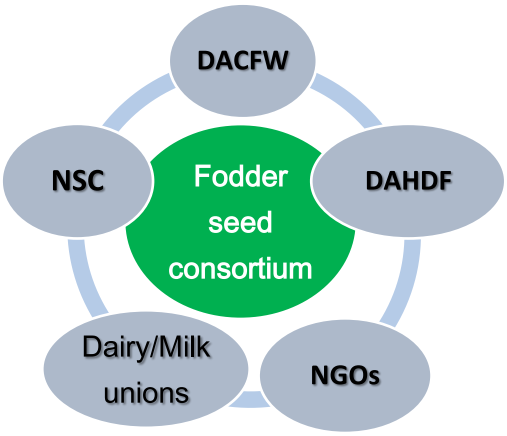
Operational cost of silage: *Kaccha pit-Rs. 60-80/quintal*
Pakka pit- Rs. 40-50 /quintal
Polythene bag- Rs. 300-400/quintal

Per unit cost of silage preparation (excluding the cost of fodder): Rs. 150-160/q (includes cost of harvesting, transportation, chaffing, filling and covering).

5.10. Strengthening of Quality Seeds

At present, availability of improved fodder seed is only 40,000 metric tonnes against a requirement of 5.4 lakh metric tonnes, which works out to 10 per cent of the requirement. There exist huge gaps in the seed chain. At the required seed replacement rate (SRR) of 20 per cent, the requirements of certified seeds is 2,68,500 quintals; that of foundation seeds is 7,765.68 quintals and that of breeder seeds is 286.96 quintals. This requirement needs to be ensured. For strengthening the seed linkage and supply, targets should be fixed zone-wise which will meet at least 50 per cent of fodder seed requirement, by adopting participatory seed production system.

It would be useful to promote fodder seed village and fodder seed hub programmes for seed production, as is in vogue in case of pulse production. IGFRI, Jhansi may be designated as the nodal institute for this programme on similar lines as Indian Institute of Pulse Research (IIPR), Kanpur has been adopted as the nodal agency to anchor pulse seed production programme. Thus an appropriate linkage (as shown below) should be established among the different stakeholders.



Note:
DACFW – Department of Agriculture, Cooperation and Farmers' Welfare
DAHDF – Department of Animal Husbandry, Dairy and Fishery Development
NSC – National Seed Corporation

5.11. Annotation

With predominance of small and marginal farms, Indian agriculture is dominated by crop-livestock based mixed farming.

Livestock resources of India are vast, but productivity of both milk and meat is low and can be improved. Apart from appropriate genetic resources and adequate animal health cover, feed and fodder constitute a critical input in animal husbandry. India is currently faced with huge deficit of quality fodder. Since more than 86 per cent of the farms are small and marginal, there is always a trade off situation between using the land for growing human food or animal fodder.

In order to meet the growing need for good quality fodder, a comprehensive approach that uses farm lands, common property resources like grazing lands and wastelands need to be adopted. Further, suitable cropping systems, including silvi-pastoral and horti-pastoral practices will help. The productivity of these systems is also an issue that has to be taken care of, so as to build a strategy for efficient livestock management.

Key Extracts

- The production potential of the vast size of the country's livestock resources has not been fully utilized due to several constraints encompassing breeding, health and management practices including that of feed and fodder.
- Majority of the farms being small & marginal, there always exist a conflict of choice between raising a crop for human consumption and animal fodder.
- A comprehensive approach to enhance availability of good quality fodder in the country is critical.
- The strategy needs to take into account optimal use of arable lands, common property resources, farm bunds and wastelands.
- Focus is needed on raising the productivity of fodder; and total output can be increased by adopting suitable models including solo fodder cultivation, silvi-pastoral, silvi-horti-pastoral etc. systems.

Chapter 6
Livestock Promotion: Research & Development Interventions and Government Initiatives

The extent to which growth in livestock production can be accelerated will depend on how technology, institutions and policies address constraints facing the livestock sector. Production growth dependent on larger animal stock is not sustainable in the long run, due to adverse effect on carrying capacity of land and available resources; hence, future growth in production should essentially come from improvements in productivity. This will require overcoming feed and fodder scarcity and improvements in delivery of animal health and breeding services. A key driver of growth and concerted the desired efforts will be the generation and dissemination of yield-enhancing and yield-saving technologies.

6.1. Introduction

The strategy to enhance farm income from livestock needs to encompass a combination of several possible routes, viz. enhancing productivity, reducing cost, ensuring better price, reducing risk and skill development (Table 6.1). These can be achieved through innovations and interventions based on science and technology, besides adoption of institutional and policy reforms.

Table 6.6.1 Possible routes to increase farmer's income

Enhancing Farmers' Income			
Enhance productivity	**Reduce costs**	**Ensure better price and reduce risk**	**Skill development and knowledge management**
• Technological interventions to bridge yield gap • Improve input supply • Improve support services • Improve infrastructure	• Efficient resource utilisation • Exploit complementarities between various enterprises • Change institutional mechanisms	• Directly linking farmers to markets • Promote value addition • Diversification • Expand insurance coverage	• Training of farm households, especially youth and women

A multi-pronged strategy encompassing various aspects for dairy production such as breeding, feeding, health care and management; milk marketing, extension network etc. need to be put in place for doubling the income of dairy farmers by 2022.

6.2. Interventions for Animal Breed Improvement

Breeding is an important tool to improve desirable attributes in diary animals like milk production, feed conversion efficiency, growth, reproduction, disease resistance etc. The interventions in animal breeding that can have visible impact in the shorter run are providing timely and quality artificial insemination (A.I.) facilities to the farmers that can be achieved through strengthening of semen stations, expanding the AI coverage and putting in place systems for effective AI delivery through information driven management. In the longer run there are several other advanced technological intervention like, Genome selection, Embryo transfer (ET)/IVF that would be required for sustained breed improvement.

6.2.1. Strengthening AI services

Artificial Insemination (AI) enables use of the semen of a few top bulls of high genetic merit in a more extensive manner and over a much larger population. Therefore, AI is the preferred method of attaining genetic progress in any population. Presently about 30 per cent of the breedable animals are bred through AI and the rest through natural service. Therefore, to accelerate genetic progress, the proportion of milch animals bred through AI needs to be raised subsequently.

Production of Quality Semen doses: First important pre-requisite for providing AI services is the availability of quality semen. During 2015-16, about 102.69 million semen doses were produced by the existing 53 Semen Stations, out of which about 97.82 million doses were produced by the 48 semen stations graded A or B which is about 95 per cent of the total semen doses produced in the country. The production is quite low to meet the requirement of higher AI coverage. For instance, if at least 60 per cent of the breedable animals are to be inseminated by 2021-22 then an aggregate of about 209 million quality semen doses of the required breeds would need to be produced.

Some important aspects related to production of high quality disease free semen doses that should form an integral part of the strategy to enhance farm income are:

- Ensuring that semen is produced only through selected and efficiently managed semen stations, where trained and dedicated manpower manage these facilities in a professional manner.
- Making it mandatory for the Semen Stations to adopt various Minimum Standard Protocols, so as to maintain the highest quality standards. Efforts till now have been more directed towards production of quality semen. To give more thrust to genetic quality of bulls, the Minimum Standards Protocol should lay more emphasis on genetic quality of bulls maintained at various semen stations.
- Semen stations should work towards maintaining bulls that are produced through genetic improvement programmes. The Minimum Standards Protocol on semen production should be modified to give higher weightage for the genetic quality of bulls maintained and include categories of bulls with "Breeding values/Genomic Breeding Value" as top priority categories. It is required to create an environment in the country which would mandate the semen stations to maintain bulls which are produced only through scientific interventions and delivery quality genetics to farmers.
- Close monitoring of bull induction in the Semen Stations, so that only the bulls from approved sources are inducted. There should be provisions for ensuring that the semen stations shall generate and publish information on the semen quality of each bull.

- Semen Stations should take-up the responsibilities of putting in place bull production programmes for various breeds, and share the bulls produced such that these programmes also become sustainable in long run.
- Semen Stations should have in place adequate quality assurance systems to consistently ensure production and supply of high quality doses.

Improving efficacy of service delivery: During the year 2015, there were 1,09,555 AI centers and 67.02 million AIs were reported in the country (i.e. 51 AI per centre per month). A scientific approach to delivery of AI services at the doorstep of the milk producer is expected to result in the animal conceiving with less than two and a half inseminations and without spread of disease and the production of a genetically superior calf. To achieve even a moderate rate of conception of 35-40 per cent, the effectiveness of existing AI centres needs to be improved. There are several factors such as reproductive health and nutritional status of female animals, proper heat detection, quality of semen, maintenance of cold chain, timely supply of liquid nitrogen, competence of AI technician, etc. which are major contributors for the success of artificial insemination. There is need to focus on aspects presented in the paragraph that follows.

AI service providers need to ensure that AI technicians are trained / re-oriented in certified/accredited AI training institutes capable of training them in the Standard Operating Procedure (SOP). The SOPs for AI delivery at the doorstep of the milk producer should include, importantly, adherence to the Breeding Policy of the state, use of disease free quality semen of HGM bulls, recording of all events such as animal identification (registration), insemination, pregnancy diagnosis and calving on an individual animal basis and providing advice on overcoming mineral and feed deficiency in the animal as they are vital for reproduction and make available inputs such as area specific mineral mixture, de-worming medicine, mastitis control kit, etc. There is a need of Multi-Purpose AI technicians in Rural India (MAITRIs).

Widening the AI network: Efforts for any genetic improvement activities of animals would yield results in desired time frame when large proportion of breedable animals is brought under Artificial Insemination network. As mentioned earlier, the current AI coverage is around 30 per cent of the breedable animals and it is required to increase it to about 60 per cent of breedable bovines. Besides catering to the requirement inputs and manpower for expanding the AI coverage, the other key challenges that need to be overcome are:

- Increasing awareness among farmers for adopting AI services through a sustained campaigning to educate farmers on the advantages of AI encouraging them to adopt it.
- Prioritizing cattle and buffalo breeds as per their economic importance. This will be helpful to farmers in order to increase their income through rearing of livestock and sale of milk, milk products and animals as well.
- Identifying location-specific high quality breeds for breed improvement programs.

- An arrangement to control the menace of scrub bulls in villages.
- Avoid duplication in area of operation of AI servicing agencies to increase the coverage.

6.2.2. Performance recording and selection

One of the key factors that influences milk productivity of animals is its genetic ability for milk production, which is an inherited character, while others provide an enabling environment. The breeding bull contributes significantly in enhancing the genetic potential of its progenies for economically important traits like milk productivity-production, fertility, body conformation etc. Therefore, selection of bull mothers and sires for production of next generation of breeding bulls is the fulcrum of any animal breeding programme.

Genetic improvement for a specific trait or group of traits largely depends on how effectively these traits are recorded and the accuracy of selection that is obtained for production of bulls. Data recording is essential for identification of high genetic merit animals. Daily recording of data on milk yield and other performance traits is required for decision making in dairying for the benefit of farmer-entrepreneur. It is the data that should drive selection of superior animals in the breed improvement programs. Except in case of a few institutional organised herds, daily recording of performance data is not practised under field conditions. Under the smallholder dairy production system prevalent in the country, and given the acute financial resource constraint, it is practically a near-to-impossible proposition under field conditions. Under such a circumstance complete data recording can be replaced by two following ways:

- First option is to record only a part of the lactation (known as part-lactation milk yield), which can be used for the prediction of 305-day lactation milk yield.
- Second way is to record milk yield once in a week (weekly) or a fortnight (fortnightly) or a month (monthly) or a period of two months (bimonthly). Test-day (TD) milk yield recording at monthly or bimonthly interval is not only convenient but also cost effective for the prediction of lactational milk yield under field conditions.

The data recording on individual insemination-wise information is also very useful in early identification of problem in animals, AI technicians (AITs) or quality of semen provided in any area. The AI network should be empowered with technical manpower that can analyse data, provide support to AITs and farmers in maintaining herd fertility levels and to evaluate interventions based on data.

Selection of bulls could be done through methods like pedigree selection and progeny testing. Progeny Testing (PT) is an internationally established practice to select bulls. However, the process takes longer period. Hence it is suggested that, young HGM bulls produced through proven sires and dams selected based on their breeding values be used. This process is called a "Young Bull/ Sire Programme". HGM bulls of breeds such as Murrah/ upgraded Murrah and Mehsana breed of buffaloes, Holstein Frisian, Holstein Frisian crossbred, Jersey, Jersey crossbred of cattle and some of the indigenous breeds like Gir cattle can be produced through Progeny Testing.

Among some of the breeds (many indigenous breeds), where one cannot practise bull production through Progeny Tcsting due to non-availability of AI infrastructure, efforts are to be made to select bulls through Pedigrce Selection (PS). wherein this case, the performance of bulls is judged on the basis of performance of their parents and grandparents. Indigenous cattle breeds such as Rathi, Sahiwal, Kankrej, Tharparkar and Hariana and indigenous breeds of buffalo such as Jaffarabadi, Pandharpuri and Nili-Ravi can be produced through pedigree selection.

6.2.3. Promoting Embryo Technology and In-Vitro Fertilization tools

There is need for a system of maximum utilization of identified elite cows through Embryo Transfer (ET)/In-Vitro-Fertilization (IVF). ET technology is used to increase the reproduction rate of cows and buffaloes. Theoretically, a cow or a buffalo can produce one calf a year that pulls down its productive rate. A cow or buffalo comes into heat every 21 days and releases one egg (ovum). If the animal is mated to a bull at the right time during the heat or inseminated artificially, the egg is fertilized which results into a pregnancy. The animal would deliver a calf after about 280 days of gestation in cows and 310 days in case of buffaloes. Due to low reproduction rate, the genetic contribution of cows to next generation is minimal. However, the bull at the same time (one year) can make about 10,000 cows pregnant and thus contributing its gene to large number of animals in future population. However, with ET, a cow can produce 5-10 calves in a year. Embryo transfer simply means collection of an embryo from a donor female and its transfer to the uterus of a recipient female of the same species.

Using the technology, bulls of various indigenous cattle and buffalo breeds may be produced which may be used for semen production. The Normal Dairy Development Board (NDDB) started using ET as a tool in 1986 and established for the first time in the country an embryo transfer technology at Sabarmati Ashram Gaushala, Bidaj, Gujarat. More number of such facilities should be established in the country. Some important aspects of Embryo Technology that should be kept in mind are:

- Embryo collection and transfer are highly skilled jobs to be performed only by trained veterinarians.
- It requires a sophisticated laboratory, equipments, consumables and biological, majority of which are not available in the country and need to be imported. Therefore, it is quite expensive and cost of embryo recovery rates besides the material cost.
- Embryo should only be collected from elite donor females whose production is well above the production of the population and are free from any diseases.

In-Vitro Fertilization is a technology similar to ET. Here Ovum are collected form live elite animals and are matured, fertilized and developed in laboratory for first seven days. The developed embryos are transferred to selected recipients. Here like ET, the genetic potential of recipient animals would not be criterion. However, good health and reproduction parameters of recipients are very important. If successfully implemented in our country, this technology will help reducing cost and faster multiplication of elite germplasm. Efforts need to be made to implement and regularly use this technology in field where performance recording of animals is undertaken.

6.2.4. Use of Genomic Selection

There are technical limitations like high age at maturity and less recording infrastructure, lack of infrastructure to store large number of semen etc. that will deter the use of proven bulls for insemination of cow directly. Hence, all the young bulls inducted in semen stations should be either sons of proven bulls and dams selected based on Breeding Values or should be sons of known top bull (based on pedigree) and top recorded cows for full lactation. This approach will give better reliabilities of bull selection up to 25 per cent. To gain higher reliability of bull selection, new technologies like genomic selection based on female reference population should be used.

6.3. Interventions for Improvement in Animal Nutrition

The production potential of livestock in the country is not fully realized because of constraints related to feeding, breeding, health and management practices. As per an estimate, the deficiency of feed and fodder accounts for half of the total loss (50.2 per cent), followed by the problems of breeding and reproduction (21.1 per cent), diseases (17.9 per cent) and management (10.5 per cent). Livestock productivity cannot be enhanced only by increasing the genetic potential of bovines. It is equally necessary to improve animal nutrition so that livestock can produce milk commensurate to their genetic potential. Feed shortage, poor nutritional quality of feed and imbalanced feeding are the key problems that need to be overcome through appropriate for enhancing productivity growth in dairy sector.

6.3.1. Addressing feed-fodder shortages

In order to meet the nutritional requirements of animals, the challenge before the researchers is to increase the bioavailability of the feeds and fodders using chemical, biological and biotechnological approaches. Also, it is necessary to improve the productivity of the land for meeting out the feed and fodder requirements from the limited area available for this purpose.

Strengthening crop residue management system: Crop residues, such as rice and wheat straw and sorghum stover, represent the largest component of animal feed. Prevention measures are required for stopping wastage of crop residues through burning by strengthening crop residues management system. It requires creating infrastructure for crop residues collection, baling, enrichment and storing by introducing most modern machines like mower, reapers, balers, straw makers, automatic harvesters in villages.

Increasing green fodder production: Presently, green fodder production is coming from cultivation of fodder crops in 9.1 million hectares of arable land, 10.343 million hectares of common grazlI1g land/pasture/rangeland and about 69.79 million hectares of forest land. Due to small size of land holding, the farmers give preference to cultivation of food crops instead of fodder crops. Detailed strategy to increase the production of green fodder in various regions and farming systems is outlined in the preceding chapter of this volume; the main points of which are as follows:

- There is great diversity in forage crops comprising perennial grasses, range legumes, cultivated forage cereals and legumes grown across varied regions and different growing seasons. There are a number of promising forage varieties with tolerance to drought/water scarcity situations that need to be promoted in different farming systems.
- Promoting cultivation of newly developed and notified varieties/ hybrids of fodder crops, perennial grasses & legumes and non-conventional/under-utilized feed resources like cactus, lathyrus, sugar beet, moringa etc. new nutritious crops like Moringa, fodder beet, azolla.
- For round the year fodder supply, fodder production systems have been developed for irrigated and rainfed situations which need to be promoted.
- In arid and semi-arid areas, vast extend of land is lying vacant and is not being used due to scarcity of water. Silvi-pasture models are suitable for highly degraded/ waste lands under rainfed situation in semi-arid region of India (rainfall 400-700 mm). Under conditions of poor soil, deficient water and nutrient status, where crop cultivation is not possible, silvi-pasture systems can serve the purposes of forage and firewood production and eco-system conservation.
- Development of common grazing land on scientific methods by involving village level institutions on commercial lines may help to increase availability of green fodder in rural areas. Some combination of range grasses and legumes that can substanitally improve the carrying capacity of land for livesttock production are *Cenchrus ciliaris, Cenchrus setigerus, Chrysopogan fulvus, Sehima nervosum, Heteropogon contortus* etc..
- Promoting hydroponic fodder production in water scarce region. Resource rich farmers can take to this practice as early adopters.
- Promotion of silage making of surplus green fodder produced during rainy season for feeding during periods of deficit to ensure supply during lean period. This will minimise wastage. There is a need to propagate cultivation of maize for silage making between Rabi-Kharif crops in irrigated area to increase the availability of conserved fodder during lean period. Commercial silage/ hay making can also be promoted to help in increasing farm income of large farmers.
- Strengthening fodder seed production, processing & marketing chain by involving various stakeholders like NSC, SSC, agriculture department, dairy cooperatives and private sector. There is huge shortage of quality fodder seed in the country, a critical input to increase the green fodder yield. Sizeable quantity of fodder seed of berseem is being imported in the country. States should develop a system to estimate crop wise/ variety wise fodder seed requirement well in advance and their production arrangement with different seed production agencies. Enhancing production of fodder seeds in the country will help in increasing the income of seed growers participating in the programme upto 10-20 per cent as compared to grains. Further, timely supply of quality fodder seed will help in enhancing

the green fodder productivity leading to lowering of the feeding cost and in turn higher profit in milk production.

Increasing production of prepared cattle feed: Among three types of animal feed, viz, dry fodder, green fodder and concentrates, the major shortage is that of concentrates. Generally, dairy farmers use locally available concentrate ingredients ((oil cakes, bran, etc.) to feed their animals depending upon the productivity of the animals. This type of feed does not always provide protein, energy, minerals and vitamins required by the animal. Therefore, the animals either do not produce milk as per their genetic potential or cost of milk production increases due to imbalanced feeding. With greater preference likely to be given in future for maintaining crossbreed cattle and buffaloes with higher production potential, demand for concentrates in the dairy sector is expected to increase considerably from 37.94 million tonnes in 2011-12 to 47.62 million tonnes by 2020, and continue to grow further thereafter.

Prepared cattle feed or Compound Cattle Feed (CCF) is a commercially available technological option for providing nutritionally balanced diet to the dairy animals and enhancing their productivity. It is a scientifically balanced mixture of different concentrate ingredients of feed in suitable proportion. For milch animals, CCF is palatable and good source of nutrients. Feeding the milch animals with a prescribed quantity of compound cattle feed along with basal diet should not only optimize the milk productivity of animal but also increase net profitability of dairy farmers. It is available in the market mostly in the form of pellet and mash. Some manufacturing units had also begun experimenting with another form of cattle feed, viz. "chips" which is a pressed large piece of compound cattle feed. The demand for animal protein and dairy products in India will increase the compound feed consumption volumes to 35.4 million tonnes by 2019-20 and higher thereafter.

Different forms of cattle feed produced in India

a) Pellet

b) Mash

c) Chips

In sum, the dry matter as well as nutritional requirement of animals can be met by focussing on supply of balanced cattle feed to animals.

A comprehensive study[3] to analyse the compound cattle feed industry in Punjab, Haryana, West Bengal and Odisha was carried out in 2016. On the basis of this analysis, the key interventions

[3] Sirohi et al. (2016).

for upgradation, management and development of the cattle feed value chain in the country are as follows:

- Revisiting the export policy on maize, oilseeds/cakes & molasses from time to time, and rationalizing the taxes, duties and levies imposed on various feed ingredients and additives for ensuring regular supply of raw material and the supplements at reasonable prices.
- Strengthening the R&D component of the cattle feed, especially through the application of bio-technology in feed compounding and the use of non-conventional feed resources in manufactured feed. The declining trend in total factor productivity observed in recent period also makes it imperative, that further scientific developments in feed manufacturing technology will ensure higher gains per rupee of cost incurred accrue to the suppliers and users of compound animal feed.
- Take up of compound feed production by the feed mills catering to the nutritional requirement of animals of different productive potential using market segmentation and targeting techniques.
- Linking small holders to feed value chain through capacity building interventions. Systematic and planned interventions are required for creating awareness among the producers and farmers about sound animal nutrition practices, quality and safety.
- Developing skill of producers, better quality control services, risk coverage mechanism and finance to strengthen service needs of the feed value chain.

Bypass protein and fat supplements: Dairy animals have four compartments in its stomach. The first and the foremost is 'rumen' where most of the feed items are degraded. Around 60 to 70 per cent of dietary protein meals fed to animals are degraded into ammonia in the rumen. A significant part of this ammonia is excreted through urine in the form of urea. Thus, a large portion of protein from expensive cakes/ meals is wasted. If suitable treatment is given to dietary protein meals, degradation in the rumen can be minimized. This process or treatment to protect dietary protein from degradation in rumen is known as bypass protein technology. These protected meals are digested more efficiently in the small intestine and result in extra protein being available for milk production. This helps the animal to produce more milk and of optimum quality.

Locally available protein meals such as rapeseed meal, sunflower meal, groundnut meal, guar meal and soybean meal can be treated suitably to reduce their degradability in the rumen from the range of 60-70 per cent to 25-30 per cent, in a specially designed airtight plant. Treated protein meal can be either fed directly to animals as top feed @ one kg per animal per day or incorporated in cattle feed @ 25 per cent and this cattle feed can be fed @ 4-5 kg per animal per day, depending upon the level of milk production. The cost of treatment of protein meals is Rs. 2.5 to 3.0 per kg but considering the resultant increase in milk yield, it is cost effective.

The post-partum energy requirement of high yielding animals is very high. Under field conditions, animals often shed around 80-100 kg of body weight after calving. This leads to delayed conception in animals after calving, resulting into longer inert-calving intervals. Such animals produce less milk during this period, and hence the decreased lactation yield. At this stage of lactation, farmers usually supplement their animals with oil or ghee. But this is not economical and also hampers fiber digestion in rumen.

Feeding bypass fat supplement to high yielders during advance pregnancy and early lactation helps in minimizing the energy deficiency. This in turn would help in improving milk production and reproduction. Use of the bypass fat should be included in the ration of dairy animals for 10 days before and 90 days after calving. It can be supplemented in the ration of dairy animals @ 15-20 g per kg milk production or 100 -150 g per animal per day.

The availability of bypass protein and fat supplements may be ensured by following interventions:

- Establishing production capacity
- Adopting formal channel for timely supply of bypass protein and fat supplement to farmers at affordable price.
- Conducting awareness programmes to popularize feeding of these supplements to animals.

Importance of bypass protein supply

- Cheaper source of protein for animals
- Enhances milk yield
- Easy way to meet requirement of high yielding animals
- Improves Fat and SNF percentage
- Better growth in young animals
- Reproduction efficiency increases
- Improved immunity and resistance to diseases.

Importance of bypass fat

- Enhances peak milk production and persistency of lactation.
- Increase reproductive efficiency after calving
- Decreases metabolic disorders such as ketosis, acidosis & milk fever.
- Increases productive life and productivity of animals

6.3.2. Addressing poor nutritional quality of feed

Crop residues such as rice and wheat straw and sorghum stover, represent the largest component of animal feed but tend to be low in nutritive value and hence cannot on their own support high levels of production. Continuous mining of nutrients from the soil and application of fertilizers in a large scale has made the soil deficient in vital minerals. As against the prevalence of deficiency of one or two nutrients including nitrogen in the 1960s, today the soil is deficient in more than 15 nutrients. This is a challenge to both crop productivity and nutrient status of food and fodder grown in such a soil environment. Livestock production in particular is imparted by the status of micro-nutrients in the feed.

Enriching crop residues: Research and developmental initiatives are required to enrich crop residues. There are a number of biotechnologies which use microorganisms to 'bio-process' feeds and fodder with a view to improving nutritional quality, including digestibility. Important feed ingredients for dairy cattle can be nutritionally enhanced through genetic manipulation. Specifically, marker-based technologies can be used to understand the genetic diversity in forages and in other crops; the technology also has potential use in field crops in ways that ensure that food yields and qualities are preserved or enhanced while at the same time improving the feed attributes.

Quality control norms for feed and feed supplements: In India, fodder and feed are not included in the Schedule under the Essential Commodity Act, 1955, and hence, the possibility of monitoring the quality of feeds available in the market can at the best be done using the provisions under the 'Consumer Protection Act, 1986', and 'The Bureau of Indian Standards Act', 1986. Under the relevant sections of the Consumer Protection Act, if any livestock feed/fish feed being sold in the market is found to be deficient with reference to the prescribed BIS standard for the said feed, then it **may be** examined if there is any violation of the above refereed sections. Under the Bureau of Indian Standards Act, 1986, although it is illegal to use Standard mark without conforming to the standards, but it is not mandatory for the product to conform to the BIS standards. Hence, under such weak regulatory mechanism, the manufacturer not using the BIS mark is clearly out of the purview of both the Acts. As for the one who is using the mark, first of all, the customer awareness about complaint mechanism for unsatisfactory goods is very weak and secondly, even if a complaint to this effect is filed, in absence of a streamlined mechanism of testing it would be very cumbersome to prove the defect. Thus, all that could be done for quality assurance and safety of compound cattle feed by the Department of Animal Husbandry, Dairying and Fisheries, Government of India was to issue an advisory as follows to the various State governments:

> "*The State Governments may designate officials with the Animal Husbandry Departments and/ or the Milk Cooperatives for regular collection of samples of branded feed being sold in the market, get the samples sealed in a transparent manner, and send the samples for testing against relevant BIS Standards. In case of any deviation from the standards, a designated official may inform the competent authority to initiate appropriate legal action in addition to making the farmers aware of the deficiency in the feeds through extension officials and advertisement / circulars, etc., and a copy of such circular be also sent to DADF. The concerned manufacturer / supplier may also be informed*." F. No. 2-35/2009/AHT/FF, Dated 24.01.2013.

The quality of prepared feed is the most important parameter that has far reaching implications, for the productivity of the animals and economics of milk production, as also for human and livestock health. Poor quality of feed ingredients of low nutritive value and/or various types of adulterants such as, groundnut husk, ground rice husk, nonedible oil cakes, maize cobs, saw dust, marble powder, sand, limestone, etc. are used in the manufactured cattle feed because of which the benefits to the farmers are not realized and shakes their confidence in more intense adoption of the product. Additionally, the improper storage and hot and humid weather conditions may lead to contamination of feedstuffs with mycotoxins. The physical or apparent effects of mycotoxin range from reduced feed intake and poor conversion ration to a general inability of an animal to thrive. The problem of mycotoxin does not, however, end in feed or in reduced animal performance, for many are actually transferred into the milk and hence, are hazardous for human health. As regards governance of laid out standards in the country, the

BIS standards prescribe that, the marking on the cattle feed bag should indicate the Aflatoxin B1 content along with providing other information such as crude protein and fibre content, soluble ash content, etc. However, in practice a lot of deviation from this practice is seen even while using the BIS Standard mark, particularly in northern & eastern India. The need of the hour is to establish a tracking and tracing system along the feed supply chain, with provision for tough BIS standards for animal feed to ensure feed quality and safety. In this direction useful learning experience can be picked up from the Chinese experience, where the inspection and monitoring of feed quality and safety is guided by a regulation titled "General Practices for the Monitoring of Feed Quality and Safety," 2010. The Department of Animal Husbandry may find it useful to adopt such a piece of law.

Area Specific Mineral Mixture (ASMM): Under Indian condition, mineral deficiencies in feed and fodder are quite common. For instance, in Haryana, the status of Zn and Cu deficiency in berseem fodder is 53.0 and 27.45 per cent; in wheat straw it is 43.7-78.9; Cu deficiency in paddy straw is 21-35.75 per cent; Zn deficiency in concentrate is 7.1-45.8 per cent; and Cu deficiency in concentrate is 10-44.4 per cent. Deficiency in the ration of animal impairs metabolic functions, which affects the growth, milk production and reproduction efficiency in dairy animals. Quality mineral mixtures is necessary to improve the productivity of milch animals and semen production performance in dairy bulls. Currently only a few agencies are producing area specific mineral mixture and the quantity is not sufficient. Availability of ASMM to farmers may be ensured with following interventions:

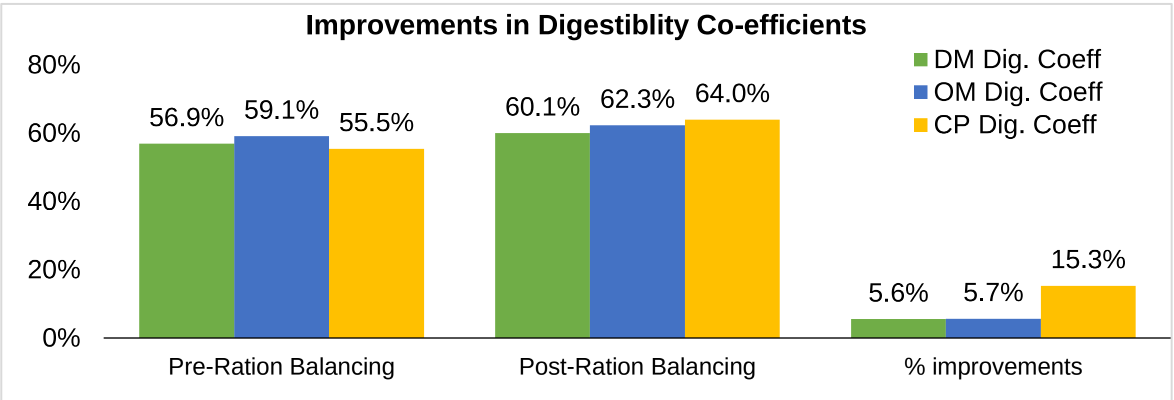
- Enhance ASMM production capacity by providing necessary infrastructure and other facilities. The NDDB has carried out mineral mapping for various states/region and accordingly ASMM formulations have been developed and information is available at NDDB website. This may be used for establishment of production capacity of area specific mineral mixtures and promoting use of trace minerals (50 per cent of the total requirement) in the form of chelates. The National Dairy Research Institute (NDRI) has also developed mineral mixture for lactating animals, including major and micro minerals, newer trace minerals for northern India. Degcure mixture for control of Degnala disease in ruminants especially rice straw fed animals, anionic mineral mixture for reducing post-partum problems in cattle and buffaloes have also been developed and commercialized to different companies.
- Adopting formal channel for timely supply of ASMM at affordable price.
- Awareness programme for farmers on benefits of feeding ASMM to animals.

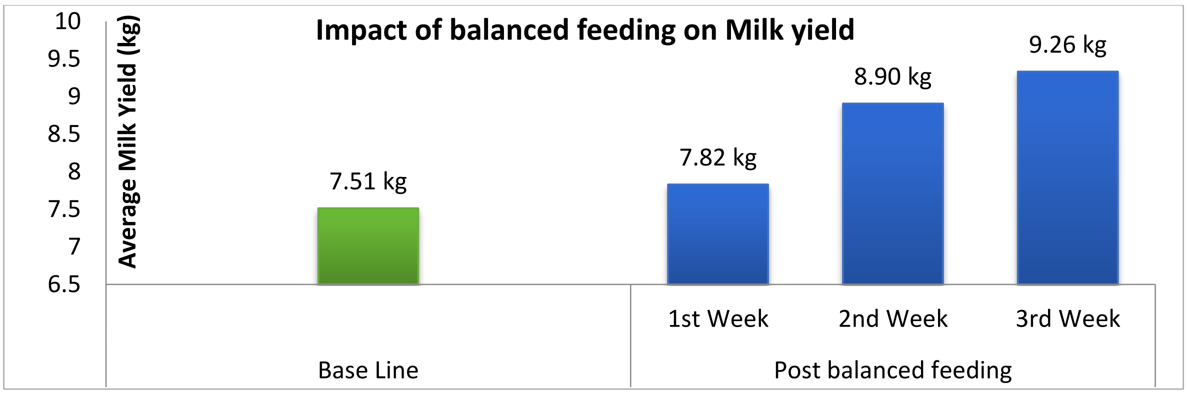
6.4. Promoting Balanced Feeding and Supplementation

Imbalanced feeding practice adversely affects the productivity and health status of animals. It hampers the growth of young animals delaying the age at first calving. The duration of lactation length and productive life of cows is shortened for want of adequate nutrition. The deterioration in the productive and reproductive performance of the animals is detrimental to the economy of the dairy farmers. While under-feeding restricts production and is detrimental for the health of animal, over-feeding increases feed cost and again cause adverse health effects. Expenditure on feed and fodder accounts for 60-70 per cent of the total cost of milk production. The productivity of feed input is inversely related to the cost of milk production. Field study in the semi-arid region of Rajasthan showed that an improvement in feed input productivity (defined as milk output per kg. dry matter intake) by 12 per cent decreased the cost of milk production by 18 per cent in case of crossbred cows. The above issues could be handled through adopting the balanced feeding as per physiological stage and production level of animals.

Upscaling ration balancing program: Ration balancing program that has been implemented under NDP-I. The objective is to produce an optimum quantity of milk at the least cost from milch animals by readjusting the proportion of locally available feed ingredients, so as to provide them adequate amount of protein, minerals vitamins as well as energy needs. The initiative needs to be up-scaled to reach out to all the dairy farmers of the country. Empirical evidence strongly suggests feeding balanced ration for increased animal intake of DM (kg/d) and ME (Mcal/d) by 27.1 per cent and 26.45 per cent, respectively. The intake of calcium and phosphorus improved by 51.35 and 56.41 per cent, respectively. Significant improvement ($P<0.01$) in milk yield (kg/d) and 4 per cent FCM yield (kg/d) was observed post balancing. Milk yield recorded an improvement of 17.97 per cent to the baseline value, it had improved at the rate of 64g/animal/day. 4 per cent FCM yield improved by 61.12 per cent (from 6.20±0.20 kg/day to 9.99 ± 0.32 kg/day).

Figure 6.1 Effect of Ration Balancing on Feed Digestibility and Animal Production





(Based on Ration Balancing intervention in Muzzafarnagar Distict of Western U.P.)

Potential of Ration Balancing to Double Farmers' Income

The simple back-of-the-envelope calculations have shown that for the crossbred animals that have milk productivity and costs similar to respective national averages, ration balancing intervention can double the real dairy income (at 2016-17 prices) even with only 5 per cent increase in milk yield and 5 per cent decline in feed cost. However, taking the low cost-productivity- milk price scenario, and as the possibility of reducing the feed cost would be limited (5 per cent decline), the milk yield from ration balancing should increase by at least 35 per cent (5.8 kg/day from the existing level of 4.3 kg/day) to realise positive returns from rearing crossbreds. In the case of buffaloes, where potential of yield increase is not as profound as for crossbreds, the ration balancing can be an option for doubling dairy farm income if at least 11 per cent feed cost reduction is achieved with 5 per cent productivity gain in average scenario and 40 per cent gain (4.5 kg/day from 3.1 kg/day) in least-productivity scenario. For the famers rearing crossbreds with average milk productivity of about 7.3 kg/day, this intervention alone has immense potential to enhance net real income form dairy farming. But, in the case of low-producing animals, management of feeding will not suffice to achieve the desired outcome and has to be supplemented by interventions to improve the breeding and reproductive efficiency of the animals. Similarly, on buffalo-dominant farm households, the potential exists for milk yielders of an average of 5.8 kg/day, while for low-producing buffaloes, efforts other than ration balancing would also be required.

Required increase in milk productivity and reduction in feed cost for doubling dairy income from ration balancing

Particulars	Scenario I Low cost-low productivity-low prices		Scenario II Average cost-average productivity-average prices	
	Crossbred cow	Buffalo	Crossbred cow	Buffalo
Daily maintenance cost (Rs./animal)	150	160	200	190
Daily feed cost (Rs./animal)	105	112	130	123
Milk yield (kg./day)	4.3	3.2	7.3	5.8
Farm gate prices of milk (Rs./kg.)	25	32	30	38
Target change in real net income (per cent)	≥ 100	≥ 100	≥ 100	≥ 100
Warranted change in Milk yield (per cent) Daily feed cost (per cent)	 35 (5.8) 5	 40 (4.5) 11	 5 (7.7) 5	 5 (6.1) 11

<u>Note:</u> (i) Cost estimates at 2016-17 prices (ii) Milk yield 2015-16 (iii) Prices 2016-17 (iv) Figures within the parentheses indicate warranted milk yield

Probiotics, prebiotics and synbiotics: Various additives in feed such as enzymes, probiotics, single-cell proteins, etc. are already being used widely in intensive production systems worldwide to improve the nutrient availability and utilization of feeds, and the productivity of livestock. There is need to popularise / create awareness for use of additives for improving nutrient availability.

In case of calves, dietary interventions in the form of probiotics, prebiotics and combination of probiotics and prebiotics (synbiotics) can be very useful for improving calf health. Calf health is a very critical factor affecting the welfare, production and economics of dairy enterprises. The gastrointestinal microbial population in new born calves is in transition and extremely sensitive; hence, sudden changes in diet or environment, disease or other stress can cause alteration in this microbial system. Microbial imbalances might permit the colonization by pathogenic and opportunistic bacteria and the appearance of many different syndromes with deleterious effect on host. Moreover, in calves less than 10-day-old, infection with *E. coli* and other microorganisms commonly cause severe diarrhea which leads to high levels of morbidity and mortality. In older calves, gastrointestinal diseases can determine slower growth and lower average daily weight gain. For several years, antibiotics have been used to prevent disease and promote growth, but the negative effects are becoming increasingly serious. Probiotics, prebiotics and combination of probiotics and prebiotics (synbiotics) came up as good adjuvants to antibiotics. Probiotic are live microorganisms that act beneficially in the host when administered orally; microorganism most widely studied includes *Lactobacill i*species. Prebiotic supplementation may be most effective in times of stress or increased pathogen exposure throughout the calf's lifetime.

6.5. Interventions for Improvement of Health and Management

Although selecting dairy animals that are suited to the local environment greatly reduces the risks to productivity posed by animal health and welfare problems**,** yet in addition to genetic interventions and providing balanced nutrition to animals, animal health care and management are essential. Animal health plays an important role in harnessing the expected production potential of dairy animals. A diseased animal cannot perform to the expected level. Timely intervention is therefore pivotal in reducing the economic losses due to diseases. Many young animals die of disease before they can lactate or reproduce. This lowers the yield and farm income, increases environmental impacts and decreases farmers' ability to select the best breeding stock**.** A large gap exists between the need and the availability of cow side-animals health service providers. As a result of this, most farmers resort to cheaper alternatives like engaging quacks, other untrained personnel or self-medication, which may, many a time, do more harm than providing a cure. The desired interventions for better health, disease control and management of dairy animals are discussed below.

6.5.1. Preventive health care management program

Strong immunity, which refers to the power to resist infection, whether natural (innate) or acquired (as by vaccination) is crucial to maintain health in animal production. Here multiple tiers of pathogens are continually challenging the health, welfare and productivity of the animals. Prevention of disease requires a multi-dimensional and holistic programme that takes into account factors ranging from pathogen exposure level on the farm to optimized animal immunity. There are two broad categories of activities under preventive health care program— (i) control and immunization against endemic diseases and (ii) disease diagnosis and surveillance. Preventive health care infrastructure and services are underfunded in India. Of the total number of veterinarian and para-veterinary staff (stock assistants and technicians) working in the livestock health institutions across the country, less than 5 per cent are engaged in disease investigation and control. Some of the key elements of preventive health care program in the country include:

- Mass vaccination of animals needs to be organised in campaign mode at village level for most common diseases like FMD, HS, Thcileriosis, Brucellosis etc., so that maximum number of animals are covered under health care management programs within a short span of time.
- Worm infection in animals causes significant losses to the farmers. Tapeworms, flukes, roundworms, and other internal parasites leave hazardous effects on cattle's overall health. A regular deworming schedule can control significant parasitic infections. Deworming of animals at a mass level would serve to reduce the egg load of parasites in the environment significantly, and reduce the chances of re-infection.
- Ticks and other blood sucking parasites are a major source of discomfort to the animals which seriously affect their productivity. They also act as vector for serious diseases like babesiosis, anaplasmosis, theileriosis and trypanosomiasis. They are also a source of newly emerging highly fatal zoonotic diseases like Crimean Congo Haemorrhagic Fever (CCHF). There is need for cost effective tick control program.
- After FMD, mastitis is one of the biggest challenges faced by the dairy farmers. Mastitis infection causes reduced milk yield in animals and entails high cost of treatment, which greatly affects the income of farmer. About 85 per cent of the milch animals are owned by marginal and landless farmers who do not have the resources to treat their animals. It is imperative that cost effective and farmer friendly mastitis control prevention programs are propagated on large scale, basically aimed at a three-pronged strategy of detection and control of sub-clinical mastitis, rationalising usage of antibiotics through use of alternate medicine systems like ethno-veterinary medicine and management of chronically infected animals which are usually the source of infection to healthy animals.

6.5.2. Disease reporting, surveillance and diagnosis

Both under-reporting and lack of reporting of diseases is very common in case of livestock. In most cases, disease reports are based on clinical symptoms and subjective assessment, lacking laboratory confirmation. Disease outbreak reports are consolidated manually at the block, district, and state levels, causing dilution of lots of the information at every stage of consolidation and transmission; and vital detailed information is often permanently lost. The information flowing through the system is incomplete, and lacks information inputs from non-government agencies, private practitioners, and universities. There is little or no cohesiveness in handling livestock diseases as a national phenomenon and each state acts with little interaction with its neighbours. There is an ardent need to take the following measures in this direction:

- Conduct organised national surveys of endemic diseases to properly assess incidence and prevalence.

- An ICT based network for epidemiological surveillance including reporting of diseases incidence, diagnosis and treatment needs to be put in place integrating different stakeholders and service providers associated with animal health activities.
- Strict implementation of "The Prevention and Control of Infectious and Contagious Diseases in Animals Act, 2009" by strengthening of check posts and real time update on the incidence of animal diseases. This would be very important so as to check the spread of the diseases from one region to another. Quarantine stations need to be established particularly at interstate borders.
- Enhancing the accuracy of disease diagnosis by providing diagnostic kits and trained manpower at least at taluk level.

6.5.3. Strengthening Infrastructure and Services for Curative Health Care

In case of curative health care services, the quality of service delivery is an important constraint. Despite a vast institutional network both at the central and state level, the animal health service delivery system is facing many difficulties. The government continues to be the primary provider of veterinary services, but current budgetary resources cover mainly the salaries and benefits of full-time staff in a vast network of veterinary dispensaries, hospitals, first aid centres leaving few funds for other recurrent needs—such as, drugs and veterinary supplies. New approaches are necessary to rationalize and reform the animal health sector:

- Government should consider devolving the responsibility of delivering curative veterinary services to the private and other providers (cooperatives, NGOs, etc.). Curative services are private goods that can be delivered much more efficiently by non-state actors. The government should focus its efforts on providing the public goods—such as disease surveillance and monitoring, regulation, and creating an enabling environment for private sector and other players to participate.
- There is evidence that livestock producers, are willing to pay for quality services, so there is an objective basis for cost recovery or private provision of such services alongside government and other providers, such as NGOs and cooperatives.
- Complete privatization of government service delivery in the immediate future may not be feasible, especially in relatively remote and marginal areas. Even in these areas, however, the government need not be the only or the dominant player. It will be desirable to work with non-government organizations and other stakeholders for sensitizing the poor communities towards creating the demand for these services, training community-based health workers for minor treatments, providing drugs and supplies on cost in areas where the private distribution network is weak, providing extension advice related to animal husbandry including feeding practices and shelter innovations, etc.
- Given the current concentration of government veterinary centres in relatively better-off areas, reducing government presence in curative service delivery in these areas can release significant resources for transfer of focus on marginal areas.

6.5.4. Fertility management

Normally an animal with a healthy reproductive function should calve every 12-14 months. Infertility causes economic losses to the farmers due to delay in maturity, calving and milk production. The farmer also incurs losses by maintaining an unproductive animal.

Infertility may be due to various reasons like diseases of genital organs, infectious diseases, physiological causes (absence of heat, repeated breeding, silent heat cystic ovary, etc.), anatomical causes, faulty AI technique etc. Some important interventions for fertility management other than the ones pertaining to improvement in the general health and nutrition status of animals are:

> **Importance of Timely Heat Detection**
>
> Timely heat detection is essential for getting one calf per year. Every missed heat is directly related to increased service period which in turn leads to longer inter-calving interval. A dairy farmer incurs an economic loss of about Rs.5,000/animal for each missed heat. A cow wrongly detected in heat and inseminated also leads to loss in terms of wasteful expenditure. In case of buffaloes, chances of missing heat are high in summer months. So, buffaloes require extra attention as compared to cattle regarding heat detection.

- Training the farmers and stockmen for timely heat detection. Also, sensor technology and biomarkers for estrus detection developed in research institutions need to be made available at the field.
- Developing the cost-effective heat-sync protocols for application at the field level.
- Reducing the gap between demand and availability of male germplasm.
- Intensified research efforts for development of technology and package of practices for early detection of heat, enhance accuracy of insemination, early pregnancy diagnosis, controlling embryonic and calf mortality.

6.5.5. Propagating scientific dairy farming practices

A herd management program is a combination of sound management, good housing, balanced nutrition, robust bio-security and proactive health measures. Animal management is quiet essential in optimizing milk production. There are several aspects of scientific dairy farming practices encompassing housing, nutrition, calf management, health care, stress management, clean milk production practices etc., the information on which needs to be disseminated among the farmers.

The package of practices based on regional agro-climatic factors and breed type need to be developed. The possible channels of delivery mechanisms of such information is discussed in later section on Extension and ICT approaches.

6.6. Extension and ICT Interventions

Training and extension activities play an important role in dissemination and upgradation of knowledge through technological empowerment and improving the farmers' awareness which in turn empowers them to improve approach towards an economic activity. Extension programmes motivate people at field level to participate actively and put efforts in right direction by efficiently utilizing resources.

Effective delivery of extension services is critical to achieve higher milk productivity. Currently, less than 1 per cent of the total plan budget for the animal husbandry sector is allocated for extension activities. Some of the desired interventions required in the field of extension are:

- A team comprising experts/professionals can be formed at village level for providing dairy extension services. The team may help in imparting good dairy practices among dairy farmers and in providing assistance to the problems like diseases, feeding, processing, and marketing and in overall management of dairy farm.
- Peer to peer learning among dairy farmers can be effective tool for disseminating best practices of dairying. There are many progressive farmers who can be resource persons and can be equipped with Micro Training Centres. MTC aims at creating centres of learning locally to demonstrate scientific dairy practices through cross learning. It will be especially very useful for the women who find it challenging to travel long distance for trainings.
- Dedicated training centres for Animal Husbandry activities (Pashu Vigyan Kendra) in the pattern of Krishi Vigyan Kendra can be initiated for promoting economically viable dairy (20-30 animals) farms . These centres may demonstrate and train the farmers with hands on experience in managing the farm with minimum investment on fixed infrastructure. This intervention may attract rural youths
- Collaborative and innovative dairy farming models have a critical role to play. Models like large scale dairy farms with ownership of cattle remaining with the farmers, model where large scale dairy farm is the hub & satellite farms are spokes, medium scale dairy farms with anchor processors, community dairy farms with 'cow hostel' models are some innovations which may give dairy farming system the required scale and at the same time integrate the small and medium dairy farmers. Public- private partnership (PPP) models need to be developed for the areas which are yet to be sufficiently attractive for private investments.
- On the model of ASHA worker in health sector, the concept of 'Pashu Sakhi' can be promoted. Locally selected and trained resources can serve as the first point of service providers in the animal health chain. Pashu Sakhis, can be trained to provide preventive health services including vaccination initiatives. They can be connected with Veterinary Dispensaries/Clinics at sub-Taluk level/GP level and further up the hierarchy with Taluk level Veterinary Hospital.
- Effective use of many communication aids in dissemination of knowledge may help dairy farmers in creating awareness for scientific dairying. Possible use of media for dissemination are shown below.

Information and Communication Technologies (ICTs) play an important role in improving dairy farmers' production systems. By fulfilling information needs of the farmers, it is possible to increase the production, profitability with the responsibility of protecting human health, animal health, animal welfare and the environment. Some key ICT interventions are:

INAPH

Information Network for Animal Productivity & Health a Desktop/ Netbook / Android (RBP Only) based Field IT Application developed by NDDB facilitates the capturing of real time reliable data on Breeding, Nutrition and Health Services delivered at Farmer's Doorstep.

- A common ICT platform should be used for effective monitoring of Animal Health and Artificial Insemination activities.
- Use of ICT to produce insights about cattle health, matching bulls to bring about genetic improvement, and even milk production forecasting. The potential of using software and genomics is immense in India's fragmented milk farming sector.
- lCT can play a pivotal role in bringing large chunk of small-holder farmers who do not have direct access to basic financial services including insurance, under the ambit of financial services. Each of the farmers may be assigned a single account where all the transactions pertaining to payments, financial services, insurance etc. can be monitored through a single platform. This will also enable the government to keep a track of the small scale farmers in order to pass them on the benefits of several important schemes implemented by it.
- Through mobile phones which are some of the key drivers of ICTs, farmers can get customized mobile alerts on various aspects which range from sowing seeds to marketing their agricultural produce. Mobile ICTs can be used to deliver validated livestock production and health knowledge and advice to farmers.

National Dairy Research Institute (NDRI) has developed a web enabled Messaging service portal. This portal is based on software to send the SMS (text and voice) from the computer to the respondent's

- ICTs can help to prevent and reduce losses in dairy sector through well-planned investments and disaster warnings or time sensitive alerts. Water management and disease or pest prevention are crucial to increased productivity. Advances in ICTs such as GPS, GIS, mediation software, mobile phones, and satellite imagery have improved smallholders' ability to adjust dairy strategies and reduce risk. At the same time, these advances allow governments and development partners to better monitor farm productivity, make more accurate projections, and plan better for the future.
- Providing ICT based Decision Support System to facilitate the dairy farmers in making economically rational decisions
- There is need for digitization of milk procurement and payment system ensuring transparent and fair practices in organised sector.

- At the organisation level, use of lCT can be made to manage data thereby increasing operational efficiency
- Use of advanced ICT tools like Dairy Toolbox, INAPH, DRASTIC, etc. need to be popularised among dairy farming community for faster and precise information.

DRASTIC

Dairy rationing system for tropics is a decision support system tool for planning dairy feeding under tropical conditions. It gives information on nutritional quality of available feeds- particularly of the basal ration.

Dairy Toolbox

Developed by ILRI & ICRISAT. It contains simple decision support tools and a broad range of modular information covering dairy-related topics including feeding, breeding, health, general management and economics, that can be easily searched via key-words, accessed and compiled to form customized fact-sheets, or other extension materials, on a wide range of dairy related topics. It gives extension workers the opportunity to produce customized extension materials that meet the real needs of the farmers they serve.

6.7. Recent Institutional Initiatives for Dairy and Animal Husbandry Development

There have been several government initiatives for promoting livestock development in the country for the improvement of production of cattle, goat, sheep, pig and poultry in the country. Schemes and programs are rolled out viz. various agencies of Central and State Governments, Dairy Cooperative Federations, NGOs, corporate houses etc. to support dairy development and animal husbandry in the country. Some of these initiatives are outlined below:

National Livestock Mission: The National Livestock Mission (NLM) commenced from 2014-15 to cover all the activities required to ensure quantitative and qualitative improvement in livestock production systems and capacity building of all stakeholders. This Mission is formulated with the objective of sustainable development of livestock sector, focusing on improving availability of quality feed and fodder. This mission is implemented in all the states including the Himalayan state of Sikkim. **The Mission has four sub-missions; namely, Fodder and Feed Development, Livestock Development, Pig Development in North-Eastern Region and Skill Development, Technology Transfer and Extension**.

The second sub-mission on Livestock Development has provisions for productivity enhancement, entrepreneurship development and employment generation (bankable projects), strengthening of infrastructure of state farms with respect to modernisation, automation and bio-security, conservation of threatened breeds, minor livestock development, rural slaughter houses, fallen animals and livestock insurance.

National Programme for Bovine Breeding and Dairy Development (NPBBD) has been initiated in February 2014 by merging four ongoing schemes of the Department of Animal Husbandry, Dairying and Fisheries in the dairy sector, viz., National Project for Cattle and Buffalo Breeding (NPCBB), Intensive Dairy Development Programme (IDDP), Strengthening Infrastructure for Quality & Clean Milk Production (SIQ & CMP) and Assistance to Cooperatives (A-C). This has been done with a view to integrating milk production and dairying activities in a scientific and holistic manner, so as to attain higher levels of milk production and productivity, to meet the increasing demand for milk in the country. The Scheme has two components (a) National Programme for Bovine Breeding (NPBB) and (b) National Programme for Dairy Development (NPDD).

The scheme in implementation emphasis on arranging quality Artificial Insemination services at farmers' doorstep; to bring all breedable females under organised breeding through Artificial Insemination or natural service using germplasm of high genetic merits; to conserve, develop and proliferate selected indigenous bovine breeds of high socio-economic importance; to provide quality breeding inputs in breeding tracts of important indigenous breeds so as to prevent the breeds from deterioration and extinction.

Govt. of India's Rashtriya Gokul Mission (RGM) is a focussed project under National Programme for Bovine Breeding and Dairy Development, and had an outlay of Rs 500 crore for three years from 2014-15 to 2016-17. The Mission also envisages establishment of integrated cattle development centres, Gokul Grams to develop indigenous breeds including upto 40 per cent nondescript breeds. It is implemented through State Implementing Agencies (SIA) viz. Livestock Development Boards. The allocation for the Mission for the period 2017-18 to 2019-20 is Rs.1012.5 crore.

National Mission on Bovine Productivity: Government of India rolled out National Mission on Bovine Productivity scheme in November 2016 with the objective to enhance milk production and productivity of indigenous bovine breeds and thereby making animal husbandry more remunerative to the farmers. The scheme comprises following components.

- **Pashu Sanjivini:** Pashu Sanjivini is an animal wellness programme; encompassing provision of animal health cards (**'Nakul Swasthya Patra'**) along with an unique identification number (UID) for animals in milk and uploading data base. Under the scheme, as may as 9 crore number of animals in milk are being identified by assigning UID and further the data is being uploaded in the INAPH database. The Health card contains information on vaccination, deworming and treatment details.
- **Advanced Reproductive Technology:** Assisated Reproductive Technique is being used to improve availibility of disease free indigenous female bovines through sex sorted technology. The scheme envisages creation of facility for productio of 16 million doses annually. Under the scheme, 50 embryo transrfer technology labs with *In Vitro*

Fertlization capacity are being established for exponential multiplication of elite animals of indigeneous breeds.

- **E Pashuhaat:** E Pashuhaat is a portal developed for connecting breeders and farmers of indigeneous breeds regarding availibility of quality bovine germplasm. The farmners/breeders may sell or purchase ther breeding stock through the portal.
- **National Bovine Genomic Centre:** National Bovine Genomic Centre has been established with the objective to increase milk production and productivity of indigenous cattle. By using genomic selection indigenous bovine breeds can be made viable within few generations.

National Dairy Plan Phase I is a Central Sector Scheme being implemented by the National Dairy Development Board (NDDB) through End Implementing Agencies (EIA) for a period of 2011-12 to 2018-19. NDP I is a scientifically planned multi-state initiative. Its various components are:

- **Productivity Enhancement:** This component aims at increasing bovine productivity through a scientific approach to animal breeding and nutrition. The expected results from the interventions proposed under this Component are many increased milk production through increased productivity per milk animal, increase in number of in-milk animals, improved AI conception rates, improved animal nutrition, reduction in feeding costs per Kg of milk produced and reduction in methane release per Kg of milk produced by animals covered under Ration Balancing Program (RBP).

- **Village based Milk Procurement Systems:** Efforts to increase milk production through increase in productivity would need to be supported by expanding the network of village based milk procurement systems to collect milk in a fair and transparent manner and ensure timely payments. Investments in village level infrastructure for milk collection and bulking such as milk cans, bulk milk coolers for a cluster of villages, associated weighing and testing equipment and related IT equipment would be made. The important expected results from the interventions proposed under this initiative are an increase in the number of additional villages covered and more milk producers organised into Dairy Cooperative Societies and Milk Producer Institutions. The organised sector is still small and needs to grow in the interest of farmers.

- **Project Management and Learning:** The main results expected under this component are effective coordination of project activities among various EIAs, timely preparation and implementation of annual plans, regular review and reporting of project progress and results, a comprehensive and functional project management information system (MIS) and learning that will support improvement and innovation. Importantly, it will also facilitate the development of the skills and knowledge of personnel involved in the implementation of the project and develops capabilities for enhanced capacity building which would extend beyond the life of the project.

Dairy Entrepreneurship Development Scheme: The Department of Animal Husbandry, Dairying and Fisheries (DAHD&F), GoI launched a pilot scheme titled "Venture Capital Scheme for Dairy and Poultry" in the year 2005-06. The main objective of the scheme was to extend assistance for setting up small dairy farms and other components to bring structural changes in the dairy sector. During a mid-term evaluation of the scheme, certain recommendations were made to accelerate the pace of implementation of the scheme.

Taking into account the recommendations of the evaluation study and the representations received from various quarters including the farmers, state governments and banks, DAHD&F decided to make some key changes to the scheme, including changing its name to Dairy Entrepreneurship Development Scheme (DEDS). The revised scheme has come into operation with effect from 1 September 2010. The objectives of the scheme are to promote setting up of modern dairy farms for production of clean milk, to encourage heifer calf rearing, thereby conserving good breeding stock, to bring structural changes in the unorganised sector so that initial processing of milk can be taken up at the village level itself, to upgrade the quality and traditional technology to handle milk on a commercial scale and to generate self-employment and provide infrastructure mainly for unorganised sector. Farmers, individual entrepreneurs, NGOs, companies, groups of organised and unorganised sectors, etc. Groups of organised sector include Self-help Groups (SHGs), dairy cooperative societies, milk unions, milk federations, etc. and they can take advantage of this scheme.

Dairy Processing & Infrastructure Development Fund: Government of India has approved creation of 'Dairy Processing & Infrastructure Development Fund (DIDF)' under Central Sector Scheme in December 2017. The DIDF with a total investment outlay of Rs. 10,881 crore comprising Rs. 8004 crore as a loan from National Bank for Agriculture and Rural Development (NABARD), Rs. 2001 crore as End Borrower's contribution, Rs. 864 crore as GoI's Interest Subvention and Rs. 12 crore by National Dairy Development Board (NDDB) and National Cooperative Development Corporation (NCDC), on *pro rata* basis towards Project Management & Learning. Funding will be in the form of interest bearing loan, which will flow from NABARD to NDDB/NCDC and in turn to eligible End Borrowers. The components of the scheme are:

- Modernisation & creation of new milk processing facilities
- Manufacturing facilities for value added products
- Milk Chilling infrastructure
- Setting up electronic milk testing equipment
- Project management and learning
- Any other activity related to the dairy sector targeted to contribute to the objectives of DIDF, as decided by Government of India in consultation with the stakeholders.

Scheme for establishment of Hi-Tech & Mini Dairy Units: This scheme was approved by the State of Haryana in its Budget for the year 2017-18 providing a sum of Rs. 10.00 crore. Haryana state is proud to be the home-tract of one of the best buffalo breeds of the world i.e. 'Murrah'. Buffalo has also been recognized to be the animal of the 21st Century and thus, systematic improvement of buffaloes for milk production of the country is a necessity.

Strategic Productivity Enhancement Programme (SPEP) initiated by Gujarat Cooperative Milk Marketing Federation (GCMMF) has been designed with an aim to develop a genetically improved animal with high productivity. It initiates with the selection of elite animals, to develop pure bred cows and buffaloes with high genetic potential by adopting Pure Breeding Programme. This programme comprises three sub programmes which can be implemented across India with certain objectives like registration of all animals covered under AI, upgradation and improving productivity of state specific cattle and buffalo breeds, elite/ superior animal identification, registration and breeding with high genetic merit semen, milk recording of elite/ superior animals for bull mother farm, genetic up gradation of non-descript animal breeds and calf rearing programme.

GCMMF has already implemented Strategic Calf Rearing Programme with objectives to achieve reduced age at first calving, inter-calving interval and improved productive life of dairy animals. The major activities of Calf rearing programme include village awareness programme, debudding, mass vaccination and deworming, distribution of naval kits/milk replacer / calf starter/cattle feed and mineral mixture etc. and calf rally.

Other initiatives for the genetic improvement of animals include, establishment of Cattle Breeding Farms, National Kamadhenu Breeding Centre, Central Herd Registration Scheme (CHRS) and Central Frozen Semen Production and Training Institute. Seven central cattle breeding farms have been established for production and supply of high genetic merit bulls of indigenous breeds (Tharparkar & Red Sindhi cattle breeds and Murrah and Surti buffalo breeds).

National Kamadhenu Breeding Centers (NKBC) are set up as a Centre of Excellence. A Nucleus Herd of all the Indigenous Bovine Breeds (41 cattle and 13 Buffaloes) will be conserved and developed with the aim of enhancing their productivity and upgrading their genetic makeup. The NKBC will act as repository of germplasm of all indigenous breeds and supply certified germplasm to the farmers undertaking rearing of indigenous breeds. Under the CHRS, four units have been established for identification and propagation of indigenous bovine breeds (Gir, Kankrej, Hariana & Ongole cattle breeds and Murrah, Mehsani, Jaffarabadi and Surti). The Central Frozen Semen Production and Training Institute is undertaking production and supply of semen doses of high genetic merit bulls of indigenous breeds (Red Sindhi, Tharparkar and Murrah buffalo).

In the field of animal nutrition, besides Ration Balancing Program other important initiatives are Mineral Mapping Programme and Quality Mark. The NDDB has done mineral mapping in most of the major dairying states to improve both productivity and productive life; and supplementation of area specific mineral mixture in ration of dairy animals. Also NDDB has initiated implementation of common 'Quality Mark' for various variants of cattle feed and mineral mixtures manufactured in the cooperative, government/semi-governments sector. Currently there are no specific regulations to monitor the quality of cattle feed and mineral mixtures produced and sold in India.

In order to reduce morbidity and mortality, various efforts are made by governments to provide better health care through Policlinics/Veterinary Hospitals, Dispensaries and First Aid Centres including Mobile Veterinary Dispensaries. Animal Quarantine and Certification Service (AQCS) stations are setup to prevent the ingress of dangerous exotic diseases and diseases of National importance into the country through imported livestock and livestock products. Zoonosis and one health policy of WHO are also the components of AQCS.

National Veterinary Biological Products Quality Control Centre has been established at Baghpat, Uttar Pradesh to undertake the quality control and assurance of standard, efficient and safe veterinary biological in India and to act as a nodal institute to recommend licensing of veterinary vaccines in the country with a vision to promote healthy and productive livestock in Indian subcontinent using standard, efficient and safe veterinary biological. One Central and five Regional Disease Diagnostic Laboratories have been setup in the country by GoI in order to provide referral services over and above the 250 existing disease diagnostic laboratories.

The Centre for Animal Disease Research and Diagnosis of Indian Veterinary Research Institute, Izatnagr is functioning as Central Laboratory. National Project on Rinderpest Surveillance and Monitoring system has been set up with the objective of strengthening the veterinary services to maintain required vigil to sustain the country's freedom from Rinderpest and Contagious Bovine Pleuropneumonia infection secured in May, 2006 and May, 2007 respectively. Under the programme, Surveillance of various animal disease including Syndromic diseases with more focus on Contagious Bovine Pleuropneumonia and Bovine Spongiform Encephalopathy are being undertaken in the country to maintain India's freedom status from these diseases. Foot & Mouth Disease Control Program is being implemented to prevent economic losses due to Foot & Mouth Disease and to develop herd immunity in cloven-footed animals.

National Animal Disease Reporting System (NADRS) is a web based Information Technology system developed in order to streamline the system of animal disease reporting from the states/UTs. The main objective of NADRS system is to record and monitor livestock disease situation in the country with a view to initiate preventive and curative action in a timely and speedy manner.

There are several developmental agencies that are operating in some states while in others the outreach is negligible. Funds are received by various agencies for similar activities also. This leads to duplication of efforts. It is suggested to have effective convergence among all the stakeholders. This will translate into synergy of efforts and funds. All the funds/ benefits need to be routed through a single channel to avoid any duplication.

Key Extracts

- The upscaling of ration balancing program is recommended to promote balanced feed including supplementation.
- There is need to popularise / create awareness for use of additives such as probiotics, prebiotics and synbiotics for improving livestock nutrient.
- The R&D across the livestock sector (large ruminants, small ruminants, poultry, etc.), requires to focus on genetic improvements and health care delivery for the animals.
- A series of interventions and programs are underway by the government to strengthen animal nutrition, preventive health care, disease reporting, and fertility management. Appropriate and enhanced use of extension and ICT systems will help result in desired results.
- Disease reporting, surveillance and diagnostic arrangements require to be strengthened.

Chapter 7
Dairy Sector: Strategies & Action Points

The recommended strategies and corresponding actionable points at the state level, categorising according to scope for enhancing productivity of livestock sector are summarised below:

Table 7.1 Regional Strategy Matrix for productivity enhancement of livestock

Regions	States/ UT	Scope for productivity increase in livestock	Activities/ strategies (focus on dairy sector)	Actionable points for production enhancement through productivity gain in dairy sector
Northern Zone	Punjab Haryana	High (5 to 7 per cent)	**Genetic improvement programme and infertility improvement** a. A.I Technology b. Induced lactation in repeat breeder animals **Animal health and physiology** a. Ameliorate summer stress b. Augmentation of productive performance by prilled fat c. Heat sync to right time AI **Feed and fodder and housing management** a. Balance rationing and Green fodder management b. Proper housing **Institutional support and marketing**	i. Establishment of hi-tech Bull mother farm ii. Administration of estrogen and progesterone hormone for 7 days iii. Prilled fat feeding during before parturition lead to more milk production and better conception rate in cow and buffaloes iv. Heat detection in buffaloes and ensures right time insemination v. Mist and fan cooling to ameliorate summer stress (15-20 per cent yield improvement) vi. Molecular Characterization and Identification of Polymorphism in Mastitis Related Genes in Sahiwal, Karan Fries Cattle vii. Establishment of poly clinic at district level viii. Intensive cropping in irrigated region to boost green fodder supply (crop sequences, i.e., Napier x Bajra hybrid + Cowpea – Berseem)

Regions	States/ UT	Scope for productivity increase in livestock	Activities/ strategies (focus on dairy sector)	Actionable points for production enhancement through productivity gain in dairy sector
			a. Promotion of concept of A2 milk b. Linking with market and improving producer share c. Hi-Tech & Mini Dairy Units **Others** a. Explore possibilities for utilization of desi cow urine and dung in more scientific manner	ix. Popularize sorghum variety UPMC-503 (seed rate 60 kg/ha) x. Popularization of Azolla as green fodder xi. Promotion of entrepreneurship in Novel dairy food products and establishment of value chain xii. National Dairy Plan-I: conservation of 6 indigenous breeds of cattle (Gir, Sahiwal, Rathi, Kankrej, Tharparkar and Hariana) and 6 buffalo breeds (Murrah, Mehsani, Jaffarabadi, Nili Ravi, Pandharpuri and Banni) through implementation of progeny testing and pedigree selection programme xiii. Multiplication and Dissemination of Tharparkar Germplasm xiv. Encourage FPO in dairy sector xv. Local desi cow are not economical unless byproducts are utilized for various purposes such as bio-pesticides, Panchagava Ghrita and panchagavya
North Eastern Zone	Arunachal Pradesh Tripura	Very high (7 to 10 per cent)	**National Livestock Mission (NLM)** a. Improving productivity	xvi. National Livestock Mission (NLM) for strengthening of infrastructure of state farms with respect to Modernisation,

Regions	States/ UT	Scope for productivity increase in livestock	Activities/ strategies (focus on dairy sector)	Actionable points for production enhancement through productivity gain in dairy sector
	Assam	High (5 to 7 per cent)	**Breed improvement programme** a. Improvement in local breed through cross breed programme b. Provision of AI at farmers door step **Animal health care** a. Vety. health care centre **Feed and Fodder management** a. Varietal intervention and package of practices **Suitable marketing system** a. Encourage cooperatives and FPO	automation and biosecurity, conservation of threatened breeds, minor livestock development, , fallen animals and livestock insurance xvii. Promotion of Yak and initiation of hybridization with cattle (F1 hybrid) for higher milk yield in West Kamang, Tawang and West Subnsiri district of Arunachal Pradesh and North, West and East Sikkim. xviii. Import of better germ-plasm of yak from Tibet xix. Central Agricultural University may take up crossbreeding programme xx. Appropriate number of Vety health care centre should be established and proper vaccination and deworming measures should be taken up. xxi. Popularization of maize and baby corn (Vivek maize hybrid 23, Vivek maize hybrid 25, HM 4, Hybrid 5, HIM 129, Pusa Extra Early Hybrid 5, Golden Baby, MLY xxii. Cenchrus, Stylo, Napier etc, will meet the fodder requirement. Package of practices should be developed for
	Meghalaya Mizoram Nagaland Sikkim	Low (1 to 3 per cent)		

Regions	States/ UT	Scope for productivity increase in livestock	Activities/ strategies (focus on dairy sector)	Actionable points for production enhancement through productivity gain in dairy sector
				fodder production (tree and grasses) xxiii. Popularization of Azolla as green fodder xxiv. Start-up Village level organization akin to the milk cooperatives and Women based SHG for dairy sector
Eastern Zone	Odisha Bihar	High (5 to 7 per cent)	**Breeding and Animal health and physiology** a. Ameliorate summer stress b. Augmentation of productive performance by prilled fat **Feed and fodder and housing management** a. Balance rationing and Green fodder management b. Proper housing	i. Promotion of improved breed of buffalo and cattle crossbred ii. Administration of estrogen and progesterone hormone for 7 days iii. Prilled fat feeding during before parturition lead to more milk production and better conception rate in cow and buffaloes iv. Popularization of *Azolla* as green fodder v. Suitable fodder cropping patter Maize + Cowpea – Teosinte + Rice bean (2 cuts) – Berseem + Mustard (3 cuts); Para grass + Centrosema pubescens (8-9 cuts/year); Hybrid Napier or Setaria grass inter-planted with Subabul or Common Sesban (Sesbania sesban) (9-10 cuts/year); Sorghum (Co.FS.29) and Cowpea (E.C.-4216, UPC-5286, UPC-9202)
	Jharkhand	Medium (3 to 5 per cent)		
	West Bengal	Low (1 to 3 per cent)		
Central Zone	Madhya Pradesh Chandigarh	High (5 to 7 per cent)	**Genetic improvement programme and**	i. Implementation of progeny testing and pedigree selection programme

Regions	**States/ UT**	**Scope for productivity increase in livestock**	**Activities/ strategies** (focus on dairy sector)	**Actionable points for production enhancement through productivity gain in dairy sector**
			infertility improvement a. A.I Technology in Murrah buffalo b. Induced lactation in repeat breeder animals **Animal health and physiology** a. Ameliorate summer stress b. Augmentation of productive performance by prilled fat c. Heat sync to right time AI **Feed and fodder and housing management** a. Balance rationing and Green fodder management b. Proper housing **Others** a. Promotion of Natural farming and Panchagava Ghrita and panchagavya concepts	ii. AI in buffalo may be popularized on large scale in association with State departments, NGOs and private sector iii. Multiplication and Dissemination of Tharparkar Germplasm iv. Establishment of value chain in dairy sector v. MP Chari + Cowpea (2 cuts) – Maize + Cowpea - Teosinte + Cowpea (2 cuts), and vi. Bajra + Guar (Clusterbean) (two cuts) – Annual Lucerne (6 cuts). • MP Chari + Cowpea (2 cuts) – Maize + Cowpea - Teosinte + Cowpea (2 cuts) vii. Popularize Sorghum dual purpose varieties/hybrid, CVS 15, CVS 13 and CVS 20 (70 tonnes/ha) viii. Popularization of Azolla as green fodder ix. Promotion of Natural farming, based on the farmer level established concepts of Rishi Krishi, Amritpani, Panchgavya Krishi, Dashgavya and Jivamruta
Western Zone	Gujarat Rajasthan	High (5 to 7 per cent)	**Establishment of integrated cattle development centres** a. Fertility improvement **Feed and fodder and housing management**	i. Upgradation of nondescript cattle using elite indigenous breeds like Gir, Sahiwal, Rathi, Deoni, Tharparkar, Red Sindhi ii. Molecular Characterization and Identification of Polymorphism in

Regions	States/ UT	Scope for productivity increase in livestock	Activities/ strategies (focus on dairy sector)	Actionable points for production enhancement through productivity gain in dairy sector
	Maharashtra	Medium (3 to 5 per cent)	a. Balance rationing and Green fodder management b. Proper housing **Others** a. Promotion of Natural farming using Panchagava Ghrita and panchagavya	Mastitis Related Genes in Sahiwal, Karan Fries Cattle iii. Multiplication and Dissemination of Tharparkar Germplasm iv. Building multi-stakeholder platform for conservation of camel in Rajasthan and Gujarat. Campaign for benefits of camel milk and inclusion of camel milk in dairy act v. Improvement in milk yield of Indian goat like Marwari, Mehsana from on an average one kg per day to 2 kg per day through breeding. Since Malarbar/ Tellicherry breed (found in Kerala state) yield is upto 2 kg/day vi. Value addition and functional food from camel and goat milk vii. Crop rotation for fodder availability viii. Bajra + Guar (Cluster bean) (two cuts) – Annual Lucerne (6 cuts); MP Chari + Cowpea (2 cuts) – Maize + Cowpea - Teosinte + Cowpea (2 cuts); Cow pea (var. Co5), Styla crop rich in protein ix. Bajra RHB-121 variety , Raj Bajra Chari-2 for Rajasthan

Regions	States/ UT	Scope for productivity increase in livestock	Activities/ strategies (focus on dairy sector)	Actionable points for production enhancement through productivity gain in dairy sector
				x. Popularize Sorghum dual purpose varieties/hybrid, CVS 15, CVS 13 and CVS 20 (70 tonnes/ha) for Gujarat and Maharashtra xi. Establishment of value chain infrastructure xii. Emphasis on entrepreneurship development programme and FPO xiii. Promotion of Natural farming using Panchagava Ghrita and panchagavya
Southern Zone	Tamil Nadu	Very high (7 to 10 per cent)	**Breeding programme** a. AI facility b. infertility improvement **Feed and fodder and housing management** a. Balance rationing and Green fodder management b. Proper housing	i. Molecular Characterization and Identification of Polymorphism in Mastitis Related Genes in Sahiwal, Karan Fries Cattle ii. AI facility at farmers doorstep iii. Fodder crops sequence: Sorghum + Cowpea (3 cuts) – Maize + Cowpea – Maize + Cowpea.; Sorghum (Co.FS.29, CVS 15, CVS 13 CVS 20) and Cowpea (E.C.-4216, UPC- 5286, UPC-9202); ybrid Napier or Guinea or Setaria grass inter-planted with Lucerne (8-9 cuts) or Hybrid Napier + Subabul / Sesbania (9-11 cuts/year). iv. Cultivation of Azolla for green fodder
	Andhra Pradesh Karnataka Kerala Telangana	Medium (3 to 5 per cent)		

Regions	States/ UT	Scope for productivity increase in livestock	Activities/ strategies (focus on dairy sector)	Actionable points for production enhancement through productivity gain in dairy sector
				v. Establishment of value chain vi. Strengthening Cooperatives and Establishment of FPO
Northern Hill zone	Uttarakhand Jammu & Kashmir	Medium (3 to 5 per cent)	**Breeding programme** a. Improvement in local breed of yak and cattle b. AI facility at farmer doorstep **Feed and Fodder management (acute shortage, 70 per cent)** a. Varietal intervention b. Skill development for silage making **Appropriate Marketing** a. Alternate marketing through FPO **Others** a. Livestock credit and insurance	i. National Livestock Mission (NLM) may be initiated with the objective of breed of cow and buffalo need to be improved considering the geographical and topography of the region and creation of other infrastructure facilities ii. Improvement in yak yield in Chamba, Kinaur and Lahul Spiti district of Himachal Pradesh and Laddak and Kashmir division of J& K through hybridization with local cattle iii. Goat breed Jammunapari, Surti, Beetal and Barbari suitable for milk production may be popularized. iv. For green fodder Vivek maize hybrid 23, Vivek maize hybrid 25; v. Cenchrus, Stylo, Napier etc, will meet the fodder requirement vii. Cultivation of Azolla for green fodder vi. Silage Proper storage of dry fodder vii. Community Fodder Farm/Godown at village level
	Himachal Pradesh	Low (1 to 3 per cent)		

Regions	States/ UT	Scope for productivity increase in livestock	Activities/ strategies (focus on dairy sector)	Actionable points for production enhancement through productivity gain in dairy sector
				viii. Cooperatives are not so strengthened in hill regions and hence FPO in dairy sector should be promoted. ix. Encourage Women entrepreneurship in dairy sector. Functional food products from goat and yak milk should be taken up x. Provision of Soft credit provision for livestock sector

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Small Ruminants Sector

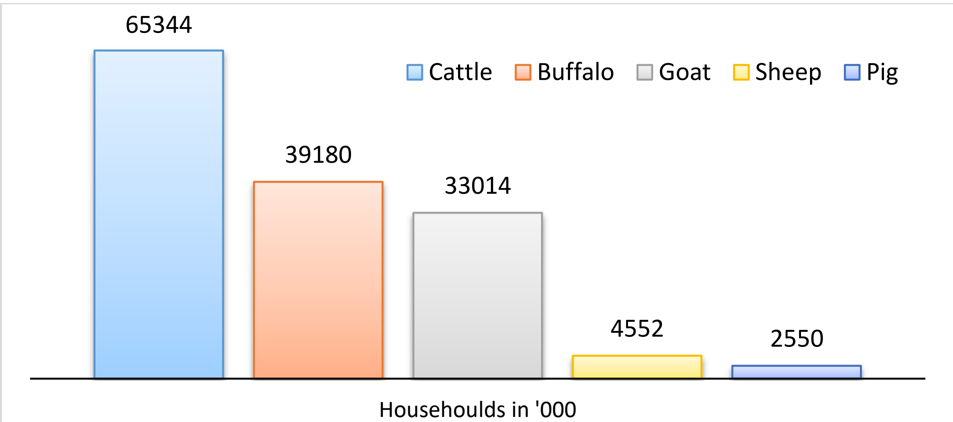
Chapter 8
Small Ruminants – National Scenario

India hosts a range of livestock, other than large ruminants, that are a greater friend of the resource-poor landless rural population and the small & marginal farmers. These include several species namely, goat, sheep, pig and poultry. The status in different states of India, along with the production statistics of milk and meat in livestock; and egg and chicken production in poultry is provided.

Livestock including poultry sector plays an important role in the success story of India's food production. In a predominant agrarian economy like that of India, livestock constitutes a natural capital, which can be more easily reproduced to act as a living bank with their offspring as interest, and an insurance against income shocks of crop failure and natural calamities. These can be relatively more easily traded in the market, when the family is in dire need of money for the family.

The small and marginal farmers, landless labourers and women are more dependent on livestock as a source of supplementary employment and incomes. Therefore, the development of livestock sector is important in the farmers' doubling income strategy. The approach should be enhancing productivity from goats, sheep, pig and poultry with the express intention of contributing to sustained and higher incomes to the farmer.

Figure 8.1 No of household enterprises having cattle, buffalo, sheep, goat & pig



Source: Livestock Census India 2007 and 2012

8.1. Overall Population (sheep, goat, pigs and poultry)

Table 8.1 Status of livestock and percentage change over the period

(In thousands)

Category	Year		Percentage Change
	2007	2012	
Sheep			
Exotic/Crossbred			
• Male	1,144	1,207	5.51
• Female	2,586	2,574	-0.46

Category	Year		Percentage Change
	2007	2012	
Total Exotic/Crossbred	3,730	3,781	1.37
Indigenous			
• Male	16,730	13,916	-16.82
• Female	51,098	47,372	-7.29
Total Indigenous	67,828	61,288	-9.64
Total Sheep	71,558	65,069	-9.07
Goat			
• Male	40,793	37,617	-7.79
• Female	99,744	97,556	-2.19
Total Goat	1,40,537	1,35,173	-3.82
Pigs			
Exotic/Crossbred			
• Male	1,209	1,283	6.12
• Female	1,180	1,174	-0.51
Total Exotic/Crossbred	2.389	2,456	2.80
Indigenous			
• Male	4,134	3,681	-10.96
• Female	4,610	4,156	-9.85
Total Indigenous	8,744	7,837	-10.37
Total Pigs	11,133	10.294	-7.54
Poultry			
• Fowls	6,17,734	6,92,646	12.13
• Ducks	27,643	23,539	-14.85
• Turkeys	3,452	13,025	277.32
Total Poultry	6,48,829	7,29,209	12.39

Source: Livestock Census India, 2007 and 2012

Note: For all three types of livestock (sheep, goat and pigs) the population of exotic breeds is very minimal, and in poultry no exotic breed is available.

8.1.1. Sheep and Goat

Sheep and goat are an important species of livestock for India. They contribute greatly to the agrarian economy, especially in areas where crop and dairy farming are not economical, and play an important role in the livelihood of a large proportion of landless as well as small and marginal farmers.

Table 8.2 Population statistics of sheep & goat

(Figure in millions)

Small ruminants	Population as per 2012 census	No. of livestock holders
Sheep	65	4.55
Goat	135	33.01

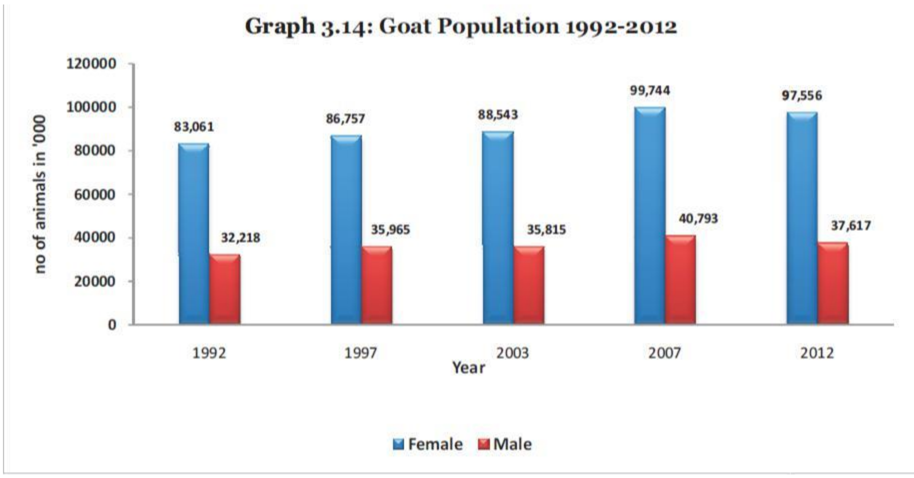
Source: Basic Animal Husbandry Statistics (BAHS) 2014-15.

There is a change of population of (-) 9.07 per cent in sheep and (-) 3.82 per cent in goats during the period 2007 to 2012 livestock census. More so, this decline is (-) 16.82 per cent in case of male indigenous sheep and (-) 7.79 per cent in male goat, which is attributed to more of culling / death of the male animals.

The sharp reduction in the population of small ruminants is a matter of concern. This is attributed to greater demand for meat in the country, compared to the natural reproduction rate from the available animal stock. The long term consequence of this could be shortage of goat and sheep meat which in turn has impact on fulfilling the nutritional requirement of the country's population. A continued shortage of this nature will have adverse impact on prices of meat and then consequential demand for imports which would be detrimental to the goat/sheep farmers, normally landless and small/marginal farmers. Simultaneously, increasing demand reflects a growing demand status, which can be gainfully taken advantage of in promoting robust production mechanism in the country. This is in the interest of sheep and goat farmers in terms of both employment and income.

As per available data, the sheep population growth rate has been 1.19 per cent CAGR for the period 1992-2012 with a decline in the period 2007-12. The goat male and female population has been 0.78 per cent CAGR and 0.81 per cent CAGR respectively for the period 1992 to 2012 as per chart with a negative growth rate in the period 2007-12.

Figure 8.2 Goat population during the period of 1992 - 2012



Source: Basic Animal Husbandry Statistics (BAHS) 2014-15.

This also goes to show that the sheep development activities undertaken in different States of the country during recent years have not made much impact. This is because Sheep-rearing continues to be subsistence occupation, primarily adopted by the poor, landless or small and marginal farmers. Owning uneconomical holding or no land at all, the only option is to graze their sheep on natural vegetation and crop stubbles supplemented by tree lopping.

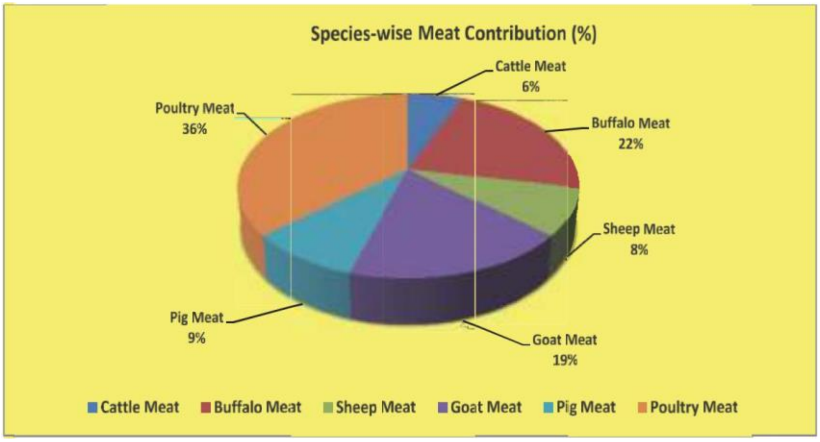
Compounding the problem, the common lots have got increasing denuded of vegetation and degraded of soil.

Similarly, almost no developmental effort has been made for improving the goat sector. The density of livestock per unit of grazing area has greatly increased, owing to increases in their numbers and the shrinkage of grazing land.

8.1.1.1. Meat and milk production

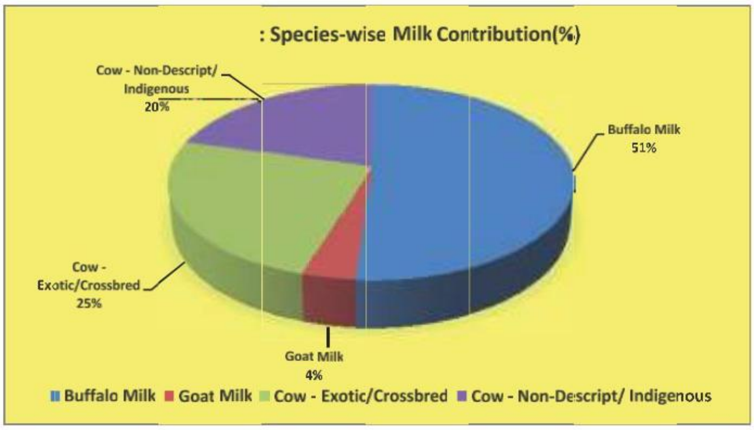
Meat and milk constitute the two primary products of the two small ruminants – goat and sheep, and other while they also livestock, yield other products like wool in case of sheep. The status of meat and milk output is presented graphics below:

Figure 8.3 Species-wise percentage of meat contribution



Sources: Basic Animal Husbandry Statistics (BAHS), 2014-15.

Figure 8.4 Species-wise percentage contribution of milk



Source: Basic Animal Husbandry Statistics (BAHS), 2014-15.

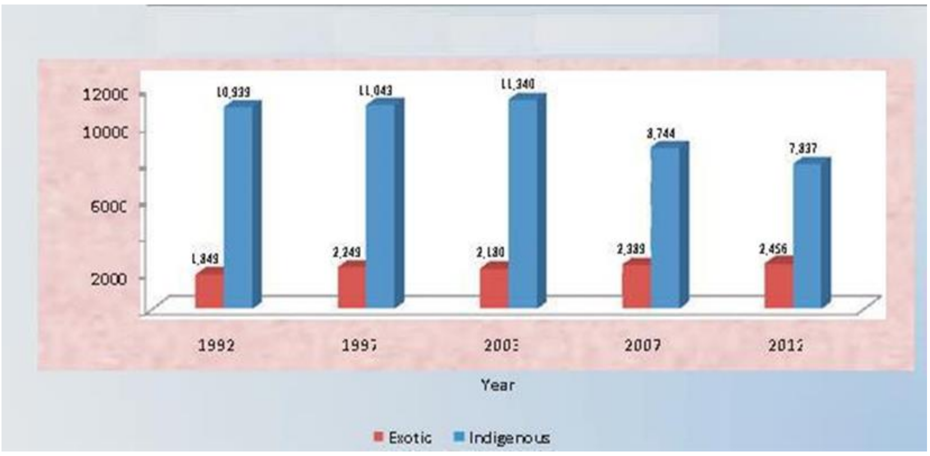
The meat production in the country as per 2014-15 data was 6.6 million tonnes with a per capita availability of 4.94 kg. Of the sheep and goats accounted for 529.03 and 914.13 thousand tonnes respectively.

The total production of goat milk in 2014-15, was 5180.18 thousand tonnes against a total milk production of 146 Million tonnes accounting for 3.23 per cent.

8.1.2. Pigs

The population of pigs in the country was 10.29 million in 2012 registering a decrease by 7.54 per cent over the previous census. Pigs contribute around 2.01 per cent of the total livestock population. Of this total population, number of males count to 4.96 million (3.68 million indigenous and 1.28 million exotic) and females at 5.33 million (4.16 million indigenous and 1.17 million exotic).

Figure 8.5 Pig population during the period of 1992-2012



Animal	Population as per 2012 census	No. of farmers holders
Pig	10.29 million	2.55 million

Source: Livestock Census India, 2007 and 2012.

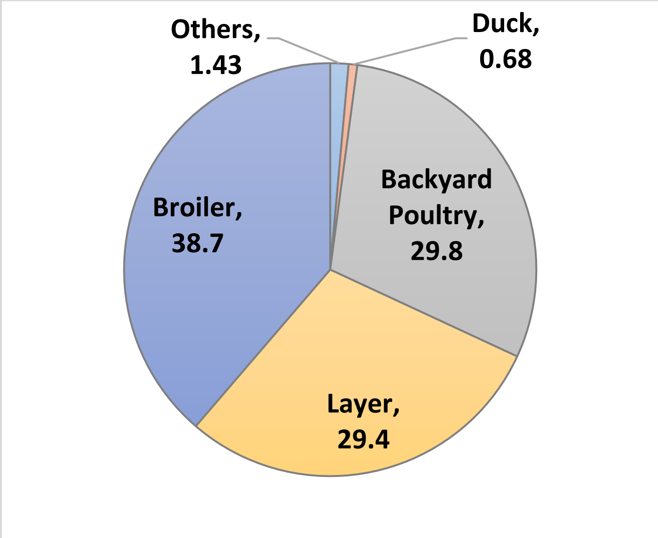
8.1.3. Poultry

Poultry is a sector, that has grown very impressively in the country and its population is around 729.21 million**.**

Table 8.3 Population distribution of poultry by type

Poultry type	Population in millions	Type of poultry	Population in millions
Backyard poultry	217.49	Chicken (fowl)	196.24
		Ducks	18.6
		Turkey	0.28
		Quails	0.29
		Others	2.08
Commercial poultry	511.743	Fowl Layer	214.24
		Fowl Broiler	282.163
		Duck	4.94
		Others	10.4

Figure 8.6 Distribution of poultry population (%)



There are two major poultry sub-sectors in India:

a. Commercial organised sector: contributing approximately 77 per cent of the poultry production (mass production)

b. Backyard unorganised sector: contributing approximately 23 per cent of poultry production (production by masses)

8.1.3.1. Annual production and growth rates of eggs and poultry meat

The population distribution of egg and meat poultry with annual growth rates for over the years (2011-12 to 2015-16) are presented in the following table.

It is seen that:

- The egg production in the country has increased from **78,484** million nos. in 2014-15 to **82,930** million nos. in 2015-16 registering a growth of **5.66 per cent**.
- The per capita availability of egg has increase from **63** in 2014-15 to **66** in 2015-16.
- The poultry meat production in the country has increased to **3.26** million tonnes during the year 2015-16 from **3.04** million tonnes during they are 2014-15.

Table 8.4 Status of production and growth rates of egg and meat

SN	Year	Egg production (in billion numbers)	Annual egg production growth rate (%)	Poultry meat production (million tonnes)	Annual poultry meat production growth rate (%)
1.	2011-12	66.45	5.4	2.48	13.22
2.	2012-13	69.73	4.94	2.68	8.01
3.	2013-14	74.75	7.2	1.92	-28.50
4.	2014-15	78.45	4.99	3.05	59.16
5.	2015-16	82.93	5.66	3.26	7.24

Perceptible Increase in egg production & per capita availability of protein

The annual growth rate of egg production is 5 per cent. Egg is one of the compact sources of nutrition, rich in essential vitamins and minerals. The increase in its per capita availability to 66 per annum is a positive development. The top five (5) egg producing states in the country are as in Table 8.5.

Table 8.5 Production status of eggs in top five states

SN	State	Egg production (in billion)
1.	Tamil Nadu	16.1
2.	Andhra Pradesh	14.2
3.	Telangana	11.2
4.	West Bengal	6.0
5.	Maharashtra	5.3

Source: Livestock Census, India 2007 and 2012

In India, the robust growth of poultry can be attributed to many factors like rising incomes and a rapidly expanding middle class, together with the emergence of vertically integrated poultry producers. Integrated production, market transition from live birds to chilled and frozen products, and policies that facilitate supplies of competitively priced corn and soybean will have an important role to play in further growth of poultry industry.

Further, disease surveillance, monitoring and control will also decide the fate of this sector. There is a strong presence of organised and federated industry in the broiler and layer segments.

Concurrently, the unorganised and backyard poultry sector is also one of the potent tools for subsidiary income generation for many landless/ marginal farmers. Demand for non-broiler (domestic fowl) is a growing niche, especially due to awareness for natural grown or range fed birds. Backyard poultry also holds potential in offering nutritional security to the rural poor. Backyard poultry is however not well connected with the wider market and could benefit from third party services in aggregation of demand and organising supply from peri-urban farmers.

8.2. Ownership of Livestock in Different States

8.2.1. Ownership by households

Table 8.6 Ownership by households

SN	State/UT	Number of house-holds	Households and household enterprises owning				
			Goats	Sheep	Pigs	Backyard poultry	Poultry farms & hatcheries
1.	Andaman & Nicobar	96396	11737	1	7257	29448	38
2.	Andhra Pradesh	20131233	740773	706538	33800	3779408	4503791
3.	Arunachal Pradesh	162891	87237	1838	97987	132920	7761
4.	Assam	6470066	1899852	136471	595662	2165086	65552

SN	State/UT	Number of house-holds	Households and household enterprises owning				
			Goats	Sheep	Pigs	Backyard poultry	Poultry farms & hatcheries
5.	Bihar	19057743	4127502	22279	127330	1431953	274195
6.	Chandigarh	239660	221	5	18	483	5161
7.	Chhattisgarh	5269657	609475	20080	92032	879427	3012831
8.	Dadra & Ngr Haveli	88028	941	40	0	11888	0
9.	Daman & Diu	31282	703	1	1	6169	1
10.	Goa	311081	839	6	8941	15268	818
11.	Gujarat	13663130	1032424	80024	593	830769	454484
12.	Haryana	5274507	67598	21899	21677	50898	1468269
13.	Himachal Pradesh	1572067	165603	77745	1151	28941	11830
14.	Jammu & Kashmir	1900452	235989	271164	293	394531	4068
15.	Jharkhand	6172894	1793681	105638	255497	1454853	14149
16.	Karnataka	13994427	714979	533266	21304	1090311	152712
17.	Kerala	8839154	450854	245	9741	1950095	142097
18.	Lakshadweep	13224	7688	0	0	6150	12
19.	Madhya Pradesh	16933095	1790784	19323	28110	805624	281358
20.	Maharashtra	28358315	2000288	98673	25637	2019032	1847564
21.	Manipur	469860	15197	3455	86491	178818	6524
22.	Meghalaya	518883	59602	4070	149211	210926	391
23.	Mizoram	236998	4658	98	65130	66951	6
24.	Nagaland	549252	22878	405	146307	172518	1316
25.	NCT of Delhi	5650491	13325	265	9484	9396	512
26.	Odisha	11095910	1271190	240163	59144	1667953	305534
27.	Puducherry	297104	12100	265	104	20852	44
28.	Punjab	4610921	73575	9210	4382	75330	286942
29.	Rajasthan	14688713	4736202	956225	32640	456571	156835
30.	Sikkim	115044	28286	542	17962	40138	17
31.	Tamil Nadu	17365066	2218302	806645	49626	3194229	3611198
32.	Tripura	969441	163517	894	181670	353587	14826
33.	Uttar Pradesh	36929882	4524902	110427	199776	1010750	2292399
34.	Uttarakhand	2298530	187707	17032	2983	62419	1834
35.	West Bengal	18535917	3943478	307187	217667	5712332	1098193
Total		**262911314**	**3301408**	**4552119**	**2549608**	**30316024**	**20023244**

Source: Basic Animal Husbandry Statistics (BAHS), 2014-15.

In table 8.6, presents the data on species-wise ownership in terms of household enterprises, provided cumulatively for rural and urban regions. It indicates that the population of households owning livestock is higher in the states of Uttar Pradesh (14 per cent), Maharashtra (10.8 per cent), Andhra Pradesh (7.8 per cent), Bihar (7.2 per cent), Tamil Nadu (6.6 per cent), Madhya Pradesh (6.4 per cent), Rajasthan (5.6 per cent), Karnataka (5.3 per cent), Gujarat (5.1), and Odisha (4.22 per cent).

8.2.2. Non-household and institutional ownership

Non-household enterprises, including institutions also own different species.

Non-household enterprises include those owned and run by a public sector which is institutional (central or state governments, local bodies, government undertakings etc.), private corporate sector (include public and private limited companies registered as joint stock companies under the Companies Act 1956), co-operative societies, other type of societies, institutions, associations, trusts, etc.

Table 8.7 Ownership status of non-households and institutions

SN	State/UT	No. of Non Household Enterprises and Institutions having			
		Goats	Sheep	Pigs	Poultry Farm & Hatcheries
1.	Andaman & Nicobar	32	0	11	43
2.	Andhra Pradesh	86	101	12	618882
3.	Arunachal Pradesh	94	0	17	0
4.	Assam	497	33	197	522
5.	Bihar	2446	92	115	17870
6.	Chandigarh	3	2	0	2
7.	Chhattisgarh	449	29	116	127809
8.	Dadra & Nagar Haveli	3	0	0	0
9.	Daman & Diu	0	0	0	1
10.	Goa	1	0	10	11
11.	Gujarat	3553	580	46	193328
12.	Haryana	62	74	34	68100
13.	Himachal Pradesh	80	82	5	720
14.	Jammu & Kashmir	49	75	0	652
15.	Jharkhand	425	31	130	11787
16.	Karnataka	141	213	52	36166
17.	Kerala	209	7	345	16980
18.	Lakshadweep	21	0	0	99
19.	Madhya Pradesh	878	13	9	58217
20.	Maharashtra	1200	229	155	151236
21.	Manipur	11	1	19	11
22.	Meghalaya	30	5	146	22
23.	Mizoram	6	2	49	21
24.	Nagaland	68	3	385	135
25.	NCT of Delhi	40	1	11	7
26.	Odisha	554	321	59	33322
27.	Puducherry	3	1	0	7
28.	Punjab	3526	784	407	72344
29.	Rajasthan	3205	1816	131	12422
30.	Sikkim	4	0	8	3
31.	Tamil Nadu	3435	2996	1686	949427
32.	Tripura	3	0	3	1540
33.	Uttar Pradesh	2185	423	607	18464

SN	State/UT	No. of Non Household Enterprises and Institutions having			
		Goats	Sheep	Pigs	Poultry Farm & Hatcheries
34.	Uttarakhand	71	27	8	11153
35.	West Bengal	1819	69	116	27953
Total		**25189**	**8010**	**4889**	**2429256**

Source: Livestock Census India, 2007 and 2012.

8.2.3. Major livestock breeds

The major species/breeds in respect of sheep, goat, pig and poultry and home tracts are listed in Table 8.8.

Table 8.8 Species-wise major breeds by State

SN	Species/Breeds	Home tract
Sheep		
1.	Balangir	Odisha
2.	Bellary	Karnataka
3.	Bhakarwal	Jammu & Kashmir
4.	Bonpala	Sikkim
5.	Changthangi	Jammu and Kashmir
6.	Chokla	Rajasthan
7.	Chhotanagpuri	Jharkhand
8.	Coimbatore	Tamil Nadu
9.	Deccani	Andhra Pradesh and Maharashtra
10.	Gaddi	Himachal Pradesh
11.	Ganjam	Odisha
12.	Garole	West Bengal
13.	Gurez	Jammu and Kashmir
14.	Hassan	Karnataka
15.	Jaisalmeri	Rajasthan
16.	Jalauni	Uttar Pradesh and Madhya Pradesh
17.	Karnah	Jammu and Kashmir
18.	Kenguri	Karnataka
19.	Kilakarsal	Tamil Nadu
20.	Madrasred	Tamil Nadu
21.	Magra	Rajasthan
22.	Malapura	Rajasthan
23.	Mandya	Karnataka
24.	Marwari	Rajasthan and Gujarat
25.	Mercheri	Tamil Nadu
26.	Muzzafarnagri	Uttar Pradesh and Uttarakhand
27.	Nali	Rajasthan
28.	Nellore	Andhra Pradesh
29.	Nilgiri	Tamil Nadu
30.	Patanwadi	Gujarat
31.	Poonchi	Jammu and Kashmir
32.	Pugal	Rajasthan

SN	Species/Breeds	Home tract
33.	Ramnad White	Tamil Nadu
34.	Rampur Bushair	Himachal Pradesh
35.	Shahbadi	Bihar
36.	Sonadi	Rajasthan
37.	Tibetan	Arunachal Pradesh
38.	Tiruchi Black	Tamil Nadu
39.	Vembur	Tamil Nadu
40.	Katchaikatty black	Tamil Nadu
41.	Chevaadu	Tamil Nadu
42.	Kendrapada	Odisha
43.	Corridale	Andhra Pradesh, Haryana, Jammu & Kashmir, Madhya Pradesh, Punjab, Tamil Nadu and West Bengal
44.	Merino	Haryana, Himachal Pradesh, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand and West Bengal
45.	Rambouillet	Andhra Pradesh, Goa, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Puducherry, Punjab, Uttarakhand, Rajasthan, Tamil Nadu and Uttar Pradesh
Goat		
1.	Attapady Black	Kerala
2.	Barbari	Uttar Pradesh
3.	Beetal	Punjab
4.	Berrari	Maharashtra
5.	Black Bengal	West Bengal
6.	Changthangi	Jammu and Kashmir
7.	Chegu	Himachal Pradesh
8.	Gaddi	Himachal Pradesh
9.	Ganjam	Odisha
10.	Gohilwadi	Gujarat
11.	Jakhrana	Rajasthan
12.	Jamunapari	Uttar Pradesh
13.	Kannaiadu	Tamil Nadu
14.	Kodi Adu	Tamil Nadu
15.	Konkan Kanyal	Maharashtra
16.	Kutchi	Gujarat
17.	Malabari	Kerala
18.	Marwari	Rajasthan
19.	Mehsana	Gujarat
20.	Osmanabadi	Maharashtra
21.	Pantja	Uttarakhand foothills
22.	Salem Black	Tamil Nadu
23.	Sangamneri	Maharashtra
24.	Sirohi	Rajasthan
25.	Sumi-Ne	Nagaland

SN	Species/Breeds	Home tract
26.	Surti	Gujarat
27.	Teressa	Andaman and Nicobar
28.	Zalawadi	Gujarat
Pig		
1.	Ghungroo	West Bengal
2.	Niang Megha	Meghalaya
3.	Agonda goan	Goa
4.	Tenyi vo	Nagaland
5.	Nicobari	Andaman and Nicobar
6.	Doom	Assam
7.	Australian Large Black	Assam, Haryana, Madhya Pradesh, Uttar Pradesh
8.	Duroc	Karnataka, Kerala, Madhya Pradesh, Puducherry, Rajasthan, Tamil Nadu
9.	Hampshire	Andhra Pradesh, Assam, Bihar, Chhattisgarh, Kerala, Manipur, Nagaland, Punjab, Rajasthan, Sikkim, Uttar Pradesh
10.	Landrace	Andhra Pradesh, Arunachal Pradesh, Bihar, Haryana, Jharkhand, Karnataka, Kerala, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal
11.	Saddleback	Chhattisgarh, Kerala, Meghalaya, Uttar Pradesh
12.	Yorkshire	Andhra Pradesh, Bihar, Chandigarh, Goa, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Odisha, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, Uttarakhand, West Bengal
Poultry		
1.	Ankaleshwar	Gujarat
2.	Assel	Chhattisgarh, Odisha, Andhra Pradesh
3.	Busra	Gujarat, Maharashtra
4.	Chittagong	Meghalaya, Tripura
5.	Danki	Andhra Pradesh
6.	Daothigir	Assam
7.	Ghagus	Andhra Pradesh, Karnataka
8.	Harringhata Black	West Bengal
9.	Kadaknath	Madhya Pradesh
10.	Kalasthi	Andhra Pradesh
11.	Kashmir Favorolla	Jammu & Kashmir
12.	Miri	Assam
13.	Nicobari	Andaman & Nicobar
14.	Punjab brown	Punjab and Haryana
15.	Tellichery	Kerala
16.	Mewari	Rajasthan
17.	Kaunayen	Manipur

Source: i. For sheep & goat: www.nbagr.res.in (ICAR-National Bureau of Animal Genetic Resources)
ii. For pigs; Livestock Census, Indian 2007 and 2012.

8.3. Annotation

A total of 43 indigenous breeds of sheep are distributed in only 16 States. However, several states have good number of non-descript sheep. Further, 28 well defined goat breeds are distributed in 14 States while in other states, non-descript goats and descript goats of neighbouring states are available. A total of 17 and 6 well defined poultry and pig breeds are present in 18 states and 6 states respectively. For improvement and increasing farmers' income exotic germplasm has been introduced.

Key Extracts

- As per Livestock Census, 2012 the population status is represented by 65 million sheep, 135 million goats, 10.29 million pigs and 729.21 million poultry.
- The number of households for sheep, goats and pigs were 4.55 million, 33.01 million and 2.55 million respectively.
- The trends during last 25 years, indicate that there is a consistent decline in the population of sheep, goat and pig, whereas poultry population is increasing at a fast pace.
- There are total of 28 goat, 45 sheep, 12 pig and 17 poultry breeds available in India.
- Of the total meat production in the country, 19 per cent, 8 per cent, 36 per cent and 9 per cent contribution came from goat, sheep, poultry and pig.

Chapter 9
Small Ruminants & Poultry: Research & Development

There have been several scientific interventions made for development of new breeds/varieties in sheep, goat, pig and poultry as well as for enhancing production of milk, meat, egg and chicken. The potential technologies are recommended for implementation to increase the profitability of livestock owners.

9.1. Varieties and Released Developed

9.1.1. Sheep

Avishaan Sheep strain was released in Jan 2016 for increasing prolificacy in sheep. It produces 60 per cent twins/triplets in flocks and further produces 40 per cent more body weight in lambs compared to non-prolific sheep. At present, farmers are getting one lambs per ewe in a year, in majority of sheep flocks under extensive system. Intogression of Fec B gene in non-prolific sheep through use of **Avishaan rams** for breeding purposes will increase twins/triplets in 60 per cent of population that will result in an additional lamb to the farmers from present lamb production.

Malpura, an indigenous mutton type sheep breed with coarse wool, is well adapted to harsh climatic conditions of semiarid region. It is found in Jaipur, Tonk and Sawai Madhopur districts of Rajasthan. Ewes yield 800-1000 milli-litre (ml) milk per day in early lactation. The average 6 month weight was found to be 29.32 kg under improved management practices. Few extraordinary lambs attain a body weight of >42.00 kg at 6 months of age in semi-intensive management system. Malpura lambs have better growth efficiency under stall feeding and attain 33-35 kg body weight at 6 months of age on complete feed.

A cross-breeding programme for improving wool production and quality was initiated at CSWRI, Avikanagar in 1964-65 involving exotic fine wool breed (Rambouillet) and native extremely coarse wool breed (Malpura). The half-breds have been pooled and interbred and the new strain arising out of this base having 50 per cent Rambouillet and 50 per cent Malpura inheritance has been named as Avikalin (Avi-Sanskrit word for sheep and Kalin- a Persian word for carpet). Body weights of 2.82, 17.16, 29.91, 33.31 and 37.15 kgs at birth, 3, 6, 9 and 12 months of age respectively have been achieved, in semiarid region. Avikalin sheep produce about 80 per cent more wool compared to the native Malpura sheep.

Chokla sheep is found in the Shekhawati area of Rajasthan viz., Churu, Jhunjhunu, Sikar, Nagaur and border area of Jaipur and Bikaner. Chokla is a carpet wool sheep breed. Chokla lambs attained a body weight of 17.09 kg at 3, 24.80 kg at 6 and 32.22 kg at 12 months of age.

Magra sheep is found in Bikaner, Nagaur, Churu and Jhunjhunu districts of Rajasthan. Magra sheep has the unique characteristic of lustrous carpet wool. Magra wool has great demand in the carpet industry because of its lustrous properties. Lambs attained a body weight of 24.0 kg at six months and 32.0 kg at twelve months.

Marwari is one of the important carpet wool producing sheep breed of north western arid and semiarid region of India. The breed is hardy and well adapted to harsh climatic conditions of the hot arid region. This breed is considered to be highest in number and distributed widely in Rajasthan and Gujarat. Marwari sheep yields 1.5 kg wool annually in two clips with a fibre diameter of 35-38 µ, staple length of 5.0 cm and medullation of 55 per cent.

Gaddi Synthetic is a crossbred sheep of temperate region for fine wool production. Gaddi Synthetic lamb attains a body weight of 14 kg at 3 months, 19 kg at 6 months and 26 kg at 12 months of age. The staple length, fibre diameter and medullation are 3.20 cm, 19.36 µ and 0.060 per cent respectively in six monthly clip.

In the year 1962, Rambouillet sheep from Texas, USA was introduced in Avikanagar, Rajasthan for evolving fine wool sheep through crossbreeding. Native sheep viz., Chokla, Malpura and Jaisalmeri breed were bred with Rambouillet for producing half bred. Half bred ewes were back-crossed with Rambouillet rams for producing ¾ Rambouillet. Similarly, the cross-breeding of native Chokla and Nali ewes with the Rambouillet and Russian Merino rams from the USSR was done since 1971 in the Institute. The ¾ crosses of both the projects were merged in the year 1982 and named as **Bharat *Merino***. Bharat Merino sheep were shifted from a hot semiarid climate of ICAR-CSWRI Avikanagar to cold climate of SRRC, Mannavanur and NTRS, Garsa in the year 2008. Presently a superior flock of Bharat Merino is being maintained at SRRC, Mannavanur. Bharat Merino sheep produce apparel wool and is one of the substitutes for exotic fine wool inheritance in the country. At Mannavanur, Bharat Merino sheep attain body weights of 19 kg at 3 months, 25 kg at 6 months and 35 kg at 12 months of age.

9.1.2. Goat

The improver breeds of high genetic merit goats for different regions suggested as follows, could be used for upgrading of non-descript goat:

Table 9.1 Suggested improver breed

Suitable Breeds	Region	States
Changthangi	Northern temperate region (above 14000 ft MSL)	Leh-Laddakh
Gaddi	Northern temperate region (Below 10000 ft MSL)	Himachal Pradesh, Uttrakhand
Beetal	Northern region (semi-arid)	Punjab, Haryana and plains of Himachal Pradesh, Uttrakhand (suitable for semi-intensive rearing)
Barbari	Entire North India (semi-arid)	Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, Delhi, East Rajasthan (suitable for both intensive and semi-intensive rearing)
Jamunapari	Entire North India (semi-arid)	Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, Delhi, East

Suitable Breeds	Region	States
		Rajasthan (suitable for semi-intensive rearing)
Sirohi	Entire North India (semi-arid)	Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, Delhi, East Rajasthan (suitable for both intensive and semi-intensive rearing)
Osmanabadi	Southern plateau	Maharastra, Chhatisgarh, Andra Pradesh, Telangana, Karnataka
Surti	*Plain and Coastal regions*	Gujarat
Malabari	*Plain and Coastal regions*	Kerala, Tamilnadu
Black Bengal	Entire eastern and noth-eastern plain regions	West Bengal, Bihar, Jharkhand, Odisha, Assam, Tripura, Nagaland, Meghalaya and other north-eastern states

Source: Singh M K and co-workers, CIRG, Makhdoom

9.1.3. Pig

Rani, the crossbred pig variety has been developed by crossing Hampshire (exotic breed) with Ghungroo (indigenous breed) to have 50 per cent inheritance of both the breeds. The breed can gain almost 75 kg body weight at slaughter age of 8 months with 1.98 cm of back fat thickness. Rani cross has been widely validated in farmers' field. The developed variety was found to be suitable for tropical and sub-tropical planes of India for breeder farmer. More than 30,000 piglets of the developed variety have been produced at farmers' field through artificial insemination.

Asha: Duroc, another exotic germplasm, was crossed with "Rani" to develop Asha cross to have 25 per cent Ghungroo, 25 per cent Hampshire and 50 per cent Duroc inheritance. Asha can produce 80 kg lean pork at slaughter age of 8 months with 1.75 cm back fat thickness. Interim performance appraisal of this cross indicates enough promise to meet the demand of finisher pig producers.

HD-K75: The All India Coordinated Research Project (AICRP) on Pig at Assam Agricultural University at Khanapara, Guwahati has developed HD-K75 variety by systematic crossbreeding with genetic constitution of 75 per cent Hampshire inheritance and 25 per cent indigenous inheritance of local pigs of Assam. The breed can gain almost 74 kg body weight at slaughter age of 8 months with 2.58 cm of back fat thickness. The developed variety was found suitable to different agro-climatic conditions of Assam and neighbouring area.

Jharsuk variety was developed under All India Coordinated Research Project on Pig at Birsa Agricultural University, Ranchi. It was developed by crossing Tamworth and local pigs of Jharkhand with 50 per cent inheritances of both. The variety can gain approximately 80 kg body weight at slaughter age of 8-10 months. It can produce 8-12 piglets in each farrowing with two farrowing each year.

Mannuthy White variety was developed under All India Coordinated Research Project on Pig at Kerala Veterinary and Animal Sciences University, Mannuthy, Kerala by crossing pure lines of Large White Yorkshire males with half bred of Large White Yorkshire x Desi females. The inheritance level has been stabilized at 75:25 per cent for LWY and Desi. The breed can gain 94 kg bodyweight at slaughter age of 10 months with 2.10 cm of back fat thickness. It is well adapted to humid tropical agro-climatic conditions to low input rearing system of Kerala. The developed variety is useful for mitigating demand of improved pig germplasm in Kerala and adjoining areas.

Lumsniang variety of pig was developed by All India Coordinated Research Project on Pig at ICAR-Research Complex for NEH Region, Barapani by crossing Niang Megha local pig of Meghalaya and Hampshire as exotic breed. The variety has better adaptability in hill ecosystem with promising growth rate and feed conservation efficiency, good mothering ability with higher litter size at the time of birth and weaning, good carcass quality and consumer preference in the region. Another key feature of the pig variety is its suitability to low input tribal production/backyard pig production system. The pig variety attains higher body weight of 90-100 kg at 12 months of age, besides higher litter size at weaning as compared to local non-descriptive pigs in the low input tribal production system.

		
Rani	**Asha**	**HD-K75**
		
Jarshuk	**Mannuthy White**	**Lumsniang**

9.1.4. Poultry

Developed chicken varieties like *Vanaraja, Gramapriya* and *Srinidhi* suitable for backyard free range farming have been developed which are well accepted by the rural and tribal people cutting across the different sectors, religions, etc., all over the country. These chicken varieties with multi-coloured plumage resemble the native chicken in their feather pattern; and produce more meat and eggs than the natives. Thanks to these advantages, the improved varieties of birds have gained wider acceptability across the country. These are generally maintained by the women with household waste, green fodder, insects, supplementary feed, etc. allowing the women to live respectful life with additional earning to the family. Some of the popular varieties are as in the following table:

Table 9.2 Improved chicken varieties available for rural poultry farming

Variety	Type/purpose	Institution
Vanaraja	Dual	DPR, Hyderabad
Srinidhi	Dual	DPR, Hyderabad
Gramapriya	Egg	DPR, Hyderabad
Swethasri	Egg	DPR, Hyderabad
Varieties developed at AICRP Centres		
Pratapdhan	Dual	MPUAT, Udaipur (AICRP)
Kamarupa	Dual	AAU, Guwahati (AICRP)
Narmadanidhi	Dual	MPPCVV, Jabalpur (AICRP)
Jharsim	Dual	BAU, Ranchi (AICRP)
Himasamrudhi	Dual	HPKVV, Palampur

***Vanaraja*:** A dual-purpose variety for free range farming in rural and tribal areas was developed and further is being continuously improved based on the feedback from end users. *Vanaraja* males weigh about 1.5 to 1.8 kg at 12 weeks and females lay upto 160 eggs under farm conditions and upto 110 eggs in free range condition in a laying year. The bird is hardy with longer shanks and having better immune competence.

On account of its multi-colored plumage and production of brown eggs, it is well accepted by the rural people. The birds have good majestic appearance and are attractive with well-built body shape. The male birds are sold at 12 weeks of age with premium price.

Hens produce eggs from 24 weeks onwards which resemble the native eggs in size and colour. This is the first bird developed by the Directorate which got wider acceptability across the country.

A pair of Vanaraja and female birds

***Gramapriya*:** A layer type coloured chicken variety was developed for free range farming in rural and tribal areas. It can lay upto 180 eggs per year in free-range conditions with required supplementary feed and produce upto 220 eggs under farm conditions. It has coloured plumage and lays bigger size eggs (52-58g) with brown shell colour. These tinted eggs are preferred by rural and tribal people. Apart from being hardy its liveability is high.

The male weighs around 1.2 to 1.5 kg at 15 weeks of age and suitable for *tandoori* preparations. It has been found to help in improving the incomes of the farmers through egg and meat production.

Male and female birds of Gramapriya

***Srinidhi* :**A promising dual purpose variety for free range farming was developed, possessing fast growth and higher egg production potential under farm and as well as backyard conditions. Unique feature of this bird is feather pattern, which is highly diversified and resembles the native chicken breeds. The birds can weigh about 1.8-2.0 kg at 15 weeks of age and can lay about 150 eggs under field conditions.

Kamrupa is a multi-coloured bird for rural poultry production. It is three way cross developed using Assam local ecotype (25 per cent), Coloured Broiler (25 per cent) and Dalhem Red (50 per cent) population. This variety has coloured plumage, medium body weight and longer shanks with optimum egg production.

A flock of Kamrupa females

Kamrupa male

Under backyard system, the body weight at 8 and 20 weeks is 500-650 grams and 1,300-1,500 grams, respectively. The male birds weigh 1,800-2,200 grams at 40 weeks of age and the annual egg production is 118-130 eggs with an egg weight of 52 grams. The survivability is above 95 per cent.

Narmadanidhi**:** A new and improved location-specific variety of chicken, '*Narmadanidhi'* was developed for rural poultry by crossing a native chicken, Kadaknath with an improved coloured broiler. The birds resemble native chicken in appearance but have higher growth and production potential, survive better in sub-optimal nutrition and management and produce brown shelled eggs of medium size (50g). They have very attractive multi-colour plumage pattern (black, brown, grey and mixed) and strong body conformation and move fast in free range. .

Male birds attained 1 kg body weight at 9-10 weeks of age and body weight at 20 weeks ranged from 1550 to 2210g in males and 1310 to 1730g in females. The female matures at around 161 days of age (intensive) and produces 181 eggs in backyard, which is 4 times higher than the local native chicken (45 eggs). Under semi-intensive system of management, the bird produces 195 eggs.

Pratapdhan is a dual purpose chicken variety which caters to the needs of rural poultry keepers. It resembles local birds of Rajasthan. It has an attractive multi-colour feather pattern, as rural people like coloured birds from aesthetic point of view. The colour plumage of these birds impart camouflagic characters and help protect themselves from predators.

These birds have longer shank length which helps in protection from predators in backyard areas, and also have capacity to survive on low plane of nutrition (low and negligible input) and under harsh climatic conditions. The chicken lays brown eggs weighing around 50 g and has broody characteristic to some extent. It has fast growth rate with average adult body weight at 20 weeks of age ranged from 1,478 to 3,020 g in males and 1,283 to 2,736 g in females. The age at sexual maturity was 170 days. *Pratapdhan* produces 161 eggs annually, which is 274 per cent higher than local native (43 eggs).

Jharsim a multi-coloured bird suitable for rural poultry production was developed under under AICRP on Poultry Breeding at BAU, Ranchi, Jharkhand. It is a dual purpose bird preferred by tribal areas of Jharkhand. The body weight at sexual maturity is 1.6-1.8 kg and annual egg production is 120-130 eggs.

9.2. Transferable Technologies Developed

9.2.1. Sheep

Accelerated lambing system **for** obtaining 3 lambs in 2 years. In the lifetime of ewe, farmers were earlier harvesting 6 lambs, but now they can harvest 9 lambs. The technology of indigenous sponges followed by AI (Artificial Insemination) in sheep for regular breeding at lambing at regular intervals has helped increase lambing per ewe in lifetime.

Avikasil–S: Progesterone impregnated intra-vaginal sponges for oestrus induction and synchronization in sheep and goats have been developed indigenously at ICAR-CSWRI, Avikanagar. One kit containing 25 sponges, 1 speculum and 1 plunger costs Rs. 722 (Year 2017).

Intensive feeding of lambs: Intensive feeding system (concentrate and roughage) for lamb has been developed to achieve growth rate of 150 g per day during pre- and post-weaning stages. Lambs can achieve a body weight of 30-32 kg at the marketable age of 6 months and fetch higher price.

Memnaprash is a milk supplements for lambs during pre-weaning stage, to enhance growth and achieve market weight at early age and reduce mortality loses.

***Value added sheep manur*e** was developed by utilizing coarse wool/ industrial wool waste. This increased water retention, soil fertility and crop yield. To reduce mortality in sheep flock which is around 7 per cent, a planned **health technology** which includes vaccination, drenching and dipping has proved useful. Artificial Insemination (AI) with liquid chilled semen in farmer's flock has shown that lambing rate can increase by 60 per cent.

9.2.2. Goat

9.2.2.1. Interventions needed to improve productivity are suggested

i) Breeding Intervention: The majority of goats (about 63.5 per cent) in the country belong to non-descript category, and their productivity is low. The unsatisfactory growth and productivity are attributed to indiscriminate breeding, lack of field based genetic improvement programmes (breeding with superior bucks) and knowledge gap among goat farmers. Breeding interventions, will improve prolificacy (addition in number of kids born), increased body weight of male kids and increased milk production. Net economic gain from breeding intervention can be of the order of 25-30 per cent (Dixit et al 2015).

Breeding bucks of Jamunapari, Barbari and Black Bengal breed

***ii) Goat health calendar*:** The mortality due to high disease incidences in goat production cause high economic losses. The major diseases in goat include *Peste des petits ruminants*

(PPR), goat pox, enterotoxaemia and foot and mouth disease (FMD). These cause mortality and morbidity losses in goats resulting in low productivity and population (flock size). Adoption of goat health calendar (developed by ICAR-CIRG) may improve net gain by 30 per cent (Dixit et al 2015). (Annexure 2.1)

A. Vaccination

Diseases	Primary vaccination		Repeat vaccination
	First injection	**Booster injection**	
1.Peste-des-Petitis Ruminants (PPR)	At 3 months of age	Not required	Every 3 years
2.Foot & Mouth Disease (FMD)	At 3-4 months of age	3-4 weeks after 1st injection	Every 6/12 month interval*
3.Goat Pox (GP)**	At 3-4 months of age	3-4 weeks after 1st injection	Every 12 month interval*
4.Enterotaxaemia (ET)	At 3-4 months of age	3-4 weeks after 1st injection	Every 6/12 month interval*
5.Haemorrhagic Septicaemia (HS)	At 3-4 months of age	3-4 weeks after 1st injection (2 doses at 1 month interval)	Every 6/12 month interval*

* As per the recommendations of manufactures
Kids are naturally protected from diseases upto 3 months by proper feeding of colostrum immediately after birth.
For optimum benefits of vaccination, deworm your animals at least 15 days before vaccination.
**For sheep – replace goat pox vaccine with sheep pox vaccine.

B. Drenching, deworming and dipping

Diseases	Age groups	Treatment period	Recommended as feed mix
Drenching Coccidiosis	1-6 months	Anti-coccidial drug for 5-7 days	Amprolium @ 50-100 mg/kg body weight
Deworming Endo-parasitic infection	3 months and above	Two deworming's annually (pre and post monsoon)	Fenbendazole @ 7.5-10 mg/kg body weight. Additional deworming may be needed in cases of heavy parasitic load or extended rainy season
Dipping* / Ecto-parasitic infestation	Any age	Pre & Post winter	As and when required close monitoring and treatment of shed/soil is essential to avoid re-infection

* Avoid cold, cloudy and rainy days for dipping, preferred time for dipping – 9 am to 11 am.

C. Screenings

Diseases	Period	Recommendations
1. Brucellosis*	Once in a year	Positive animals need to be euthanized and buried
2. Johne's Disease*	6 months/once in a year	Positive animals are to be removed from herd/flock
3. Mycoplasmosis	Once in a year	Treatment with specific drugs

4. Mastitis	Early milking stage	Treatment with specific drugs
5. Endoparasites	Regular screening of faecal samples	Monitor worm load (EPG/OPG) of the animals to decide time of deworming

Source: ICAR – Central Institute of Research in Goats

* Preferably one month after kidding
+ Screening of adult goats especially breeding bucks and breedable females. From aborted animals submit 2 serum samples (Zero day i.e. day of abortion/still births and 21 days after abortion/still birth)

***iii) Nutrition Interventions and area specific mineral mixture*:** India's goats are predominantly reared under extensive management system. There is high dependence on common resources as majority of the goat farmers are landless or hold marginal and small farms. Under nutrition intervention, the farmers are advised to feed their goats with concentrate in appropriate quantity. Feed supplementation of growing kids with 175 g of concentrate for 180 days may increase their body weight by 30 per cent until 9-10 months of age. Improved feeding also improves milk yield by 50 per cent over the current milk yield. In sum, nutrition intervention will increase net economic gain of goat farmers by 25-30 per cent (Dixit et al 2015). Both mineral mixtures and pellets are commercially available in the market.

9.2.2.2. Artificial Insemination in Goats

The goat semen freezing protocol developed at ICAR-CIRG will help to multiply superior goats at a faster rate. In this protocol, semen is collected using artificial vagina from elite and superior quality breeding bucks. Immediately after collection, volume, colour, consistency and mass activity of the ejaculates are assessed. Semen is extended in Tris–Egg yolk-citrate-Fructose (TCF) diluent having 10 per cent (v/v) egg yolk and 6 per cent glycerol (v/v). Sperm concentrations are adjusted to 100 million per semen straw (0.25 ml) and diluted semen equilibrated at 5°C for 4 hours. Horizontal vapour freezing should be done 2 cm above the level of liquid nitrogen (LN_2) for 10 minutes and finally semen straws stored in LN_2 container (-196°C). With this protocol, the post thaw motility of semen ranges from 50 to 60 per cent.

Artificial Insemination is performed by intra-cervical method in order to get maximum benefits. AI should be done twice at 12 hours interval and is to be performed after 10-12 hours of oestrous exhibition. Due to the complex cervical anatomy in goats, it becomes very difficult to pass the AI gun through the cervix. Therefore, the conception rate is highly correlated with depth of penetration. This technique is more suited in case of Indian goats and is easy to perform within 2-3 minutes. Using frozen semen can result in a success rate (kidding) of about 37-45 per cent.

9.2.2.3. Shelter Management and Marketing

Improved shelter management with feeding and watering devices have been developed by ICAR-CIRG. Properly implemented, these can help to improve the overall health, production and productivity of the animals. Need based designs of feeding devices can also reduce feed-fodder losses by 20-25 per cent.

9.2.2.4. Value Added Products of Goat Meat

While goat meat is already popular, new products have been developed. The processing and food industry based on goat meat can grow. Some of the possibilities are in Annexure 2.1.

9.3. Technologies for Promotion of Piggery

i) Technology for Artificial Insemination in pigs

The technology of Artificial Insemination (AI) developed offers the most economically viable method for maintaining genetic variability in a positive direction. The technique involves standard procedures by which, artificially collected semen from selected healthy boars is evaluated and diluted in suitable semen extender for preservation at 13-15ºC in order to inseminate artificially 20 to 30 numbers of sows with more than 80 per cent conception rate.

ii) Comminuted pork products

Technology provides avenues for inactivation of cysticercus larvae in pork, if present while processing momos and thereby contribute to reduce the incidence of neuro-cysticercosis in human beings. Many pork products are easily adoptable by small and medium sized entrepreneurial units and some are discussed below:

Sausage can be produced, even highly seasoned sausages which are generally cooked in hot water till their internal temperature reaches 70 °C have been developed.

Pork salami is a type of cured sausage consisting of fermented and air-dried pork. During processing, usually the raw meat mixture ferments for a day, which is then stuffed into either an edible natural or inedible cellulose casing, and hung to cure. This improves the yield of the product, nutritive value and shelf life.

Ham slices and pork nuggets have been developed for utilization of a) tough pork from older pigs; and b) by-products with fortification with non-meat ingredients.

Burger patties *are* a flattened, usually round, serving of ground pork/ comminuted pork product. The product has a shelf life of 6 months under frozen storage (-20 °C).

Restructured nuggets are a catch-all term to describe a class of restructured pork made from smaller pieces of pork fused together by a binding agent. The product has a shelf life of 6 months under frozen storage (-20ºC), for utilisation of a) tough pork from older pigs; b) byproducts; and c) fortification with non-meat ingredients.

***Pork pickle*:** The pickling process provides a simple and least cost method of preservation. This technology can improve the yield of the product, nutritive value and shelf life and can be stored at ambient temperature which facilitates its marketing without the cold chain.

Pork soup is a liquid food prepared from meat or vegetable stock combined with various other ingredients. Technology provides avenues for utilization of remnants of meat remaining in the bones after deboning process.

Functional pork products - Low fat pork products is simple product for reducing the fat content which leads to a firmer, rubbery, less juicy product with dark colour. The product has a shelf life of 6 months under frozen storage (-20 °C). Technology provides avenues for processing of pork products with health benefits to the consumers.

***Pork products with kordoi fruit juice*:** Has found good consumer acceptability.

9.4. Technologies for promotion of Poultry

The following are the new technologies that need to be promoted:

i) ***Effective alternate feed ingredients*** for maize and soybean meal have been identified. Maize could be fully replaced with sorghum, pearl millet or fox-tail millet on weight basis in broiler diets. In layers, *pearl millet* and sunflower cake could be used at higher levels (30 per cent) with reduction in cost of feed. Soybean meal could be replaced with distillery dried grain, guar meal, cotton seed meal, sunflower cake, til cake, double-zero mustard cake either completely or to a great extent in commercial broiler diets.

ii) ***Thermal stress (stress indices*)** can be reduced by supplementing the diets with certain herbal compounds, organic trace minerals (Se, Cr, Zn), osmolytes (betaine anhydrous, potassium chloride), sprouts of millets (sorghum, korra, ragi, bajra) and pulses (green gram, black gram, wild gram), prebiotics (MOS, FOS, GOS), optimizing essential amino acid (lysine, total sulphur amino acids, threonine) in chicken reared in open sided poultry houses.

iv) ***Knock down chicken for myostatin gene*** *developed for improving productivity in birds.*

iii) ***Vaccination schedules*:** have been developed for controlling two common diseases of rural poultry, viz. newcastle disease and fowl pox.

Key Extracts

- Rearing of sheep and goats should promote the use of recommended breeds.
- Specific breeds of backyard poultry have been developed for better egg production. For chicken production, differentiated breeds are recommended.
- Technologies such as intensive feeding of lambs and value added manure have been developed, which are helpful in the income from sheep rearing.
- Selective breeding, goat health calendar, nutritional interventions including area specific mineral mixture, shelter management and marketing are other interventions that will help to increase the goat livestock owner's income.
- To upgrade the pig breeds for higher yield, artificial insemination is found useful.
- Effective alternatives of feed ingredients, and following vaccination schedules help to increase the production and income of poultry farmers.
- Different value addition products from meat and wool developed will help farmers to generate additional income if utilised appropriately.

Chapter 10
Goat Sector: Status and Vision

Goats are traditionally reared by resource poor and socially backward segments of rural community, especially those living in ecologically vulnerable areas. Development of the goat sector will reinvigorate growth and positively impact the livelihoods of 20 million goat rearers and their incomes.

10.1. Background

A review of the data collated by the National Sample Survey Office (NSSO), indicates that there are about 33 million goat rearers in the country. Of these farmers, nearly 84 per cent are identified as SC/ST (Scheduled Caste/Scheduled Tribe) and OBC (Other Backward Classes) communities and 83.4 per cent are categorised as landless, small and marginal farmers. Goat rearing is largely undertaken with small herds of 3 to 10 goats per household. Larger herd sizes are prevalent in areas, like tribal belts of Odisha and desert region of Rajasthan, where there is higher access to Common Property Resources (CPRs). However, the goat population density is highest in Bihar and West Bengal (Figure 11.1).

Goats are hardy animals and they are typically reared in regions that are considered ecologically vulnerable for other types of production. The activity is taken up to supplement household income and helps to de-risk the farmers in drought prone areas. Seen as a secondary or add-on activity by households, goat rearing is known to contribute about 10 to 40 per cent to the household income, depending on the scope of other primary activities. Live goats are sold to slaughterhouses in response to demand for goat meat, and in times of economic distress, while they also fulfil some localised milk requirements. The contribution to income from goat rearing can be in multiples, if herd sizes are increased and scientific practices are adopted.

This sector has focused on meeting the domestic demand for mutton. The word 'mutton' is used to refer to meat of adult sheep specifically, in most English speaking countries. However, in the Indian Sub-continent (India, Pakistan, Bangladesh etc.) and Arabian Gulf Countries (Saudi, Dubai etc.), the consumers refer to goat meat as mutton, and sheep meat is known as lamb. However, most global data assessments use the term sheep meat to include goat meat.

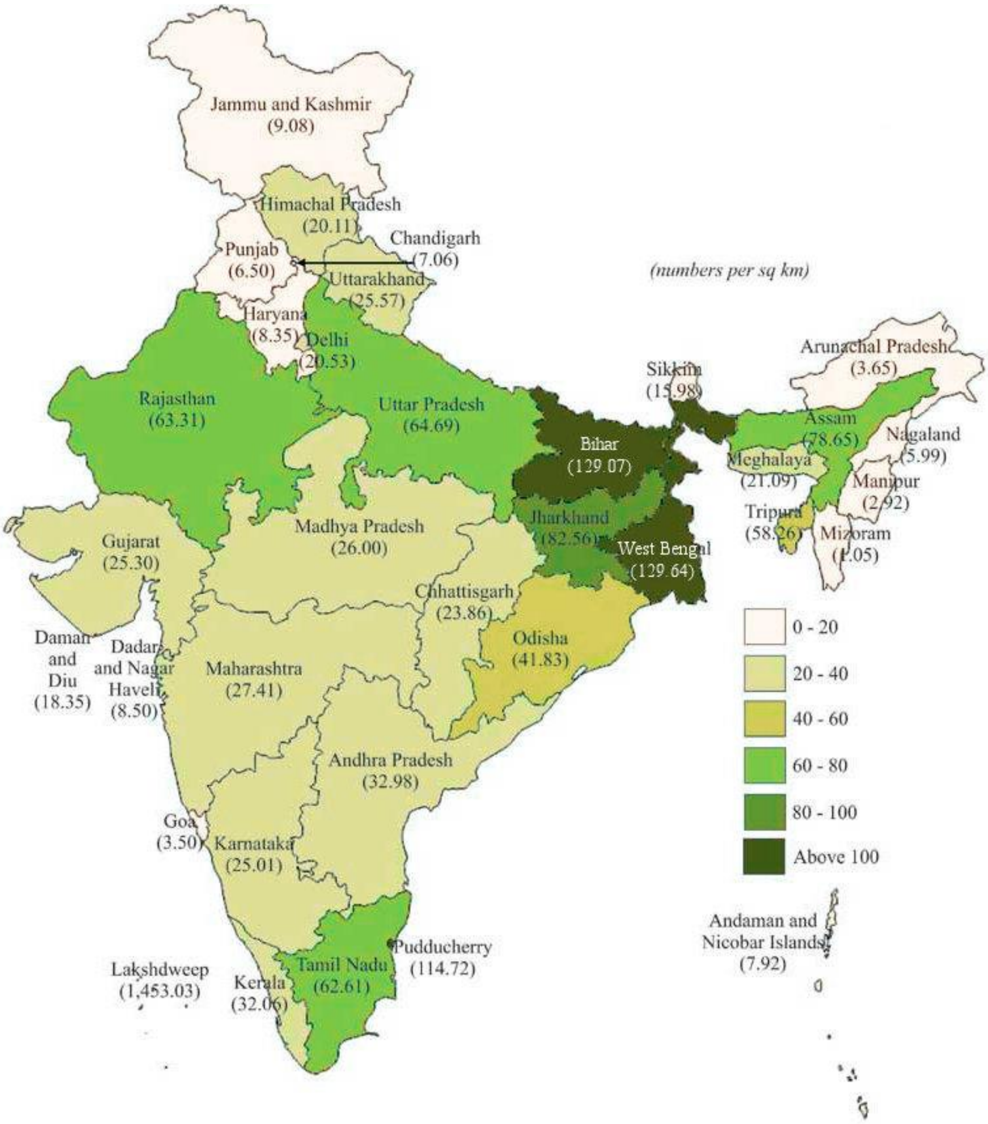
Table 10.1 Nutritional components in different meats

Per 100 gm	Goat	Chicken	Pork	Lamb	Beef
Calories *kcal*	143	223	211	258	187
Cholesterol *mg*	75	76	94	93	79
Iron *mg*	3.73	1.26	1.12	1.98	2.24
Protein *gm*	27.1	23.97	29.41	25.55	27.42
Saturated fat *gm*	0.93	3.74	3.3	6.89	2.77
Total Fat *gm*	3.03	13.39	9.44	16.48	7.72

Source: Various

Goat meat is actually lower in calories, saturated fats and cholesterol than beef, pork, lamb and chicken. It also contains a higher amount of protein and even more iron than beef. Goat meat is commonly consumed in Africa, Latin and Central America, Middle East and South Asian countries. It is not as commonplace in European cuisine though it is now found as a delicacy in upmarket restaurants in USA and Europe.

Figure 10.1 Population density of Goat in India (per sq. km.)



Goats, like other small ruminants, require less forage than large cattle, and an acre of pasture land can sustain five times as many goats than cattle. Goats forage on plant varieties that are not preferred by other grazing animals and can improve the quality of pasture land. They are often more manageable, affordable and hardy for the small holder farmer. Goats produce milk and meat, and diverse by-products (cheese, skin, cosmetics, gut string, etc.). However, because of size and body structure, the meat produced per goat is comparatively less than in case of pigs or other quadrupeds, and hence not always found suitable by modern meat processors. This is one of the reasons that goats are normally handled in smaller slaughter houses and butchers, and hence its supply chain is not equal in organisation. There is a growing demand and opportunity for multi-dimensional growth of the sector to meet the robust demand for high value goat meat and milk products in domestic and global market.

10.2. Outline of Goat Sector

Goat sector has primarily focused on catering to internal domestic demand, met through informal linkages with small farmers who sell their goat on need basis. The limited exports, are met through supply from progressive commercial farmers who supply quality goats to export units. Notably, the bulk of goat rearers belong to the poorest communities, undertaking this as a backyard activity. In contrast, goat meat is a higher priced compared to chicken, and is consumed by the richer segments of the population. Goat meat prices are as high as Rs 450/kg, which is nearly more than two times the Rs 180/kg price for beef or chicken meat. Processed goat cheese is also catching interest of niche section of consumers.

Thanks to the socio-economic backdrops linked to goats, focused development of the goat sector can help to meet the objectives committed vis-a-vis the Sustainable Development Goals (SDGs) and outcomes under the National Rural Livelihood Mission (NLM). Women empowerment is an expected key benefit from such development, as goats are predominantly reared by women among the landless, as also small & marginal farmers.

In the census period 2007 to 2012, the goat population in the country dipped from 141 million to about 135 million. However, estimates put up on e-pashuhaat portal, indicate that the goat population is at 146 million in 2018.

Figure 10.1 Livestock information – 2018 estimated numbers from e-pashuhaat portal

Globally, China tops in goat meat production with 2.2 million tonnes of annual production (FAOSTAT, 2016), and India is second in world production (1.04 million tonnes) contributing about 20 per cent to global production of 5 million tonnes. The world goat milk production was 15.2 million tonnes (FAOSTAT, 2016) with India leading at 5.6 million tonnes.

However, the meat yield in India is 10.0 to 10.5 kg per goat, less than most other countries- China (27.7 kg), Malaysia (27.3 kg), Iran (14.0 kg) and Pakistan at 17 kg/carcass.

10.2.1. Small and marginal goat rearers

Most goat owners are from the poorer section of society and studies indicate that the majority own less than five goats at any given time. Among such owners, a herd of more than 10 goats is considered large sized. The goat rearing functions, especially grazing, are mainly handled by the women and children.

Feed and fodder requirements of goat are mainly met from Common Property Resources (CPRs). CPRs in dry tropical regions can contribute significantly to the income generation for the rural poor. CPRs included the village pastures and grazing lands, village forests and woodlots, protected and un-classed government forests, waste lands, common threshing grounds, watershed drainage, ponds and tanks, rivers, rivulets, water reservoirs, etc. The landless households possess relatively lesser number of cattle-variety of livestock and relatively greater number small ruminants, especially goats.

Goat rearing families tend to retain female stock for replacement and for milk requirements, and purchase from fellow herders for replacement is also common. The buck is normally sold for meat as per need and there is little trade in high quality bucks for breeding purposes.

A study undertaken by International Fund for Agricultural Development (IFAD) with the Bill Melinda Gates (BMG) Foundation on the goat sector, focused on Uttar Pradesh (UP), Bihar and Odisha, the three states that rank 2^{nd}, 3^{rd} and 10^{th} in goat population, with goat population density ranging from 41 to 129 per square kilometre. The report brings forth that in UP about 74 per cent of the goat rearers were those who lived below the poverty line and in Odisha and Bihar this was 90 and 94 per cent respectively. In all three states, 35 to 38 per cent of the goat rearers saw goat as their main source of income. The average herd size per household was seen to be small (3-4 goats in Bihar), UP (<5) and Odisha (5-10).

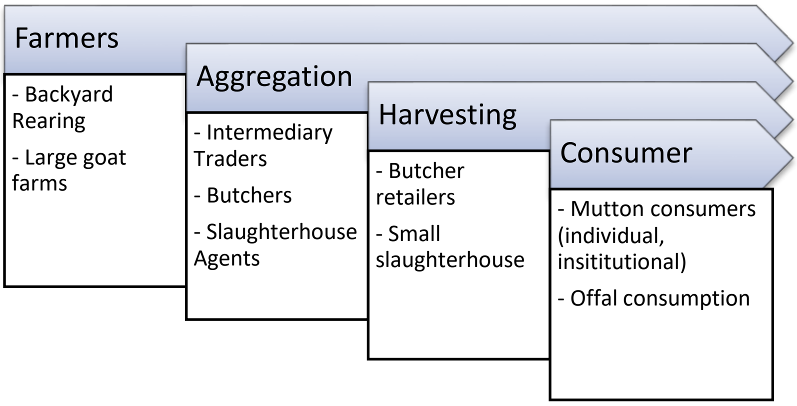
10.2.2. Traditional supply chain

The typical domestic goat supply chain, operates in the informal sector, while the larger animals are favoured in the supply chain that integrates with the value chain of the organised meat processing industry.

Various studies have been done at the state and regional levels on the functioning of the goat value system (the qualitative inputs and the supply chain). The reports indicate that the goat sector primarily functions along lines of the traditional and disaggregated supply chain, and there is little organised rearing and marketing of goat products.

Goats are normally marketed by herd owners on need basis, at block or district markets which may operate once a week. The transactions of farmers is with primary traders and local butchers, though a few traders from terminal markets may also transact. Market Committees that manage the market levy a fee on per goat basis which can range from Rs 5 to 15 per goat. The volume of sale at the primary markets can range from 50 to 200 goats per week. The local butchers with small requirement of goats on a daily basis, tend to procure directly from rearers or the primary traders. The larger butchers who manage a steady supply to hotels, canteens, etc., tend to assure their supply through secondary or terminal market traders.

Figure 10.2 Overview of supply chain in goat meat



In case of goat milk collection and supply, a similar situation exists. The Department of Animal Husbandry, Dairying & Fisheries (DAHDF) under the Union Ministry of Agriculture and Farmers' Welfare provides support and inputs to improve the value chain of the individual actors in the supply chain. The primary inputs are in the form of supply of materials such as feed and veterinary goods, and services such as vet-care, litter management and husbandry training, etc. Various Non-Government Organisations (NGOs) and rural development agencies also undertake such supporting/mentoring activities. However, enhanced and structured emphasis on the development of this sector will bring further benefits to the small and marginal goat owners.

The earlier referenced study by IFAD and BMG in 2015, on the goat sector in Bihar, Odisha and Uttar Pradesh, reports that the goat farmers get upto 80 per cent of the of the final consumer price. This is far higher, than the farmers share in the consumers' spend on other agricultural commodities.

The setting up of large processing units requires high number of goat as supply. The fragmented nature of ownership and lack of organised agglomeration at source, is seen as a constraint to such development.

10.2.3. Organised goat farming and processing

There are very few examples in organised goat farming and processing of products. In Maharashtra, the Ahmednagar Goat Co-op Federation (AGF - District goat rearing and processing enterprise) is one such example, where goats are reared under stall fed conditions, and a modern abattoir and meat processing plant has been established. The plant has capacity to handle 1,600 goats and sheeps per day, supplied by members of the cooperative. The scientific slaughtering allows the facility to maximise on value from meat, hoofs, horn, offal and skin. Even the gut lining can be brought into use as thread for medical uses.

This kind of organised animal and product handling, helps the local goat rearers with access to professional management, record keeping and tracking of the progress of each goat, and regular medical-checks and vaccinations of the goats. The product, including milk and meat, is locally processed and is of suitable quality for domestic and export markets. However, such organised goat farming and processing can face social prejudice at times.

Nevertheless, from the perspective of enhancing farmers' income, especially of those who that are landless and impoverished, policy attention to ease such an enterprises is recommended. Such focus will also be eased by establishing village level goat producer organisations of goat rearers, so as to streamline the process of rearing including health care and in the post-production phase of marketing.

10.2.4. Availability status of inputs

Branded feed for cattle is sometimes fed to goat in small quantities and feed input sellers are reportedly available in almost all areas. Goats account for about 1 to 4 per cent of sale of feed input, and it is usually loose ingredients that are purchased. Medical support is usually available with local veterinary institute, though supply of vaccines though the state department are usually lower in comparison to population. At times, curative medicines are purchased from medical shops, when these are not available with veterinary dispensaries.

Breeding services are not organised and can utilise stray bucks or those selected from own herd or the buck of other farmer in the village. Breeding stock when sourced elsewhere, need to transportation over long distances, and the poorer farmers get dissuaded from incurring such costs. The livestock sale also requires transportation to reach markets. Reports indicate that illegal payments need to be made to assure the safety of animals during transit. This also indicates that transporters are not complying with animal transportation rules and not holding way bills and health certificate of the goats carried. Transportation is an important input cost, when procuring a new goat or when marketing the goat. The mode of transport, depends on volume handled, and can vary from motorcycles, tractor trailers, vans, trucks and even buses.

The health and breeding services through a network of veterinary centres, have traditionally focused on large ruminants. The weak social status of goat herders is reflected in their inability to express their demands accordingly. Many small ruminants are located in remote areas and are migratory in nature; and the available services may not reach them. The Krishi Vigyan Kendras (KVKs) are also expected to focus on goats, and can take up more focused training and development of goat rearers.

Access to credit is also a challenge, since most goat rearers and traders do not have ample assets as collateral or the banks do not cater to such backyard farming enterprises. Butchers are also not able to opt for credit easily. However, launched in May 2017, the Pradhan Mantri Kisan Sampada Yojana (Scheme for Agro-Marine Processing and Development of Agro-Processing Clusters) has opened support, aimed at modernising of meat shops and slaughter houses.

10.3. Major Challenges

In comparison to crop sectors, small ruminants, especially goat sector possess esgreater scope to grow in production since there exists a large demand supply gap. Despite being a strong contributor to the income and livelihoods of the poorest segments of the society, the sector has remained largely underinvested and neglected at various levels. With increasing income levels and changing consumption patterns, the demand for meat/lamb is expected to grow vigorously.

The constraints to growth can be summed up as follows-

i. Absence of organisations of small ruminant keepers: The attention towards development of goat keepers is limited due to absence of or weak social organisation. Lacking organisation, they are unable to suitably express their requirements. This also includes other rights such as access to common grazing land

ii. Disease and mortality rate of goats can be reduced with improved methods of goat farming, higher level of prophylactic care, vaccines and access to veterinary services.

iii. Breeding stock are not easily identified by goat keepers and they face difficulty in accessing good quality breeding animals. The shortage of better quality breeds can be addressed by developing parameters to help identify and provide breeding stock.

iv. Transportation is a major constraint faced by goat farmers, including safe access and transit of live goats.

v. Poor access and availability of institutional credit makes it difficult for small scale entrepreneurs with meagre capital assets for collateral security. Furthermore, insurance for livestock, particularly of small ruminants is largely neglected by insurance providers. The existing livestock insurance scheme needs a revisit to make it more farmer-friendly.

vi. Lack of grazing land and goat shelters is also reported from goat rearers in various regions. Common lands are t developed for such prupose.

Mitigation of these production-centric constraints, will also help to bring greater organisation in forward linkages with output markets, both domestic and international. The advantages of lower investment costs, high fertility, easy marketing, and higher social acceptance of goat meat, goat farming is an ideal option for the rural households.

10.4. Vision and Recommendations

The goat sector directly impacts the landless and marginal population of rural India, and hence focused development can make meaningful socio-economic impact where it is needed most. This sector touches the weakest section of society and can not only increase incomes multi-fold, but also empower the involved women. India already has the second largest goat population in the world.

The vision for this sector is that it the Indian farmer should become the dominant and organised source of all goat products, globally. Since the majority of goat rearers are small and marginal, dependent on goats for income the future development to fulfil the vision should maintain their stake, and not merely focus on developing commercial entities under single ownership. Village scale Producer Organisations or Associations will ensure that individual herd owners can function as a collective, and benefit from greater operational efficiency at different stages of value chain.

In order to achieve this vision, the strategic roadmap for transforming the goat sector is enclosed in Annexure A10. The annexure may be referred to for details on the challenges, recommended plan of action and potential partners under the following heads:

- Goat herd size management and goat housing
- Breed development
- Goat health services
- Goat feeding practices
- Goat marketing
- Goat processing
- Goat extension services

Key Extracts

- The demand and supply gaps in goat sector are evident from price differentials between goat products and other livestock products.
- The market opportunity is not fully tapped due to a lack of appropriate attention and disorganised and fragmented nature of goat sector.
- Organising the goat owners into producer organisations, especially at village level can streamline the rearing and marketing of goat products.
- Inter-state coordination and trade promotion will be needed to rapidly scale up the socio-economic benefits from goat sector.
- There is equal opportunity to promote commercial goat farms as well as organised backyard rearing in the country.

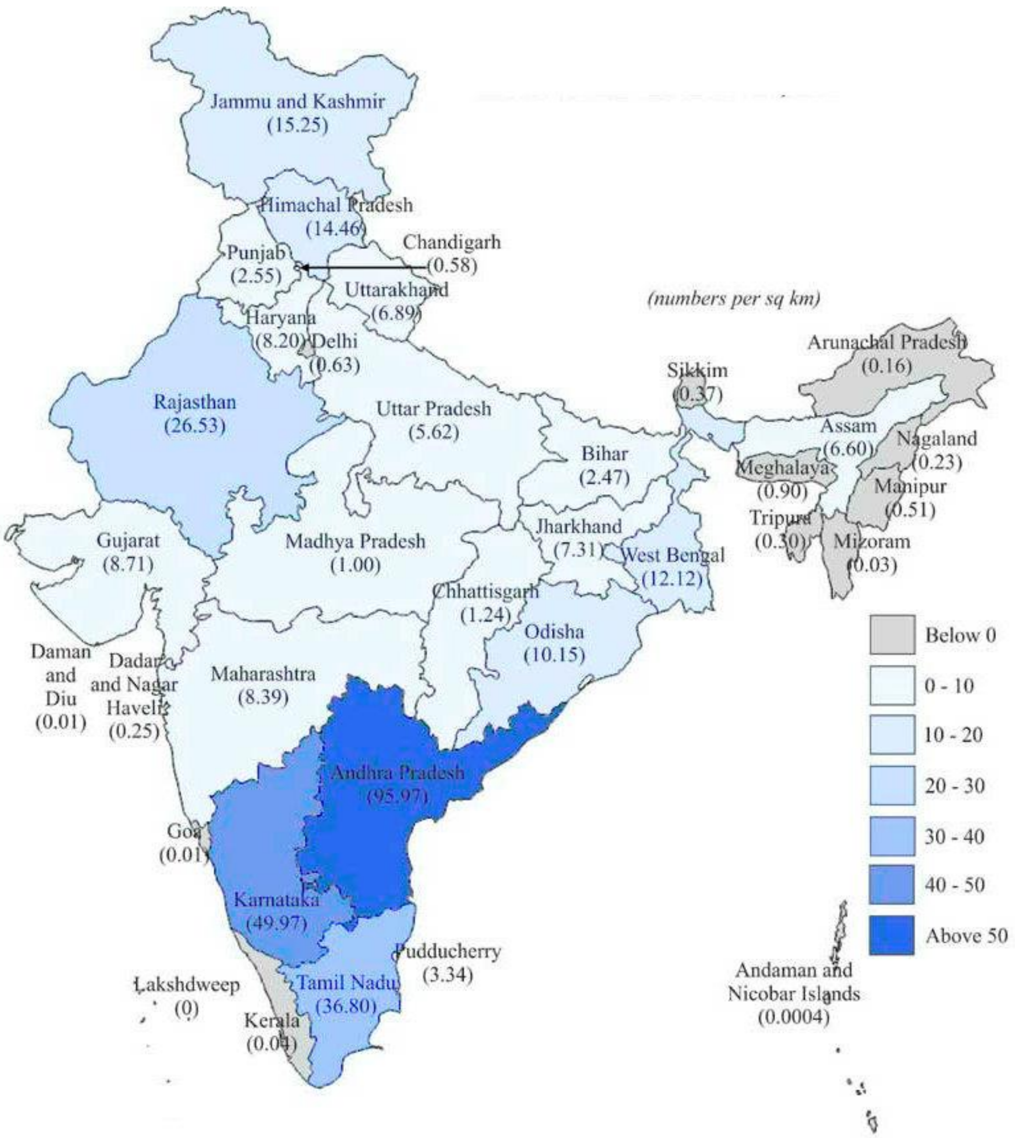
Chapter 11
Sheep Sector: Status and Vision

Sheep with multiple outputs including meat, wool, milk, skin and manure is an important small ruminant. Sheep constitutes an important segment of rural economy in many states, particularly in arid, semi-arid and mountainous areas of the country. There is a growing gap between demand for meat and wool and supply. Hence, there is scope to improve productivity with improved breeds and management.

11.1. Background

NSSO, 2013 reports about 2.5 million sheep rearing households in the country. Out of these, around 65 per cent of the sheep are reared by marginal and small farmers while 35 per cent belong to semi-medium and medium categories. Sheep are largely reared in herds which vary by breed, with average herd size ranging about 50-60 but it can go up to more than 100-200 in some cases.

Figure 11.1 Population density of sheep in India



Sheep have a multi-faceted use by way of wool, meat, milk, skins and manure, and are an important component of rural economy particularly in the arid, semi-arid and mountainous areas of the country. It provides a dependable source of income to the shepherds through sale of wool and animals. Most of the Indian sheep breeds are used for dual purpose, viz. meat and wool. Sheep rearing is a traditional activity in many parts of the country. It provides gainful employment and income to the weaker section especially in rural areas. Meat production contributes about 70-80 per cent and wool contributes only 15-20 per cent to the income of sheep farmers. The average annual household income from sheep rearing ranges from Rs.50,000 to Rs.1,00,000 depending on the herd size. This can go up significantly higher in the case of commercial goat farming or in the case of premium wool as in the case of Jammu & Kashmir and Himachal Pradesh.

Traditionally, sheep rearing has been the primary source of livelihood for shepherds, who often belong to distinct communities. Normally sheep-herders have less land than required, and have to migrate for about 6 months in a year to meet the feed and fodder requirements of their flock. Sheep are grazed on fallow lands during monsoon and after the Kharif crops are harvested on stubbles in the harvested fields. Nutrient requirements of these flocks are largely dependent on the common property resources. The shepherds migrate their flocks over extensive areas within or even in the neighbouring states. Sheep rearing is thus practised in a diversified manner, depending upon the region. In Rajasthan, for example, around five lakh sheep are in permanent migration where the flocks do not return to their home tract at any time of the year.

Sheep meat is more preferred in the certain parts of the country, and competes with goat meat which is somewhat more costly. There is a small price difference of 10-15 per cent in the price of sheep meat and goat meat, with the latter at a premium.

The domestic demand for non-vegetarian food in general and for sheep or lamb meat in particular, is highly income elastic. The demand for non-vegetarian food products is increasing due to high per capita income growth, urbanization and changes in the taste and preferences of consumers (Birthal and Rao, 2004). As per NSSO, 2012 6.4 per cent of rural Indians eat goat/sheep meat, 21.7 per cent eat chicken, 26.5 per cent consume fish, while 29.2 per cent eats eggs. In urban India, about 10 per cent consume goat/sheep meat, 21 per cent and, 27 per cent population consuming fish and chicken respectively, and a huge 37.6 per cent of the urban population eating eggs.

The demand for meat cannot be met from the existing sheep genetic resource reared under traditional extensive and/migratory production systems. The wider gap in demand and supply of sheep meat unless bridged will cause sharp rise in price, leading to dependency on import in future. To combat this situation, a paradigm shift is required in the sheep production from existing extensive to semi-intensive and commercial system. Thus, inputs are required to increase life time production, per animal productivity, reproductive and feed efficiencies.

11.2. Outline of Sheep Sector

Of the total sheep population of the world (1173 million heads) Asia and Africa are home to about 74 per cent of the population with Asia accounting for 44 per cent. The top two leading countries in sheep population are China and Australia which contributes about 42 per cent of the total population of the world. India stands at third contributing 12 per cent to the global population (FAOSTAT, 2016).

As per the Livestock Census 2012, the total sheep in the country was 65.06 million heads reporting a dip in the population from 71 million heads during the census period 2007. Sheep population contributes about 12.7 per cent to the total livestock population of the country. Top five states in sheep population in the country account for more than 80 per cent of sheep population, and these include Andhra Pradesh, Telangana, Tamil Nadu, Karnataka and Rajasthan. However, there has been significant decline in the population in these states too.

A major challenge seen in the recent years is a significant decline in herd size owing to decline in fodder from Common Property Resources (CPRs) driven by changing rainfall patterns. Additionally, changing socio-economic dynamics with higher income generating opportunities, and higher enrolment of children going to school, are bringing about a decline in the migratory pattern.

The overall sheep population in the country has seen a substantive decline of 9.07 per cent over census period 2007 to 2012. This decline is driven by decreasing productivity of community pastures, non-availability of proper feed & fodder varieties, decline in traditional involvement of sheep rearing communities. Climate change is also one of the major factors affecting the survival of many species, ecosystems and livestock production. Another major reason for the decline in population cited by some studies emphasized the higher slaughter rate as compared with rate of reproduction, driven by higher demand, whereby even small lambs are sent for slaughter.

11.2.1. Perspective of Indian market for sheep products

Sheep rearing, integrated into natural resources is an essential complement of diversification of livelihoods. Sheep converts naturally available grasses and agriculture residues into meat, manure and wool. In India sheep are mostly reared for wool and meat. A number of rural based industries use wool and sheep skin as raw material. In addition to this, sheep manure is an important source of soil fertility.

Sheep skin and manure constitute important sources of earning, the latter particularly in southern India. Milk from sheep is of limited importance and that too in very limited areas of Jammu and Kashmir, Rajasthan and Gujarat. Indian sheep breed are largely wool and meat breeds.

11.2.1.1. Meat-Milk-Wool production and trade

Meat is a valuable commodity and an important source of protein. The meat availability in India is only about 15g/person/day against the ICMR (Indian Council of Medical Research) recommendation of 30g/person/day (Islam *et al.*, 2016). As per FAOSTAT, 2016 the total sheep meat production in the world was nine million tonnes with China contributing highest with two million tonnes while India remained at ninth with 0.2 million tonnes of meat production. There is a discrepancy with the production figures in Basic Animal Husbandry Report which reported annual production of 0.4 million tonnes for 2015-16. This suggests the need for data integrity across board so as to develop an accurate roadmap.

As per Basic Animal Husbandry Statistics report, sheep meat production in the country evidenced a steady increase over the past decade. However, in the recent years, the production figures show a decline of 8 per cent. In terms of export, the country exported 23,612 tonnes of sheep and goat meat worth Rs. 8.281 billion during 2014-15 mostly to Middle Eastern countries (APEDA, 2015). Though the sheep and goat meat are reported jointly for exports, the export comprises a larger share of lamb and sheep meat, with mutton (goat meat) having lowest share.

The wool production in India was estimated at 48,000 metric tonnes (MT) during 2014-15. This production figures have largely remained stagnant for the past two decades and also evidenced a decline of 10 per cent in recent years. The top five states accounts for about 80 per cent of the total wool production in India- Rajasthan, Karnataka, J&K, Telangana and Gujarat. The average annual yield of wool is 0.9 kg per sheep, much lower than the world average of 2.4 kg per sheep.

Since indigenous production of fine quality wool required by the organised mill and the decentralized hosiery sector is very limited, India depends upon imports. Imports have been mainly from Australia and New Zealand, the major supplier being Australia. New Zealand wool is being imported mainly for carpet sector for blending it with indigenous wool. Similarly, for the shoddy sector, import of pre-mutilated woollen/synthetic rags is allowed under Open Government Licence.

There is a potential to increase required quantity of carpet wool for fulfilling the demand of the carpet industry. The dominant states for wool industry include Punjab, Haryana, Rajasthan, Uttar Pradesh, Maharashtra and Gujarat. The state-wise location of woollen units shows, that it is 40 per cent in Gujarat, 27 per cent in Haryana and 10 per cent in Rajasthan, and 23 per cent in rest of the states. A few of the larger units are located in Maharashtra, Punjab, U.P., Gujarat and West Bengal[4].

India does not export raw wool, but does ship intermediate and finished products such as woollen yarn, fabric, clothing, and carpets, which generally have increased in the last few years due to price competitiveness. During 2014, in comparison to 2013, overall woollen exports

[4] http://woolboard.nic.in/iwi.htm

increased by 10.5 per cent to $1.058 billion. During 2014, yarn and woven fabric exports were $178.6 million, up by 19.6 per cent. The exports of woollen apparel and clothing in 2014 were $321.31 million, up by 4.15 per cent. The exports of other textiles of woollen were $5.32 million in 2014, up by 30 percent (NAP, 2017).

The total sheep milk production in the country was 0.2 million tonnes during 2016 which accounts for 2 per cent of total milk production in the world (FAOSTAT, 2016). China leads in global milk production with a contribution of 13 per cent. Indian sheep breeds are not considered as pure milch breeds.

11.2.1.2. Manure

Sheep droppings are good manure for the fields. Sheep manure is low in nitrogen with high phosphorous & potassium contents which is good for the growth of plant and can be used as organic mulch.

Sale of sheep manure is an important income generating activity for sheep farmers in many parts of the country. One of the major examples of such practice comes from various states across the country, where the semi-nomadic group of pastoralists keep travelling from village to village. They are invited by the farmers to pen their flock and stay in their farmlands just before the sowing season. The sheep are made to pen in a farm on the farmer's request for a number of days in a fenced area called *wada*. During the day, the sheep are taken away to graze in the fields. The fenced areas are shifted from time to time and the sheep droppings provide manure in the fields. The rearers are paid approximately Rs. 500 per day for this. Sheep manure proves to be a double benefit, while giving income it also provides the space for penning the sheep at night.

11.2.2. Typology of sheep farmers

In most parts of the country, the grazing and feeding practices of sheep are taken care of by the women members, and men are usually involved in marketing. The average herd size per household varies from region to region and farmer to farmer. For example, the average herd size in many parts of southern peninsular region of the country ranges between 40-50 with one or two rams (which depends on the herd size)[5]. However, in some cases it was noted that some farmers own around 200-300 sheep of various breeds (SEVA[6], 2017).

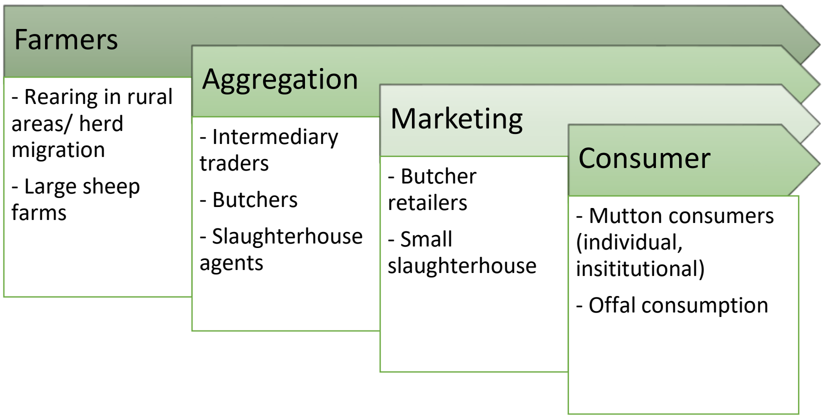
In cold and arid regions, sheep are reared under semi-intensive production system while in southern parts of the country they are reared under extensive system, where they rely on common grazing lands. Financial inputs are much less as compared to other livestock sector. However, due to decreasing size of the pastoral lands in the country production systems are getting restricted to backyard where they are fed with various supplements bought from the local markets.

[5] Tamil Nadu Veterinary and Agricultural Sciences University
[6] SEVA: Sustainable Agriculture & Environmental Voluntary Action

11.2.3. Traditional Supply Chain

The major players involved in sheep sub-sector are primary sheep producers, small and big traders, meat retail shop, wool trader, slaughter houses, processors and exporters, banks, carpet industry, private companies, insurance companies and government department.

Figure 11.2 Overview of supply chain in sheep meat



The main functionaries involved in marketing and trade are sheep rearers, wool/sheep local traders/agents, butchers, processing industries, etc.

Similar to goat, sheep rearers also sell off their male sheep and old female sheep to traders visiting from nearby towns and cities once or twice a week. Another alternative of marketing the sheep are at weekly markets/haats in the various village/township localities. Dealers/traders buy live animals directly from farmers or via primary collectors. The price of animal is quoted by the trader first (on visual estimate) and not by the sheep rearer. As reported in Rajasthan, the rearers have a tendency to sell off their male stocks at an early age.

In some cases, during the drought period when rearers migrate with flocks to places within state or in neighbouring states, they sell sheep and wool to traders/ agents in the migrated places. As per Mehta, 2011 very little value addition is happening from rearer to the end user. All the actors who are involved in the chain gain through economics of the scale and economics of market location.

Local traders visit villages to procure sheep and sell them in sheep mandi at district level. Meat sheep producers sell either slaughter lambs or feeder lambs. Slaughter lambs are usually purchased for immediate slaughter. In the present conditions, the average slaughter weight for a lamb is 20-35 kg and the dressing percentage is 40-50 per cent. However, as per the BAHS 2016 data, average yield per animal is only 9.05/kg/animal. Due to high market demand, there is a market for slaughter lambs of any weight.

Exporters are located mainly in Mumbai, Delhi, etc. from where sheep and sheep meat are exported to Gulf countries. Supplies to big cities are organised, and done through various organisations and associations of traders. The meat is marketed in the retail shops in small towns and in air conditioned shops in metro towns. In metro towns, shops are licenced to maintain prescribed hygienic conditions. Similarly, sheep exports to various countries are also done in a systematic manner which involves careful scrutiny of sheep by veterinary and medical officers. Concerned authorities certify meat exports.

11.2.4. Organised sheep farming and processing

In the recent years, a number of rural youth are getting involved in setting up commercial sheep farms. This is an upcoming trend in the country. These commercial farms undertake sheep rearing in a scientific approach and have also identified alternate channels for marketing of sheep directly to the processors or traders, bypassing the local traders.

Organised processing of sheep is very limited. Currently, it is reported that there are merely 2 modern abattoirs in the country focusing only on small ruminant processing. They are largely focusing on processing of sheep as the export demand is mostly for sheep meat. The scientific slaughtering at scale allows the facilities to maximize on the value generated from by products including hoofs, horn, offal and skin.

11.2.5. Wool trade

Rajasthan ranks first among wool producing states in India. Breeds of the southern peninsular and eastern region hardly contribute wool; they are primarily meat-producing sheep.

Wool production in India is divided into four regions (North western arid and semiarid region; Southern peninsular region; Eastern region; and Northern temperate region) on the basis of the agro-climatic conditions and the types of sheep available.

There are more than 60 marketing centres (wool mandis) in different states of the country, where wool is sold in variable quantities. About 50 per cent of the produced wool is brought to the nearest wool mandis (markets) and sold through open auction. The sheep owners, who belong to a highly illiterate and economically weaker section of the society and live in remote areas, still depend, by and large, on local brokers (middlemen) to sell their stock.

Sheep wool is mainly used in carpet industry within various states or in neighbouring states across the country. Supply channel for Wool in Himalayan Regions (Wani *et al*., 2014):

Channel-I: Producer → Wool Dealer → Processing Industry of Punjab
Channel-II: Producer → Wool Board → Processing Industry of state

Male sheep tend to produce slightly more wool than female sheep. Shearing is done twice a year in most of the cases[7]. As per a few reports it was noted that the shepherds who borrow from commission agents are bound to sell their wool to them, which means that they forego the higher returns that could possibly accrue from an open auction in the market. Further, they

[7] http://www.fao.org/docrep/004/X6532E/X6532E04.htm

are also required to pay an interest of 2 per cent per month on the outstanding loan. These factors further diminish the already poor returns that accrue to shepherds (Mehta, 2011).

In states like Rajasthan, the villagers wash and cut the wool and sell to local traders at Rs. 40-50 per kg. Whereas in some cases rearers hire labour for wool cutting and sell wool without cleaning and get only Rs. 30-35 per kg. A rearer spends about Rs. 12-14 per sheep on persons (labour and food) who cuts the wool. The wool reaches mandis (markets) where it is sorted and graded, processed into yarn to feed the carpet industries across various states. After sorting and grading, wool is sold for Rs. 60-90 per kg. However, the price of wool varies from state to state and from breed to breed[8].

11.2.6. Availability situation of inputs and services

Sheep husbandry is severely affected by health hazards if infectious diseases like PPR etc. are not controlled in time. Diseases are the major source of economic loss to the sheep production. About 15 to 20 per cent of sheep die due to various diseases in India. During the migration, shepherds face high morbidity and mortality in flocks due to various diseases resulting in economic loss, as there is no access to medicines and veterinary facilities in the areas of migration.

The cost on feed supplements is negligible in many parts of the country as they are left to graze on pastures, paddy fallows, etc. The flocks are grazed in morning and in evening. In some parts, sheep are fed with maize, barley, wheat, horse gram clover, sesbania leaves, *Acacia nilotica* leaves, cluster beans, tender shoot/stems, etc. Water mixed with oil cake is also provided to the flock.

Grazing and browsing are the main resources to meet the nutrient requirements of small ruminants in India. However, the area under grazing is steadily decreasing due to increase in human population, urbanization, pressure on land for growing food and commercial crops to meet the demands. Further, there is a shortage of dry fodder, green fodder and concentrates to an extent of 31, 23 and 47 per cents, respectively in meeting the nutritional demands of existing population, which shows that large gap still exists between requirements and availability of feed resources in India. Hence, sheep are most often prone to severe nutritional stress which adversely affects their production performance (NRCM, 2012).

Though most of the disease outbreaks in sheep can be controlled through preventive care, the coverage of preventive care in the country is limited to a small percentage of animals. The supply of vaccines, de-worming and medicine facilities are mostly provided by animal husbandry departments of various states at a very subsidized rates. However, due to limited manpower and veterinary/outreach centres, the accessibility is limited. In the case of sheep, which are on migratory route, the outreach of services becomes even more difficult which is further aggravated by cross-state movement.

[8] http://www.mpowerraj.gov.in/

In many cases, the farmers themselves are adept at injecting animals (Mehta, 2011). In rural parts of Rajasthan, for minor ailments the rearers self-administer drugs to their flocks, and women are quite used to injecting the animals. It is interesting to note that in Rajasthan, especially in rural areas, practice of vaccination is generally adopted at the time of migration of flock or if there is an outbreak in nearby areas (Singh *et al*., 2018).

In Southern Peninsular Region, total annual expense of vaccines and medicines for a shepherd for one animal would be in a range of Rs. 50. Ethno-veterinary practices are also undertaken in rural areas across the country. Many local NGOs and community organisations are involved in providing veterinary care to the ewes and rams.

11.3. Gap in demand-supply position

Sheep contribute 263 million kg in meat, which is expected to reach 356 million kg by 2030. The demand for sheep and lamb meat is progressively increasing with economic empowerment of Indian consumers throughout the country particularly in J&K and Southern States. During this period, demand for sheep/lamb meat in the country would be 579.5 million kg indicating a deficit of 37.2 per cent. This is a serious problem, when demand of sheep meat is growing and import of wool is increasing, the declining activities of sheep husbandry may cause agrarian distress.

The demand of wool in the country is increasing and woollen industries in the country would require 296 million kg of wool by 2030. The country's requirement would not match with the current production trend, and about 220 million kgs of raw wool will have to be imported from wool producing countries by 2030. Woollen industry provides employment to about 2.6 million people and earns more than Rs.5,000 crore of foreign exchange through exports. Sheep husbandry provides export earnings of Rs.250 crore from meat and animal casing and processed meat.

Looking into future demand of wool and availability in domestic as well as international market, it is a challenge to meet the demand of wool in the country. Indian woollen sector consumes about 50 million kg apparel grade and 100 million kg carpet grade wool. The requirement of apparel grade wool is met through import from Australia, Russia, UK & USA; and demand of carpet grade wool is partially met (40 per cent) from domestic market and rest through import from New Zealand, Argentina, Spain etc. The installed capacity in woollen industry and consumption of woollen products in India is continuously growing by 1 per cent per annum, hence the demand of wool would raise in future.

11.4. Major Challenges

The weaknesses of sheep husbandry indicate following factors e.g. shrinkage of grazing resources, scarcity of water, climate change, poor health management, unorganised marketing structure for meat & wool, dependence on imported wool, ineffective financial support from financial institutions, poor risk management strategies, frequent drought and other disaster which are responsible for deteriorating sheep production in the country. It has been observed that flock sizes over the period are declining, mainly due to shrinking grazing resources. If this trend continues, flock size may further reduce to less than 25 per household by the year 2030 in comparison to earlier 100-200.

The challenge arising from probable deficit of meat and wool against the rising domestic demand can be seen as opportunity, and an appropriate policy adopted to accelerate the growth of sheep sector in the country. Given the increasing demand for meat and wool, there is an urgent need to genetically improve these animals through scientific breeding tools to enhance their productivity. Emphasis on well adapted indigenous breeds, to harness the better adaptive traits developed through natural selection, is needed.

The constraints to growth can be summed up as follows:

i. The majority of sheep (63 per cent) in India belong to 'un-described' (usually referred to as non-descript) breeds or they are 'local' animals not necessarily belonging to a distinct, 'recognized' group or breed. There is also a lack of good quality data on small ruminant numbers, breed population, trends over time and drivers of these trends.

ii. Poor breeding practices due to lack of awareness of scientific breeding practices as well as inter-mating among available animals is common due to limited availability of high quality rams. The current pattern of producing low genetic merit animals is due to little selection process of rams/ewes used for breeding.

iii. In most states, there is a virtual absence of para-veterinary and extension services at the village level; the government veterinary system reaches only upto the Block level and is inadequately staffed. The para-vets and community animal health workers have been trained in veterinary care, however, questions around the sustainability and legality of the services provided by these trained para-vets and extension workers persist.

iv. Vaccines for major diseases are either not available in adequate numbers, or cold chain supply systems are not adequately maintained, affecting the efficacy of the product.

v. An erosion of synergies between agriculture and animal husbandry due to an interplay of various factors, makes small holder rearers' livelihoods more vulnerable. Factors like loss of designated grazing lands, closure of forest areas, and diversion of common lands for other purposes has intensified pressure on available resources, and their degradation.

vi. Encroachment of common lands, and increasing industrialisation have adversely affected sheep rearing, which used to be a highly productive low-input system, dependent on these lands for fodder and grazing resources.

vii. Market transactions are non-standardised and unfair trade practices can be observed because of the ad-hoc nature of the market. Animals are sold on the basis of a visual estimation of their weight, age and appearance; transactions remain unrecorded and unreported, resulting in loss of potential taxes/revenue to the government, which could go towards development of livestock market infrastructure.

viii. There is little processing or value-addition in the chain from goat/sheep rearers to the end user; the main players simply target economies of scale, market location and credit-based market dynamics, which necessitate the presence of brokers and guarantors.

ix. Adequate slaughter facilities, to produce meat under hygienic conditions, are lacking. Practices in authorised and unauthorised units, make meat inspection impossible.

x. The livestock extension services for sheep in particular are poor in comparison to overall agriculture. Little efforts have been made to transfer improved production technologies to the sheep farmers. The State Animal Husbandry Departments (AHDs) maintain services only for health and breeding coverage.

11.5. Vision for Sheep

The future vision is to enhance productivity of sheep for livelihood security, economic sustenance of farmers and to provide wholesome, hygienic meat for consumers and wool for industries in the country. For this, the focus must be to improve per animal productivity with suitable market-led interventions so that efficient utilisation of products is assured. Newer technological innovations are a necessity for making the livestock enterprise, a profitable one. Women empowerment and livelihood security, especially in arid, semi-arid sub-humid and hilly areas is part of this vision.

Adoption of new economic and viable technologies are needed to enhance sheep production. With associated market development, it will ultimately help to harvest the benefit in terms of increase in production of wool & meat, with higher returns to farmers. To meet demand for quality produce, the vision requires mid and long term strategies to value addition and market.

Key Extracts

- Shrinking grazing resources and non-descript breeds define sheep sector, with insufficient veterinary outreach and general lack of selective breeding in sheep.
- There is little organised industry in sheep production and formalised arrangements or farmers' linkage with processing industry for meat and wool is at a minimal.
- KVKs have a large footprint in the country and can act as training centres for para vets and community help animal workers, besides providing other technical support.
- Specific programmes to improve quality of wool and yield is an opportunity, since more than half of wool requirement is still being imported.
- Forward & backward linkages of primary producers with meat and wool industries and input supplies must be promoted, to support growth and quality of sheep production.
- Cooperatives and FPCs of sheep rearers need to be actively promoted and developed.

Chapter 12
Small Ruminants: Project Economics

This chapter deals with the economic analysis of livestock management (in small units or commercial rearing system) with cost: benefit ratio and improvement in socio-economic status of livestock farmers.

12.1. Sheep

Current income from sheep rearing

Majority of the sheep flocks in the country are maintained under extensive management system with a small supplementation during critical seasons. The net income of sheep rearing under extensive system in farmers' field of Rajasthan has been worked out in different studies, and it comes to Rs 946 / sheep /year. In organised farms where flocks are maintained under grazing plus concentrate feeding, net income comes to Rs 872 / sheep/ year. Some of the farmers in semi-urban areas are found to be rearing lambs under intensive feeding on concentrate and roughages for mutton production. These lambs fetch higher price in market. In this system, net return comes to Rs 2,074 / lamb at market age. In another system where lambs are grazed on pasture and supplemented with concentrate at 300-400 g per day at stall, the net income realised is Rs 1950 / lamb at market age.

Table 12.1 Doubling the income of Farmers by sheep farming

Component of Sheep Income	Contribution at present	Target/strategies by 2022	Target for income of farmers by 2022 in Rs.
Live animal	Rs. 740.00 (85 per cent)	• At least 60 per cent of the population to yield 2 lambs in a year by introgression of Fec B gene from Avishaan sheep • Accelerating lambing for producing 3 lambs in two years • Intensive feeding in lambs to achieve 150 gms ADG • Application of planned flock health technology to reduce mortality loss	1445.00
Wool	Rs. 70.00 (8 per cent)	• Skill development and value addition to coarse wool by developing handicraft (Rs. 1450.00) in villages	195.00
Manure	Rs. 60.00 (7 per cent)	• Value addition of manure with wool waste to increase soil fertility	90.00
Total	**Rs. 870.00**		**1730.00**

At present income of farmers from sheep rearing in prevailing system of extensive system is Rs 870/sheep/ year. By better technological and managerial interventions, the income of farmers can be increased to Rs 1730/sheep/year. (ICAR-Central Sheep and Wool Research Institute, Avikanagar).

12.2. Goat

Table 12.2 Case study of profit in Barbari goats under extensive and strategic management systems

Parameter	Performance of goats in Extensive Management system	Performance of goats with support of strategic interventions
Mortality of kids	25 per cent	<8 per cent
Mortality of adult goat	15 per cent	<5 per cent
Lactation period	65 days	110 days
Lactation milk yield	40 litre	65 litre
Body weight at one year	16 kg	22 kg
Kidding interval (KI)	12 month	8 month
Age at first kidding (AFC)	18 month	14 month
Multiple birth (per cent)	40 per cent	65 per cent
Average increase in number of kids/year/goat	6 kids	9 kids
Number of surplus kids/year (assuming average adult flock size of 5 and 25 per cent kids mortality in Extensive management and 7 per cent with strategic management intervention)	07	11
Net income/goat/year due to increased productivity (body weight, milk yield, kidding rate, saving due to reduction in age at first kidding, kidding interval) and survivability. ▪ Kids for sale increased from 7 to 11 ▪ Weight increased from 16 kg to 22 kg /goat ▪ Surplus milk 25 kg @ Rs. 25 ▪ Survival of adult goat ▪ Decrease in feed, labour etc cost due to decrease in AFC, KI	Rs. 3000	Rs. 5000
Income from surplus milk/adult goat/year	Nil	625
Manure @ Rs. 1/goat/day	4300	5840
Income from sale of male @ Rs. 4500 under EMS Income from sale of male @ Rs. 6000 under SIM on account of higher weight (6 kg)	35000	66000
Survival of adult goat (0.6)	-	3000
Saving of feed and labour on account of reduction in AFK, Kidding Interval	-	5000
Book Value of 5 adult goats	25000	30000

Cost/goat/year @ Rs. 1550 goat/year (5 adult + 7 kid) in EMS (labour, health etc) Additional cost @ Rs. 3000 goat (feed, health, housing) in strategic management	18600	48000
Return over variable cost with flock of 05 adult female/year	Rs. 16,400	Rs. 32,465

Source: Singh M K and co-workers, 2018.

Return over variable cost per goat under extensive management from one adult Barbari goat is Rs. 3,280 whereas with strategic feeding support it could rise to Rs. 6,493. The profit increased with strategic support on account of increased body weight (>40 per cent), increased milk yield (80 per cent), increased survivability (50 per cent), increased multiple birth (50 per cent), increase in premium value on account of breed purity (20 per cent).

Table 12.3 Production and economic characteristics of major goat breeds of India

SN	Production Characteristics	Barbari	Jamunapari	Sirohi	Black Bengal
1	Suitable climate	Semi-arid	Semi-arid	Semi-arid	Hot-humid
2	Cost of adult female (Rs.)	5000	8000	7000	3500
3	Age at First Kidding (months)	12-16	18-22	18-20	10-12
4	Kidding Interval (months)	9	10	10	8
5	Multiple Birth (number)	1.6	1.3	1.3	2.2
6	Kids produced in 3 years	6.4	4.7	4.7	10
7	Survival of kids up to 12 months (%)	92.5	92.5	92.5	80
8	Survived kids available in 3 years	6.4	4	4	8
9	Body weight at 12 months (kg)	22	27	27	16
10	Weight delivered/goat/year (kg)	42	38	38	42
11	Milk yield/goat/year (litre)	80	135	100	30
12	Surplus milk/year (litre)	25	78	60	0
13	Income surplus milk	625	1950	1500	-
14	Maintenance cost - adult female & its kid/year (Rs.)	4250	4550	4150	3840
15	Sale Price of kids/year (Rs.)	8400	7300	7300	8440
16	Net profit per goat per year (Rs.)	4775	4700	4650	4600

Source: Singh M K and co-workers, 2018.

Note: Productivity and economics have been worked out of goats maintained under semi-intensive feeding system, where are provided about 50 per cent of feed-fodder requirement through supplementation, and remaining 50 per cent from grazing area.

12.3. Economics of Pig Farming

- Foundation stock: 10 gilts and 1 boar purchased at 30 kg live weight @ Rs 100 per kg live weight. The animals get ready for breeding after 3 months.

- 1/3rd of the female are expected to conceive at a time
- 5 numbers of gilts will be housed in one pen and boars will be housed singly
- Feed requirement till puberty @ 1.0 kg/head /day
- Feed requirement of breeding boar @ 2.0 kg/head /day
- Feed requirement of pregnant sow @ 2.0 kg/head /day
- Feed requirement of lactating sow @ 2.5 kg/head /day for the period of 56 days
- Feed requirement of sow after weaning for 30 days @ 1.5 kg/head/day
- Feed requirement of piglet during suckling period @ 2kg/piglet for 56 days

Cost A. Non-recurring expenditure

- Cost of foundation stock : Rs. 33,000
- Cost of house : Rs. 88,500.00
- Miscellaneous Cost : 5,500/- (Rs.500/animals)

Cost B. Variable cost

- Cost of feed: Rs. 1,86,000.00 (using 60 per cent concentrate and 40 per cent locally available unconventional feed material
- Labour cost: self
- Vaccination and medicine : Rs. 4,000.00

Total Cost (A + B) : Rs. 3,17,000.00

Returns: Sale of piglets in 1st year : 6,00,000.00 (20 piglets per pig per year @ Rs.3000.00/per piglet)

Gross Income (Total Returns –Recurring Expenditure) : Rs. 2,83,000.00

(Source: ICAR – National Research Centre on Pig)

12.4. Economics of Poultry Farming

An economic analysis was carried out for the rural improved chicken germplasm aimed for dual purpose (*Vanaraja*) and egg type (*Gramapriya*) birds. The cost analysis was done considering cost of day old chick, rearing expenses for feed and health care, body weight of the bird at market age, number of eggs produced under free range conditions.

However, the cost also varies dramatically primarily based on the quantity of natural food base available. The male birds are disposed off, for table purpose and female birds are kept for long laying cycle i.e. 72 weeks of age.

The input cost includes price of the chick, feed health, etc, upto 4-6 weeks of age, and thereafter the recommended mode of rearing is free range without any feed supplementation. Additional feed supplementation which may increase the performance of the birds is optional. The input cost of include medication and additional feed supplementation (optional) under the free range conditions.

Table 12.4 Economics of dual purpose rural chicken (Vanaraja) variety in free range conditions (per male and female pair)

Input			Output		
Sex	**Age of the bird**	**Cost (Rs.)**	**Particulars/details of the bird**	**Receipt (Rs.)**	**Profit (Rs.)**
Male	12 wk	100	Bird at 12 wks (1.5-1.8 kg) @ Rs. 120/kg	180-240	80-140
Female	72 wk	225	Eggs: 100-110 @ Rs. 3/egg Birds: 3.0 kg @ Rs. 80 kg Total	300-330 240 540-570	315-355

From the above table, the total profits form a pair of birds works out as follows"

Cost	-	Rs. 325
Receipt	-	Rs. 720-810
Profit	-	Rs. 395-810

Table 12.5 Economics of egg type rural chicken (Gramapriya) variety in free range conditions per male and female pair

Input			Output		
Sex	**Age of the bird**	**Cost (Rs.)**	**Particulars/details of the bird**	**Receipt (Rs.)**	**Profit (Rs.)**
Male	15 wk	90	Bird at 15 wks (1.5-1.8 kg) @ Rs. 120/kg	180-240	90-150
Female	72 wk	220	Eggs: 160-180 @ Rs. 3/egg Birds: 2.5 kg @ Rs. 80 kg Total	480-540 200 680-740	460-520
Total profit from a pair of birds		310		860-980	550-670

Source: ICAR – Directorate of Poultry Research Hyderabad.

* Includes cost of day old chick, feed, medicines and healthcare etc.

These economics were estimated under the assumption that the natural food base under free range system is reasonable available to meet the bird's nutritional requirements. The estimates were calculated hypothetically taking into consideration the present market price and demand for eggs and meat.

Considering the germplasm supply in the year 2016-17, the Directorate has supplied about 55 lakh improved rural chicken including PSP and AICRP centres, which means the supply accounts for about 27 lakh pairs of rural chicken. The calculated total profit from the supply is **Rs 10,665 to 13,095 lakh** considering that the total supply was dual purpose birds; or **Rs 14,850 to 18,090 lakhs** considering the total supply was egg type chicken varieties.

It is pertinent to mention here, that for a comprehensive and holistic development of sheep, goat, pig and poultry in the climate change scenario, it is also essential that:

a) the bio-resources, that contribute to feed and fodder basket are tapped; and
b) a good livestock insurance policy is adopted to secure the farmers' income against possible events of natural calamity.

12.5. Government Interventions in Small Ruminants

Livestock include small ruminants and poultry and the Government also has initiated some pilot projects planned to promote the small ruminant sub-sector. Some of these include:

<table>
<tr><th rowspan="2">SN</th><th rowspan="2">Pilot Intervention</th><th rowspan="2">Activity</th><th colspan="5">Milestones</th></tr>
<tr><th>2017-18</th><th>2018-19</th><th>2019-20</th><th>2020-21</th><th>2021-22</th></tr>
<tr><td rowspan="2">1.</td><td rowspan="2">Innovative Project for "Genetic Improvement of Sheep and Goat" (GISG)</td><td rowspan="2">The action plan for sheep and goat breed improvement would firstly involve identification of the herd population of high genetic merit and propagation in earmarked districts of selected 8 States only (sheep = 5 states & goat = 4 states) on pilot basis.</td><td colspan="5">Expected Outcomes: Sheep
i) The expected number of High Genetic Merit lambs to be born through one mating upto F2 level only is 2.46 lakh out of natural service, and 3.60 lakh out of artificial insemination (AI) through frozen semen. This is after considering mortality and other losses at 10 per cent and 50 per cent success in AI.

ii) An estimated total of 1.59 lakh farmers will be benefitted upto F2 level.</td></tr>
<tr><td colspan="5">Expected outcomes: Goat
i) An anticipated total of 6.74 lakh of High Genetic Merit kids will be born at F2 generation level through one mating of the selected/identified animals.</td></tr>
</table>

SN	Pilot Intervention	Activity	Milestones				
			2017-18	2018-19	2019-20	2020-21	2021-22
			ii) An estimated total of 2.33 lakh farmers will be benefitted upto F2 level.				
2.	Innovative Pig Development Project for North East (IPDPNE)	HGM breed to be imported and up-gradation through cross-breeding by natural service also AI by liquid semen in north eastern states including Sikkim on pilot basis with a capacity to cover 10 per cent non-descript pig population on an average	The plan targets to cover 75,097 numbers of non-descript breed through natural service and 1,50,193 numbers through Artificial Insemination. Expected number of F1 upgraded animals produced per functional year considering 1.5 farrowing per year & 15 per cent mortality (i.e. 12 piglets per sow per year) through Natural Service is 9,01,164 numbers and through Artificial Insemination is 13,51,728 numbers. Approx. Farmers to be benefitted {@ 4 animals per Household} are expected to be around 5.63 lakh numbers.				
3.	Innovative Poultry Productivity Project (IPPP) to be implemented on pilot basis in 15 States	To encourage broiler rearing by giving 600 broiler chicks in 4 batches	Distribution over four years of 72 lakh broilers in 4 batches of 150 birds each year to around 12,000 beneficiaries; this will produce 123 lakh kg meat valued at Rs. 12,312 lakh.				
		400 low-input technology (LIT) birds in 2 batches with a gap of one and a half years	Distribution over 2 years of LIT birds – 200 in first year and then after 18 months to be repeated twice i.e. over 4 years 48 lakh LIT chicks to be distributed to 12,000 beneficiaries; this will produce 61.20 lakh kg meat and 2880 lakh eggs valued at Rs. 26,280 lakh.				

12.5.1. Genetic Improvement in Sheep and Goat (GISC)

In order to enhance the incomes from livestock, one of the critical needs is to achieve higher productivity of meat, milk and wool. This calls for the genetic improvement of indigenous breeds, as well as non-descript small ruminants.

Based on a gap analysis of productivity parameters, a two (2) step Action Plan with focus on separately identified breeds for meat, milk and wool production is proposed. These steps are:

i. Genetic improvement of identified indigenous descript breeds of sheep and goat through selective breeding for better yielding breed stock for meat, milk and wool.
ii. Genetic improvement of non-descript breeds from existing improved descript indigenous breeds.

Accordingly, a breeding plan has been formulated to fulfil the twin goals for Genetic Improvement in Sheep and Goat. This must be implemented in a comprehensive manner.

12.5.2. Animal Husbandry Infrastructure Development Fund (AHIDF)

The infrastructure needs of the animal husbandry sector including sheep, goat, poultry and piggery gets a big push with the Union Budget, 2018 announcement of creating a Corpus Fund of the size of Rs. 2,450 crore. The objectives of AHIDF are to address the inadequacy of animal husbandry infrastructure at different levels with financial leveraging for:

- doubling of farmers income; and
- increasing availability and accessibility to protein-rich food to the young population.

Proposed activities:

- Establishment / strengthening of livestock breeding farms, poultry breeding farms, poultry hatcheries.
- Establishment/strengthening of semen stations for goat, sheep and pig
- Establishment/strengthening of Skill Training Institutes (with residential facility),
- Establishment/strengthening of feed mixing units, by-pass protein units, fodder block making unit, veterinary healthcare centers, dispensaries, biological units for healthcare
- Catering to the need for upgrading the forward linkages like livestock and livestock product markets, retail outlets, cold-chain connectivity, etc.

12.5.3. Innovative Pig Development Projects for North-East (IPDNE)

Piggery is a popular activity, with no social taboo in the north eastern states including Sikkim. However, this sector has not been able to flourish as an enterprise, since it is mainly the non-descript breeds having low productivity rate, that are reared. The efforts to introduce exotic germplasm have not met success as yet, and indiscriminate breeding among animals of inferior quality has continued. Inbreeding has become common. Further, quality animals have ended up in slaughter houses. In order to check this negative trend, and provide an impetus to piggery, a sub-mission, "Innovative Pig Development Project for North East (IPDPNE)" has been rolled out under the 'National Livestock Mission (NLM)'.

As per Census 2012, the population of the pigs in the country is 10.29 million numbers, which was a decrease by 7.54 per cent over the previous Census. Pigs account for 2.01 per cent of the total livestock population of the country. Of the total pig population, number of males are

4.96 million (4.68 million indigenous and 1.28 million exotic) and 5.33 million are females (4.16 million indigenous and 1.17 million exotic).

The meat production in the country (from all sources) as per 2014-15 data was 6.6 million tons with a per capita availability of 4.94 kg. Of this, pig contributed 9 per cent with a total meat production of 4.64 lakh tonnes.

The challenges of this sector lie in bridging the gap that exists between the current low productivity index of the Indian breeds and the potential growth rate and mature weight. The objective of IPDPNE is to increase the pig meat production and to increase the income of the pig rearing farmer /entrepreneur/NGO/Cooperative Society, etc. This is envisaged to be achieved by importing and incorporating superior germplasm of high genetic merit.

The components of this initiative include strengthening of pig breeding farmers, import of germplasm, support breeding programmes, propagate reproductive technologies, and health cover. Appropriate measurable outcomes, including income growth of farmers, may be developed and monitored.

12.5.4. Innovative Poultry Productivity Project (IPPP)

Private Industry and NABARD generally encourage economically large scale poultry which are viable/bankable projects. However, these remain beyond the reach of the small and marginal farmers and resource poor, and they need to be supported. Accordingly special focus maybe provisioned to upscale small poultry farmers and develop suitbale linkages with larger processing industry.

Presently, under National Livestock Mission (NLM), there exists a scheme called, 'Rural Backyard Poultry Development (RBPD)', which covers Below Poverty Line (BPL) families to enable them to gain supplementary income and nutritional support. Under RBPD, chicks/birds suitable for raising in the backyard are reared in the mother units, for upto four (4) weeks, and are then distributed to the beneficiaries spread over at least two batches.

It is possible to move incrementally from this subsistence model of backyard poultry farming to an entrepreneur model comprising 200-400 birds. In case of low-input technology (LIT) birds, it would be possible to later upscale to 1,000-2,000 birds for larger scale poultry farming.

A similar model is also feasible in case of broilers, where small scale broilers set up initially can be scaled up to commercial scale. It would help to promote small scale broiler in a cluster mode. This would help in providing various services, including market linkages in an efficient manner.

Key Extracts

- Sheep rearing profits can be doubled with the extensive management systems and income generated from meat, wool, and manure can be enhanced.
- Goats can be reared under extensive and strategic management system to obtain optimal benefit and enhance the farmers' income two folds. Value addition to the products is also suggested for better returns from goat rearing.
- Pig rearing can be made highly profitable through introduction of exotic breeds and their crosses with indigenous breeds. Moreover, value addition through meat processing can further increase the income of pig rearers and double their income easily.
- Rearing of newly developed varieties can increase the egg and chicken production many folds. Value addition to the poultry meat products can provide an additional source of income to the farmers.
- Overriding challenge will be to promote and strengthen a more effective and efficient marketing system of the output from small ruminant rearing.
- The scheme 'Genetic Improvement of Sheep and Goat (GISG) would help in upgrading the genetic quality of undescribed (non-descript) sheep & goat and result in higher productivity. The scheme enables to undertake selective breeding among recognised breeds for genetic improvement.
- The initiative, namely, 'Innovative Pig Development Project for North East (IPDNE)' has been launched to import and incorporate the superior pig germplasm of high merit.
- Under 'Innovative Poultry Productivity Project (IPPP)', backyard poultry is promoted to benefit the families below poverty line (BPL). There is scope to upgrade these small operations to larger units of 200-400 birds, and further to units of 1000-2000 birds in some cases. If these are promoted on cluster basis, economics of scale would operate and benefit the beneficiaries / entrepreneurs.

Chapter 13
Marketing of Live Animals and Livestock Produce

Livestock is an important source of income for farmers and the growing demand for animal protein and other products signifies an added opportunity for farmers. Besides the produce from livestock, the live animals themselves are tradeable assets, and improvement in the marketing system will benefit farmers.

13.1. Background

Livestock production and crop based agriculture are intrinsically linked, each being dependent on the other, and both are crucial for overall food and nutritional security. The ownership of the livestock is more evenly distributed, with landless labourers and marginal farmers owning bulk of livestock. Rural women play a significant role in animal husbandry, being involved directly in livestock operations relating to feeding, breeding, management and health-care.

Broadly, livestock is defined as farm animals regarded as an asset, who are raised on a farm to generate a profit, and refers to animals such as cows, sheep, chicken and pigs. The FAO/WHO Food Standards Programme defines livestock "as any domestic or domesticated animal including bovine (including buffalo and bison), ovine, porcine, caprine, equine, poultry and bees raised for food or in the production of food. The products of hunting or fishing of wild animals shall not be considered part of this definition." The animals included are large and small quadrupeds, birds (including poultry like partridge, pheasant, ostrich), insects (bees) and larvae of insects (silkworms). However, in today's age even snake and scorpions are being farmed for venom. With the growth in inland fisheries, fish farms can also be considered as farmer's livestock as it is an animal asset and is cultivated for commercial production.

From the perspective of the DFI Committee, livestock broadly implies living stock or assets, of animals that are reared in agricultural setting, to produce goods (such as meat, milk, eggs, wool, hide, feather, honey, etc.) and/or to produce labour to service agricultural activities. Livestock marketing involves the facilitation of trade of the goods and services that arise from livestock. The produce from livestock can undergo agro-processing and the resultant products are marketed by attached industries and therefore different from livestock marketing.

13.2. Livestock produce and products

Livestock production can be broadly categorised into production of animals themselves and the secondary produce such milk, eggs, wool, hide, meat, etc. Besides trade in live animals, the other livestock produce that is traded can be categorised into produce from live animals, products from slaughtered animals and by-products from livestock production.

Produce from live animals are whole milk (from cow, buffalo, camel, sheep, goat), eggs (from hens, duck, partridge, ostrich, etc.), wool, honey, bees wax, *ahimsa* silk, germplasm, etc. Products from slaughtered animals include meat, offal, fat, skin (sheepskin, buffalo hide, pig skin, rabbit skin, etc.), fur, etc.

Table 13.1 Livestock Population in India (in million) – Livestock Census, 2012

Species	1951	1982	1987	1992	1997	2003	2007	2012
Cattle	*155.3*	*192.5*	*199.7*	*204.6*	*198.9*	*185.2*	*199.1*	*190.9*
Buffalo	*43.4*	*69.8*	*76.0*	*84.2*	*89.9*	*97.9*	*105.3*	*108.7*
Total Bovines	198.7	262.4	275.8	289.0	289.0	283.1	304.8	300.0
Sheep	39.1	48.8	45.7	50.8	57.5	61.5	71.6	65.1
Goats	47.2	95.3	110.2	115.3	122.7	124.4	140.5	135.2
Horses & Ponies	1.5	0.9	0.8	0.8	0.8	0.8	0.6	0.6
Camels	0.6	1.1	1.0	1.0	0.9	0.6	0.5	0.4
Pigs	4.4	10.1	10.6	12.8	13.3	13.5	11.1	10.3
Mules	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.2
Donkeys	1.3	1.0	1.0	1.0	0.9	0.7	0.4	0.3
Yaks	NC	0.1	0.0	0.1	0.1	0.1	0.1	0.1
Total Livestock	292.8	419.6	445.3	470.9	485.4	485.0	529.7	512.1
Poultry	73.5	207.7	275.3	307.1	347.6	489.1	648.9	729.2
Dogs	-	18.5	18.0	21.8	25.5	29.0	19.1	11.7
Rabbits	-	-	-	-	-	0.5	0.4	0.6

Table 13.2 Production of major livestock products – all India

Year	Milk (mill tonnes)	Eggs (mill nos.)	Wool (mill kgs)	Meat (mill tonnes)
2006-07	102.6	50,663	45.1	2.3
2007-08	107.9	53,583	43.9	4.0
2008-09	112.2	55,562	42.8	4.2
2009-10	116.4	60,267	43.1	4.5
2010-11	121.8	63,024	43.0	4.9
2011-12	127.9	66,449	44.7	5.5
2012-13	132.4	69,731	46.1	5.9
2013-14	137.7	73,438	47.9	6.2
2014-15	146.3	78,484	48.1	6.7
2015-16	155.5	82,929	43.6	7.0
2016-17	165.4	88,139	43.5	7.4

Source: DAHD Annual Report, 2017-18

The by-products of livestock production are both dairy based and non-dairy based requiring added activity besides initial harvesting. The dairy based products include butter, ghee, curds, cheese, whey, casein, rennet, ice-cream, powdered milk, dried eggs, egg albumin, etc. and are closely integrated with the primary produce (milk) from livestock farming.

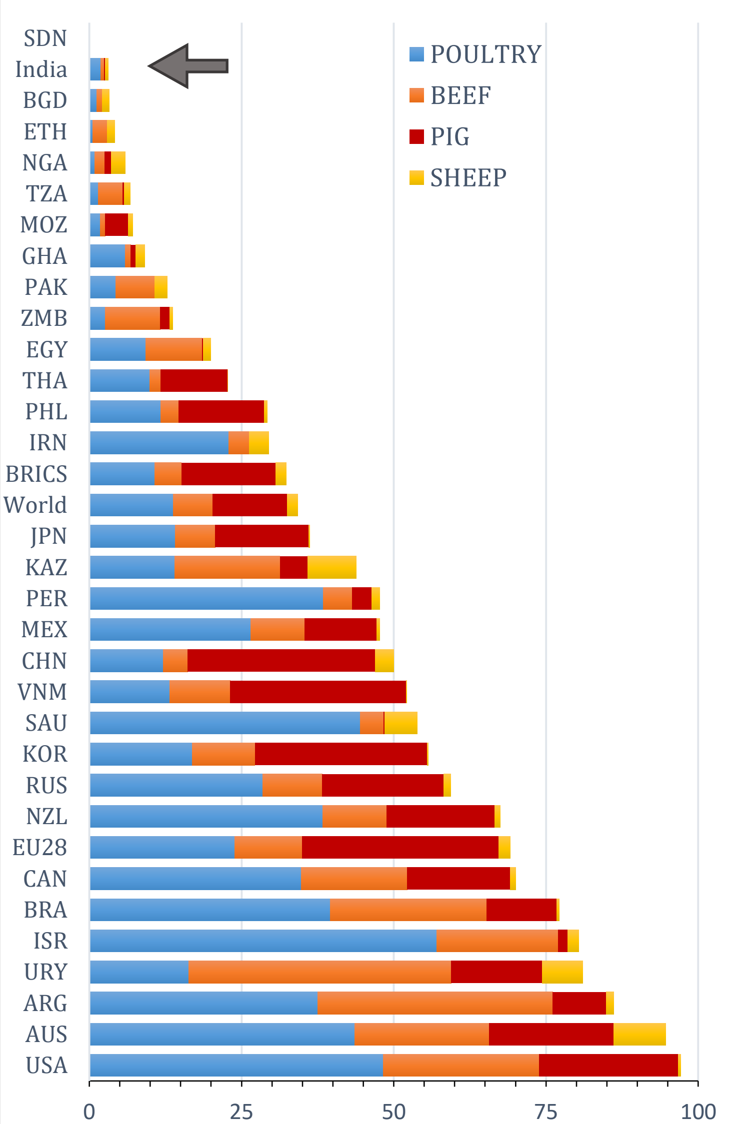
The other by-products are linked to products of slaughtered animals such as meat preparations (dried, salted, canned, homogenised, cured, etc.), animal fat (lard, tallow, etc.), animal oils, gelatin (food and non-food), bio-extracts (cosmetics, life sciences, medicine, etc.), clothing (goods using leather, fur, feather), composites (bone, feather, etc.), and much more.

Livestock by-products form an integral part of various products of secondary sector, like some processed foods, wax paper, crayons, margarine, paints, brushes, cleaners, adhesives, lubricants, candles, soaps, lipsticks, shaving cream, water filters, insulation, antifreeze, certain plastics and rubber, upholstery, vaccines, pharmacological proteins, floor waxes, sporting goods, etc. Like other forms of agriculture, livestock farming is an extensive subject and the commodities that result touch every aspect of human life.

13.3. Primary Livestock Consumption

Meat consumption in India is much lower than global averages, for cultural and religious reasons. Yet, extraordinary growth is seen in the consumption of milk, eggs, and poultry meat.

Figure 13.1 Meat consumption per capita, globally



As per OECD (2018), Meat consumption (indicator), the total meat consumption in India, is 3.099 (kilograms per capita). In comparison, the World per capita consumption at 34.24 kgs and this consumption in BRICs is reported at 32.22 kgs.

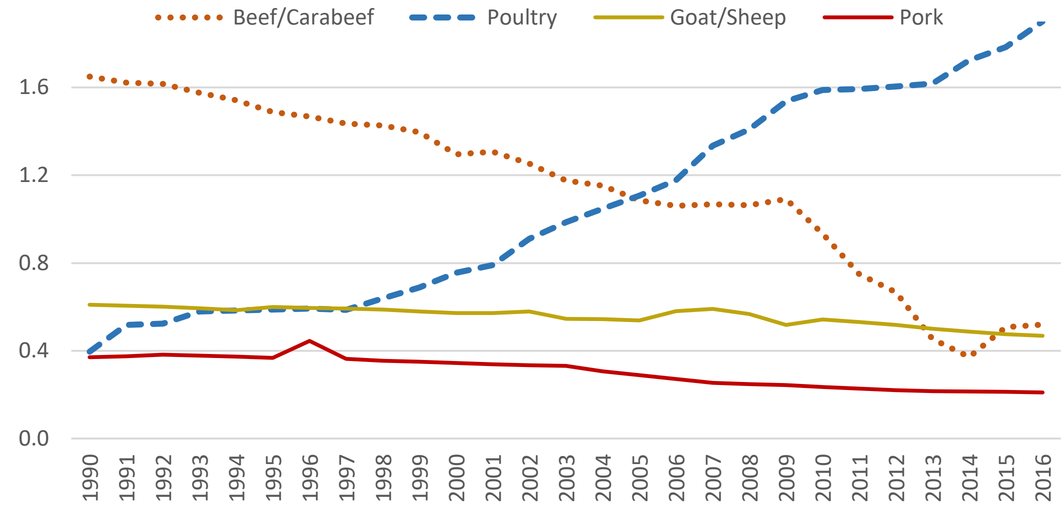
The breakdown of meat consumed by Indians, by type, is as follows - poultry has the highest share of consumption at 61 per cent, followed by beef and sheep (goat) at 17 and 15 per cent each, and pig meat at 7 per cent.

Worldwide indicators show that poultry holds the highest share at 40 percent, followed by pig meat, beef and sheep at 36, 19 and 5 per cent respectively (in quantity 13.8, 12.3, 6.6 and 1.7 kg per person per annum respectively)

Meat consumption is measured in carcass weight (except for poultry expressed as ready to cook weight) and in kilograms of retail weight per capita. Carcass weight to retail weight conversion factors are: 0.7 for beef and veal, 0.78 for pig meat, and 0.88 for both sheep meat and poultry meat. Trend lines indicate retail kg per capita.

Poultry is in fact one of the fastest growing segments of the agricultural sector in India today. Poultry meat is the primary growth driver among meats, with growing preference for this over more traditional red meats. As a result, the industry estimates the broiler meat market is at about Rs 65,000 crore and pegs egg market at Rs 30,000 crore.

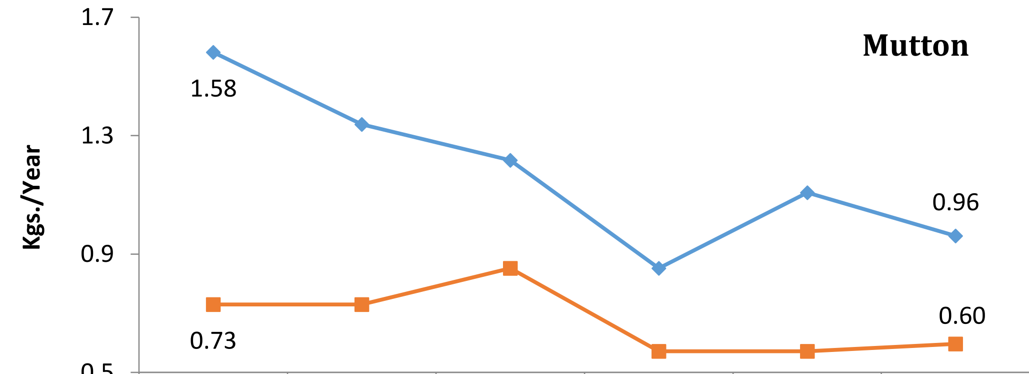
Figure 13.2 Meat consumption trends in India (OECD-FAO data)



Source: OECD-FAO Agricultural Outlook (Edition 2017)

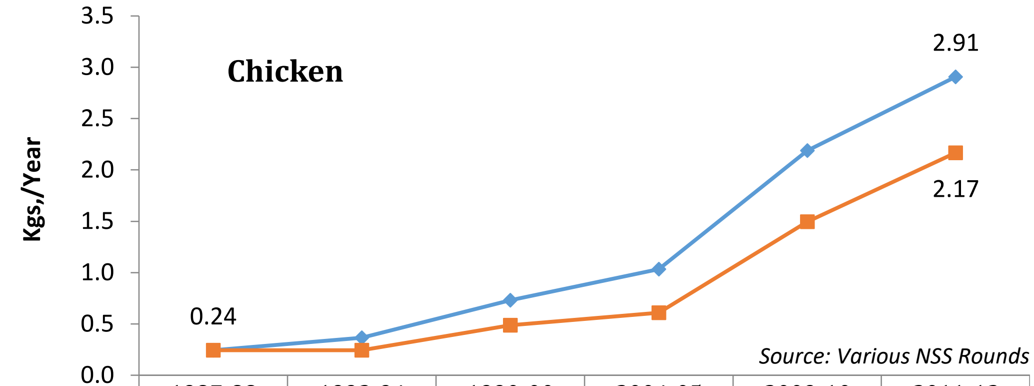
Historical trends indicate that red meat consumption is generally declining while that of poultry meat is growing rapidly in India. These trends are also indicated by other observations. The per capita consumption data from multiple NSSO rounds, also indicates that domestic demand for red meat is declining whereas protein intake in the form of poultry, fish and eggs shows consistent increase. Pork consumption has grown 1.4 per cent in the last five years, below par with vis-à-vis population growth rates. Beef consumption has shown overall 25 per cent decline in consumption since 2011. These trends are also discussed in Volume-III of this report.

Figure 13.3 Trends in mutton consumption (per capita annual)



	1987-88	1993-94	1990-00	2004-05	2009-10	2011-12
Urban	1.58	1.34	1.22	0.85	1.11	0.96
Rural	0.73	0.73	0.85	0.57	0.57	0.60

Figure 13.4 Trends in chicken consumption (per capita annual)



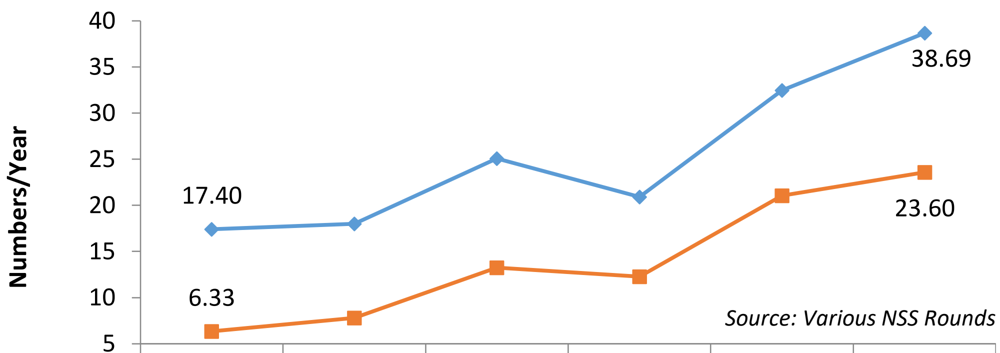
	1987-88	1993-94	1990-00	2004-05	2009-10	2011-12
Urban	0.24	0.37	0.73	1.03	2.19	2.91
Rural	0.24	0.24	0.49	0.61	1.50	2.17

Meanwhile, consumers show significant preference for poultry with a growth of 16 per cent in five years. Evidently, domestic demand for red meats is generally slowing down and even reversing, while demand for white meat (chicken and fish) is growing robustly.

Nevertheless, the per capita consumption in poultry is yet only in the range of 1.5-2 kgs per annum. The poultry industry is categorised into the layer (egg) industry and the broiler (meat) industry. There are obvious overlaps between the two, with layer farms that focus on egg production also providing broiler meat.

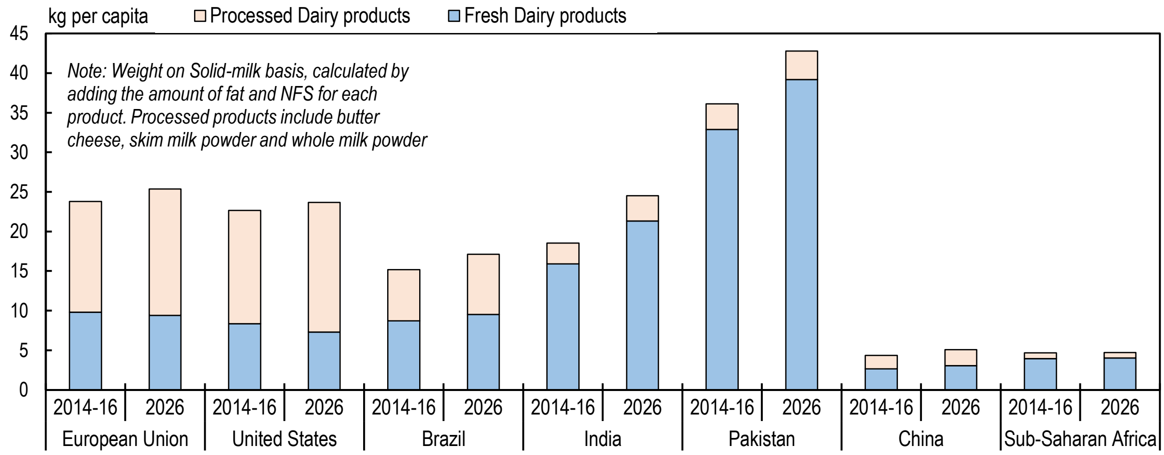
The small layer farms are increasingly giving way to large layer units with hundreds of thousands of birds in a single unit. The layer farms are concentrated in certain states and the fresh eggs are transported to other regions across the country. Consumption of eggs shows constant growth, having doubled in the past decade. This coincides with consumption growth in poultry meat.

Figure 13.5 Trends in Egg Consumption (per capita annual)



	1987-88	1993-94	1990-00	2004-05	2009-10	2011-12
Urban	17.40	18.01	25.06	20.93	32.49	38.69
Rural	6.33	7.79	13.26	12.29	21.05	23.60

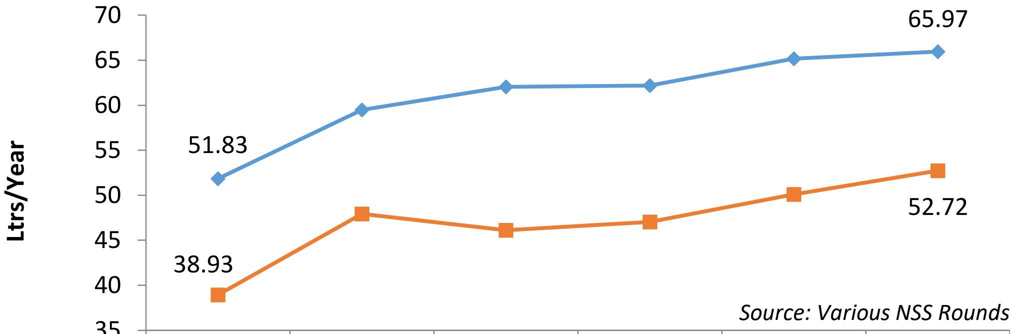
Figure 13.6 Trends in milk consumption (per capita annual)



Source: OECD/FAO (2017), "OECD-FAO Agricultural Outlook"

Consumption of fresh dairy is more prevalent in India, unlike a preference for processed dairy products in western countries.

Figure 13.7 Trends in milk consumption (per capita annual)



	1987-88	1993-94	1990-00	2004-05	2009-10	2011-12
Urban	51.83	59.50	62.05	62.17	65.19	65.97
Rural	38.93	47.94	46.11	47.04	50.09	52.72

13.4. Status of Marketing of Livestock Commodities

Markets are anticipated to facilitate trade and provide for growth. Value addition on the produce, optimises and aligns the output with consumer demand and further assists growth. The potential of livestock sub-sector in sustaining agricultural growth is increasingly recognised. The lack of producers' access to markets may stall such expected growth. Livestock marketing involves the trade of many commodities resulting from farming of quadrupeds, birds, insects and fish. This chapter broadly deals with the marketing of the following:

i. Live animals (cattle, buffalo, goat, sheep, poultry)

ii. Livestock Products (meat and dairy products)

iii. Produce of live animals (Milk, Egg, Wool)

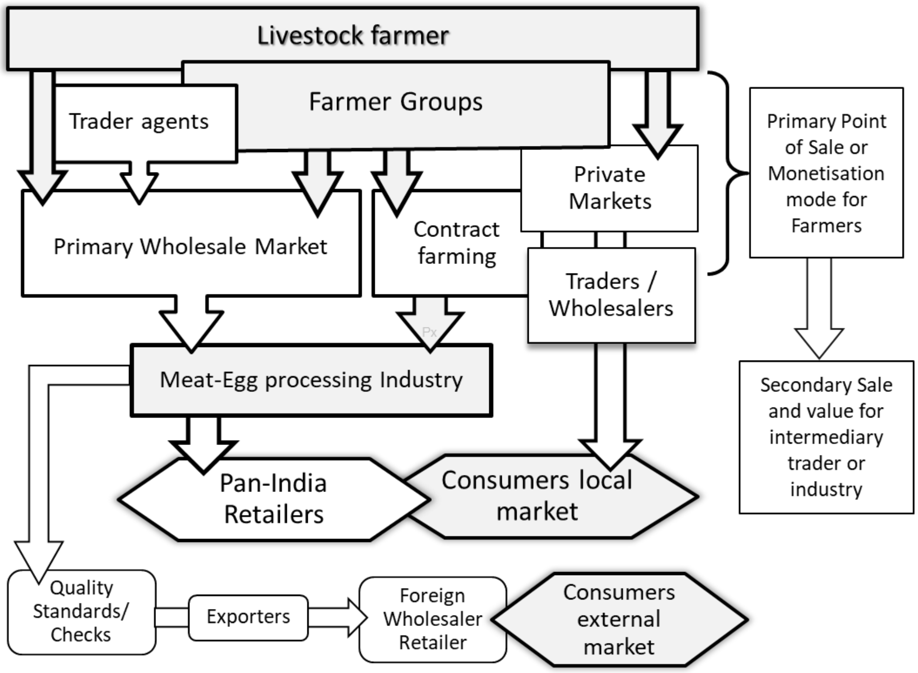
These three segments are discussed vide sections 13.4.1, 13.4.2 and 13.4.3 respectively. The marketing of fisheries is dealt separately. As regards in this the production from beekeeping and silkworms (sericulture), they are discussed in Volume VIII of this Report, and therefore not included herein. That their marketing too, is important needs to be recognised.

13.4.1. Marketing of live animals

Like other agricultural markets in India, those for livestock have also remained under-developed, 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. Most of these markets are irregular, lack transparency in transactions and are short of basic infrastructure and marketing facilities. In handling live animals, the role of available infrastructure is important to comply with animal welfare and to maintain the health of the animal. The traded livestock subsequently undergoes transportation between markets; as also market and final buyer. Initiated at such market centres, special care needs to be taken, not to treat the living animals like other "cargo". This will though add to the transportation/transaction cost.

A considerable proportion of live animals, mainly small ruminants (sheep & goat) are exchanged amongst livestock farmers themselves and between farmers and intermediary traders. Intermediaries assemble animals from farmers for further sale to larger traders as well as to slaughter houses and butchers. Bulk of the trade with farmers of small ruminants takes place with intermediary traders.

Figure 13.8 Typical marketing chain for livestock farmers



Large livestock farmers generally are able to directly access the organised markets for sale. Sometimes, small producers assemble their produce to sell collectively to large buyers. Butchers-cum-retailers in small towns too procure live animals directly from producers. Unlike in case of fruits and vegetable farmers, direct sales to end-consumers are rare.

There are a number of reasons for low participation of livestock producers in markets. The marketed surplus is often small, while markets for live animals are thin, irregular and often at far distance from the production centres. These escalate the cost of transportation and associated activities like housing for animals, and the opportunity cost of time. Further, lack of basic facilities in markets, for producers as well as animals also discourages producers to bring their animals to the markets. Most livestock produced by smallholder farmers are marketed by non-farming entrepreneurs, who operating as a marketing chain, collect, pool and distribute the livestock products to processing industry and wholesale buyers.

Ease of livestock movement, including the documentation to ensure safe transit, is also an aspect that livestock markets are expected to facilitate. Prices of live animals, especially ruminants, are negotiated by buyers and sellers, taking into consideration the animal characteristics, such as age, body weight and structure, appearance, breed, yield and health status. However, no harmonised standard of the identified parameters is uniformly applied.

Marketing of poultry live birds is similar, though more organised, where the producers have integrated their output into the supply chain of the poultry processing industry. Bulk of trade in live broilers and eggs takes place between producers and traders, directly or indirectly through commission agents, in designated markets or at the farm gates. Retail traders procure broilers either directly from producers or from wholesale traders. Direct sale between producers and consumers/retail traders is comparatively limited. In some states, poultry co-operatives also facilitate marketing, but on a limited scale.

Live poultry markets can range from local markets at a community or district level that open intermittently and may only sell a few dozen live birds in a day, to large wholesale markets with a daily throughput of thousands of poultry, where hundreds of birds are sold, slaughtered and butchered on a daily basis. Poultry marketing, is undergoing significant transformation in major producing regions. Contract farming in poultry has emerged big taking poultry down the path of industrial farming. Producers associations like Broiler Producers Marketing Association (BROMARK) set the daily harvest prices depending on the market.

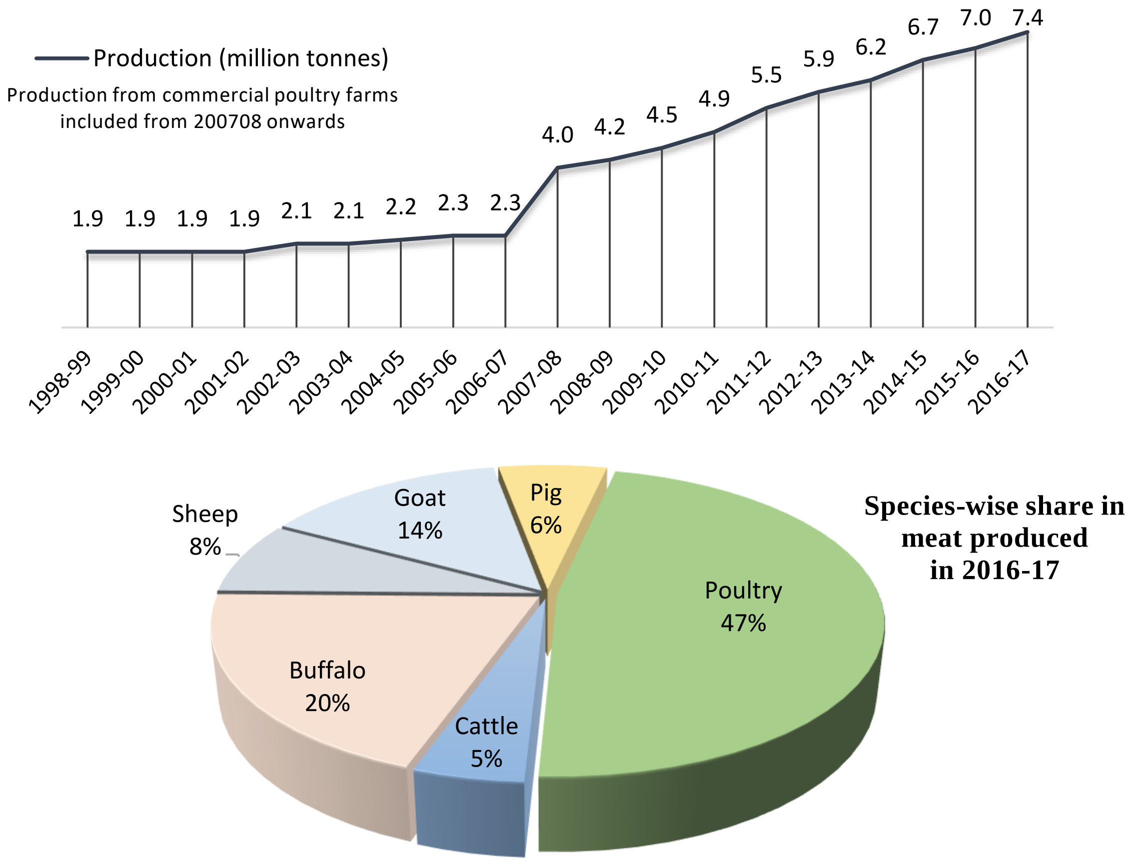
The majority of domestic consumers prefer poultry meat from small butchers, and reports indicate that more than 90 per cent of chicken is sold freshly butchered at retail level. This allows smallholding farmers to continue trade in the live animals with small town butchers and wet market retailers. Smallholder farm enterprises have organised themselves to undertake direct marketing of chicken and eggs into adjoining cities (Volume III, 3.2-A), resulting in income growth. In these cases, peri-urban poultry farmers have opportunity to capture a larger share of the consumers spend. Both market channels, formal and non-formal, are valuable to the farmers.

13.4.2. Marketing of livestock products

13.4.2.1. Meat

The country is produced about 7.4 million metric tonnes (mMT) of meat, including poultry meat, in 2016-17.

Figure 13.9 Meat production India (million metric tonnes)



Source: DAHD Annual Report

This quantum of meat is routed through slaughter houses, to organised domestic and export trade or through the informal fresh market retail system. There are said to be about 4,000 slaughter houses registered with local bodies and more than 25,000 unregistered premises. Other accounts indicate even higher numbers. As per status shared by Food Safety and Standards Authority (FSSAI), among these 120 slaughter houses are central licensed, 389 slaughter houses are state licensed and only 2,409 slaughter houses are registered under FSSAI. In case of meat processing units (active), 225 have central license and 181 units have state license. Slaughter houses have agents to procure animals directly from farmers or through the livestock markets.

The slaughter ratio for cattle and buffalo population is about 2 per cent every year, and in case of sheep, goat and pigs it is 40, 46 and 80 per cent respectively. Most of the slaughter houses are overcrowded and the practices are traditional, resulting into low recovery rate, and wastage of by-products like blood, skins, tallow etc. The meat slaughter houses are intrinsically linked to hide production and the leather industry.

Table 13.3 Export of carabeef and poultry (2016-17)

Product: Carabeef

Port (State)	2016-17	
	Qty (tons)	Rs. Crore
Andhra Pradesh	15351.57	280.99
Bihar	2.3	0.03
Delhi	9065.06	268.73
Haryana	160841.17	3287.04
Kerala	2119	38.57
Maharashtra	559399.42	11234.74
Punjab	430	6.12
Tamil Nadu	71657.35	1238.56
Uttar Pradesh	504696.59	9806.54
West Bengal	13.58	0.16
Total	13,23,576	26,161

Product: Poultry (eggs and meat) items

Port (State)	2016-17	
	Qty (tons)	Rs. Crore
Andhra Pradesh	12896.21	70.8
Delhi	87.36	1.22
Gujarat	0.85	0.03
Karnataka	5647.56	65.78
Kerala	24595.3	12.45
Maharashtra	19621	80.62
Tamil Nadu	385024.96	289.9
Uttar Pradesh	64	0.15
West Bengal	787.39	9.49
Total	4,48,724	530

Source: DGCIS

Table 13.4 Export of small ruminants, processed meats, casings (2016-17)

Product: Sheep/Goat meat

Port (State)	2016-17	
	Qty (tons)	Rs. Crore
Andhra Pradesh	238.41	8.99
Bihar	0.6	0.02
Delhi	12115.94	496.56
Haryana	137	4.2
Kerala	0.99	0.06
Maharashtra	8004.71	308.31
Uttar Pradesh	1510.9	51.59
Total	22,008	870

Product: Processed meats

Port (State)	2016-17	
	Qty (tons)	Rs. Crore
Andhra Pradesh	14	0.25
Maharashtra	126.7	4.33
Total	140.7	4.58

Product: Animal Casings

Port (State)	2016-17	
	Qty	Rs. Crore
Delhi	14.01	2.02
Gujarat	0.2	0.01
Maharashtra	159.03	11.81
Total	173.24	13.84

Source: DGCIS

On the export front, private enterprises have achieved well in marketing of meat. The country has 28 integrated meat processing plants that have been approved by APEDA, besides 80 stand-alone abattoirs cum meat processing plants.

These export plants follow sanitary and phyto-sanitary (SPS) guidelines of the Codex Alimentarius and have HACCP (hazard analysis and critical control points) and ISO certification. The live animals are bought by the slaughter house from a disease free zone, about 100 km in radius around the plant, where disease control programmes are in place. The plants have various facilities for holding of animals, lairage, race, knocking box, stunning units, abbatoir with slaughter line, de-boning, chilling freezing, packaging and cold storage. Facilities for by-product processing, effluent treatment, bio-methanation, rendering, etc. are also incorporated. The animals, bought at the local livestock markets, are first tagged to ensure traceability and transported as per guidelines of Society for Prevention of Cruelty to Animals (SPCA) Act, 1960 and Bureaus of Indian Standards (BIS), 2007 Standards to take care of animal welfare. Standard Operating Procedures (SOPs) are followed, including those required by importing countries. After slaughter and skinning, the carcass is chilled and then de-boned or cut before being packed and subjected to refrigerated processes before the frozen meat enters the cold-chain for market linkage. All the integrated plants have separate line for handling small ruminants (sheep, goat). The meat from most of the small ruminants meat is exported to Gulf region. The frozen meat is loaded onto refrigerated containers, maintained at -18°C to -20°C, for onward connectivity to importing countries through seaports or airports.

India, as of now holds the top position in beef exports, albeit carabeef (buffalo meat), over a few years, indicating a well-established marketing and supply chain network. However, the domestic marketing system does not demonstrate equal quality and standardisation in these products. India's exports of animal meat products include buffalo meat (USD 3.9 billion), sheep/goat meat (USD 130 million), poultry products (USD 79.5 million), animal casing (USD 2.1 million), processed meat (USD 0.69 million). The main markets for Indian buffalo meat and other animal products are Vietnam, Malaysia, Iraq, Algeria, Egypt, Indonesia and UAE. Poultry products go to Oman, Saudi Arabia, Indonesia, Russia and Maldives.

The status in meat exports indicates, that further development can be undertaken to capture a larger share of world markets, thereby providing more income generating opportunity to the local farmers. Having demonstrated the capability to maintain standards through large export presence, the improvement in domestic marketing is also feasible, and is largely related to lower per capita demand for meat, among the lowest in the world. Meat exports are affected by health concerns and the indiscriminate use of anti-biotics is a major challenge, especially in poultry. India is also one of the biggest consumers of agricultural antibiotics, accounting for 3 per cent of global consumption. Though antibiotics aid in intensive food production, their uncontrolled use on farms is a concern. In India, standards for tolerance of antibiotic residues in poultry are yet to be adopted, although such standards do exist for seafood.

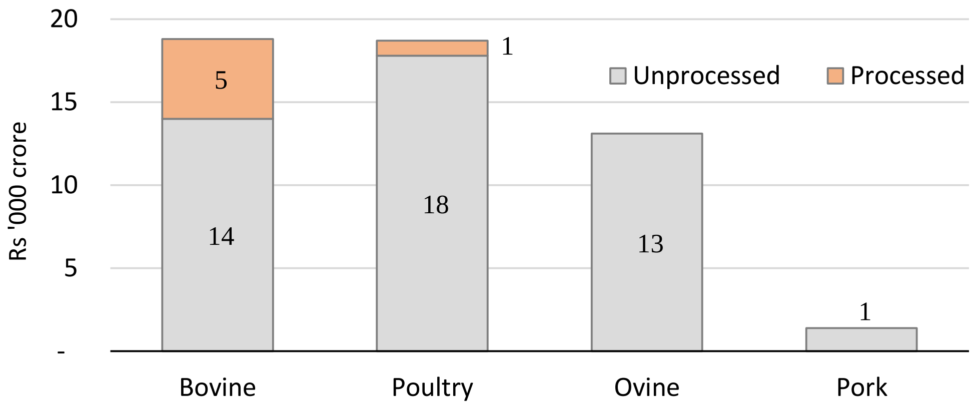
Poultry market is currently dominated by meat of broiler birds, whereas earlier chicken implied "spent hens" or male birds. Broiler birds made inroads into India around 1975, when hatcheries imported the parents of the hybrid broilers. The breeding operations started in Delhi, and hatcheries sold day-old chicks to farmers who raised them and sold to traders. Live broilers have tender meat and are more efficient, and became a food entity within 10 years. Movement of parent stock, hatching eggs, day-old chicks initiated the broiler growing everywhere and later concentrated in South India. Live broilers are typically not transported for long distances.

Further development in domestic meat markets, from the farmers' income perspective, will be demand led. However, interventions for food safety by the health ministry, are expected to have their impact in organising the meat processing industry and its marketing. Currently, the majority of the domestic meat consumption is in the fresh format, through retailer/butchers.

The meat is mostly marketed in fresh cut format, where local butcher dress the meat on demand. The majority of consumers, both occasional buyers and regular eaters, have not taken to pre-cut and packaged meat as is the case in western countries. There are various reasons for domestic consumers preferring meat freshly cut in corner shops, over processed and pre-cut meats, including the differentiated cooking practices which traditionally involve many processes, unlike in case of barbequing or roasting of meat. The fresh meat selling process is expected to continue to predominate in the Indian meat market.

A 2012 study on Indian Agribusiness[9] by the Boston Consulting Group, analysed the sales of meat in India, which highlights the market share between processed and unprocessed consumption. It indicates that the bulk of meat demand was routed via the fresh or wet markets. Not much has changed in ensuing years, and the growth in consumption has maintained a similar ratio in markets between processed and unprocessed meats. In case of bovine meats, the processed volume is mainly for export markets.

Figure 13.10 Meat market share India (Rs '000 crore in 2010)



Source: BCG Study on Indian Agribusiness 2012.

In case of poultry, majority of the consumers still prefer buying the meat that is freshly harvested at point of sale, and only a small share of output is marketed as chilled, frozen, or further processed products. It is worth noting, that if the live poultry is kept disease-free and safely tended until point of consumption, the supply does not require complicated cold-chain with its associated costs and hazards, and the meat is safe for consumption.

However, such process can generate waste in the form of unutilised offal and by-products are not properly captured. The costs of moving live birds, including transport, shrinkage, and mortality costs, also limits the inter-regional movements. As a result, poultry markets are regional, rather than national in scope. The potential for low-cost producers to market their

[9] Indian Agribusiness – Cultivating Future Opportunities, Boston Consulting Group, 2012

product in higher priced markets is limited and this is captured by interventions by the industrial sector.

The lowering of costs and marketed prices can further ramp up demand from consumers. This increase in demand, would be beneficial to the farmers who can then safely scale up production. However, the poultry industry is one of the most organised and a recent report by ICRA in March 2018 indicates, that the broiler volume growth is intentionally kept at lower levels by the organised players, to control the supply and ensure reasonable broiler realisations. This strategy might be restraining from faster growth in domestic consumption; and given the easy acceptability of chicken meat, domestic demand would get a fillip from lower prices, and result in far greater volumes in sales, which would bring down fixed costs in the overall supply chain.

Though many projections suggest, that over time the Indian consumer might eventually opt to shift consumption from unprocessed to processed meat, the ground reality of current consumer preference cannot be disregarded. Therefore, to the immediate benefit of farmers, organising the supply chain into the fresh or unprocessed market is important. Farmers should be enabled to capture a greater share of the existing trade, rather than await a long term shift in consumption habits and growth in demand.

The current demand-supply gap in the meat processing industry is largely attributed to the capital involved in maintaining cold chain temperatures. Large capital is also required for processing and preservation of meat, which results in higher costs, and sellers having to spike up the price of the meat. Food safety concerns are sometimes used to justify such options. However, provided the live animal and harvested carcass is kept hygienic, the fresh meat is safe for the short term. Fast selling cycles ensure that stock is not held for long and the meat is normally harvested and replenished on a daily basis.

About five to six per cent of poultry meat is sold in processed form, of which only about one per cent undergoes processing into value-added products (ready-to-eat/ready-to-cook). However, for farmers, the growing demand for poultry meat is an opportunity to scale up volumes into their existing markets. The poultry market is expanding, as there are very few social barriers for consuming poultry meat and also because of it being relatively more affordable than other meats.

In such a market situation, the informal status of markets with regionally limited supply lines, is an opportunity for start-ups to initiate differentiated online marketing and local delivery services. Instead of developing long distance supply systems, the start-up entrepreneurs can organise the steady demand from urban centres to provide a service to both farmer and consumer, by linking source with nearby demand for fresh meat.

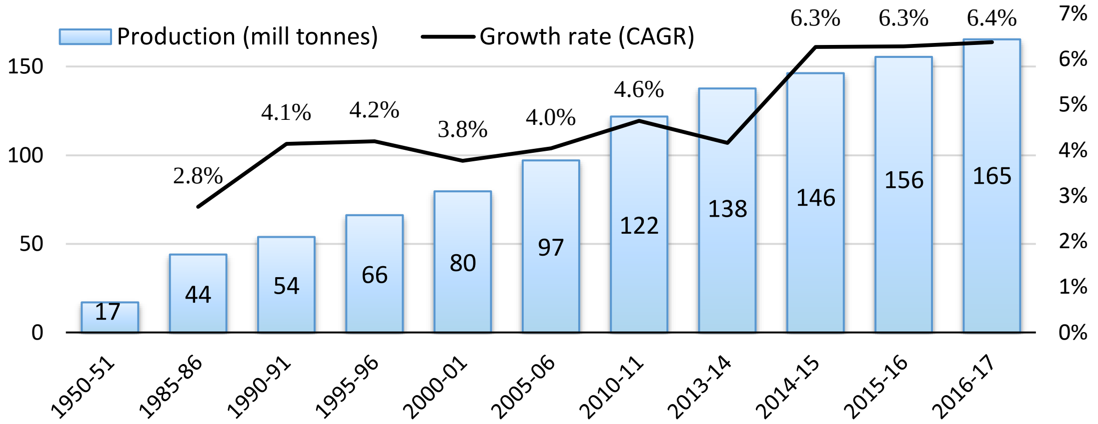
This is seen in growing use of ICT platforms, to streamline the marketing channel of many perishable foods. Farmers with small land-holding can grow broilers on contractual arrangements for a company, which can reach the housewife directly to supply the chicken, cutting down the middlemen. Such mechanism is already being practised by farmers, who get better and assured returns compared to crops that are more nature-dependent and uncertain.

13.4.3. Marketing produce of live animals

13.4.3.1. Milk

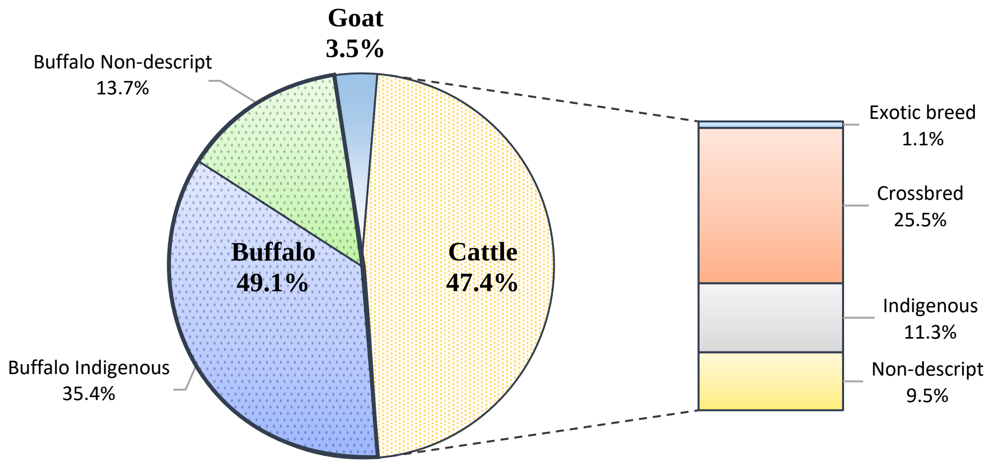
The total milk production in India was 17 million tonnes during the year 1950-51 and this has grown to touch 165 million tonnes in 2016-17. India remains one of the largest milk consumers and also the producers in the world and demand for fresh milk and dairy products is expected to grow in the coming decade.

Figure 13.11 Milk production and corresponding Growth Rate



Source: data from DAHDF

Figure 13.12 Share in milk production by species (2016-17)



In comparing the milk contribution by the major species, the highest share is from buffalos.

Though marketing and transaction costs are also high for milk, dairy co-operatives have fairly succeeded well in linking the producers to markets, especially in Gujarat, Maharashtra, Karnataka, Tamil Nadu and Kerala. Coincidentally, these states account for large tracts of rainfed cultivation. Procurement of milk by cooperatives in most other states is reported to be less than 7 per cent of the milk produced. The private sector has a larger presence than cooperatives in Uttar Pradesh, Punjab and Haryana, and these states account for more than 50 per cent of the private dairy processing plants. These were the states, where dairy cooperatives had not developed during the pre-reform period. With the launch of economic liberalisation in 1991 in the country, diary sector too was opened up to private sector. It appears that in states where no robust cooperatives enlisted, private sector grew up appreciably.

Being a homogenous produce, milk supply is readily organised through establishing pooling points or collection centres, to thereafter communicate it in most economical way to consumers, including processing factories (see Volume III, 4.6.2). Dairy cooperatives, as well as private sector processors, have adopted this aggregation and supply model, establishing many hub-spoke sourcing and delivery systems. The linking of milk producers to domestic markets, has acted as a stimulant to growth. A good supply chain network and growing demand also protects the Indian farmer from global price crashes, as observed in 2015-16. Milk and dairy products hold cultural significance in the Indian diet and a large portion of the population is lacto-vegetarian. The demand for milk and dairy products is income-responsive, and growth in per capita income is expected to increase demand for milk and milk products. Projections indicate, that by 2025 the production of milk in India will cross 200 million tons per annum, implying a growth of over 30 per cent over the average of annual production in 2013-2015. All other countries are expected to enhance their milk production by 2025, with growth ranging from 1 to 29 per cent (average growth of 13 per cent) over their 2013-2015 production average. As there continues demand for milk and dairy products from consumers, the sector will benefit most from productivity increase by expanding its network of milk collection centres.

Domestic demand is primarily centred on fresh milk, and some value added products such as powdered milk is a result of milk surplus being converted into long term storable format. Indian milk economy is worth Rs. 5 lakh crore, growing at 15 to 16 per cent per annum, of which the processed milk economy is estimated at Rs. 80,000 crore. As per the annual report (2015-16) of National Dairy Development Board (NDDB), almost 80 per cent of the milk procured by cooperatives is marketed as liquid milk. In 2015-16, the dairy cooperatives collectively procured 15.58 million tonnes of milk, of which liquid milk marketing stood at 12.08 million tonnes (an increase of around 2.73 per cent over the previous year).

The post-production activities for milk are well exemplified in the supply chain model deployed. The model includes provision of village level pooling/collection points which initiate the post-production market linkage. The pooling points are strengthened by supporting village level capital items like bulk milk coolers, milk cans, etc. This system has resulted in greater transparency and fairness in milk procurement, as well as improvement in quality of milk. In this same sector, private companies also exist and compete with farmers. The competition has also brought greater transparency and economic benefits to the farmers.

Private sector found an entry into this segment only after 1991, when the country embarked upon economic liberalisation. Till then the dairy sector was cooperative-sector, protected from external competition by import restrictions, and from the domestic market by disallowing the private players.

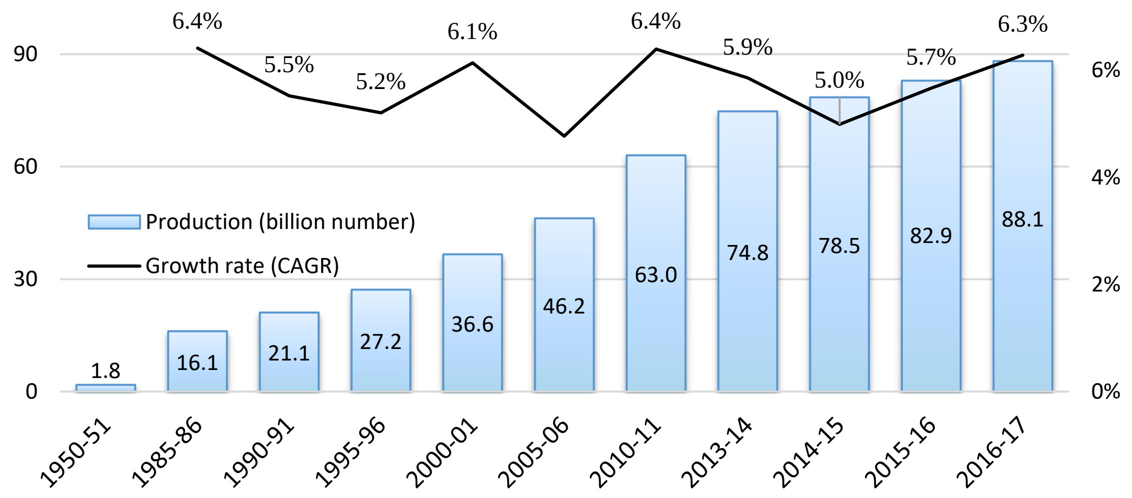
The use of appropriate technology, has ensured that the milk can safely travel to various destinations – to processors, markets and consumers over longer distances, thereby expanding the selling reach of the farmers. The expanded marketing radius, allowed for growth in selling volumes, nurtured production and higher incomes thereof. The farmers' cooperatives have taken responsibility of pooling and chilling the milk, and in some cases, even the processing, packaging and retailing is taken up by cooperatives. The milk is sold in multiple formats, the form varying from liquid milk to ghee, butter, beverage, sweets, etc. The market is pan-India and the supply chain is dynamic with fresh milk supplies replenished twice daily at times.

There are barriers and apprehensions for greater participation from smallholder producers' in the marketing system. There is apprehension that small-scale producers will be marginalised in the process of scaling-up of private sector in the milk production and marketing systems. Though there is evidence to indicate, that smallholders are not altogether excluded from these systems, the concerns relate to identifying and promoting suitable institutional structures that will not disfavour the smallholders. Contract farming is one such solution that will allows smallholders to integrate their production into the supply chain of processing plants. Farmers' cooperatives also can do with a focus on rejuvenating and replicating the successful examples, especially those that focus more on marketing of farmers' production viz those that primarily focus on channelising farm inputs.

13.4.3.2. Eggs

Annual production of eggs has grown from 183 crore pieces in 1950-51 to 8,814 crore eggs in 2016-17. This amounts to about 24 crore eggs a day, every day of the year. If 60 per cent of India's 130 crore population were to eat an egg every day, the production would have to triple.

Figure 13.13 Egg production and corresponding Growth Rate

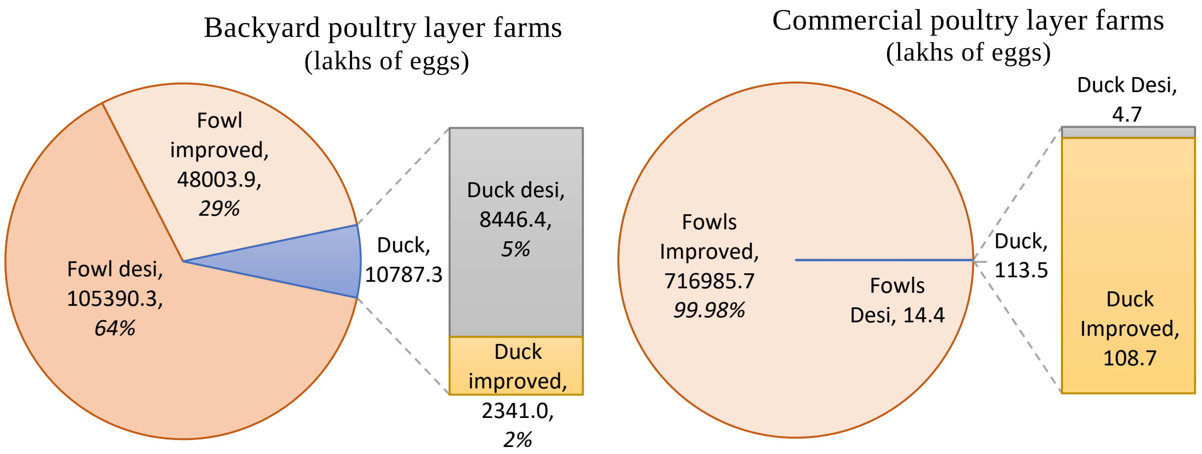


Source: data from DAHDF

Nationally, around 19 per cent of the egg production is from backyard poultry enterprises, in which 64 per cent are produced by indigenous (desi) fowl. Ducks contribute about 7 per cent of the eggs in this sector. The organised or commercial sector contributes about 81 per cent of the eggs produced. Commercial ventures also source eggs from smallholders, regularly or on contract, and are a channel for the small farmers to access the larger market.

The large commercial poultry layer farms are mainly concentrated in South India with Andhra Pradesh, Tamil Nadu and Telengana representing nearly 60 per cent of the egg production. The next four states, Haryana, Punjab, Karnataka and Maharashtra, account for about 26 per cent of eggs produced from commercial layer farming. Odisha, West Bengal, Uttar Pradesh, Gujarat and Chhattisgarh contribute about 2 per cent each. Ranked next are Madhya Pradesh, Rajasthan and Uttarakhand who share 3.6 per cent of such production. The rest of the states have negligible or zero output from commercial layer poultry farms.

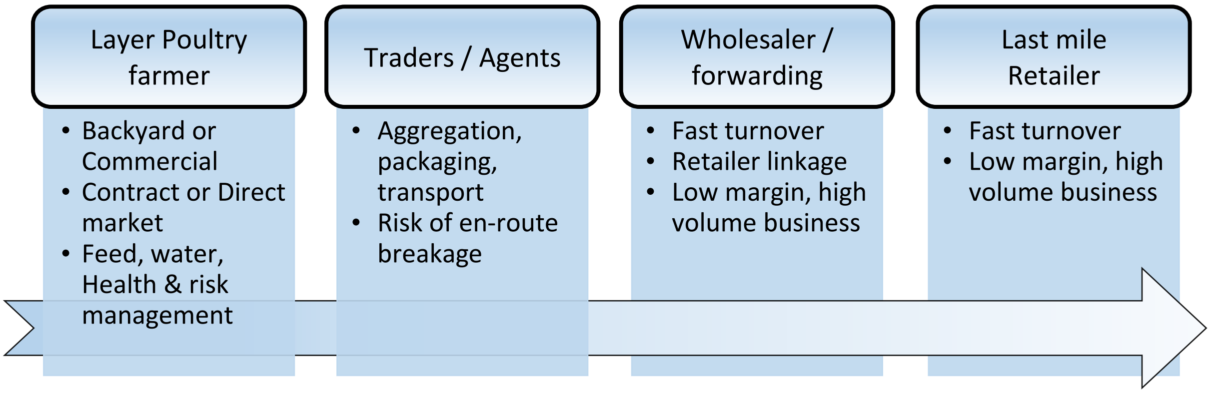
Figure 13.14 Share in egg production – backyard and commercial (2016-17)



In case of egg production from backyard poultry farms, West Bengal alone contributes nearly 30 per cent of the total egg production, with Kerala providing around 14 per cent of the eggs. The next two states, Maharashtra and Bihar contribute around 6.8 and 6.4 per cent respectively. Andhra Pradesh, Telengana and Uttar Pradesh account respectively for 5.6, 4.4 and 4.2 per cent each. The next dozen states share about 25 per cent of the egg production from backyard poultry farms. Meghalaya, Manipur, Uttarakhand and A&N (Andaman & Nicobar) islands rank next with production share of 0.6 to 0.5 per cent. Backyard poultry farms are prevalent across the country and more dependent on their reach into nearby markets.

In all, Tamil Nadu is the largest producer of eggs followed closely by Andhra Pradesh, respectively holding 18.9 and 18.0 per cent share in the total eggs produced in the country. Telangana is the third largest egg producer state with 13.4 per cent share in the total egg production. These production figures are not to infer as a reflection of state-wide per capita egg availability or consumption of eggs, as these are traded and transported across regions, making per capita availability more a factor of the forward supply chain.

Figure 13.15 Eggs market chain



To meet the increasing demand, apart from egg production, efficient egg marketing is necessary. It is difficult to run a profitable business without proper and organized marketing system. The channelling of eggs to markets through commercial organised enterprises is different from those produced by backyard layer poultry farms. In the marketing systems used, transport logistics (costs and availability) are the key differentiators. The smaller backyard layer farms, typically do not have capacity to transfer the eggs directly into demand centres, and hence it is the intermediary who aggregates and transports to markets. In case of commercial layers, the organisation of the logistics is more easily facilitated due to commercial scale production as the first stage of aggregation is eased.

The egg prices fluctuate across the markets, directly influenced by the consumption trends. Increased consumption (by 20 per cent) of egg during winter season results in higher demand and prices in the market. The demand is also high around festivities and dips during fasting periods.

Table 13.5 Egg wholesale price (monthly average over 5 years) - Rs per 100 pieces

Year/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	334.2	349.9	289.6	257.7	254.9	337.7	315.0	301.6	312.6	326.6	379.9	389.0
2014	374.3	337.0	320.9	263.2	303.2	321.8	318.5	301.8	336.7	333.1	381.6	381.4
2015	349.3	279.1	262.5	253.0	282.2	359.3	313.4	308.7	296.0	304.1	357.2	395.0
2016	397.8	350.7	303.9	298.2	369.7	386.1	417.0	348.9	347.3	365.1	379.2	381.7
2017	338.5	325.9	329.2	280.1	325.8	359.0	342.3	344.6	357.7	383.0	475.8	383.5
2018	396.0	367.7	323.8	299.5	-	-	-	-	-	-	-	-
Average	**371.2**	**332.1**	**308.1**	**278.8**	**320.2**	**356.6**	**347.8**	**326.0**	**334.4**	**346.3**	**398.5**	**385.4**
Median	**374.3**	**337.0**	**320.9**	**280.1**	**314.5**	**359.2**	**330.4**	**326.7**	**342.0**	**349.1**	**380.4**	**383.5**

Source: National Egg Co-ordination Committee

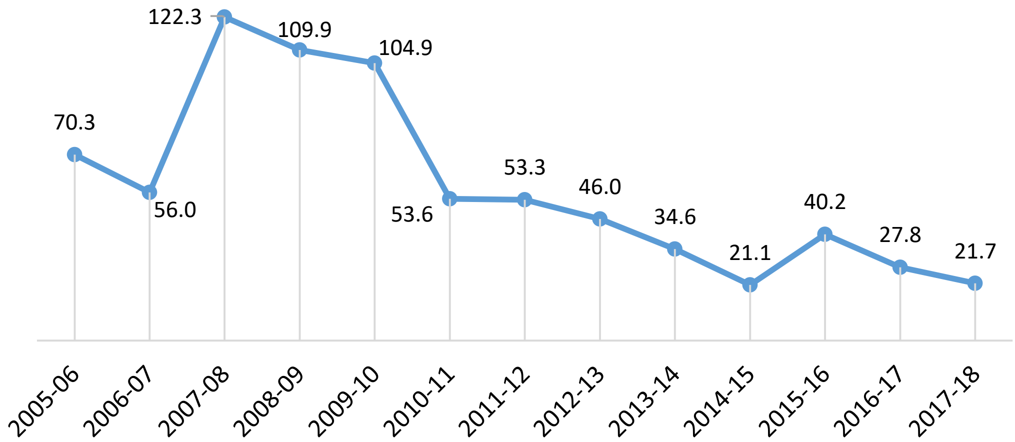
The price is lowest in summers due to poor demand in the hot weather season during months of March, April and May. In fact, reports have observed that when vegetables turn costly in winters, consumers substitute with eggs, which in turn pushes up their price. To illustrate, in the year 2017 winters, the spike in egg prices was largely attributed to the rise in prices of vegetables such as beans, cauliflower, cabbage, brinjal, etc. However, the price variations in egg are less than those experienced in perishable fruits and vegetable crops, largely because of the extensive supply chain network into markets and the organisational capacity to adjust production.

Large egg layer commercial ventures are organised to adjust their production with forecasted demand. The National Egg Co-ordination Committee (NECC), registered as a Trust in 1982, is an Association of more than 25,000 farmers and traders. Among other aspects, it monitors and manages surplus stock into deficit markets and advises farmers on the sale price of eggs.

For example, in Namakkal zone (Tamil Nadu) in 2016, after reports that traders were driving down prices of smaller eggs, the NECC held a special meeting to discuss discrepancies in egg procurement by the traders and to fix categories. It decided, that from 1st May, 2016 farmers would sell eggs as per following categories - 53 gram plus egg (large eggs), and 40 gram to 53 gram egg (export eggs), for which the price per piece is large egg price less 10 paise; 45 gram to 48 gram (medium eggs), for which price is 20 paise less large egg price; and 40 gram to 44 gram (small eggs) for which large egg price less 30 paise was set. The average weight of egg produced in the country is 53 gram.

Though sensitive to breakage, eggs are normally safe if kept free of moisture – moisture allows bacteria to penetrate the shell and washing dirt off the shell can infest it with salmonella if water is untreated. In studies, it was observed that fresh eggs collected at farms had less incidence of salmonella contamination, compared to those collected at retail shops. This indicates that transportation and handling in the logistics chain needs to be improved. FSSAI has proposed standards for fresh eggs, laying down parameters that eggshell must be free of blood rings, not be soiled or have faecal matter and must not be cracked or leaking. FSSAI has also laid emphasis on the storage conditions like moisture and temperature so as to reduce chance of microbial contamination. These proposed standards will come into force if approved.

Figure 13.16 Egg exports from India (numbers in crore eggs)



Note: 2017-18 figures till January 2018.

On the export front, a downwards trend is seen. India mainly exports table eggs, egg white powder & egg yolk powder. The bulk of exports is as eggs & egg powder to Afghanistan, Angola, Bahrain, Comoros, Congo, Cote D'Ivoire, Gambia, Hong Kong, Indonesia, Iran, Kenya, Lebanon, Liberia, Malaysia, Maldives, Mozambique, Nepal, Nigeria, Oman, Philippines, Russia, Saudi Arabia, Singapore, South Africa, Sri Lanka, Sudan, Taiwan, Tajikistan, Tanzania, Thailand, UAE, Vietnam.

Exports are affected by factors such as bird flu and other food safety and health concerns, besides other international trade dynamics. In revenue terms, India is among the top fifteen exporters of shell eggs though in terms of total export volume, the ranking is higher. Improved terms of trade of exported shell eggs will help farmers. However, the domestic consumer is an immediate and growing market opportunity.

On an average, eggs sold to domestic consumer are laid about 10 days to two weeks earlier. In summers, the eggs can stay saleable for another week or two without refrigeration, and upto a month or more in winters in the northern markets.

Traditionally in India, eggs are perceived as commodity products, with little or no differentiation in terms of quality. Reports indicate that sale of eggs through modern retail formats have no impact to those sold through traditional formats. Eggs are purchased from the neighbourhood groceries, and these are highly dependent for supply on the regularity and efficiency of the logistics. The produce from backyard layer poultry farms can have a far shorter market cycle if farmers organise delivery to nearby towns and cities.

Egg marketing is an opportunity for social entrepreneurs and start-ups. Sourcing from smallholder famers and organising the supply into homes, retailers and institutional buyers will benefit the farmers and facilitate safe supply to buyers.

Branded and speciality eggs are slowly picking up in market and are projected to be richer in proteins, contain less fat and are picked from bio-layer farms. With attractive packaging and promise of a healthier proposition, these eggs command a premium over ordinary eggs. These enriched and low-fat branded eggs are becoming a staple choice of some families, as income levels and health consciousness rise.

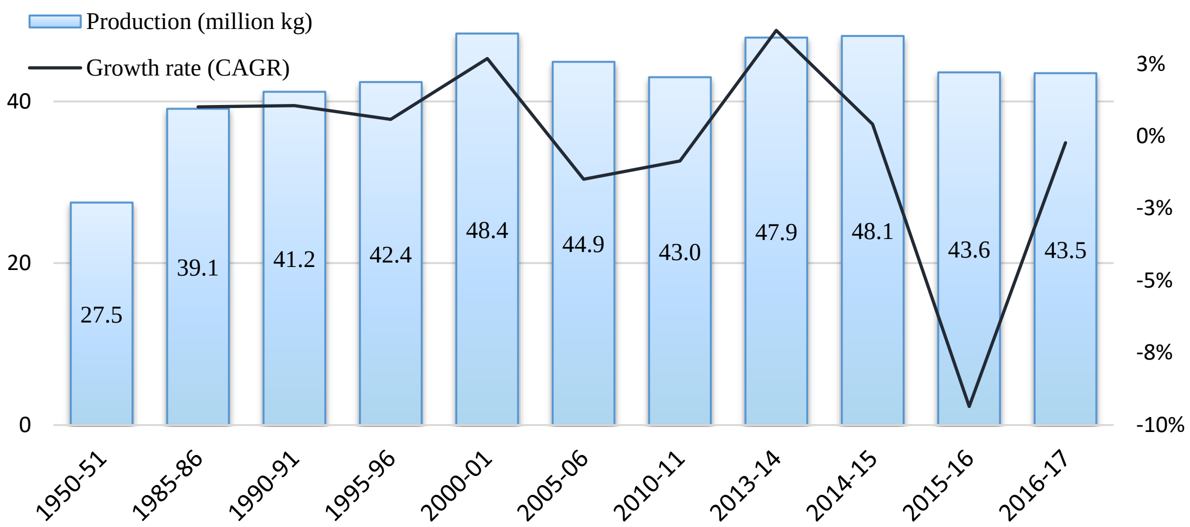
13.4.3.3. Wool

India is the seventh-largest producer of wool in the world with a global production share of nearly 1.8 per cent. More than 80 per cent of the country's wool is produced in the states of Rajasthan (32.9%), Jammu & Kashmir (16.7%), Karnataka (15.1%), Telengana (10.7%) and Gujarat (5.2%). Raw wool production grew steadily from 27.5 million kgs in 1950-51 and peaked during 2002-03 at 50.5 million kgs (50,500 tonnes).

The wool is supplied to the woollen industry, which is mainly concentrated in Punjab which alone accounts for about 35 per cent of wool production units, followed by Maharashtra and

Rajasthan; and with a few others located in Haryana, Uttar Pradesh, and Gujarat. The final product portfolio from the textile industry is divergent, ranging from finished textiles, knitwear, blankets, carpets and some presence of wool in technical textiles.

Figure 13.17 Wool production and corresponding Growth Rate

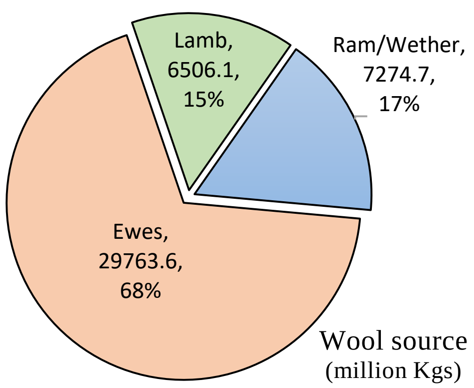


Source: Department of Animal Husbandry, Dairy and Fishery Development (DAHDF)

Woollen products face stiff competition from artificial fibres and this has been depleting the hosieries in many towns and the woollen industry has undergone a consolidation phase since its heydays.

The raw sheep wool is categorised by source, from ewe (adult female sheep), ram (adult male), wether (castrated male), or lamb (young sheep). The ratio of wool from these sources is shown in the adjoining graphic. Yaks are another source of wool though the production is minimal. At the last livestock census in 2012, India had 65,069 thousand sheep and about 77 thousand yaks. The total wool production in India is not enough to meet the requirement of the country's woollen industry. The bulk of Indian wool is of rough quality and is used mostly in the hand-made carpet industry.

Table 13.6 Wool Production by animal source (2016-17)



The woollen industry in India is assessed to be about Rs. 11,484.8 crore and broadly scattered between the organized and decentralized sectors, comprising composite mills, combing units, spinning units, knitwear and woven garments units, machine made carpets manufacturing units and smaller hosiery and knitting, power-looms, and independent dyeing, process houses, woollen handlooms and hand knotted carpets, rugs and druggets.

The Ministry of Textiles reported that of the total wool produced, 85 per cent is carpet grade wool, 5 per cent is apparel grade and the remaining 10 per cent is coarser grade wool used for making rough *kambals*, etc. India depends almost exclusively on the import for fine quality wool, which is demanded by the industrial woollen mills and decentralised hosiery sector.

Table 13.7 Raw wool imports by India

Year	Quantity (in million kgs.)	Value (Rs.in crore)
2010-11	94.77	1434.65
2011-12	76.29	1876.87
2012-13	77.16	1801.90
2013-14	89.60	1967.72
2014-15	96.53	2125.74
2015-16	97.83	2016.12
2016-17	87.15	1894.26
2017-18	79.95	1884.59

Source: Ministry of Textiles, DGCI&S

The gap between wool production and wool demand form the woollen industry is an opportunity for Indian farmers. The following countries are the top six raw wool exporters to India in 2017-18:

SN	Country	Qty. in million kgs (2017-18)
1	Australia	14.08
2	China	10.51
3	New Zealand	9.16
4	Saudi Arabia	4.92
5	Pakistan	4.69
6	Syria	4.50

Source: Ministry of Textiles, DGCI&S

The quantity of raw wool imports, is nearly double the domestic wool production. Combined domestic raw wool production and the imports in 2016-17 indicate that total wool requirement was 130.65 million kilograms. The Ministry of Textiles, in its National Fibre Policy of 2010, has projected wool consumption in India to increase beyond 200 million kgs by 2020.

Notwithstanding such projections, the fact that the woollen industry is importing large amounts of raw wool, can be addressed through appropriate interventions at production and post-production levels. These will include improving the quality of wool and the handling of raw wool, such that it can compete with the quality from global supply. This will not help farmers capture more of the demand from textile units, and in turn motivate them to adopt better practices and achieve greater productivity.

The constraints faced by wool sector can be summarised as follows:

- Low priority of state governments in development of wool sector.
- Shortage of pasture land, forcing breeders to migrate their flock from one area to another throughout the year.
- Piecemeal value capture by the sheep breeders i.e. from sale of raw wool, live sheep, manure, milk, mutton, skin, etc., without reaping full benefit from value capture across all possible outputs.
- Inadequate production of specialty fibres i.e. pashmina goat wool, angora rabbit wool, etc. and low productivity per animal.
- Lack of contract farming and associated motivation to adopt modern methods of animal management, machine shearing of sheep, washing & grading of raw wool etc. (a Model Contract & Servicing Act, can be expected to support contracts in this area).
- Inadequate raw wool marketing facilities and infrastructure.
- Ineffective role of state wool marketing organisations in wool producing states.

The weakest link after wool production is primarily the marketing of wool. The wool marketing is essentially in the hands of private wool merchants and traders. The wool producers do not have the benefit of organized market of wool available. The prices of wool have been widely fluctuating, and in real terms there has been hardly any increase in the price of wool in last decade.

To bring greater focus on marketing of raw wool, the Ministry of Textiles has introduced a new scheme, namely, Wool Marketing Scheme (WMS) in all major wool producing states to support greater procurement of wool on remunerative price by creation of Revolving Fund for Marketing of Wool. Another activities supported are operation of e-portal for auction of wool, formation of wool producers' societies, financial assistance to strengthening infrastructure required for marketing of existing wool mandi/grading centres (storage halls, auction facility, testing platform etc.). A financial provision of Rs. 10 crore has been made under this scheme for implementation for the years from 2017-18 to 2019-20.

13.5. Interventions in Livestock Marketing

Marketing is typically associated with production and productivity of livestock, the latter affecting the economics or cost of production. These aspects, including making available grazing lands, breed and feed improvements, better rearing practices, etc. are dealt with in Volume VIII-D of this Report. At this stage of development in livestock farming, it is imperative that eased access to markets, standardisation of market parameters, health and safety of livestock, bio-security of animals and humans, and overall ease of business in the post-production cycle, are taken care of.

Livestock marketing involves trade in live animals as well as commerce in the produce from live animals. When managing living animals, their welfare is to be facilitated, as much as hygiene and safety of produce and products from the livestock.

The live animals are traded between farmers, largely for purpose of breeding and farm labour, or to build on existing livestock assets. The trade of live animals also occurs between farmers or their intermediaries with meat processing factories, who optimise on the meat as their primary product and feed leather, blood, feathers and other by-products to other industries. Live animals are also bought by local wet market butchers and retailers. As bulk of livestock owners are smallholder farmers, a primary intervention will be to facilitate the grouping and transport of their assets to wholesale buyers. Such organisation is also envisaged for crops, through the Gramin Agri-Markets (GrAMs), which are discussed in Volume IV of this Report under the nomenclature of Primary Retail Agricultural Markets (PRAMs).

Production enhancing policies have pushed economies of scale on feed and production, but the output marketing systems have not been given suitable focus. Markets have remained informal and at times exploitative of small producers. This demotivates them from adopting modern practices and new technologies. Easing of market access and connectivity will benefit the large number of small livestock owners.

The country has no authentic market for quality, disease-free germplasm in the form of i) sperm; ii) embryos; iii) calves; iv) heifer; and v) adult bovines. As such, poor quality of germplasm with unknown genetic is sold in unorganised markets. This is of importance if indigenous breeds are to be refined and promoted.

13.5.1. NCDFI eMarket - Digitalization of dairy cooperative trade

The National Cooperative Dairy Federation of India, has its primary objective to facilitate the working of dairy cooperatives through coordination, networking and advocacy. It supports 27 state milk federations comprising of 218 District/Tehsil processing unions that incorporate about 1.73 lakh primary village societies that focus on milk production and collection. Among its major activities, is coordination of milk and dairy product supplies, arranged on contractual terms, to the Ministry of Defence, functioning as a 'carry & forwarding agent' for frozen semen doses, and coordinating the sale of dairy commodities and procurement of agri-commodities through its eMarket.

The NCDFI eMarket was developed, with technical support of NCDEX, designed to facilitate fair market price discovery, to overcome time consuming tender procedures and to bring in faster processes while having wider participation and transparency in the process. This eMarket exemplifies the role of market platforms that need to be further strengthened to help to balance the demand and supply gaps at a national level.

Table 13.8 Overview of Dairy Auctions on NCDFI eMarket

Period	SMP (MT)	Butter (MT)	WMP (MT)	Ghee (MT)	Turnover (Rs crore)
Jan 2015 - Mar 2016	3,667	4,701			162
Apr 2016 - Mar 2017	15,904	3,623	850	143	415
Apr 2017 - Mar 2018	14,576	3,115	2,000	5	371
Totals	**34,147**	**11,439**	**2,850**	**148**	**948**

Source: NCDFI

Since launch, a total of 48,584 tonnes of dairy products have been traded, using the NCDFI eMarket. The transactions are conducted by way of auctions, using the following two methods:

1. Forward Ascending Price Auctions, for the following products:
   - Milk Powder (Skimmed & Whole)
   - Ghee
   - Butter
2. Reverse Descending Price Auctions, for the following products:
   - Cattle Feed
   - Mineral Mixtures
   - Edible Oils
   - Sugar
   - Maize
   - De Oiled Rice Bran (DORB)

Any dispute or difference in respect of any matter relating to or arising out of the Contract would be first brought to the Market Oversight Committee of NCDFI eMarket. If the parties do not agree to the resolution proposed by Market Oversight Committee, the parties are free to appeal to the National Dairy Development Board (NDDB). The decision of the NDDB shall be final and binding on all parties.

13.5.2. Markets and online trading in livestock and produce

The Department of Animal Husbandry, Dairying and Fisheries Development (DAHDF), Ministry of Agriculture & Farmers Welfare has launched a web-portal, epsahuhaat.gov.in, to provide an electronic platform that provides real time access to relevant information on germplasm and live animals. The platform helps connect breeders, state agencies and farmer stakeholders. Initiated in 2016, the portal has also helped in updating estimates on the livestock population, for which a census was last held in 2012.

The e-Pashuhaat platform also lists information on availability of artificial insemination technicians with contact details, real-time availability of germplasm, identification and traceability of germplasm and other related information. Live animal exchange is also a function of this platform. The platform is the first step in unifying and harmonising the livestock market.

Key Extracts

- Livestock broadly implies living stock or assets, of animals that are reared in agricultural setting, to produce goods (such as meat, milk, eggs, wool, hide, feather, honey, etc.) and/or to produce labour to service agricultural activities. Livestock marketing involves the facilitation of trade of the goods and services that arise from livestock. The produce from livestock can undergo agro-processing and resultant products are marketed by attached industries and hence vertical integration of farmers with industries is indicated.
- Livestock production and crop based agriculture are intrinsically linked, each being dependent on the other, and both are crucial for overall food and nutritional security. The ownership of the livestock is more evenly distributed, with landless labourers and marginal farmers owning bulk of livestock. Rural women play a significant role in animal husbandry, being involved directly in livestock operations relating to feeding, breeding, management and health-care.
- Meat consumption in India is among the lowest globally, for cultural and religious reasons. Yet, extraordinary growth is seen in the consumption of milk, eggs, and poultry meat.
- Livestock markets have generally been under developed, in comparison to crop based commodities. However dairy and commercial poultry markets are more organised. Backyard poultry can benefit from similar organisation with market linkage.
- Wool and mutton sector lag far behind. India imports almost twice the raw wool it produces, which is an opportunity for sheep rearers, that remains untapped.
- Market reach through online platforms for livestock produce and products show potential and need to be promoted. Associated standardisation of the traded goods need to be undertaken.

Chapter 14
Small Ruminants: Recommendations and Strategies

Small ruminant farmers remain underdeveloped. This chapters lays out broad recommendations and strategies with special focus on small ruminant livestock sector.

14.1. Strategies Recommended to Enhance Productivity

i. To enhance the feed, fodder production and pasture development an efficient and integrated land use management system which includes better utilisation of wastelands and CPRs through proven silvi-pastoral system/agri-silvi-pastoral system needs to be encouraged. State AHDs and forest department can come together to adapt and implement such models in an appropriate manner, balancing the economic needs and ecological demands.

ii. Livestock production is mainly dependent on crop residues and by-products as major components of animal feed. Therefore, fodder enrichment will facilitate for better utilisation and enhancement of productivity. Government initiative to control burning of wheat/paddy straw and making available straw bailing machines provided to various states, will also help to supply these crop straws to adjoining states for enhancing livestock productivity.

iii. Strengthening of existing infrastructure of veterinary institutions, laboratories, diagnostic centres, education and training to increase indigenous wool production through adoption of integrated approach optimizing nutritional and management inputs with adequate disease control measures.

iv. A sound breeding policy for small ruminants at state level can be developed, keeping in mind the needs of various states due to presence of different breeds, to ensure breed improvement and to develop better quality breeding rams. Genetic improvement can be achieved by selection of rams of high genetic merit for breeding and also incentivising the owners so that the select high genetic merit rams/bucks are not sold for slaughter but used for natural or AI service as required.

v. As sheep rearing is a nomadic practice at large, support to these sheep rearers can be provided in terms of better health services. Mobile veterinary clinics can be promoted across various regions in the country to cover important migratory routes of these flocks. These units can be made available 24x7 with the presence of trained veterinarian and a support staff.

vi. Overall productivity of sheep can be increased to improve income of farmers through introduction of prolific sheep in the flock of farmers, by accelerating lambing system, grazing with concentrate supplementation, etc. Proper guidelines can be prepared by State AHDs to ensure the implementation these techniques.

vii. Krishi Vigyan Kendras (KVKs) are present in every district across the country for technical support, which can act as training centres for para vets with the support of AHDs. However, the staff strength with professional education in veterinary sciences at the KVKs needs to be strengthened.

viii. Trained para-vets and community animal health workers, have demonstrated their worth in last mile service delivery in many states across the country. There is a need to recognise them through official/legal framework across the country.

ix. The funds allocated for veterinary services for small ruminant sector must be enhanced, keeping priority focus on providing support to rearers with small herds. Funds should be allocated to develop and maintain cold chain infrastructure for vaccines and biological products to ensure the last mile delivery.

x. Village communities are involved in goat and sheep rearing. The development of Village Producer Organisations (VPOs), comprising the goat/sheep rearers of each village can be promoted. The VPOs can be formalised as cooperatives or companies, to induct professional management, in line with crop sector and be given the same fiscal and financial benefits as in case of FPOs.

xi. The small ruminant rearers in form of collectives, as VPOs (as Cooperatives or FPCs) can retain independent ownership of goats, while bringing in better organisation in production. This will bring suitable empowerment to access credit and veterinary inputs as a collective. Where livestock keeper organisations already exist, they should be strengthened. Shelter facility for goats may be provided at village level.

xii. The VPOs of small ruminants can be provided financial and material support to maintain and develop Common Property Resources (CPRs) at village level. This will motivate gram panchayats to address tenure rights for developing CPRs and bring stakeholder attention to regeneration of such depleted land. Waste land and non-arable land can be developed for stall fed rearing systems.

xiii. The entrepreneurship in sheep farming can be encouraged by providing more leverage in funding through Entrepreneurship Development and Employment Generation component of the National Livestock Mission. Under RKVY-RAFTAAR, funds are available for promoting enterprise and incubation centres. The educated youth, who have been showing inclination towards sheep farming can be supported.

xiv. Various organisations, including multilateral organisations and NGOs are involved in the development of the small ruminant sector across the country, covering all aspects of sheep supply chain. Such organisations can be supported to act as service providers and support these producer organisations and cooperatives for better health coverage and for extension services. Focused outcome linked support to such actors by the government can help ensure better coverage and result from such services.

xv. A knowledge sharing platform should be formed at centre and state level comprising representatives from Animal Husbandry Department, Watershed, Research Institutes, Veterinary Colleges, Rural Development Department, Forest Department, Panchayati Raj Institutions, and private sector actors linked to small ruminants production.

xvi. A comprehensive "Small Ruminant Policy" at national level should be developed as a model for states to adopt and implement. This should cover all aspects – breed development, training of para vets, disease mapping and reporting along with disease control, marketing regulations, food quality and safety regulations along with strong implementation of policies. Such a policy needs to be formulated with the help of various departments namely animal husbandry, forest, rural development, food processing, textile, etc. The policy can include mechanism for inter-state coordination (neighbouring states) to fix migratory routes, standard of care and hygiene during migration.

xvii. The KVK's can establish free training and subsidised veterinary services for small ruminants. KVKs can become a source of knowledge and breeding. The various records including birth, health, medical, mortality, weighing, vaccination, etc. can be maintained at KVKs. Selection of rams/bucks of high genetic merit for breeding and incentivising the owners so that selected high genetic merit bucks are not sold for slaughter but used for natural or AI service can be undertaken.

xviii. The higher share of women involvement, also justifies developing of women goat rearer groups & associations, and women farmer friends dedicated for goat sector. The women groups can be empowered to take decisions on goat rearing matters.

xix. Migration of sheep rearers is adverse to their socio-economic and educational interests. It causes disruption in families affecting the women left behind, and discourages education of the children who are also taken along by the elders. From the society's egalitarian perspective, a paradigm shift in sheep rearing is necessary from migration to stall-fed system. This calls for focussed attention to strengthening of feed and fodder resources, besides other support systems.

xx. Upgrading of infrastructure facilities for small ruminants care, by the Department of Animal Husbandry, such as for inputs, goat shelter, distribution, and livestock marketing could be coordinated with SAMPADA scheme of the Ministry of Food Processing, so that production is suitably aligned with development of processing industry.

14.2. Market Recommendations

To fully facilitate livestock transactions, the first step will require organising and modernising the existing livestock market places to safeguard the living animals, to minimise their suffering and thereby securing their imminent health and their ability to resist disease. This warrants appropriate focus on livestock market infrastructure. It is recommended that livestock markets be developed so that-

i. Forward & backward linkages of primary producers with meat and wool industries and input supplies would accelerate the growth of sheep production and enhance the income of farmers. Specific commodity zones including disease free as well as marketing zone for developing internationally competitive production with hygienic and quality meat and wool would facilitate the development of sheep husbandry in future.

ii. Development of local markets as gathering and selling points for livestock fully equipped with infrastructural facilities would help. These markets/mandis can be facilitated and monitored by local public sector authorities or by public and private both.

iii. The bio-security at the physical markets is improved. This will reduce risk of disease spreading from one animal to the other, or from animals to human. Live poultry markets are frequently implicated in zoonotic transmission of avian flu from birds to humans.

iv. The Department of Animal Husbandry, Dairying and Fisheries Development in coordination with the recently set up Intersectoral Coordination Committee and the Core Working Group on Anti-microbial Resistance (NAP-AMR) 2017-2021, is to develop suitable protocols at animal markets to maximise animal and human safety at the live animal markets. It should also intervene on indiscriminate use of antibiotics.

v. Proper standards should be implemented at live animal markets, such as providing for non-porous or tile floors and walls, segregation of animals, sufficient potable water for animals, feed and fodder, washing system and covered drains, liquid waste treatment systems, handwashing and sanitation facilities for traders and farmers, separate entry and exit gates for vehicles bringing animals, etc. No retail activity or slaughtering should be allowed inside premises of wholesale live markets

vi. Tagging of animals at live markets to ensure traceability will improve the marketing system and aid in food safety implementation. No wild animals must be sold at markets. The accuracy of tagging can be ensured by adopting technologies like RFID, micro-chips etc.

vii. Premises for quadrupeds and ruminants should be developed to separate them from bird markets. Shade and water availability (troughs, etc.) should be made mandatory for live animal at the markets.

viii. Rodent and insect control programs and systems must be in place and rigorously monitored.

ix. Safe disposal of dead animals must be built into the marketing mechanism, including a dead animal testing and reporting system.

x. A complete list of live animal market infrastructure and facilities may be circulated and markets should be jointly inspected, regularly with producer associations, state government and central government officers.

xi. India's development story in livestock is replete with eased mobility of animals across the country. Cross-regional movement of live animals (quadrupeds and poultry) is essential and the transport of live animals from their breeding grounds to markets and processors should be facilitated. Relevant documentation to allow unhindered inter-state passage is required.

xii. Livestock transportation of small ruminants can be exempted from in-transit inspections, if within four hours travel radius. Inspections may be implemented at final destination or at loading point.

xiii. An inter-departmental committee, headed by Animal Husbandry Department in each state may be formed to explore convergence in policies/programmes with other concerned departments including related issues faced by the transporters.

xiv. Organised sheep and goat rearing should be linked to attracting investment in proximity located modern processing and abbatoir units, who can function as a suitable market channel for goat milk and meat products.

xv. Trade policy must attend to supporting and promoting the supply of meat, milk, cheese, wool and other products from small ruminants to meet global demand.

xvi. Prices of live animals, especially ruminants, are negotiated by taking into consideration the characteristics, such as age, body weight and structure, appearance, breed, yield and health status of the animal. These parameters need to be standardised, as far as practical, to streamline the market transactions.

xvii. Wool markets can be improved by providing modern shearing facilities. Similar facilities can be developed at specialised GrAMs (proposed for development) in sheep rearing areas. The shearing tools and raw wool handling can be provisioned as service option at these GrAMs, besides subsequent e-marketing to the woollen industry. Clean wool handling will protect the quality of wool and help meet some of the demands from industry. Speciality wool development can also be undertaken, since wool from rabbits and yaks is mostly in hand of small and marginal farmers.

xviii. The DAHDF, Ministry of Agriculture & Farmers Welfare had four Regional Directorates for poultry development with various farms and units. In 2003, all the poultry units of the central government were restructured into Central Poultry Development Organisations. The development however, is still largely focused on production side and marketing is not directly addressed. **The National Action Plan for Egg & Poultry-2022**, also needs to focus on market development and marketing to the benefit of small holder farmers. Commensurate market development will avoid the situation as in crops, where surplus production has had to be supported through government procurement. Given the higher perishable nature of eggs and poultry meat, an efficient marketing system supported by needed agri-logistics is a sine-qua-non.

xix. Livestock export is normally not in live animals (live animal trade is on the decline), but mainly is in the form of meat and other products. There is considerable scope to increase buffalo meat exports due to its price competitiveness and huge production potential. Such trade also supports the important hide and leather industry. Efforts need to be made to remove bottlenecks to further growth in such trade.

xx. Export of meat from small ruminants is limited, largely due to higher domestic demand. However, the demand from existing markets for goat meat from Gulf countries can be developed further. Domestic demand for poultry is also high, and a priority would be to improve the market network and access of backyard poultry farmers into niche peri-urban markets, especially for traditionally reared desi fowl and duck meat.

xxi. Modernisation of milk collection points and rejuvenation of cooperatives is necessary. Imports and private sector dairy plants have competed with cooperatives, since removal of quantitative restrictions and de-monopolisation of imports post the liberalisation of Indian Economy rolled out in 1991. The competition is healthy, as it has helped build new products and capabilities. However, capacity building and greater technology support can be provisioned for cooperatives and farmer producer groups.

xxii. Most livestock development programs are focused on on-production side and setting up infrastructure. At the same time, concerted effort are needed to strengthen the output supply from small and marginal farmers, to link them with markets and bulk buyers. This will require developing back-end operations for small farmers to aggregate their poultry, small ruminants and efficiently connect onwards with markets. Existing trade in this activity can be modernised with the necessary infrastructure if client farmers of existing traders are provided equity or other sharing mechanism in the service.

xxiii. The processing industry has been developed to an extent where the units are not always acting to the benefit of farmers. Policies and government support should be linked to demonstrable measures of economic growth leading to the doubling of farmers' income.

xxiv. Trade in livestock by-products needs to be promoted. With a large livestock population and growing meat, egg and dairy industry, various by-products like extracts, bone char, hair, hide, enzymes, and many more are generated. These items have not caught active attention on development front. These possess value and capture of this value is important from the perspective of generating additional income to the livestock farmers.

xxv. Livestock sector will benefit by organising a division on livestock marketing under the Department of Animal Husbandry, Dairying and Fisheries Development. The focus on infrastructure development can include parameters to ensure that the infrastructure is brought to use to benefit income growth in small farmers.

xxvi. Marketing lessons from NDDB can be transferred to small ruminant sector. The existing Sheep and Wool Cooperatives and their state level Federations need financial and managerial strengthening.

xxvii. The Model Agriculture Produce and Livestock Marketing (Promotion and Facilitation) Act, 2017 released by the central government enables development of different types of markets for livestock in both public & private sectors. The states should promote these markets in the interest of livestock farmers including small ruminants.

xxviii. The Model Contract Farming and Services Act, 2018 enables involvement of private sector across the value chain. The states should find it useful to legislate appropriate State Acts.

14.2.1. Model Agricultural Produce and Livestock Marketing Act, 2017

The Model APLM Act, 2017 is described in Volume IV of this Report. Designed to include livestock marketing and as a promotion and facilitation Act, and states need to adopt the principles in a progressive manner. The Model APLM Act, 2017 has forward looking and facilitative provisions for the integration of processors, exporters, bulk buyers, end users, etc. with farmers. In convergence with the subsequent Model Contract Farming and Services Act, the agricultural marketing environment will be developed in a more inclusive, competitive fashion with the desired of "**ease of doing agri-business**".

The Model APLM Act, 2017 is recommended for the States to adopt, to initiate greater and relevant marketing changes in agriculture and to encourage a single national agricultural market, including for livestock. Government policies with objective of doubling farmers' income should be driven with overriding purpose to promote ease of doing agri-business.

Key Extracts

- States need to adopt the Model Agriculture Produce and Livestock Marketing (Promotion & Facilitation) Act, 2018 and legislate their provisions of law on priority. The Model Act supports promoting sheep, goat, poultry and piggery markets.
- Biosecurity of livestock markets needs to be improved with focus on modernisation of the market infrastructure, in line with scientific segregation of live animals, complying with animal cruelty laws, and minimise zoonotic spread of disease.
- Livestock farmers transact in live animals and primary produce, such as milk, eggs, meat and wool. Each aspect of these valuable outputs need to be promoted to bring appropriate and substantive benefits to the farmer producer.
- Cross-regional movement of live animals (quadrupeds and poultry) is essential and the transport of live animals from their breeding grounds to markets and processors should be facilitated. Ease of doing agri-business should be the driving factor.
- The National Action Plan for Egg & Poultry-2022, may also focus on market development and marketing to the benefit of small holder farmers.
- Policies and government support to processing industry should be linked to demonstrable measures of economic growth and to the doubling of farmers' income.
- Trade in livestock by-products needs to be promoted. With a large livestock population and growing meat, egg and dairy industry, various by-products like extracts, bone char, hair, hide, enzymes, and more are generated. These items have not caught active attention on development front.
- Livestock sector will benefit by organising a division on livestock marketing under the Department of Animal Husbandry, Dairying and Fisheries Development. The focus on infrastructure development can include parameters to ensure that the infrastructure is brought to use to benefit income growth in small farmers.

Fisheries Sector

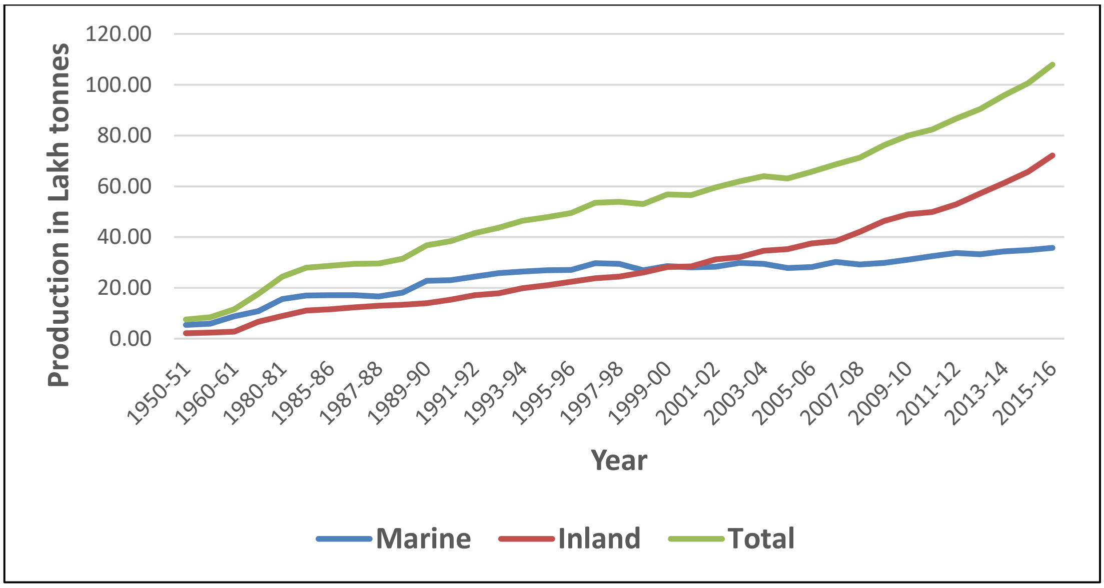
Chapter 15
Fishery Sector: Role and Potential in India

India has rich fishery resources, in terms of both size and diversity. At the macro-level, there exists vast potential to take advantage of both inland and marine resources, to increase the output, for the benefit of about 14.5 million fishermen engaged in this sector. In order to ameliorate the economic and welfare status of this section, credit and marketing, apart from practices of fish raising need priority attention.

15.1. Background

India is the second largest fish producing nation in the world, next only to China. Its total fish production during 2016-17 (provisional) was 11.41 million metric tonnes (mMT) with a contribution of 7.7691 mMT from inland and 3.641 mMT from marine sectors. Fish production during first three quarters of 2016-17 has also shown an increasing trend and is estimated at 8.18 mMT. The transformation of the fisheries sector from traditional to commercial scale has led to such increase in fish production from a mere 0.75 mMT in 1950-51. The earnings from fish exports were worth Rs. 37,871 crore during 2016-17. The sector contributed 5.23 per cent to the agricultural GVA (Gross Value Added) and about 0.92 per cent to the National Gross Value (2016-17) (DADF, 2018).

Figure 15.1 Year-wise growth of fish production



Source: SMD (Fisheries), Indian Council of Agricultural Research (ICAR)

15.1.1. Indian fisheries resources

At the current rate of around 6 per cent overall growth of the sector and 8 per cent in the aquaculture sector, it is expected that the country's production may rise to 15 mMT by the end of 2020 (DAHDF, 2017) and 17 mMT in 2022-23. The sector engages over 14.50 million people at the primary level and many more along the fresh and processed supply chain. In the following table, the status of fishery-resources of the country is presented.

Table 15.1 Status of Indian fisheries resources and its size

SN	Resources	Size
Inland Fisheries Resources		
1.	Length of rivers including canals	0.19 million km
2.	Freshwater ponds and tanks	2.41 million ha
3.	Reservoirs	3.15 million ha
4.	Flood plains / derelict water bodies	1.00 million ha
5.	Inland saline / alkaline land	1.20 million ha
6.	Brackish water area	1.24 million ha
Marine Resources		
7.	Length of coastline	8118 km
8.	Exclusive Economic Zone (EEZ)	2.02 million sq. km
9.	Continental shelf	0.53 million sq. km.

Source: Annual Report 2016-17, Department of Animal Husbandry, Dairying and Fisheries

15.2. Production and Income Trends of Capture Fisheries

In the following sections, the status of capture fisheries in terms of production and income is examined.

15.2.1. Reservoirs fisheries

The man-made reservoir resources account for around 3.15 million ha of water spread area, and are mostly distributed in varied climatic environments that are congenial for fish growth. In India, the reservoirs are categorized into small (area >10 to 1000 ha), medium (area 1000 to 5000 ha)) and large (area >5000 ha). There are 19,370 numbers of reservoirs in the country covering an area of 3.15 million ha. The number of small reservoirs are 19,134 (14, 85,557 ha), medium are 180 nos (5, 27,541 ha) and large number 56 (1,140,268 ha). There also exist wide gaps in the average production/productivity of reservoirs and the actual production in many of the reservoirs is less than normal due to poor management practices.

The major intervention required for harvesting the production potential are stocking of right type of fish species in right size & number; and timely harvesting.

All essential supply chain systems need to be established before any government scheme is implemented at the field level. The launch of the Reservoir Fishery Program, Andhra Pradesh is in the right direction (Box 1.1) in terms of organisational structure as well as institutional arrangements. The involvement of a private sector stakeholders also lends the needed flexibility and credibility to such initiatives. **Distinct improvements in production and marketing management along the lines of the above model alone can ensure income enhancements of reservoir fishers in the long run and is, therefore, suggested for replication in other states too. This demonstrates the scope and value of mobilizing farmers and supporting them through joint initiatives of government and private sectors.**

Box 1.1: Reservoir Fishery Program, Andhra Pradesh

The Department of Fisheries, Government of Andhra Pradesh and Tata Trust are implementing a reservoir fishery program in ten (10) selected districts of Andhra Pradesh. This program has a multi-stakeholder engagement besides the State Fishery Department. Existing fisheries cooperatives at installed cage locations are responsible for entire operation and management. Such a vision requires self-governed and institutionally sustainable cooperatives. All such cooperatives are catered to with capacity building engagement and support services, to adhere to institutional norms and practices of producer organisation. All new technical advancements and support systems like hatchery, nursery, feeding system, logistics development support etc. are also provided at these locations. Community based fishery resource units regularly engage with farmers, women SHG and fishery cooperatives.

Box 1.2. Maharashtra Experience – Cage Culture

At present, Maharashtra has just around 10 cages at irrigation dams located at Dimbhe, Ujani, Panshet and Vangani, and other projects promoted by government, private, fishermen co-operatives and NGOs.

The fish is reared in a high-density controlled environment; and weight, feed and growth parameters are monitored on a real-time basis. Around 5,000-7,000 fingerlings are released in one tank and they grow upto 1 kg, ensuring that each cage can produce around five tonnes of fish. If even 50 cages are promoted in a reservoir, 250 tons of fish can be harvested annually.

The state government seeks to boost productivity of fish farming in open reservoirs. Maharashtra records 4 lakh metric tonnes (LMT) of marine fish production and 1.5 LMT of inland fish production. During 2014-15, the state's contribution in marine, inland and total fish production (provisional) of India was 13.1 per cent, 2.2 per cent and 6 per cent, respectively, according to the Economic Survey of Maharashtra 2015-16. In 2014-15, Maharashtra exported 1.52 LMT fish worth Rs. 4,273 crore. According to Govt. of India statistics, fish production has increased from 0.75 mMt in 1950-51 to 10.79 mMt (provisional) in 2016-17.

Riverine fisheries need to be re-organised on the lines of successful implementation at a few places (Box 1.2 – case of Maharashtra). The country is bestowed with vast and varied hill fishery resources which are spread over the Himalayan and Peninsular regions, in the upland rivers, streams, high and low altitude natural lakes and reservoirs. The riverine systems comprise streams and rivers with a length of around 8,243 km; 20,500 ha. spread of natural lakes; 50,000 ha of reservoirs - both natural and manmade; and 2,500 ha. of brackish water lakes in the high altitude. **Re-organisation and institutional involvement hold the potential for ensuring doubling of incomes of riverine fishers.**

Box. 1.3: Riverine Fisheries and User Rights

"In Maharashtra's Kolhapur district alone, there are 52 different fishing cooperative societies fishing in the open river. The numbers of fishermen in the region are 4,000-5,000 approximately and are deeply familiar with the waters, as they have been conventionally practicing fishing. Each fishing cooperative society has fishing rights decided traditionally on the rivers of Krishna and Panchaganga".

"It is by the very process of leasing, that the rights of fisher-folks on the river are recognized and protected. If the process of such leasing is stopped, anyone could come in the area and do fishing compromising the local fishermen's ability to make their ends meet".

"At least some user right of these fisher-folk on the rivers is thus recognized. In Vidarbha, dams like Gosi Khurd constrain downstream fisheries and fisher-folk. Since they do not even have nominal user rights on the river, they are not even counted as being affected by the dam!"

Source:https://sandrp.wordpress.com/2013/10/09/who-cares-for-riverine-fisheries-in-Maharashtra/

The illustration in Box 1.3 indicates the **need for recognising the traditional fisherman's user rights across the waterbodies. A policy that offers first right to the traditional fishers is recommended.**

15.2.2. Brackish water fisheries

India has 1.24 million ha of brackish water area spread over 9 maritime States, 2 Union Territories (UTs) and 2 Island Territories (ITs), but hardly an extent 15 per cent of brackish water area has been developed for commercial farming. Shrimps, mussels, crabs, seabass, groupers, mullets, milkfish, pearl spot, are being farmed to some extent in this sector. The recent intervention by ICAR-CIBA (Central Institute for Brackish water Aquaculture) has opened up avenues for improved farming in Pokkali fields, where spatial and temporal integration of agriculture, and brackish water fish and shrimps has been demonstrated for successful realisation of high returns.

Further, poly-culture of brackish water finfish and shell fishes with much higher production has been demonstrated by stocking seed of suitable varieties of fishes and prawns. The integrated multi-trophic model in which fish, animals and vegetable are simultaneously grown has also proved its ability to generate higher rate of return. According to NABARD (National Bank for Agriculture and Rural Development), the conservate estimate is 50 per cent of IRR (Internal Rate of Return) in farming of *P. vannammei* (The Pacific white shrimp) (Box).

Box 1.4. Financial Viability of P. Vannamei (Pacific white shrimp) culture

NPV @ 15% : Rs. 30.03 lakh
BCR @ 15%: 1.18: 1
IRR: > 50%

==============================

Species: P. Vannamei

Estimated Production: 2 tonnes/ ha
Culture period: 3-4 months
Size at harvest: 17 – 30 gms
Farm gate price: Rs. 400- 650
Gross returns: Rs. 8 Lakh/ha
Risks: Price and Production

Source: NABARD

However, a complete re-organisation of Indian shrimp farming culture, production, processing and exports is called for. **Shrimp culture is not a small farmer activity.** The small farmer with less than a hectare of land area cannot achieve economy of scale of operations for different species of shrimp, *P.vannamei* and *P. monodon*.

Furthermore, shrimp being highly sensitive to both pond as well as external environment, needs top class technical management and requires years of experience in the field. It is, therefore, common to see involvement of corporate sector in shrimp cultivation. Its vulnerability to disease infliction constricts realisation of the sector's full potential. It is, therefore, suggested that in case of marginal fishermen, besides allocating them brackish water lands, they should also be mobilised into farmer producer organisations (FPOs) to promote cluster based farming, thus imparting the required scales of economy to the operations.

Needless to say, regulatory authorities like the Coastal Aquaculture Authority (CAA) and the Marine Products Exports Development Authority (MPEDA) need to play a significant role in regulating the private sector investments from overexploiting the resources for short run gains. **Incomes in shrimp farming are high and a transparent supply chain management will ensure value percolates to the shrimp producer, usually a marginal farmer.**

15.2.3. Marine fisheries[10]

The marine fisheries sector provides employment to nearly 4 million people, comprising 8.64 lakh fishermen families inhabiting 3,288 fishing villages along the east and west coasts of the Indian sub-continent. As per the Marine Fishery Census, 2010, about 61.1 per cent of coastal fisher folk were engaged in fishing and allied activities, of which about 38 per cent are active fisher folk. This includes about 7.9 lakh numbers of full-time fishermen and 1.35 lakh part-

[10] Drawn largely from Shinoj et al., (2017)

time, apart from 0.64 lakh fish seed collectors. Among those involved in allied activities in the sector, 36.5 per cent were engaged in marketing of fish and 32.6 per cent were working as labourers (GoI, 2012). Apart from this, a significant number of coastal inhabitants find their livelihood in secondary and tertiary activities related to fishing, such as post-harvest handling and processing of fish, activities related to craft and gear manufacturing, supply & maintenance of fishing equipment, transport and logistics and so on.

There are three (3) sub-sectors in marine fishery, namely, mechanised, motorized and non-motorized. The types of gear and main resources targeted and the extent of involvement vary across these three. The mechanised sub-sector that contributes to about 82 per cent of total landings is the dominant one that comprises 72,559 fishing crafts with the value of capital investments estimated at Rs. 20,810 crore (Table 15.2).

Table 15.2 An overview of marine fishery across its sub-sectors in India

Particulars	Mechanised	Motorized	Non-motorized
Main type of gears	Trawl net, Gillnet, Purse- seine, Hook & line	Ring-seine, Purse-seine, Boat-seine, Hook & line, Dol net, Driftnet, Long line	Hook & line, Pole & line, Bag net, Long line
Main resources targeted	Indian mackerel, Cephalopods, Ribbon fishes, Penaeid prawns, *Priacanthus* spp., Threadfin breams, Croakers	Oil sardine, Other sardines, Tunas, Anchovies, Seer fishes, Mullets	Tunas, Oil sardine, Other sardines, Mullets
Contribution to total landings (%) (2010)	82	17	1
Number of fishing crafts (2010)	72,559	71,313	50,618
Estimated value of inventories (crores) (2015)	20,810 (92%)	1,498 (7%)	354 (1%)
Active fishers engaged (Nos. in lakhs) (2010)	3.27 (33%)	6.14 (62%)	0.49 (5%)

Sources: Government of India (2012); Central Marine Fisheries Research Institute (CMFRI) (2016)

15.2.4. An appraisal of income from fishing

The multiplicity of vessel and gear types, their varying catch capacities and efficiency levels, high level of variability associated with catches during routine operations, variability across seasons, heterogeneity in resources and the volatility in prices they command under different market conditions add to the complexity of marine fishing. It is difficult, therefore, to arrive at a figure that represents income from marine fishing in realistic terms.

The economics of **single-day fishing w**ith respect to a **few selected craft-gear combinations** in seven maritime states is presented in Table 15.3. The estimates of net operating income and incomes of vessel crew varied widely across craft-gear categories and states. While the mechanised trawl-net and purse-seine operations (purse seining in Maharashtra is now banned but still continues clandestinely) in Maharashtra fetched as high as Rs. 51,575 and Rs. 50,333 respectively on an average; and non-motorized gillnet operations in Andhra Pradesh returned only Rs. 729 per trip (Narayanakumar *et al.*, 2016).

Similarly, net operating incomes from motorized mini-trawl in Andhra Pradesh (Rs. 867/trip) and mechanised gillnet in Gujarat (Rs. 862/trip) were also among the lowest. The lay system of wage sharing (McConnel and Price, 2006) is followed in all the states under consideration, wherein, the crew were remunerated with a share of revenues or share of revenues less the costs. Nevertheless, high level of variability in shares is noticed across regions, with the highest in Tamil Nadu (60-75% of gross revenue) and Kerala (50-60%), and the least in Odisha (12-20%).

Accordingly, the estimated crew share per person also varies considerably, and it is highest (Rs. 4,497/trip) for mechanised trawl operations in Kerala, followed by motorized purse-seining in Maharashtra. On the other hand, the income earned by a crew member in non-motorized gillnet in Andhra Pradesh is low at Rs. 117/trip on an average. The crew wages of motorized mini-trawler in Andhra Pradesh (Rs. 300/trip), motorized gillnet in Odisha (Rs. 314/trip) and mechanised gillnet in Gujarat (Rs. 390/trip) are also quite low indicating the vulnerability of the labour force that is dependent on these vessels for livelihood.

The incomes from various craft-gear combinations engaged in **multi-day fishing operations (2-5 days)** for the selected states are presented in Table 15.4. Compared to single-day operations, the operating costs, gross revenue and net operating incomes are higher in most cases considered. The highest net operating income is observed in the case of multi-day trawl fishing in Kerala with an average estimate of Rs. 3,48,016 /trip of 2-5 days. This was followed by mechanised trawl fishing in Maharashtra (Rs.1,84,126/trip) and Karnataka (Rs. 1,71,315).

Among all, the least net income is earned by motorized hook and line fishing in Odisha with an average of Rs. 498/trip. The craft-gear combinations such as mechanised purse-seine in Maharashtra, mechanised gillnet in Gujarat and Andhra Pradesh yielded modest net incomes ranging from Rs. 11,000 to Rs. 16,000 per trip. The crew share per person is the highest from mechanised gillnetting in Gujarat (Rs. 19,055), closely followed by mechanised trawling in Kerala (Rs. 18,733) and Karnataka (Rs 17,982).

Table 15.3 Economics of single-day fishing operation - selected craft-gear combinations (per trip), 2015

Particulars	Kerala	Karnataka		Maharashtra		Gujarat		Tamil Nadu		Andhra Pradesh		Odisha	
	Mechan-ised	Motor-ised	Non-Motorised	Motor-ised	Mechan-ised	Motor-ised	Mechan-ised	Mechan-ised	Mechan-ised	Mechan-ised	Motor-ised	Non-Motor-ised	Motor-ised
	Trawl net	Ring seine	Gill net	Purse seine	Trawl net	Gill net	Trawl net	Trawl net	Gill net	Mini trawl-net	Gill net	Gill net	Lowpin /Highpin
Operating Cost (Rs)	63,664	72,983	1840	5954	53,427	32,669	1,481	10,440	9,741	2,188	447	5,914	7,093
Average crew size (No)	7	22	1	5	10	35	3	5	4	3	3	5	5
Average catch (kg)	1,006	1,964	190	322	659	1,781	37	78	389	37	37	270	326
Gross revenue (Rs)	1,06,767	1,00,754	4,100	40,105	75,002	83,007	2,343	12,331	11,387	3,055	1,176	13,136	32,638
Net operating income (Rs)	40,103	27,771	2,260	34,151	51,575	50,338	862	1,891	1,646	867	729	7,222	25,545
Crew share per person (Rs)	4497	1861	1440	962	540	2359	390	929	1875	300	117	314	811

Note: Data pertain to selected landing centers and include Ponnani and Thottapalli in Kerala; Majali in Karnataka: Ratnagiri in Maharashtra; Okha in Gujarat

Table 15.4 Economics of multi-day fishing operation (2-5 days) - selected craft-gear combinations (per trip), 2015

Particulars	Kerala	Karnataka		Maharashtra		Gujarat		Tamil Nadu		Andhra Pradesh		Odisha	
	Mechanised	Mechanised	Mechanised	Mechanised	Mechanised	Mechanised	Mechanised	Mechanised	Mechanised	Mechanised	Mechanised	Motorised	Motorised
	Trawl net	Gill net	Trawl net	Trawl net	Purse seine	Gill net	Dol net	Trawl net	Gill net	Trawl net	Gill net	Lowpin /Highpin	Hook & line
Operating Cost (Rs)	3,81,487	2,48,303	4,27,645	69,026	84,025	2,02,183	13,304	44,161	1,37,031	81,462	64,812	1,31,211	1,227
Average crew size (No)	10	15	10	10	35	8	4	5	8	9	9	7	5
Average catch (kg)	6,617	1,161	2762	1497	5938	805	732	520	2336	2663	689	2135	57
Gross revenue (Rs)	7,29,053	3,90,597	5,98,960	2,53,152	1,98,583	2,17,775	99,850	80,217	2,44,826	2,09,118	80,370	2,23,525	1,725
Net operating income (Rs)	3,48,016	1,42,294	1,71,315	1,84,126	11,455	15,592	86,549	36,056	1,07,795	1,27,656	15,558	92,314	498
Crew share per Person (Rs)	18,733	13,254	17,982	1,356	5,135	19,055	1,381	2286	1875	1,758	1,686	3,831	109

Methods such as mechanised trawling, gillnetting, purse-seining and motorized low pin/high pin are found to yield impressive returns, for both the boat owners and the crew. However, there were several other cases, particularly under motorized and non-motorized sectors, that yielded modest incomes supporting only subsistence levels of living. **Nearly 67 per cent of active fishers belong to the non-mechanised sector, majority of whom operate under subsistence level.** Further, per trip incomes, as outlined above, give only partial understanding of the earnings of a fisherman. This is because, fishing in the sea depends a lot on factors such as weather conditions, season of fishing, stock of major fishes and so on.

The number of actual fishing days for a mechanised fishing boat generally range from 200 to 250 annually, after taking due account of closed seasons, off seasons, period of maintenance of vessel and gear, religious holidays, etc. (Najmudeen and Sathiadhas, 2007; Geetha *et al.*, 2014). Certain vessels such as mechanised purse seine boats fish only for 90-120 days a year. Even in the case of non-motorized vessels, the maximum number of fishing days is limited to 250-280 days (Sathiadhas, 1997). Therefore, the average per day income of a fisher is much lower than what the above estimates give. Moreover, **to consider income per trip as the foremost variable that determines the standard of living of a fisherman would be misleading.**

Unlike in many other sectors, fishermen face high level of vulnerabilities in their day-to-day life. Being coastal dwellers, fishermen are highly exposed to the vagaries of extreme climatic events which add to the risks associated with their routine fishing activities. Further, ownership of productive assets such as land and livestock is comparatively lower among fishermen mostly living in the coastal settlements. Therefore, the majority of fishermen live with perpetual income vulnerability with little opportunities to generate supplementary income through any alternative source.

15.3. Exploring Opportunities to Enhance Incomes of Fisher Folk

15.3.1. Enhancing efficiency of fishing fleet

- Enhancing the efficiency of existing fishing fleet through suitable conversion and up-gradation, together with introduction of improved crafts and fishing gears could prove useful in bringing about profitable and responsible fishing in marine waters. These could include navigation and position monitoring systems, sonar to locate shoals, upgraded maintenance and repair facilities, and other need based systems in consultation with local fleets.
- Low-cost fuel-efficient and solar power-operated fishing vessels designed and developed by ICAR-CIFT (Central Institute of Fisheries Technology), together with improved fishing gears such as juvenile excluder, semi-pelagic trawl system, short-body shrimp trawl and cut-away top belly shrimp trawl could help the fishers in efficient use of inputs and thereby cut costs. The technologies also help in minimising catching of juvenile fish and selective harvesting of fish.

15.3.2. Use of space technology and ICT

Recent advances, particularly in the field of space science and information technology can be effectively utilized for improving the efficiency of fishing in India, thereby driving up incomes of the fishers.

15.3.3. Dissemination of Potential Fishing Zone (PFZ) advisories to the fishermen:

The Portal, m@krishi launched by CMFRI (Central Marine Fisheries Institute) in partnership with INCOIS, Hyderabad and Tata Consultancy Service (TCS) for the fishermen of Maharashtra is an excellent example that can be emulated by others too. Based on a survey conducted by the CMFRI on Maharashtra coast, it is estimated that adoption of m@krishi service has resulted in 30-40 per cent increase in fish catch and 30 per cent saving in fuel costs (Singh and Singh, 2016). Another study by George *et al.* (2011) in Andaman and Nicobar islands for selected craft types has indicated increase in fishing revenues by 40-50 per cent through adoption of PFZ advisories. Similarly, measures such as spatial planning of marine and coastal habitats covering major fishing grounds, using advanced GIS mapping tools as well as robust vessel monitoring system (VMS) could ensure efficient fishing operations besides enabling fool proof monitoring, controlling and surveillance (MCS) as well as enhanced security across the coastline.

15.3.4. Mari-culture

Mari-culture, i.e., culture of marine organisms under controlled conditions in sea, has immense potential to meet the growing demand for fish. Some of the promising mari-culture options include open sea cage farming, sea weed farming, integrated multi-tropic aquaculture (IMTA), mussel and oyster culture, ornamental fish production and pearl culture.

The lack of a comprehensive policy is a major lacuna in tapping the potential of mari-culture ventures, such as sea cage farming in the country. It is anticipated, that with the availability of favourable policy guidelines for utilization of coastal waters and increased private investments, the enterprise has scope to expand in the coming days.

The areas of focus include development of a leasing policy, demarcation of potential mari-culture sites along the Indian coasts on a GIS platform, measures to strengthen seed and feed supply for mari-culture ventures, guidelines for development of infrastructure and supply chains for brood stock management, and large scale seed production of prospective fish and shell fish species (George *et al.*, 2017). Some of the promising mari-culture ventures that have considerable potential to augment income of coastal fisher folk are elaborated in the following paragraphs.

15.3.5. Open sea cage farming

Open sea cage farming is a promising venture for prospective entrepreneurs to realise high net returns through culture of high-value marine fish species in the open sea. Open sea farming is amenable to several fish species such as cobia, pompano, grouper, sea bass, etc. On an average, 2-4 tonnes of fish can be produced in a 6 m diameter cage per cycle. The net economic return per crop ranges from Rs. 1.5 lakh to Rs. 4.0 lakh, depending on the species grown (Gopalakrishnan *et al.*, 2017). The indicative economics of sea bass and cobia in open sea, as well as brackish water cages in Kerala and Goa are presented in Table 15.5 for better understanding.

Table 15.5 Economics of fin fish farming in sea/brackish water cages in India, 2016

Particulars	**Goa** (Sea cage of 6m diameter and 4m depth)		**Kerala** (brackish water cage of 8m x 4m x 4m)
	Sea bass	Cobia	Sea bass
Capital expenditure (in Rs)			
Cage structure (GI pipe, including nets)	1,10,000	1,10,000	60,000
Expenses on mooring	15,000	15,000	10,000
Other fixed expenses (refrigerator, containers, etc.)	25,000	25,000	15,000
Gross fixed cost	1,50,000	1,50,000	85,000
Operational expenditure (in Rs)			
Seed cost	65,000	50,000	40,000
Feed cost	90,000	1,30,500	1,50,000
Labour charges	36,000	36,000	36,000
Harvesting charges	10,000	10,000	8,000
Boat hire and fuel charges	30,000	30,000	-
Interest on fixed capital (12%)	18,000	18,000	10,200
Annual depreciation (20%)	27,000	27,000	25,000
Miscellaneous expenditure	10,000	10,000	10,000
Gross operating cost	2,86,000	3,11,500	2,79,200
Revenue and net income (in Rs)			
Gross revenue	7,00,000	6,00,000	4,00,000
Net operating income	4,14,000	2,88,500	1,20,800
B:C Ratio	2.44	1.92	1.43

Sea bass at Goa: Seed cost: ` 32.50/seed for 2000 seeds; Feed cost: ` 22,500 for pellet feed and ` 67500 for sardine feed (FCR: 1:2); Labour charges: ` 150/day for one person for 8 months. Interest: 12 % per annum; Depreciation: 20% per annum; Gross revenue: ` 350/kg for 2 tonnes of harvest.
Cobia at Goa: Seed cost: ` 50/seed for 1000 seeds; Feed cost: ` 22,500 for pellet feed and ` 1,08000 for sardine feed (FCR: 1:6); Gross revenue: ` 300/kg for 2 tonnes of harvest; Other calculations same as above.
Sea bass at Kerala: Seed cost: ` 40/seed for 1000 seeds; Feed cost: ` 1,50,000 for sardine feed (FCR: 1:2); Gross revenue: ` 350/kg for 1.1 tonnes of harvest; Other calculations same as above

With successful demonstrations along the maritime states, cage farming has started gaining momentum in various states of India. Several farmer groups and development agencies in the coastal regions are actively contemplating to take up cage farming in the near future.

Box 1.5. Sea Cage Fish Culture

The conventional fishing does not hold out much promise for the future, as the fish stock in the open sea is depleting and pollution is killing it in the near shore area.

The Andhra Pradesh State Government is promoting cage fish culture among the traditional sea faring fishermen (November 2015). Under the programme, each fisher-folk family is given more than one cage at subsidy, and the Government provides the initial seedlings and feed. The family is able to harvest the fully grown fish in six months or so, depending on the type of fish.

This enables a fisher-folk family earn close to Rs. 5 lakh per annum as against Rs. 50,000 per annum prior to this intervention. However, cage culture cannot be taken up at every location, as the conditions have to be suitable. Some places like Rushikonda and Ramakrishna beaches are well suited to a few types of fish culture.

Box 1.6. Open Sea Cage Farming

The Central Marine Fisheries Research Institute's (CMFRI) open sea cage farming model in Gujarat has received national recognition, with a fisherman associated with the institute bagging the Pandit Deen Dayal Upadhyay Antoyodaya Krishi Puraskar instituted by ICAR in the year 2016.

The regional centre of CMFRI provided cages and technical guidance to the co-operative society in Veraval to take to the farming as an alternate livelihood option for Siddi tribes in the region. The Centre also offered the community a farming demonstration, training and hands-on exposure, under the Tribal Sub Plan outlay of the Institute.

For success of the venture, the Institute has been supporting the farming group financially and technically every year since 2011. The sea cage farm, which is regarded as one of the largest commercial sea farms in the country, comprised 22 galvanised iron cages of 6 m diameter. The farmers were empowered to operate the farm by themselves, and they obtained four crops of lobsters and cobia, realising a quality livelihood.

15.3.6. Seaweed farming

Seaweed mari-culture is a profitable livelihood option for fisherwomen, who can earn a substantial income for the household with little effort. India possesses 434 species of red seaweeds, consisting of 194 species of brown seaweeds and 216 species of green seaweeds. (CMFRI, 1987). The seaweed production potential in India is estimated at 1,005,000 metric tonnes (MT) distributed across six (6) states of India (Modayil, 2004) comprising 250,000 MT in Gujarat; 250,000 MT in Tamilnadu; 100,000 MT in Kerala; 100,000 MT in Andhra Pradesh; 5,000 MT in Maharashtra and 300,000 MT in Andaman and Nicobar islands.

However, no significant progress in organised seaweed farming was made till the beginning of the 21st century due to various reasons. The estimated Net Present Value (at 20% discount rate) was Rs. 1.30 million (implying an IRR higher than 100 %), while the Benefit-Cost Ratio was 1.70. All these indicators provide strong evidence of the economic and financial feasibility of seaweed farming in Tamil Nadu (Krishnan and Narayanakumar, 2009).

Assuming that two members in each household are engaged in seaweed farming for 144 and 161 days in an year at Mandapam and Rameshwaram, respectively, the sector would be providing 1,48, 896 and 1,55 ,526 man-days of employment per year in the two regions (this estimate assumes a total of 1,000 families engaged in seaweed farming in the Ramanathapuram District).

Various developmental programmes in the region are currently targeting to involve a total of 5,000 families in seaweed farming, which would translate into 7,65,000/-days of employment in the district (at an average employment of 153 days per person per year). It has been argued that, seaweed farming could provide employment to 2,00,000/- families in the country, generating an annual earning of about Rs. 0.10 million per family(Aquaculture Foundation of India, 2008).

Table 15.6 Economic viability and financial feasibility indicators for 1 ha seaweed farm (project cycle of three years)

Indicators	Unit	Year I	Year II	Year III	Average
Gross investment	INR(thousands)	597.1	N/A	N/A	597.1
Total cost of production	INR(thousands)	694.1	942.5	942.5	859.7
Gross returns	INR(thousands)	1 152.00	1 728.00	1 728.00	1 536.00
Net income	INR(thousands)	457.9	785.5	785.5	676.3
Net Present Value (20% discount rate)	INR(thousands)		1,300.00		
Benefit Cost Ratio (20% discount rate)	Ratio		1.7		
Return on investment	Percent		113.26		
Payback period	Years		0.9		
IRR	Percent		>100		

Source: *Krishnan and Narayanakumar (2009)*

15.3.7. Other promising mari-culture ventures

Culture of mussel and oyster has gradually spread across the backwater belts of Kerala, Karnataka, Goa and Maharashtra owing to their high profitability. A number of methods such as stake culture, on-bottom culture, long-line culture, raft culture, rack culture, etc. are followed in mussel and oyster farming.

Over 1,000 farmers are practising rack culture of green mussel in the Padanna estuary areas in Kasargod, which is contributing three-fourths of green mussel production in India (Mohammed, 2015). A net return of about Rs. 88,000 per unit of 200 seeded strings can be obtained through rack method of green mussel farming in this region (Table 15.6). Though technology for mussel and oyster farming is fairly well established, as in case of most other agricultural produce, what remains lacking is the adequate marketing and processing infrastructure.

Other promising mari-culture avenues include ornamental fish farming and pearl culture for which technology has been perfected by now. Larger number of entrepreneurs may be encouraged to take up these ventures by providing technological, financial, marketing as well as logistical support.

15.4. Holistic development of the marine fish supply chain

Various modern infrastructure and equipment play an important role in the fish supply chain, even more so than in conventional farming systems. A wide array of logistics infrastructure development can be initiated in the marine fisheries sector, so that the fish and fishery products reach the consumer in good quality. Considerable investment needs to be made in the sector to modernise cold chains in fishing boats, as also along main links in the supply chain including reefers transportation, small retail outlets, retail carrier vehicles, and in small scale fish handling and fish processing units.

Fisher folk are traditional communities that form entire villages. This makes village level secondary activities feasible, including fish handling, processing and blast freezing units. The fishing villages can be developed as village producer organisations (VPOs), with specific need based secondary units, GrAMs (Gramin Agri-Markets) as fish handling and transport units, net repair and boat maintenance facilities, as well as mariculture and other land based fishing businesses.

Quality control of marketed fish is another major concern in the context of strengthening the supply chains. In recent times, concerns have been raised in various quarters over the quality of fish marketed. With rapid increase in fish demand, which remains unmatched by capacity of the domestic supply chain, the widespread use of unauthorized preservatives and other harmful chemicals has been reported across the country.

In this context, it would be relevant to set up fish quality certification units in every major harbour/fish landing centre/wholesale market so that not only the fish landed but also those transported from other markets are adequately checked for the presence of harmful preservatives. The technologies and detection kits developed by the Central Institute of Fisheries Technology (CIFT), Kochi, can be utilized for this purpose.

Ecological certification of selected fisheries for green /sustainable fishing activities is another important intervention that has the potential to enhance value of fish marketed, so that more entrepreneurs can be mobilized into mari-culture activities. Specific fisheries, particularly mari-culture ventures, along the coast can be selected for certification so that the fishermen/fish farmers associated with them can benefit from premium prices realised at global/ high-end domestic markets. MSC certification of Ashtamudi short neck clam facilitated by CMFRI is an example worth emulating in this regard (Mohammed, 2016).

Table 15.7 Economics of rack method of green mussel farming in Padanna, Kerala, 2016

Expenditure head	Details of expenditure for a rack of 200 seeded strings	Amount (Rs)
Fixed expenditure		
Rack construction (Poles and rope)	20 bamboo poles @ of Rs 300/pole; 4 kg of 3-4 mm rope @ Rs 250 / kg	7,000
Labour charges for rack construction	4 male labourers @ Rs 750/person	3,000
Gross fixed expenditure		10,000
Operational expenditure		
Seed cost	200 kg of seeds @ Rs 50/kg	10,000
Associated costs in stocking	Cloth, rope, coir, etc.	5,500
Labour charges for stocking	8 female labourers @ Rs 400 / person	3,200
Rack maintenance charges	5 man-days @ Rs 750/man-day	3,750
Harvesting charges	2 male labourers @ Rs 750/person	1,500
Miscellaneous	Hiring of canoe, etc.	2,550
Interest on fixed cost	12 % per annum	1,200
Depreciation	33.3 % per annum	3,300
Gross operational expenditure		31,000
Revenue and Net income		
Gross revenue	Total harvest of 1.4 tonnes / rack (@ 7 kg/string) valued at Rs 85/kg	1,19,000
Net operating income		88,000
B:C Ratio (%)		3.83

15.5. Annotation

India has enviable resources needed for promoting both inland and marine fisheries, and improve the income status of about 14.50 million fishermen engaged in this farming. In the year 2015-16, the fishery sector contributed 5.43 per cent to the agricultural GVA and about 0.9 per cent to National Gross Value. At the current overall growth rate of 6 per cent for the sector, the projected fishery production is expected to rise from 10.79 mMT (2015-16) to 17 mMT by 2022-23.

The umbrella scheme, 'Blue Revolution: Integrated Development and Management of Fisheries', covers inland fisheries, aquaculture, marine fisheries, including deep sea fishing, mariculture and all activities undertaken by the National Fisheries Development Board (NFDB). The overall fish production in India has crossed 10 million tonnes with a growth rate of over 5 per cent and today.

In both marine as well as inland sectors, income of fishers and fish farmers' can be enhanced by reducing structural and organisational imbalances. Inland fish farming can serve as a fulcrum to income enhancement efforts in an integrated farming systems model. At a rough guess, the country could be producing 25-30 million tons fish from inland bodies against the current 6 million tons, an annual income gain of over Rs 4 trillion (Phansalkar, 2017).

Key Extracts

- There exists vast and diverse fishery resources (both marine and inland), that can be used to improve the income returns from fishery practices.
- The output of fish that was 10.79 mMT in 2015-16 is projected to grow the 17 mMT by 2022-23 at current growth rate of 6 per cent per annum. With accelerated growth, the production can grow substantively higher than this.
- In order to focus on fishermen's incomes, access to collateral-free credit and enhanced marketing through cooperatives and FPOs (including FPCs) will need priority attention. Fishermen are more naturally aligned to village communities and would be amenable to forming village producer organisations (VPOs).
- Marine fishing faces problems seen from smaller quantities and size of fish landings. The fishermen's income avenues can be widened by promoting added activities like seaweed farming, mussel & clam culture, pearl culture, ornamental fish culture etc.
- Mariculture huge opportunities, but requires large investments and intensive management. Integration of fishers in mariculture fisheries management should become a pre-condition to potential investors to ensure income generation / enhancements among the marginalized sections of the population.
- Brackish water shrimp farming needs to be regulated with utmost seriousness to ensure sustained income transfers to the marginalized small farmers.
- Seaweed farming needs extensive promotion. Kappaphycus alvarezii offers immense scope for wide spread promotion for culture. The Aquagri Networking Business Model offers the right approach to promote this small fisher activity to ensure income and welfare gains to local population.

Chapter 16
Inland Fisheries: Short Term Strategies

Freshwater aquaculture offers the maximum scope for increasing farm income. The farming of Indian Major Carp (IMC) with scope for multiple stocking and multiple harvesting offers an irresistible opportunity for enhanced production and income generation activities. An analysis of the costs and returns of various species that are being cultured in India will help in deciding on adoption of those that are advantageous to a particular location.

16.1. Freshwater Aquaculture

Freshwater aquaculture is practised all over India. The freshwater species consist of Indian Major Carps. These include Catla, Rohu, Mrigal, Silver Carp, Grass Carp and Common Carp. The culture of these fishes can be done in all types of freshwater bodies. The projected production is about 6 to 8 metric tons (MT) per hectare. The cost of production works out to Rs. 60 to 75 lakh per hectare. The capital cost is estimated at Rs. 4 to 5 lakh per acre. The culture duration of the crop is around 8 to 10 months.

The carp sells for a price of Rs. 110 to Rs. 130/- per kg. The estimated capital cost projected is around Rs. 3 to 4 lakh. There exists potential for doubling the income of carp farmers. Genetically improved fish varieties like, Jayanthi Rohu gives 17 per cent higher yield. The cost of production can be reduced by optimizing the input use efficiency. It is also possible to popularize the concept of aquaculture farmer producers companies (Aquaculture FPCs) by formalising the existing fishing communities, such that entire villages function as business enterprises focused on fishing and allied activities. Village Producer Organisations could be developed to function as integrated fishing based business ecosystems. Incomes would also be increased if market imperfections are removed.

Table 16.1 Freshwater Aquaculture

Items	Details / Remarks
Carp culture	Catla, rohu, mrigal, silver carp, grass carp and common carp and Amur Carp-
Production Plans	i) single stocking-single harvest, ii) single stocking-multiple harvest and iii) multiple stocking-multi-harvest
Stocking density	8000-10,000 fingerlings/ ha
Feeding regime	Live food propagation through manure/fertilizer application/ Supplementary feeding (Farm made/Formulated feed) - 1-2% of biomass per day
Projected production/ ha	6-8 tonnes
Cost of Production (Rs./ha)	60-75
Capital cost (Rs./ha)	4 – 5
Sale price (Kg)	110-130
Gross profit (Rs./ha/Yr.)	3.00 – 4.00

Items	**Details / Remarks**
Potentiality of doubling income	30% Reducing the cost of production through optimising the input use efficiency Introduction of minor carps to increase per unit productivity and profitability of the water spread area. Popularising the genetically improved fish varieties such as Jayanti Rohu which gives 17 percent higher yield. Popularising the Aquafarmers Producer Companies to facilitate the collective bargaining and elimination of market imperfections

16.2. Carp breeding

There are different types of hatcheries for carp breeding like eco-hatchery or FRP hatchery. The capital cost of establishing the carp seed producing hatchery of a capacity upto 30 to 40 million works out to Rs. 10 to 12 lakh.

The gross returns (GR) per year work out to Rs. 5 to 6 lakh. It is possible to increase the income of carp seed breeders by around 30 per cent with the establishment of sound network of brood banks, structured implementation of best management practices and modernization of hatchery through support from NFDB (National Fishery Development Board) and NABARD (National Bank for Agriculture and Rural Development).

Table 16.2 Project details of carp breeding

Items	**Details**	**Remarks**
Type of hatchery	Eco hatchery/FRP hatchery	-
Broodstock	Indian Major Carps	1.5 Kg each
	Chinese carp	1.5- 5 Kg
Area of pond (ha)	0.2 – 0. 5	-
Water depth	1.2 – 1.5 meters	Throughout the year
Stocking density sex ratio	1 : 1	-
Breeding	Induced breeding Via Hormonal injection	Synthetic hormones are used to induce the breeding along with the simulated rain environment in the hatchery. Pl give your remarks on this hormone

Items	**Details**	**Remarks**
Technology	Cryopreserved fish milt	Fish milt is collected from good quality male brooders and kept in chemical compounds namely extenders and cryo-protectants in extremely low temperature to keep the sperm cells viable for a longer period.
Capital cost (Rs./Lakh)	10-12	30-40 million
Gross returns (Rs./Lakh)	5-6	-
Scope for increasing income	For increasing rural employment among unemployed youth	• Establishment of a sound network of brood banks for different fish species across India to ensure high quality brood stock. • Strict implementation of hatchery accreditation and Best Management Practices will increase the productivity of the hatchery operations • Modernization of hatcheries through NFDB / NABARD financial support

16.2.1. Rearing of fish seed

Fish seed rearing can be done in a pond area of 0.521 acres. Adequate fertilizer and insect control are part of pond preparation measures. Feeding must be done through proper treatments like feed propagation by manure and fertilizer application.

In cases where supplementary feeding is also done, the seeds can grow to 25 mm size in 15 days. In two to three months' time, they grow to a size of 80 to 100 mm.

The gross return per acre per month works out to Rs. 30,000/- to 40,000/-. By promoting fish seed rearing clusters, it is possible to ensure all year round supply of cultured finger lings.

Table 16.3 Project details of fish seed rearing

Items	**Details / Remarks**
Pond area (Ac)	0.5-1.00
Pond preparation	Adequate liming, fertilization and insect control
Feeding	Proper Live food propagation through manure/fertilizer application/ Supplementary feeding
Expected growth rate	25 mm in 15 days
Period of rearing	2.5 – 3 months

Items	Details / Remarks
	80-100 mm
Gross returns (Rs./Ac/ month)	30 – 40,000
Scope for doubling income	Function of involved management and seed quality. Promotion of fish seed rearing clusters to ensure the year round supply of quality fingerlings

16.2.2. Minor carps

Minor carps include several species and they can be cultured along with IMC, upto a stocking density of 33 per cent.

The gross return per acre per year is estimated at Rs. 65,000. There is possibility of increasing income by 30 per cent by cultivating minor carps along with IMC.

Table 16.4 Project details of minor carps

Items	Details / Remarks
Species	Fringed lipped carp, kuria labeo, kalbasu, bata, reba, olive barb, silver barb
Culture type	Mixed culture upto 33% with IMC
Expected income enhancement in mixed culture	30%
Gross returns (Rs./Ac/year)	65,000
Scope for doubling farm income from minor carp mixed culture with IMC	30% To be popularized along with the major and chinese carp farming systems.

16.2.3. Costs and returns of carp hatchery in India

Carp hatchery yields very good returns on investment. At the All India level, the rate of return on investment stands at 167 per cent.

Variable cost in carp hatchery at All India level is estimated at Rs. 19 to 23 lakh per year. The gross return is estimated at Rs. 51 lakh per year.

The price cost ratio has been worked out to be at 2.67 lakh. Therefore, promotion of carp hatcheries is a viable income generating enterprise for budding fish cultivators.

Table 16.5 Costs and returns of crop hatchery in India

State	Brood stock no.	Gross returns (Rs./Lakh)	Variable input cost (Rs./Lakh)	Gross returns to variable cost (Rs./Lakh)	Rate of return (%)	Ave variable cost (Rs./000)	Fish Seed price (per 1000)	Price – Cost ratio
Odisha	430	6.98	4.87	2.12	43.50	453.12	650.24	1.44
West Bengal	2392	17.36	7.92	9.45	119.40	211.20	462.72	2.19
Andhra Pradesh	3423	70.21	25.48	44.73	175.60	255.36	702.72	2.75
All hatcheries	2082	51.38	19.23	32.14	167.10	226.56	605.44	2.67

16.3. Magur Breeding

The Magur fish is bred in small shallow ponds and the stocking density per hectare is 50-60,000 fingerlings. Magur requires fish meal based feeding and the recommended size at stocking is 100 to 150 gms per piece. The culture period extends over a year. The gross output is 2 to 3 times and the cost of production per kg works out to Rs. 160 to 180.

The farm gate price of Magur fish is Rs. 350 to Rs. 400/- per kg. The gross returns worked out to Rs. 4 to 5 lakh per hectare per year. There is potentiality for increasing income by 30 per cent by promoting fish seed rearing to ensure year round sup-ply of carp finger lings along with brood bank facilities.

Table 16.6 Project details of Magur fish

Items	Details	Remarks
Small and Shallow Ponds	0.02-0.1 ha/ 0.75-10 m	Area / Depth
Stocking density (ha)	50-70,000	-
Feed	Fish meal based feed	30-32% protein
Size at stocking	100-150 g	10-12 months
Gross output (t/ha)	2-3 t	-
Cost of Production (Rs./kg)	160-180	-
Sale price (Rs./Kg)	350-400	-
Gross returns (Rs. Lakh/ha)	4-5	-
Potential for doubling income	30%	Promotion of fish seed rearing clusters to ensure the year round supply of quality fingerlings along with broodbank facilities

16.4. Freshwater Prawn Culture

Freshwater Prawn is cultivated over 8 months. There is a nursery pond of 40 to 60 days. Fresh prawn is cultivated as monoculture. The survival rate of the fish is expected to be only 50 per cent. But, the size of the prawn at harvest would be an average of 50 gms per piece.

The variable cost in freshwater prawn culture is estimated to be Rs. 150/- to Rs. 175/- and it is one Mt per hectare. The prawn fetches sale price of Rs. 400/- to 600/- per kg. The gross return per hectare is estimated to be Rs. 1 to 2 lakhs. By introducing genetically improved varieties and popularizing this culture, the potentiality of increasing the income is 50 per cent.

Table 16.7 Project details of freshwater prawn culture

Items	Details	Remarks
Nursery period	40-60 days	PL 2-5 g size
Culture practice	Monoculture: @ 3-4 juveniles/m^2	Polyculture @ 1-1.5 juveniles/m^2 with 1000-1500 seed/ha
Culture period	8 months	-
Survival rate	50%	-
Size at harvest `	50 gms	-
Variable cost/Kg	Rs.150-175	-
Yield	1 ton	-
Sale price (Rs./Kg)	400-600	-
Gross returns (Rs. lakh./ha)	- 2.00	-
Potential for increasing income	50%	Introduction of genetically improved varieties and popularization for increasing the local demand.

16.5. Murrel Breeding and Culture

The Murrell fish is bred over 8 to 10 months. The operational cost is Rs.90,000/- per acre. The gross return per acre is estimated to be 1.2 to 2 lakh per acre.

Table 16.8 Project details of murrell fish

Items	Details	Remarks
Culture period	8-10 months	-
Operational cost (Rs. lakh/ac)	0.9	-
Gross returns (Rs. Lakh/acre)	1.20-2.00	-
Intrinsic qualities of murrels that determine market demand		Flavour, meaty flesh, few intramuscular bones, medicinal value
Scope for increasing income of murrel farmers	25 – 30 %	Dedicated investment to be made to establish a seed supply network Popularization for farmed murrel for consumption.

The Murrell fish has high market demand because it has good flavor, meaty flesh, few intra-muscular bones and medicinal value. Estimates indicate that investment made in establishing the seed supply network, the income of murrell farmers can increase by 25 to 30 per cent.

16.6. Tilapia Farming

Genetically improved farmed Tilapia (GIFT) fish variety is gaining popularity among fish farmers. An acre of pond yields around 3,000 kilograms of Tilapia variety. The total cost of production for farming Tilapia in an acre of pond works out to Rs.1.80 lakh, while the farmed fish is sold for Rs 3 lakh. The farmer thus makes a profit of Rs 1.20 lakh per acre. Besides, as the fishes mature in four to five months, farmers can harvest at least two crops per year.

The species takes six months to reach a size of 600 to 900 gm from 50 to 80 gm size.The profits earned from Tilapia fish farming are significantly higher than earnings from present varieties of farmed fish. The fish variety has turned out to be a great hit among customers also as it is nutritious, juicy and with a single bone. A large number of farmers have taken up the new farming model, and succeeded. There is a sharp increase in the demand for GIFT seeds. The number of seeds distributed among farmers increased to 16 lakh in 2016-17 from 22,000 in 2013-14. The demand is expected to reach 50 lakh in 2017-18, demonstrating the popularity.

16.7. Pangasius

Pangasius belongs to a family of catfish, which is native to Vietnam, Cambodia and Thailand. The fish is bred in floating cages or in open aquaculture ponds. The fish is farmed for six months so that it weighs 900gm to 1 kg. Pangasius has a range of qualities that make it a suitable candidate for aquaculture. Its culture holds good potential in areas with adequate water resources such as the global tropics. The speciality of Pangasius is that in six months' time, its weight increases to 1 kg. The cost of production for 1 kg of Pangasius is Rs 35-40 and the selling price is Rs 70-80. For Indian conditions, this variety of fish is good for cultivation in open aquaculture ponds or in dam reservoirs. The fish is cheap, high in demand, easy to cultivate and can yield high profits in a short span of time. The production of fish in one cage varies from four to five tons every six months.

16.8. Freshwater Pearl Culture

Pearl culture spreads over a period of 8 to 12 months. The stocking density per hectare is around 50,000 to 75,000. The culture is done in nylon bags @ 2 mussels per bag. It is advisable to go for culturing 10,000 mussels which make an economic unit. The operational cost per year is estimated to be Rs.2 to 3 lakh and gross return depends upon the market demand and location of the market. Expanding the market through substantial public and private investments, and value addition of pearl culture through design pearls can double the income of fresh water pearl culture farmers.

Table 16.9 Project details of pearl culture

Items	Details	Remarks
Species	*Lamellidens marginalis*	-
Duration	8-12 months	-
Stocking density (ha)	50-75,000	-

Items	Details	Remarks
Culture practice	In nylon bags (30 cm x 13 cm; mesh size 1.5 cm	@2 mussels per bag. Green water needs to be added periodically
Economic unit	10,000 mussels	-
Operational cost (Rs./Yr)	2-3 Lakh	-
Gross returns / yr (Rs/ lakh)	Based on market demand and locational advantages	-
Scope for doubling income	100%	Expanding the market through substantial public and private investments Value addition of pearl culture by designer pearls

16.9. Freshwater Ornamental Fish Culture

This type of culture can be done over a land area of 250 to 500 sq.ft. It is also called backyard or small scale work activity. Two to three breeder cycles can be completed in a year. Each cycle is of a duration of four months. The size at harvest is 65 to 75mm depending on the species. The expected cost for establishing the freshwater ornamental fish culture unit works out to Rs.10 lakh.

Table 16.10 Project details of freshwater ornamental fish

Items	Details	Remarks
Land area	250-500 SFT	Backyard / Small Scale
No. of breeding cycles	2-3	Regulated conditions
Duration of each cycle	4 months	-
Size at harvest	65-75 mm	90-300 mm (depending on species)
Capital cost (Rs/ lakh)	10.00	-
Operational cost (Rs. / Lakh)	05.00	-
Gross returns/ Yr (Rs/ lakh)	12-13	-
Scope for doubling OF farmers income	100% (Sellers market)	Collective farming to eliminate middlemen for better fish breeder prices Shifting the farmers to only high value and export oriented ornamental fish culture through proper technical backup.

The operational cost is around Rs.5 lakh. The gross return on fresh water ornamental fisheries is estimated at Rs. 12 to 30 lakhs per year. The profits on this activity can rise if middlemen are eased out through adoption of direct marketing, high value and export oriented ornamental fish culture is practised.

16.10. Annotation

India is geographically poised to be the world leader in the fisheries sector. Being the largest peninsula in the world, with its vast coastline of 7,517 km and EEZ (Exclusive Economic Zone) of 200 nautical miles, network of lakes, rivers and numerous other inland water bodies, it can easily surpass any other nation in fish production.

The demand for fish is increasing and it has become necessary to increase species diversification in aquaculture by including more species for increasing the output and to suit consumer demand. Inland fisheries and aquaculture are poised for a big break. With the right economic, institutional and technical support, this sub-sector can play a key role in strengthening of IFS (integrated farming system) practices and income enhancement opportunities for the farmers.

Key Extracts

- Inland fisheries offer the best opportunity for growth in employment, income and farmer welfare, not only by production for domestic markets but also for exports
- Freshwater aquaculture requires an overhaul of supply chain management. Broodstock holdings, hatchery production of seeds, quality feed, efficient management and a copy book style marketing model are required to ensure consistent and enhanced income.
- Marketing is inexplicably wired to operational finance at the field level. The role of the local traders and commission agents needs to be eliminated or integrated with farmers, to help achieve growth potential and higher share to farmers in the returns.
- Long distance marketing of freshwater fishes is fraught with malpractices which needs to be addressed on priority.

Chapter 17
Fisheries: Sectoral and Sub-sectoral Action Plan

This chapter is devoted to presenting the sub-sectors of fisheries at a glance. Various sub-sectors under fisheries provide scope for enterprises. Towards this, it would help in examining the present status and growth potential by regions. By identifying the gaps and preparing an integrated action plan to bridge the same, the growth potential can be realised. The action plan needs to include technologies, developmental initiatives and policy interventions.

17.1. Indian Fisheries – Potential for Income Growth

As already brought out in chapter 1, India the largest peninsula, which also enjoys vastness of geography and water bodies, as also diversity of agro-climates possesses impressive potential for realising higher fish output. On account of the scope, which the country enjoys in respect of both marine and inland fisheries, interventions can be made for promoting different types of fishery based enterprises. The large number of fishers in the country will stand to benefit from a technology based, scientifically managed, financially supported and market facilitated production initiatives.

17.2. Sectors and Sub-sectors for Promotion

The diverse set of sectors and sub-sectors, possible in the country can be delineated as follows:

i. Freshwater capture fisheries (excluding cold-water) (Table.17.1)
ii. Marine fisheries (Table 17.2)
iii. Freshwater aquaculture (excluding cold-water) (Table 17.3)
iv. Coldwater aquaculture (Table 17.4)
v. Brackish water aquaculture (Table 17.5)
vi. Inland saline aquaculture (Table 17.6)
vii. Mariculture (Table 17.7)

The above mentioned sectors and sub-sectors have been analysed in terms of current status so as to identify the existing gaps, and interventions needed to realise the growth potential. The action plan needed to make this possible has also been suggested, and it has to be comprehensive by addressing the following:

- Developmental activities
- Technological intervention
- Policy support

In order to enable a clear, well delineated and focused intervention, the action plan has been presented in a tabular form. For each of the sectors/sub-sectors indicated in 3.2 above, the table numbers shown against each of them may be referred to.

Table 17.1 Action plan for specific sub-sectors of Freshwater Capture Fisheries (excluding coldwater)

Sector/sub-sector	Specific enterprise	Region	Present status	Potential	Main gaps	Actionable points to bridge the gaps		
						Developmental activities	Technological interventions	Policy support
Freshwater fisheries: capture-based	Reservoir fisheries		Average per ha productions from reservoirs are a low of 190 kg (small), 105 kg (medium) and 46 (large).	Based on study on selected reservoirs, the potential production from small, medium and major reservoirs can be enhanced to 500 kg/ha, 200 kg/ha and 100 kg/ha respectively.	Assessment of productivity; productivity based stocking of fish seed in right quantity, prescribed fingerling size, at right time and timely harvesting.	Facility for raising fingerling in required quantity which could be pond, pen or cage-based, observing closed season strictly.	Assessment of carrying capacity and productivity of reservoirs.	Establishment of hatcheries, fingerlings rearing facilities including ponds, pens and cages; timely harvesting of fish using larger mesh size nets.
Floodplain wetland fisheries		Average production 500 kg/ha/yr.	Based on study on selected pens, the wetlands, have potential production of 1500-	Assessment of productivity; productivity based stocking of fish seed in right quantity,	Facility for raising fingerling is required	Assessment of carrying capacity and productivity of reservoirs,	Establishment of hatcheries, fingerlings rearing facilities including ponds, pens and cages;	

Sector/sub-sector	Specific enterprise	Region	Present status	Potential	Main gaps	Actionable points to bridge the gaps		
						Developmental activities	Technological interventions	Policy support
			2000 kg/ha/yr.	prescribed fingerling size and at right time.			timely harvesting.	
Riverine fisheries	All India	No record of average production.	Potential not defined.	Inadequate water flow, introduction of alien species, pollution, habitat destruction, etc.	Dredging of rivers for increasing depth, and maintaining required water flow for fish life, diversion of pollution causing water channels, habitat restoration for fish spawning and assembling, ranching of fish seed, etc.	Assessment on minimum water flow for rivers, development of habitat restoration methodologies, devising methodologies for minimizing population of alien fish species, protocols for seed production and ranching of fish seed, etc.	Holistic approach from all the concerned departments having stake over riverine system.	

Table 17.2 Action plan under specific sectors/sub-sectors Marine Fisheries

Sector/Sub-sector	Specific enterprise/ activity	Regions	Present status	Present potential	Main Gaps	Actionable Points		
						Development* activities	Technological Interventions#	Policy support
Marine capture fisheries	Potential fishing zone (PFZ) advisories for fishermen	Maharashtra coast.	CMFRI in collaboration with INCOIS has been operating m-krishi service for fishermen in Maharashtra	The service is proven in reducing scouting time for fishing by 50% and increasing profit to the tune of 25-35%.	The coverage of PFZ service is limited only to the Maharashtra coast.	More fishermen can be added under the PFZ service delivery system by scaling up the model in Maharashtra. Pilot projects may be launched in other coasts.	Technical inputs on PFZ and related matters can be sourced from CMFRI (Central Marine Fisheries Research Institute).	Initiatives from fishery departments of coastal states for launching / replicating / promoting PFZ advisory services.
	Development of oceanic tuna resources in Lakshadweep and A&N islands	Lakshadweep archipelago and A&N islands	The tuna resources in Lakshadweep and A&N remain under-utilized.	The total estimated potential of oceanic tuna is around 2.78 lakh tonnes valued at Rs. 3,195 crore.	Insufficient long-line fleet capacity and inadequate storage facilities in existing long liners. Facilities for post-harvest management, value addition, market intelligence, food safety control, etc. are scanty.	Training fishermen for tuna long lining, package of practices for on-board handling of harvest, etc. Training of potential small-scale entrepreneurs on protocols for preparation of improved *Masmin* using liquid smoke, value added and ready to eat products, etc.	On-board handling protocols for making sashimi grade tuna, technologies for quality maintenance and enhancement of traditional products, development of value added products from processing discards, etc.	Launching a comprehensive government scheme for market led supply chain development of tuna fishery. Subsidies to fishermen for acquiring long-liners and for enhancing storage capacity. Export promotion measures; strengthening market intelligence.

Table 17.3 Action plan for specific sectors/sub-sectors of Freshwater Aquaculture (excluding cold water)

Sector/sub-sector	Specific enterprise	Region	Present Status	Potential	Main Gaps	Actionable points to bridge the gaps		
						Development activities	Technological interventions	Policy support
Freshwater aquaculture - pond/tank based	Carp farming	All states and union territories of the country excepting coldwater regions.	Semi-intensive farming in most places with average production being 3 MT /ha/year.	5-6 MT/ha/yr is easily achievable.	Limited knowledge of scientific farming. Inadequate availability of quality seed Inadequate availability of low cost feed.	Field based demonstrations & HRD programmes. Brood bank development for quality seed production. Establishment of feed mills on PPP models for easy availability at reasonable cost.	Replacement of Normal Rohu with *Jayanti Rohu* for yield improvement. Development of low cost feeds. Better management practices.	Aquaculture sector to be treated at par with Agriculture. Certification including hatchery system to be made mandatory.
	Carp farming	Andhra Pradesh, W.B., Punjab, Haryana, U.P., etc.	Intensive farming (5-8 Mt/ha/yr.	Can be further increased to 12 – 15 MT/ha/yr.	Limited knowledge on scientific farming. Inadequate availability of quality seed. Inadequate availability of low cost feed. No crop insurance support.	Field based demonstrations & HRD programmes. Brood bank development for quality seed production. Establishment of feed mills on PPP models for easy availability at reasonable cost.	Replacement of Normal Rohu with *Jayanti Rohu* for yield improvement. Development of low cost feeds. Better management practices.	Aquaculture sector to be treated at par with Agriculture. Certification including hatchery system to be made mandatory.

Sector/sub-sector	Specific enterprise	Region	Present Status	Potential	Main Gaps	Actionable points to bridge the gaps: Development activities	Technological interventions	Policy support
	Carp hatchery	All states excepting cold water areas.	Some states are self-sufficient but still many states import seed from other states. No consideration on quality seed production for higher survival and growth.	Well-developed indigenous technology existed in the country and seed can be produced in the desired quantities within all the states. Guidelines for improvement of quality seed production already defined.	The states deficient in seed production are not actively participating in seed production process. Poor quality brood stock. Improper brood management practices	Develop more hatcheries in the states deficient in seed production. Human resource development for transfer of new technology.	Brood improvement through genetic and nutritional interventions (genetically improved brood stock, carp brood feed like CIFABROOD.	Seed certification of hatcheries to be made mandatory.
	Ornamental Fish farming	All state with a tropical climate.	Activities limited to mainly metro cities such as Chennai,	Potential for expansion in most of the states with tropical climate.	Lack of quality brood stock. Lack of feed. Lack of technical knowledge.	Human resource development for transfer of new technology.	Standardization of breeding and seed production technology of important	Popularization of public aquarium. Prevention of trade of Indigenous

Sector/sub-sector	Specific enterprise	Region	Present Status	Potential	Main Gaps	Actionable points to bridge the gaps		
						Development activities	Technological interventions	Policy support
			Kolkata, Mumbai, Kerala.		Lack of trained manpower.	Establishment of marketing channels. Establishment of infrastructure.	ornamental fishes. Development of low cost feed.	wild stock of ornamental fishes.
	Catfish farming	South & Eastern India.	Scattered Small scale farming except for Pangasius.	Potential to expand to few south, eastern & Central Indian States.	Lack of quality seed. Lack of technical knowledge.	Human resource development for transfer of new technology. Post-harvest value addition for Pangasius.	Development of better management practices. Development of low cost fish feed.	Policy for long term lease of water bodies. More focus on cage culture of Pangasius.
	Air breathing fish breeding & culture (Murrel & Anabas).	Eastern & South India (Telengana, A.P., West Bengal).	Limited scale (new emerging sector).	Potential for expansion of culture area.	Lack of quality seed. Lack of technical knowledge.	Establishment of hatcheries. Human resource development for transfer of new technology. Post-harvest value addition.	Development of suitable feed & health management practices.	Introduction of Govt. scheme for encouraging the entrepreneurs.
Freshwater aquaculture from open waters: culture-	Cage culture in reservoirs	All India	Growing very well in Jharkhand and Chhattisgarh; and well	Farming of catfish (Pangasius)-4-6 MT/ha/yr, mass Carp	Lack of adoption by other states, shortage of feed mills and availability of	All states having medium and large size reservoirs should introduce cage culture in their	Gaps in hatchery seed production of catfish that are suitable for cage farming may be identified for	Establishment of hatcheries of pangasius and carps, funding support for

Sector/sub-sector	Specific enterprise	Region	Present Status	Potential	Main Gaps	Actionable points to bridge the gaps		
						Development activities	Technological interventions	Policy support
based capture			demonstrated in Maharashtra, M.P., U.P.	fingerling production.	more cost effective feed, establishment of large number of catfish hatcheries, more species to bring under cage culture system, organised system for fish fingerling rearing and its marketing.	state; training and skill development of farmers and enterprises; setting up of hatcheries for selected species; establishment of fish feed mills.	large-scale seed production; development of cost-effective fish feeds particularly floating.	infrastructure and running costs.
	Pen culture in wetlands	Mainly eastern part of the country including Bihar & U.P.	Limited to only the states of Assam and W.B. Successful demonstration made in Bihar & U.P.	Average production from selected pen farming system was assessed at 2-4 MT/ha/yr with carps and prawn. Seasonal water bodies may be used	Lack of adoption due to poor extension support, initiation from the owning departments & funding.	All states having wetlands should introduce pen culture; undertake training and skill development of farmers and enterprises, setting up of hatcheries for selected species, establishment of fish feed mills.	Gaps in hatchery seed production of carps, prawns and other species of importance may be identified for large-scale seed production, development of cost-effective fish feeds particularly floating.	Establishment of hatcheries of carps, funding support for infrastructure and running costs.

Sector/sub-sector	Specific enterprise	Region	Present Status	Potential	Main Gaps	Actionable points to bridge the gaps		
						Development activities	Technological interventions	Policy support
				for fingerling rearing.				
	Fish cultivation in canals	All India	Pilot scale demonstration has been made in Sundarban area with a production of 850 kg/ha/yr.	2000 kg/ha/yr	Limited knowledge of scientific farming. Inadequate availability of quality seed. Inadequate availability of low cost feed.	Field based demonstrations & HRD programmes. Brood bank development for quality seed production. Establishment of feed mills on PPP models for easy availability and at lower cost.	Development of low cost feeds. Better management practices. Better governance.	Aquaculture sector to be treated at par with Agriculture.

Table 17.4 Action plan for specific sectors/sub-sectors of Coldwater Aquaculture

Sector-Sub sector	Specific enterprise	Region	Present status	Potential	Main gaps	Actionable points to bridge the gaps		
						Developmental activities	Technological interventions	Policy support
Coldwater aquaculture	Rainbow trout farming	J&K, H.P., U.K., Sikkim, Arunachal Pradesh.	Un-organised farming and on a limited scale.	Great potential all through the states listed in column 3. Does not require large land for a small-scale production. High valued sport & food fish.	Inadequate extension support. Lack of seed availability & feed. Unorganised marketing. High Input farming cost.	Identification of more potential sites for expansion. Increase availability of spring water. Establishment of new hatcheries Supply chain to be intensified. Establishment of seed bank and feed mills in the area of culture.	Brood improvement and quality seed production. Development of low cost feed technology.	Import of improved strain of rainbow trout. Creation of more number of hatcheries for meeting out seed demand. Creation of cold chain and value addition in the states of culture. Rationalization of import duties on feed ingredients/ finished feeds.
	Polyculture of exotic carps in low & mid altitude areas	U.K, Meghalaya, Arunachal Pradesh, Manipu	Limited scale in all hill states.	Production of 5-7 Mt/ha/yr is possible	Lack of seed availability. Poor transportation and limited growth.	Cheaper Geo-membranes to be made available for higher seepage control. Cost effective formulated feed	Introduction of improved strains. Polyculture in polytanks.	Establishment of feed mills locally. Establishment of brood bank and seed bank.

Sector-Sub sector	Specific enterprise	Region	Present status	Potential	Main gaps	Actionable points to bridge the gaps		
						Developmental activities	Technological interventions	Policy support
		r, Assam, Sikkim.				to be made available.	Stocking of stunt fish/advanced fingerlings. Integration of horticulture with fish polytank.	Local fish markets in hills
	Reservoir & Riverine fishery	All hill states	Low productivity. Unorganised fishing. Post-harvest loss.	50-200kg/ha for reservoirs	Low productivity and unsustainable. Fragmented stock of wild fish	Hatchery infrastructure brood bank & seed bank. Cold storage facility. Floating cages in reservoirs.	Regular stocking of reservoirs/streams with quality seed of appropriate species and proper size Seed rearing in floating cages.	Regulation on stocking size & stocking material Legislation on bag and size limit during close season Regulation on Environmental Flow Rate (EFR).

Table 17.5 Action plan for specific sectors/sub-sectors of Brackishwater Aquaculture

Sector-Sub sector	Specific enterprise	Region	Present status	Main gaps	Actionable points to bridge the gaps		
					Developmental activities	Technological interventions	Policy support
Brackishwater aquaculture	**Vannamei farming**	Andhra Pradesh, Tamil Nadu & Gujarat.	87 per cent of area under culture and 92 per cent production.	Disease issues. International market price fluctuations. High price of feed. Export rejections based on anti-dumping duties and anti-biotic residue.	Strengthening national surveillance programmes. Training field staff in disease management aspects. Linking aquaculture with e-NAM. Establishment of local feed units by Fisheries Development Corporations and on PPP mode. Capacity building of farming personnel.	Development of vaccines & Field diagnostic kits. Creation of Market Intelligence cell for export/domestic market price information. Development of low cost feed. Establishment of antibiotic testing facilities.	Issues of land leasing and licensing & Aqua-zonation / permission to culture in low saline areas. Creation of cold chain/ buffer storage for domestic markets & bringing down fuel prices to international level to enable Indian farmers to compete with international peers. Rationalization of import duties on feed ingredients/ finished. feeds. Regulatory guidelines for safe use of chemicals/ antibiotics.

Sector-Sub sector	Specific enterprise	Region	Present status	Main gaps	Actionable points to bridge the gaps		
					Developmental activities	Technological interventions	Policy support
	Tiger shrimp farming	West Bengal, Odisha and Kerala.	92.2 per cent of area & 91.7 per cent production.	Absence of SPF / selectively bred lines. Disease issues. Price fluctuations in international markets. High price of feed	Developing brood banks on PPP mode. As stated earlier under A.1. As stated earlier under A.2. As stated earlier under A.3.	Standardization of brood bank protocols. As stated earlier under A.1. As stated earlier under A.2. As stated earlier under A.3	Support for establishment of brood centres. As stated earlier under A.1. As stated earlier under A.2. As stated earlier under A.3.
	Diversification-other shrimp species, finfishes Seaweed Molluscs	West Bengal, Kerala, Odisha.	Minimal level of traditional / poly culture.	Non availability of seeds.	Multi species hatcheries under state/PPP mode.	Technology protocols for breeding and seed production.	Incentivization of farming new species.
Hatcheries	**Vannamei**	Andhra Pradesh, Tamil Nadu and Gujarat.	Inadequate number of hatcheries in Gujarat.	Inadequate supply of quality SPF seeds.	Identification of more SPF brood suppliers.	Development of technology protocols.	Review of import & quarantine system in relation to demand & issue of permissions.

Sector-Sub sector	Specific enterprise	Region	Present status	Main gaps	Actionable points to bridge the gaps		
					Developmental activities	Technological interventions	Policy support
	Diversification & other shrimps finfish	Andhra Pradesh, West Bengal, Kerala, Odisha	Absence of multi-species hatcheries.	Non-availability of seeds.	Establishing brood banks/ broodstock multiplication centres.	Development of technology protocols.	Supportive policies for establishment of hatcheries of new species.
Feed mills	**Vannamei farming**	Andhra Pradesh, Tamil Nadu & Gujarat.	Dependence on MNC / imported feeds.	High price of feed.	Establishment of desi feed mills under public sector/ PPP mode.	Developing cost effective technologies.	Rationalization of duties/tariffs on imported ingredients/ intermediate products/finished feeds.
Market / Trade	**Export markets**	Andhra Pradesh, Tamil Nadu and Gujarat.	Testing facilities are minimum.	Inadequate testing facilities for antibiotic residues and high expenses.	Establishing anti-biotic residue testing facilities at higher learning centres/ fisheries colleges	Capacity building for technical personnel.	Reduction of import duties on required equipment like LCMS.
	Domestic markets	All states	Inadequate infrastructure.	Poor handling and Post-harvest losses.	Sensitization of supply chain functionaries.	Development of technologies of on farm and off farm handling to reduce spoilage.	Incentivisation of processing, storage and cold chain enterprises.

Table 17.6 Action plan under specific sectors/sub-sectors of Inland Saline Aquaculture

Sector-Sub sector	Specific enterprise	Region	Present status	Main gaps	Actionable points to bridge the gaps		
					Developmental activities	Technological interventions	Policy support
Shrimp aquacul-ture	**Vannamei farming**	Haryana, Punjab, Rajasthan, Uttar Pradesh, Delhi, Maharashtra, Karnataka	Adoption of culture by farming community in Haryana & Punjab with an average yield of 5-8 Mt/ha crops of 4 months.	More states to join; Soil & water testing facility in the area of cluster farming. Absence of local feed availability, poor marketing facility, no post-harvest facility and active disease surveillance facility.	More units to be added under culture in the states of operation as well other states listed in column-3. Local facility for feed manufacturing, post harvesting and active disease surveillance.	Development of vaccines & Field diagnostic kits. Research on to check secondary salinization in the area of operation.	States having problems of inland salinity should explore adoption of the technology. Issues of land leasing, licensing & Aqua-zonation / permission to culture in low saline areas to be permitted.

Table 17.7 Action plan for specific sectors/sub-sectors Mariculture

Sector/Sub-sector	Specific enterprise/activity	Regions	Present status	Present potential	Main Gaps	Actionable Points		
						Development* activities	**Technological Interventions#**	**Policy support @**
Mariculture	**Open sea cage farming (Pompano, Sea bass, Red snapper, Cobia, Mullets, Groupers).**	Coromandel coast, Tamil Nadu; Karwar, Karnataka; Goa coast; Veraval and Diu in Gujarat; Ratnagiri, Maharashtra; Southern coast of Kerala.	Nearly 1300 cages in operation with technical support from CMFRI.	In-shore areas and sheltered bays along the coast can be utilized for installing sea cages. A $6^1 \times 6^1$ diameter cage can yield 2-4 MT of fish on average.	Lack of seed and feed supply. Ambiguity in lease rules. Lack of technical skills.	Identification of suitable sites in potential regions. Promotion of seed production by mobilizing local entrepreneurs. Development of small scale feed production units. Training programs for interested entrepreneurs.	Technologies for cage construction, stocking, nutrition management, disease control, etc. to be made available to farmers with the help of CMFRI.	Guidelines for lease of water bodies. Subsidized supply of fingerlings / feed. Interest subvention on credit for setting up cages. Establishment of special zones/ mariculture parks in designated areas.
	Nursery rearing of food fishes (Cobia, pompano, grouper, seabass)	Across the Indian coast.	Nurseries maintained by CMFRI in Mandapam, Vizhinjam and Karwar.	Nursery rearing of food fishes has a scope in areas where cage culture is promoted.	Short supply of stockable size fingerlings. Shortage of trained and skilled manpower. Shortage of feed availability.	Establishment of more hatcheries in public / private sectors. Training programs for interested entrepreneurs on nursery rearing techniques. Development of linkages between	CMFRI has the technology for seed production as well as nursery rearing and management; and hence needs only extension support from line departments.	Credit and investment subsidies for establishing hatcheries, small scale nursery rearing units and feed units.

Sector/Sub-sector	Specific enterprise/activity	Regions	Present status	Present potential	Main Gaps	Actionable Points		
						Development* activities	Technological Interventions#	Policy support @
						nurseries and fish farmers through market intelligence networks.		
	Integrated Multi-tropic Aquaculture (IMTA) – Integrated farming of seaweed with finfishes in cages.	Palk bay, Tamil Nadu;	About 100 farmers in Palk Bay are practising IMTA.	IMTA can be extended to all seaweed farming areas. An additional yield of 110 kg/raft can be obtained through IMTA.	Under-developed seaweed production and marketing supply chains; poaching; and incidence of diseases.	Integration of IMTA under the SHG-based contract farming model in Palk bay areas to be expanded to similar other areas. Adequate supply of farm credit by financial agencies. Training programs for interested entrepreneurs.	Demonstration of the potential of IMTA to prospective entrepreneurs for building interest.	Launch of pilot programmes for extending seaweed farming in potential areas in Gujarat, Lakshadweep and Andaman & Nicobar islands.
	Green mussel farming	Malabar region in Kerala; Dakshina Kannada district in Karnataka, Ratnagiri and Sindhudurg	About 18000-20,000 MT of mussel are being produced in India per year. A raft of green mussel with 100 strings (1	There is scope to further widen green mussel farming in non-conventional areas endowed with	Low supply of good quality spat. Crop loss due to summer kill. Excessive culture pressure beyond	Training of more farmers on standardized farming techniques like raft culture, rack culture, long-line culture, etc.; Training potential	Technology for green mussel culture under alternate conditions and nursery production technology for green mussel spat	Interest subvention on credit for establishing small scale value addition units, spat producing units, cold storage units,

Sector/Sub-sector	Specific enterprise/activity	Regions	Present status	Present potential	Main Gaps	Actionable Points		
						Development* activities	Technological Interventions#	Policy support @
		districts in Maharashtra	meter) yield around 400-700 kg.	backwaters in the states of Karnataka, Goa, Maharashtra, etc.	carrying capacity in major growing areas. Low cold storage and processing infrastructure.	entrepreneurs on spat production. Develop small-scale processing infrastructure under SHG model. Strengthening of cold chains.	are available with ICAR-CMFRI.	etc.; Strengthening safety labeling for green mussel products.
	Edible oyster farming	Astamudi and Vembanad lakes, Estuaries and creeks in North Malabar, Kerala; Ratnagiri and Sindhudurg districts in Maharashtra.	An edible oyster raft of 100 strings of 1 (one) meter length yield around 700-1000 kg. The present average annual production of edible oyster is around 15,000 MT.	There is scope to further widen oyster farming in estuaries and creeks across the coastal areas.	Low supply of good quality spat. Inadequate processing infrastructure and cold chain.	Training of more farmers on standardized farming techniques like rack and ren method, rack and tray method, stake culture, etc. Develop small-scale processing infrastructure under SHG model. Strengthening of cold chains.	Improved technical protocols for edible oysters spat production, oyster productivity enhancement, oyster depuration and maintenance. Value addition of oyster meat, etc. (The needed technology protocols are available with ICAR-CMFRI).	Interest subvention on credit for establishing small scale value addition units, cold storage units, etc. Strengthening certification and eco-labeling of oyster fishery and safety labeling for oyster products.

Note: $ Separate action plans are to be given to each region where the enterprise mentioned has a scope.

Chapter 18
Non-farm Fishery Enterprises

It is well recognised, that farmers under different sub-sectors of the agricultural economy need to be offered multiple sources of incomes, as returns from the primary agricultural source may not always be sustained or adequate. This approach can also serve as an instrument of risk management, for small & marginal farmers (including fish farmers) who dominate the agricultural structure. Fishery sector too, provides scope for several such opportunities for gainful engagement and additional incomes.

18.1. Non-farm Activities in the Fisheries Sector

The structure of the rural economy too has been undergoing a change in India along with its overall economy. The farm and non-farm sectors, the two components of the rural economy, have been undergoing a structural change through diversification of activities, and on account of higher opportunities available for employment and income generation.

Similar to other rural economic sectors, there are a number of avenues for promoting non-farm activities in the fisheries and aquaculture domain. These include harvesting of fish, marketing, processing, value-addition, manufacture and mending of fishing nets, boat repairing & building etc. these are all in the nature of support services, that will aid the primary profession of fishing. These supplement or/and complement the primary fishing activity by facilitating minimization of input costs and maximization of output and income.

Many of the low cost technologies in the field of fisheries & aquaculture and at harvest & post-harvest stages are simple, easy-to-adopt, low in capital intensity, economically viable, as also socially and ecologically acceptable.

These are seen to have already found favour with as alternate and or off-season activities generating for them additional income through value addition. The activities include fish waste utilization for fish products, fish & poultry feed, fodder and high quality manure; low-cost fish processing equipment such as solar driers, smoking kiln, fish de-boner, fish de-scalar, insulated containers for fresh fish transportation etc.

These offer better returns on investment, additional opportunities for employment generation, avenues for self-employment, and scope for establishment of small enterprises, helping thereby overall socio-economic and livelihood empowerment of fish farmers.

Non-farm income (NFI) plays an important role in reducing rural poverty by supplementing primary sources of incomes; and creating effective demand for goods and services besides reducing migration of people to urban areas.

Expansion of NFI activities may provide two opportunities of (i) increasing the scale of the existing activities; and (ii) increasing the multiplicity of activities. Whereas, the former is helpful mostly in increasing the scope for absorbing larger number of labour, the later provides options for adding a number of related high value activities for higher income generation.

The second opportunity also helps in providing security and reducing the risk and uncertainty associated with farm income. Generating local on-farm and off-farm jobs will contain distress migration.

The fishery related non-farm activities can create options for the skilled workers, such as fish feed manufacturing, testing of soil & water samples, testing water and fish for health management and consultancy services. Eco-tourism, that uses water bodies for sport fishing, venturing in a boat/vessel for entertainment and also as a lodging facility has been found to be an attractive economic activity. Such initiatives can be scaled up by upgrading the rural infrastructure (roads, electricity, communication & health services); creating a well-trained and skilled manpower; and offering access to credit, information and training facilities.

The Skill India Programme, MUDRA and Make in India initiatives of the government are helpful in this regard. The Department of Animal Husbandry, Dairy and Fishery Development (DAHDF) should use the services of a large number of institutes that operate under the three departments of the Ministry of Agriculture and Farmers' Welfare to identify feasible projects, prepare model project reports, choose institutes and SAUs to set up incubation centres and to train the entrepreneurs.

A Division of Non-Farm Enterprise Activities needs to be set up in DAHDF to bring focus on fishery related NFI. Many strategies and programs to promote rural non-farm income (RNFI) have been formulated in various countries. China's labour-intensive township and village enterprises (TVEs), for example, often described as the "engine of growth" represents the vanguard in that country's new capitalism. These enterprises were able to engage large number of people seeking jobs, after training & skilling them appropriately. These units are low capital & technology intensive in relative terms.

For success of such enterprises, it would be necessary to facilitate market links between the village entrepreneurs and the larger commercial businesses or industry. These strategic alliances or partnerships can contribute to the sustainability of small village and tiny enterprises by catering to the needs of technology, inputs and marketing.

Other important considerations that need to be focused on, may include human resource development, financial/credit facilities, research and development and women's participation with a view to making the activities, equitable & self-sustaining in the changing competitive environment.

In Table 18.1 that follows, identified non-farm activities have been examined for their current status and the gaps that need to be filled for upgrading them with a view to harvesting their full potential.

Table 18.1 Fisheries and aquaculture – action plan for non-farming enterprises

Sector/Sub-sector	Specific enterprise/ Activity	Regions	Present status	Present potential	Main gaps	Actionable Points		
						Development activities	Technological interventions	Policy support
Soil and water testing and pond health cards	**Consultancy services**	Prevalent only in few areas of some states; but this facility is required in all the states.	Very few farmers are aware about the importance of pond soil and fish health in aquaculture.	Available facility is limited to public institutions in general, which cannot meet the demand across the country.	Lack of knowledge, adequate facility and skilled man-power and consultants in the area.	At least district-wise facility at charges. Lower labs to be established on PPP mode. Issue soil and water health cards by the certified professionals.	HRD/skill development initiatives for developing professional manpower and strengthening fisheries extension machinery.	Creation of more labs in public as well in private sector by providing financial support to trained persons.
Sale of fish seed	**Supply of fish seed from hatchery to growers**	All over the country	Only few persons are involved	High demand of seed by the farmers particularly in remote areas. Provide good number of livelihood options.	Lack of organised marketing in fish seed trade leading to waste of time and energy in search of quality fish seed. A professional in this field would help the farmer in getting quality seed with ease and at	Skill development, and financial support for development of fish seed holding facility.	Development of simple reusable transport containers for fish seed transport.	Financial support for creation of infrastructure facility, certification of the supplier based on training/skill/ experience acquired.

Sector/Sub-sector	Specific enterprise/ Activity	Regions	Present status	Present potential	Main gaps	Actionable Points		
						Development activities	Technological interventions	Policy support
					lower cost due to bulk buying and transport.			
Sale of fresh fish and fish products	**Small-scale to large activity**	All the states and union territories	No organised fish market in rural areas. Urban fish markets are also unorganised and are in the clutches of few persons .	Marketing through cooperative system/e-marketing being successfully operated in milk and grain marketing.	Non-existence of active fish marketing cooperative system in almost all the states. Lack of e-market facility all through the country.	Need to develop active fish marketing facility on cooperative and e-market basis.	Development of a set-up for restructuring fish cooperatives to facilitate farmer- friendly marketing and minimizing the role of middle men, development of e-marketing protocols.	Policy to restructure fish cooperatives structure for farmer-friendly fish marketing and minimizing/removing the role of middle men. Implementation of e-market system.
Feed manufacturing	**Small-scale feed manufacturing unit**	All states and UTs.	The sector is mainly under the control of few multi-nationals, and the cost is high and limited mainly to large urban areas.	Indigenous technology for good number of feeds available in the country which are cost-effective, and can be	Lack of trained manpower, lack of cost-effective mini feed mills, lack of skilled manpower and financial support.	Skill development, entrepreneur-friendly State schemes for purchase of mini fish feed mills, marketing support.	More number of Indian feeds for diversified fish species to be developed, demonstration of available technology.	A policy on Fisheries sector in each state to quantify mapping out local ingredients and subsidizing the cost of cultivation of such ingredients. Establishment of feed mills on PPP mode, financial support for mini feed mills.

Sector/Sub-sector	Specific enterprise/ Activity	Regions	Present status	Present potential	Main gaps	Actionable Points		
						Development activities	Technological interventions	Policy support
				prepared from locally available feed ingredients.				
Sale of critical inputs (feed, fertilizers and drugs)	**Small scale input dealers**	Across the country.	Managed and administered without any scientific knowledge and information.	Huge demand for inputs that are essential for aquaculture.	Scientific recommendations of input dealers can reduce the excess use of critical inputs.	Registration of inputs dealers for a formal certificate or any other form for delivery of scientific information and providing right quantity and quality of inputs.	On-farm trial of all critical inputs to demonstrate their utility and adoption on a large scale in famers' fields.	Regulation of inputs in terms of price and quality with appropriate standards required as done in agriculture. Policy towards input dealers to be certified for selling/business on critical inputs
Boat manufacturing/ repairing	**Small scale enterprise**	All states and Union territories.	Boat building enterprise is catered to by few entrepreneurs in the country who uses traditional methodology for	Energy efficient designs and low cost wood materials are available with ICAR.	Lack of awareness on energy efficient designs, low cost wood materials, antifouling agents.	Skill development, financial support.	Development of boat designs based on type of water bodies in different terrain.	Financial support for creation of infrastructure facility. Certification of the supplier based on training/skill/ experience acquired

Sector/Sub-sector	Specific enterprise/ Activity	Regions	Present status	Present potential	Main gaps	Actionable Points		
						Development activities	Technological interventions	Policy support
			construction of boats, and deploy designs and wood material which are defective and costly increasing cost of work.					
Net fabrication, net mending and supply	**Small scale enterprise**	All states and Union territories.	Net fabrication is mainly by the large industries and is costly. Non availability of specialized nets for different types of water bodies.	Efficient and cost effective designs for all types of water bodies available with the ICAR.	Net fabrication to be popularized as small scale enterprise for supply of cost effective, location specific nets.	Skill & infrastructure development, cluster based production of nets.	Demonstration of suitable nets efficient for location specific water bodies.	Financial support for creation of infrastructure facility. Certification of the supplier based on training/skill/ experience acquired.
Fish harvest and post-harvest	**Value addition**	All states.	Prevalent only in few states as small-scale industry.	High demand both in domestic and export markets.	Lack of technical knowhow, skill development and	Packaging of technology and linking to the mainstream	Technology as a package of practice in the state; large scale demonstration	State driven schemes on post-harvest and value addition with additional common investments for

Sector/Sub-sector	Specific enterprise/ Activity	Regions	Present status	Present potential	Main gaps	Actionable Points		
						Development activities	Technological interventions	Policy support
					Infrastructure.	extension at the state.	and popularization	developing the industry like processing plants and others.
	Recycling of fish waste	All states	Popularized in some parts of the Eastern state.	Fish wastes can be converted for production of high valued manures.	Lack of technical knowhow and awareness on the conversion of such waste to wealth.	-Do-	-Do-	Fisheries policy in each state in mapping out the fish resources that are waste and its quantification.
Consultancy services	**Fish and shrimp hatcheries/ farms**	All states and Union territories.	Negligent number of consultants in the country to support fish farmers for carrying out scientific fish farming.	Country has large number of unemployed educated youth to take up these services for their livelihood.		Skill development on various farming related issues.	Development of incubators to adopt consultancy services.	Financial support for skill development programmes and required infrastructure.

Chapter 19
Fisheries Marketing

Fisheries has been well supported by institutional agencies since independence. This has resulted in creditable export volumes fish and fishery products, forming the backbone of agricultural exports from the country. In direct contrast, domestic fish marketing is highly unorganised and inefficient and leaves much to be desired. Yet, domestic demand is the mainstay of fish marketing and needs improving.

19.1. Background

The many dictionaries broadly define livestock as farm animals regarded as an asset, who are raised on a farm to generate a profit, such as cows, sheep, chicken and pigs. In today's age even snake and scorpions are being farmed for venom. With the growth in inland fisheries, fish farms can also be considered as farmer's livestock as it is an animal asset and is cultivated for commercial production.

Fish and fish products have presently emerged as the largest group in agricultural exports of India, with 995.1 thousand tonnes in terms of quantity and 5.4 million US dollars in value. This accounts for around 10 per cent of the total exports of the country and nearly 20 per cent of the agricultural exports. More than 50 different types of fish and shellfish products are exported to 75 countries around the world.

On the domestic front, fish marketing system is working on traditional and informal patterns, mostly run by private traders, lacking modern facilities and involving a large number of intermediaries between producer and consumer. All this reduces the marketing efficiency and fisherman's share in consumer's rupee. Though domestic fish marketing holds a great potential, it is still vastly disorganised and unregulated. In most of the cases physical facilities and infrastructure in all types of fish markets are far from satisfactory.

19.1.1. Status of the Fish Processing Industry

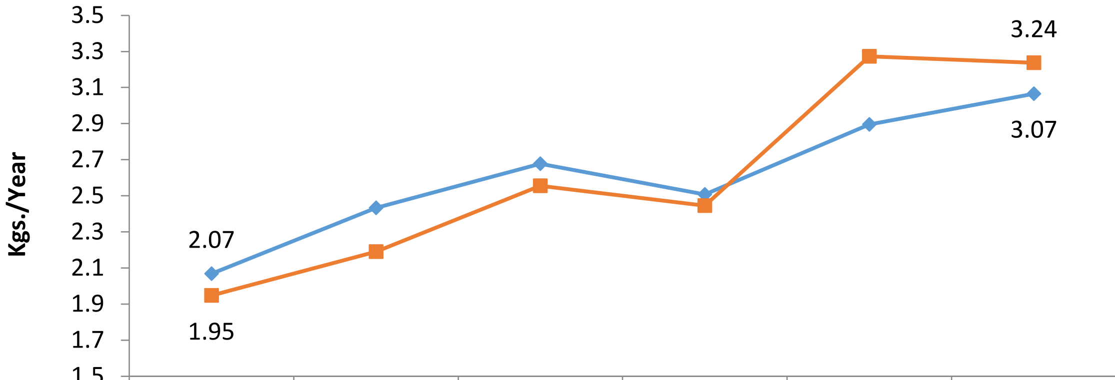
The fish processing industry in India is focused on exports and appears well developed. Out of the 625 registered exporters, 380 are manufacturer exporters and 240 are merchant exporters. The fish processing industry consists of 215 ice plants, 481 shrimp peeling plants, 371 freezing plants, 495 cold storage units, 7 canning plants, 16 fish meal plants, 11 surumi plants and 1 agar-agar production units. Of the sea food processing plants about 95 per cent are concentrated in 20 major clusters in 9 states. HACCP certification is mandatory and all the sea food processing plants are HACCP complaint. About 15 per cent of the total fish landed is used for the export of fishery products.

Generally, the fish passes through several intermediaries from the landing centre or fish farms to the consumer, through a network of wholesale, major, minor retail, roadside markets, etc. The intermediaries provide different services of head loading, icing, packing, transporting, processing and preservation. Value added activity happens at the level of primary level through sorting, grading, cleaning, icing and packing of fish. Normally fish is graded and sorted manually. If the same fish is meant for exports the processers further grade, clean, process and pack the fish for exports.

19.1.2. Status of Domestic fish marketing

The importance of domestic marketing can be understood from the fact that about 85 per cent of the fish landed, is distributed through domestic markets. As more and more trade restrictions are being imposed on the fishery product exports, the domestic market is expected to remain the mainstay of the fisheries sector. The domestic demand is also showing an increasing trend.

Figure 19.1 Trends in fish consumption (per capita annual)



	1987-88	1993-94	1990-00	2004-05	2009-10	2011-12
Urban	2.07	2.43	2.68	2.51	2.90	3.07
Rural	1.95	2.19	2.56	2.45	3.27	3.24

Source: Various NSS Rounds

The fish market in the northern parts of the country has remained untested to a large extent. Appropriate fish handling and cold-chain connectivity will be required to deliver fish to the northern markets of the country. Private sector entrepreneurs are recognising opportunity from this unserved demand and realise, that regular and efficient supply to these untapped markets will make fish more affordable and in turn further drive consumption volumes upwards.

The key constraint in domestic fish marketing arises from the perishable nature of the fish, and the time lag to transport the fresh catch from the fish landing centres to the interior markets. Lack of proper handling, results in poor quality of material, risk of food borne diseases, nutritional and post-harvest loss. Fish also needs to be segregated from other food types which tends to disallow shared infrastructure usage. The harvested fish is not evenly distributed to interior areas due to lack of refrigerated transportation.

Mostly, the fresh fish meant for domestic consumption is not processed and transportation is undertaken in insulated or covered trucks (non-refrigerated), using ice flakes to chill and pack the fish. This system is preferred for saving costs, compared to actively refrigerated transport modes (reefer containers or trucks). The commission agents and traders are known to compromise on the quantity and type of ice used, putting the hygiene and food safety at risk. Ice flakes made from non-potable water can cause serious contamination.

The majority of domestic markets have poor handling facilities the fish that reaches the consumer for domestic consumption is already one or two days old. Availability of potable water, good quality ice, electricity, waste disposal system, etc. is inadequate. This also hampers consumer acceptance and demand for fish from hinterland population. The various stakeholders in the marketing channels sell the fish to the next level as soon as possible that coincidentally results in a fast selling cycle in the trade. This has advantages of reduced inventory holding costs and risks. Processed and preserved fish can be stored for longer duration and has a longer production to selling cycle.

Due to variety of reasons fisheries sector has long been neglected and serious efforts are needed for efficient marketing of fishes so as to match up with its production. Fish marketing usually starts with the auction system which is highly irregular, disorganised and unregulated in most states of India making it very tough task for any new entrant to enter into these markets. There is need for improvement in various regulation by the cooperative federations so as to make entry easy for new entrants, also there is need for improvement in facilities like creating and maintaining much needed infrastructures such as launching cold storages at major collection points, improved road access to fish catching centres (ponds, rivers etc.), from the main markets, ice factories, etc. The domestic marketing channel of fish, irrespective of its form, i.e. fresh, dried, processed, etc. is multi-layered and requires collaboration among various actors in the marketing chain.

However, in case of ornamental fish, the business is more closely integrated in the hands of a few enterprises. The ornamental fish production and trade is also emerging as a lucrative commercial aquaculture venture.

Table 19.1 Quantity of ornamental fish sold in selected markets of India (2015) (In lakhs)

Name of the Ornamental Fish	Kolkatta (Howrah)	Chennai (Kolathur)	Mumbai (Kurla)
Molly	40.30	27.8	11.20
Guppy	24.20	27.80	19.00
Platy	24.20	10.70	11.20
Gold Fish	56.40	49.50	23.40
Koi Carp	9.70	14.30	6.10
Zebra	19.30	10.70	8.90
Angel Fish	24.20	25.70	16.20
Total (in lakhs)	198.30	166.50	96.00

Source: Nightingale Devi B. 2014

Ornamental fish markets are located in different parts of the country. The most important ornamental fish markets in the country are located at Howrah, Kolkatta, Kolathur, Chennai and Kurla, Mumbai. Many other centres like Kochi, NCR of Delhi are developing as important hubs. Vertical integration is high at 64.44 per cent among ornamental fish marketing firms in Kurla, 83.33 per cent in Howrah and 76.19 per cent in Kolathur.

Vertical integration essentially implies that the firms are performing more than one function at a time, in the marketing process. The firms in these markets work as wholesalers, commission agents, retailers and post production service agents of ornamental fishes. The extent of horizontal integration in selected ornamental fish markets was negligible at 6.64 per cent which indicated that the number of firms having a spread of outlets performing the same function was almost negligible. The vertical integration also concentrates market power in the hands of a few firms; the top three account for 10.6, 8.5 and 9.8 per cent of total ornamental fish transactions respectively. The extent of concentration of market power indicates a lower degree of market freedom.

19.1.3. Value to Fishermen

As in case of all perishable produce, the farmer or fisher, has little time to evacuate the harvest, and without any market connectivity services, has to sell off the produce at first instance to the local agents. The price discovery therefore is made on the basis of incoming daily catch and demand that is monopolised by the commission agents. Therefore, the fish farmers are obliged to take the price offered by the commission agents who in turn can delay payments by as many as 6 months to 1 year. Such delays can bind the farmers in a debt trap.

Marketing services in the form of refrigerated connectivity with the up country consumers is lacking and would empower the fishing community with a seller's choice. Such marketing services would also help them capture a greater share of the final wholesale value at terminal markets.

19.2. Institutional Support for Fish Marketing (Domestic / Exports)

19.2.1. National Fisheries Development Board

The National Fisheries Development Board (NFDB), established in 2006 under the administrative control of the Department of Animal Husbandry, Dairying & Fisheries, works to enhance fish production and productivity in the country and to coordinate fishery development in an integrated and holistic manner.

A wide range of fishery development activities are supported through state governments and implementing agencies. This include, intensive aquaculture in ponds and tanks, culture based capture fisheries in reservoirs, coastal aquaculture, mariculture, sea weed cultivation, establishing infrastructure like fishing harbours and fish landing centres, fishing dressing centres, solar drying of fish, domestic marketing, fish processing, ornamental fisheries, etc. Capacity building of fishermen and fish farmers is also being supported. NFDB activities are overseen by its Governing Body, chaired by the Union Minister of Agriculture and Farmers Welfare. The Executive committee, has the Secretary of the Department of Animal Husbandry, Dairying and Fisheries as its Chairman, provides the general superintendence, direction and the control of the affairs and functions of the Board.

In the backdrop of the above, the following areas have been identified for the development of domestic fish marketing system in the country:

- Modernisation of wholesale markets
- Cold-chain and hygienic retail outlets of varying levels

The retail outlets are an important link in the domestic marketing system. It is only through retail markets and the fish is traded to the outlets to reach the actual consumer. The quality of fish that reaches the retail end, is effected by the conditions of the wholesale markets and connecting cold-chain logistics.

The main drawback of the retail market is that the fish reaches for distribution is in poor quality due to weakness that exist in the wholesale handling, storage and transportation. Initial freezing and refrigerated transport to safely connect the primary producer to the domestic consumer in the system is necessary. Apart from a dynamic cold-chain, provision of other amenities like hygienic retail outlets for merchandising, are required.

Schemes under rural development for promoting women and weaker sections in domestic fish marketing are also undertaken by NFDB.

19.2.2. Marine Products Exports Development Authority (MPEDA)

The erstwhile Marine Products Export Promotion Council established by the Government of India in September 1961 was converged in to MPEDA on 24-August-1972, by an act of the Parliament. MPEDA is given the mandate to promote the marine products industry with special reference to exports from the country.

The organisation is envisaged to take all actions to develop and augment the resources required for promoting the exports of "all varieties of fishery products known commercially as shrimp, prawn, lobster, crab, fish, shell-fish, other aquatic animals or plants or part thereof and any other products which the authority may, by notification in the Gazette of India, declare to be marine products for the purposes of (the) Act".

The Act empowers MPEDA to regulate exports of marine products and take all measures required for ensuring sustained, quality seafood exports from the country. MPEDA is given the authority to prescribe for itself any matters, which the future might require, for protecting and augmenting the seafood exports from the country. It is also empowered to carry out inspection of marine products, its raw material, fixing standards, specifications, and training as well as take all necessary steps for marketing the seafood overseas.

MPEDA is the nodal agency for the holistic development of seafood industry in India to realise its full export potential. Based on the recommendations of MPEDA, Government of India notified new standards for fishing vessels, storage premises, processing plants and conveyances. MPEDA's focus is mainly on market promotion, capture fisheries, culture fisheries, processing infrastructure & value addition, quality control, research and development.

MPEDA activities include:

- Registration of infrastructural facilities for seafood export trade.
- Collection and dissemination of trade information and the promotion of Indian marine products in overseas markets.
- Implementation of schemes vital to the industry by extending assistance for infrastructure development for better preservation and modernised processing.
- Promotion of aquaculture for augmenting export production through development of hatcheries, new farms, diversification of species and technology upgradation
- Promotion of deep-sea fishing projects through test fishing, joint ventures and up gradation & installation of equipments to increase the efficiency of fishing.
- To carry out inspection of marine products, its raw material, fixing standards and specifications, training, regulating as well as to take all necessary steps for maintaining the quality of seafood that are marketed overseas.
- Impart trainings to fishermen, fish processing workers, aquaculture farmers and other stake holders in the respective fields related to fisheries.
- Conduct research and development for the aquaculture of aquatic species having export potential through Rajiv Gandhi Centre for Aquaculture (RGCA).
- Conduct extension and awareness activities, trainings etc through Network for Fish Quality Management and Sustainable Fishing (NETFISH) & National Centre for Sustainable Aquaculture (NaCSA).

MPEDA also launched the Fish Exchange Portal', http://fishexchange.mpeda.gov.in, to enhance the export trade between registered seafood exporters of India and buyers abroad. The portal provides a platform for buyers across the globe to interact and source the 'Irresistible Seafood from Incredible India' from the registered exporters under this Authority. The portal also features latest and updated information on world's and India's seafood trade statistics, production information and price trends, for the users to refer and understand the market scenario. It is loaded with directory of Indian seafood exporters, country profiles, regulatory, and tariff information, standards, notifications, information on upcoming business events / fairs etc. so that it will act like a 'one stop shop' for the trade needs.

19.3. Recent Government initiatives to modernise market infrastructure

The various fiscal and financial incentives by the government is listed in chapter 5 of Volume III of this Report. The Integrated National Fisheries Action Plan envisages facilities for reduction of post-harvest loss and to increase market accessibility for consumers.

Pursuant to the announcement in the 2017 Budget, the Dairy Infrastructure Development Fund (DIDF) of. Rs. 11,700 crore was set up as a corpus fund under NABARD, for modernisation of obsolete infrastructure with the cooperatives over next 3 years.

Thereafter the 2018 Union Budget, announced setting up a Fisheries and Aquaculture Infrastructure Development Fund (FAIDF) for fisheries sector and an Animal Husbandry Infrastructure Development Fund (AHIDF) for financing infrastructure requirement of animal husbandry sector. A provision of Rs 7,522.48 crore has been made for the establishment of FAIDF. The total corpus of these two new funds would be about Rs 10,000 crore.

This is expected this will help in developing infrastructure in farms located in remote locations and well as in enabling market connectivity from fish farms to domestic and international consumers.

Key Extracts

- Fisheries sector has received sustained government support to increase production and has also garnered private initiatives and grown. However, market and marketing development has been largely left to the devices of cooperatives and private sector.
- Small fishers have to rely on multi-layered market chain to supply the domestic market which leads to inefficiencies and lower value share for farmers. .
- Unlike horticultural produce, fish requires to undergo food processing to fully capture consumer demand in hinterland cities. Focus on fish processing industries for domestic market should be a priority area.
- Domestic fish markets remain the mainstay of fishers and hinterland demand is not fully tested due to insufficient cold-chain connectivity. The growth potential for fresh fish in domestic markets is somewhat hindered due to quality concerns. There is need to strategically focus on upgrading and scaling up the marketing and logistics network, to meet and amplify such domestic demand.

Chapter 20
Fisheries: Policy Recommendations

Based on examination and deliberations of the fishery sector from different angles, in the percentage chapters, some important policy recommendations emerge. Adoption would help in imparting greater stability and robustness to the sector.

20.1. Marine fisheries

i. The fleet strength of marine fishing vessels needs to be reduced as recommended by the National Policy on Marine Fisheries, 2017 in order to reduce fishing pressure and to optimize income from marine fisheries. Sustainability is important.

ii. It is necessary to promote off-shore and near-shore alternative employment opportunities for the fishers during the fishing ban period to sustain their livelihood, and also enhance their annual incomes from different sources. The alternatives for gainful engagement include seaweed farming, mussel and clam culture, pearl culture, marine ornamental fish culture etc.

iii. Cage culture needs to be promoted by attracting foreign direct investment (FDI) by professional & experienced corporates. It must be ensured, that local stakeholders gain from such investments in terms of income and welfare.

iv. In a business-as-usual scenario, the ocean is expected to contain one tonne of plastic for every three tonnes of fish by 2025, and by 2050, there will be more plastic than fish [by weight] in the seas. The fishers (marine) could be trained in collection and recycling and in making the best use of the collected plastic for supplementing their income.

20.2. Inland fisheries

20.2.1. Riverine fisheries

i. Leasing polices for use of rivers for fishing must be streamlined. Cooperatives have to be strengthened in riverine fisheries. The Kolhapur (Maharashtra) model deserves to be replicated across the country for increased landings and income.

ii. Recreational fisheries need to be promoted by professional and experienced angling associations in cooperation with State departments of fisheries. This can generate new income for local stakeholders in hill areas.

20.2.2. Reservoir fisheries

i. Lease rights for reservoir cooperatives need to be strengthened with specified user rights.

ii. Cage culture in reservoirs needs to be promoted for increased production and income.

iii. The Andhra Pradesh model (with TATA Trust) for improving the performance of reservoir fisheries may be considered for replication across the country

20.2.3. Freshwater aquaculture

i. Freshwater aquaculture needs to be promoted as a national activity under "Blue Revolution: Integrated Development and Management of Fisheries', the umbrella scheme of NFDB (National Fisheries Development Board). Substantial enhancement in income of farmers and fishers' can be achieved.

ii. Specific freshwater culture activities like freshwater ornamental fisheries and freshwater pearl culture need to be given special attention in terms of funds and extension support for popularisation of such enterprises.

iii. When credit needs of the fish farmers are not met from formal sources, a dependency is created with local traders, which binds farmers in an unequal relationship. The fishermen be offered credit without collateral and also ensuring timely dispersal. This will enable them to sell their produce at the right place at the right price of their volition.

iv. An efficient and effective market structure for fishery crop and products is necessary and deserves highest attention.

20.3. Brackishwater aquaculture

i. Shrimp farming needs to be regulated intensely. Shrimp farming is a delicate farming activity that requires high technical and management skills. The current model of leasing out fallow government lands to marginalised sections of the population cannot yield sustained and substantial gains - neither economic nor social unless modelled in a collective way. Shrimp farming requires high technology and management skills that can be (considered for) obtained via FDI from experienced companies. The only rider that needs to be placed is the need for these companies to involve local stakeholders in the income generation process. One way of doing it is to lease out potential sites to the landless & weaker sections, and organise them into VPOs/FPOs, which can then engage themselves with Companies / Corporates for professional management. Contract farming arrangement can facilitate such an arrangement.

ii. Marketing needs to be streamlined to provide steady prices and income for the farmers. Shrimp is essentially an export product and is subject to regulation of WTO and volatility of international trade. The issue of anti- dumping duties keeps raising its head periodically. This needs intervention at appropriate level.

iii. Brackish water fish culture like Asian Seabass, Cobia should be handled by technically competent and highly skilled management personnel, and is not a small farmer activity. Yet, the involvement of local stakeholders in off-shore corporate fish farming needs to be ensured for the economic and welfare gains of the local stakeholders. Further, as suggested above FPO model will offer strength to fishermen.

iv. Tilapia and Pangasius can be promoted as an income earning activity in brackish water areas. The fish has high market potential and is hardy.

20.4. Advisories

20.4.1. Weather advisories

i. Fishermen are exposed to high degree of weather truancies, particularly in case of marine fishing. This risk can be addressed by using weather forecast system.

ii. Weather advisories shared in real time will be highly useful.

20.4.2. Potential fishing zone advisories

A Portal, m@krishi developed by CMFRI has demonstrated, that the fishermen along Maharashtra coast benefitted from enhanced fish catch (by 30-40 per cent) and savings in fuel (by 30 per cent). Such facility should be made available to all the fishermen along the entire coastline of India.

20.4.3. Deployment of advanced technologies

Deployment of GIS mapping technology and wholesome adoption of vessel monitoring system (VMS) will enhance operational efficiency in fishing and enable monitoring, control and surveillance.

20.5. Policy and Implementation Focus

i. Active development of fishing village communities into Village Producer Organisations, as companies so as to enable modern organisation, credit, investment and partnerships with allied industries. The VPOs could also facilitate the formalising of village level equipment hiring, maintenance and repairs, as well as output handling. The village scale organisations could be structured as companies or cooperatives.

ii. A Division called 'Division of Non-farm Enterprise Activities' may be created in the DAHDFD, with a mandate to promote all such secondary actions and activities relating to dairy, livestock, poultry, fishery & aquaculture. It is necessary to promote fishery related non-farm income generating activities, for which several opportunities are available.

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Bibliography – Vol VIII-D

Annual Reports of DAHDF – 2016-17 and 2017-18

Aquaculture Economics and Management, 12(2): 130-144

Building a Vibrant Goat Sector: Approach Paper for Vision 2030 - BMGF, IFAD, Department of Animal Husbandry Dairying and Fisheries, MoAFW, GOI

Gittinger, J. P. 1982. *Economic analysis of agricultural projects*. The John Hopkins University Press, 2nd edn. Baltimore, London.

Kaliaperumal, N., Kalimuthu, S. and Ramalingam, J. R. 2004. Present scenario of seaweed exploitation and industry in India. *Seaweed Res.Utiln.*, 26: 47-53.

Krishnan, M. and Narayanakumar, R. 2009. *Socio-economic dimensions of seaweed farming in India, Consultancy Report*, Personal Services Agreement, FAO of UN, Rome, p. 103.

Livestock Census-2012, All India Report – GoI

Modayil, M. J. 2004. How to increase marine fish production.*Fishing Chimes*, 28(1): 14-16.

Padilla, J. E. and Lampe, H. C. 1989. The economics of seaweed farming in the Philippines, *Naga, The ICLARM Quarterly* 12(3): 3-5.

Phansalkar Sanjiv (2017) Indian gear up for blue revolution, Village Square, January 11.

Public-private-producer partnerships (4Ps) in small ruminant value chain development in India - IFAD and the Bill & Melinda Gates Foundation

Rao, G. Syda, and Kumar R. Narayana 2008. An economic analysis of land based production of marine pearls in India.

Sathiadhas, R., Najmudeen, T. M. and Sangeetha Prathap 2009. Break-even analysis and profitability of Aquaculture Practices in India. *Asian Fish. Sci.*, 22: 667-680.

Shang, Y. C. 1976. Economic aspects of *Gracilaria* culture in Taiwan. *Aquaculture*, 8: 1-7

Shang, Y. C. 1981. *Aquaculture Economics: basic concepts and methods of analysis*. Westview, Press, Boulderview, Colorado

Shinoj Parappurathu*, Grinson George, R. Narayanakumar, N. Aswathy, C. Ramachandran and A. Gopalakrishnan (2017), Priorities and Strategies to Boost Incomes of Marine Fisher Folk in India, *Agricultural Economics Research Review*,Vol. 30, 2017 pp 205-216

Small ruminant value chain in India: opportunities and constraints, 2017 - Indian Journal of Economics and Development, M Chakraborty, D. Gupta

Tisdell, C. 1972. *The Microeconomics: the theory of economic allocation.* John Wiley and Sons, Sydney, 247 pp

Annexures

Table A1: Number of In-Milk Animals during 2015-16 & 2016-17 *(In 000 nos.)*

	States/UTs	Cattle							
		Exotic 2015-16	Exotic 2016-17	Crossbred 2015-16	Crossbred 2016-17	Indigenous 2015-16	Indigenous 2016-17	Non-Descript 2015-16	Non-Descript 2016-17
1	Andhra Pradesh	2.4	3.0	913.5	1,038.0	118.8	131.2	727.7	801.2
2	Arunachal Pradesh	-	0.6	7.1	7.0	65.2	69.0	-	-
3	Assam	-	-	163.5	154.9	-	-	1,309.4	1,155.0
4	Bihar	-	-	1,104.0	1,162.6	1,941.2	1,976.1	-	-
5	Chhattisgarh	4.2	4.4	46.0	47.6	416.4	418.9	759.9	780.5
6	Goa	-	-	10.3	9.8	-	-	8.8	8.3
7	Gujarat	-	-	806.5	877.3	1,286.3	1,319.0	560.1	581.2
8	Haryana	38.9	40.9	364.9	383.1	127.0	133.0	53.5	55.9
9	Himachal Pradesh	7.7	8.1	404.7	431.0	2.7	3.3	217.4	215.5
10	Jammu & Kashmir	-	-	505.0	526.4	-	-	275.2	281.7
11	Jharkhand	12.5	13.3	147.7	195.4	192.0	224.9	1,179.0	1,259.0
12	Karnataka	-	-	1,391.1	1,370.7	924.3	886.7	598.9	732.6
13	Kerala	0.4	-	668.1	630.5	2.6	2.0	21.3	19.2
14	Madhya Pradesh	18.4	21.0	428.1	483.1	635.4	700.3	4,218.4	4,363.5
15	Maharashtra	11.9	12.4	1,536.2	1,491.9	332.9	364.8	1,325.1	1,339.4
16	Manipur	1.0	1.0	14.6	14.8	-	-	44.7	45.5
17	Meghalaya	-	-	15.2	15.0	116.7	121.7	-	-
18	Mizoram	-	-	7.6	8.1	-	-	3.5	3.9
19	Nagaland	-	-	28.9	30.3	-	-	18.6	17.8
20	Odisha	-	-	368.1	384.0	193.8	129.5	1,402.4	1,640.9
21	Punjab	114.4	115.8	505.0	513.6	74.7	76.9	22.1	21.4
22	Rajasthan *	-	-	785.0	721.3	1,445.9	1,710.1	1,592.7	1,868.2
23	Sikkim	-	29.4	32.5	0.1	0.8	-	-	-
24	Tamil Nadu	19.4	29.3	2,424.6	2,587.1	621.5	126.8	-	463.0
25	Telangana	12.0	11.9	192.3	204.7	86.1	90.2	894.9	878.2
26	Tripura	-	-	30.1	30.4	-	-	136.5	141.3
27	Uttar Pradesh	123.6	140.8	1,103.2	1,162.9	3,040.7	3,181.6	1,682.3	1,735.4
28	Uttarakhand	5.8	6.5	215.5	227.8	34.0	35.7	333.7	319.4
29	West Bengal	-	-	768.5	786.1	2,680.4	2,730.0	-	-
30	A&N Island s	2.9	2.8	1.4	1.4	3.3	1.4	3.7	2.4
31	Chandigarh	-	-	3.4	3.9	-	-	0.4	1.2
32	D.& N. Haveli	-	-	-	-	-	-	-	-
33	Daman & Diu	-	-	0.2	0.0	-	0.1	-	0.1
34	Delhi	-		22.1		23.1		-	
35	Lakshadweep	-	-	0.2	0.2	-	-	0.3	0.4
36	Puducherry	-	-	20.9	21.0	-	-	0.6	0.6
	All India	**375.53**	**441.05**	**15036.09**	**15521.59**	**14365.58**	**14432.93**	**17391.11**	**18732.7**

Continued…

Table A2: Number of In-Milk Animals during 2015-16 & 2016-17 *(In 000 nos.)*

States/UTs		Buffalo				Goat 2015-16	Goat 2016-17
		Indigenous Buffalo 2015-16	Indigenous Buffalo 2016-17	Non-Descript Buffalo 2015-16	Non-Descript Buffalo 2016-17		
1	Andhra Pradesh	2,101.7	2,326.1	1,591.4	1,100.6	7 0.33	73.8
2	Arunachal Pradesh	0.4	0.5	-	-	0 .00	-
3	Assam	96.1	86.4	-	-	497.0	344.7
4	Bihar	2058 .97	2,138.5	-	-	3,220.8	3,287.4
5	Chhattisgarh	52.9	59.0	136.8	137.7	612.2	630.7
6	Goa	-	-	12.6	11.4	3 .17	2.7
7	Gujarat	2,781.5	2,793.6	839.4	907.6	1,776.8	1,844.4
8	Haryana	1,900.8	2,000.9	358.5	372.6	140.6	133.8
9	Himachal Pradesh	141.9	147.5	145.3	133.4	234.4	251.9
10	Jammu & Kashmir	50.9	54.7	187.6	190.8	491.2	515.1
11	Jharkhand	73.2	89.2	187.5	191.1	1,684.5	1,685.3
12	Karnataka	988.0	853.9	710.6	749.0	1513 .8 0	1,348.4
13	Kerala	4.7	5.0	2.3	1.5	508.4	503.7
14	Madhya Pradesh	824.0	893.7	2,879.1	3,048.9	2,786.2	3,176.8
15	Maharashtra	928.6	932 .96	1,268.7	1,218.2	2,727.0	2,658.0
16	Manipur	-	-	11.5	11.7	-	-
17	Meghalaya	2.5	2.0	-	-	-	-
18	Mizoram	-	-	-	-	-	-
19	Nagaland	-	-	4.2	4.9	19.5	21.9
20	Odisha	29.9	30.7	144.6	149.5	98.2	103 .11
21	Punjab	1,874.5	1,878.9	810.0	811.9	115.2	116.5
22	Rajasthan *	2,766.8	2,899.9	1,818.5	2,040.3	7,513.8	7,404.3
23	Sikkim	-	-	-	-	-	-
24	Tamil Nadu	168.0	157.5	96.0	106.6	2,681.8	2,681.9
25	Telangana	779.9	818.1	1,036.2	1,034.8	154.4	155.4
26	Tripura	-	-	1.8	1.8	125.2	127.9
27	Uttar Pradesh	8,249.2	8,521.3	2,387.0	2,405.1	4580 .00	4,686.0
28	Uttarakhand	204.6	213.4	251.6	243.0	347.9	357.5
29	West Bengal	120.5	123.5	-	-	2,332.1	2,377.4
30	A&N Islands	0.8	1.1	-	-	11.5	11.3
31	Chandigarh	12.4	7.3	-	0.0	0.2	0.1
32	D.& N. Haveli	-		-		-	
33	Daman & Diu	-	0.0	0.3	0.0	0.6	0.1
34	Delhi	95.2		-		-	
35	Lakshadweep	-	-	-	-	13 . 35	13.3
36	Puducherry	-	-	0.9	1.1	-	-
	All India	**26307.89**	**27035.39**	**14882.19**	**15534.07**	**34259.99**	**34513.15**

Source: State/UT Animal Husbandry Departments

"-" *not received/not available*

**estimates are projected on the basis of existing growth rates and previous year estimates due ta non-availability af data Nate: estimated number of animal of rural and urban area are taken together*

Table A3: Milk Production during 2012-13 to 2016-17 (numbers in '000 tonnes)

SN	States/UTs	2012-13	2013-14	2014-15	2015-16	2016-17
1	Andhra Pradesh#	12761.7	13007.1	9656.2	10817.0	12177.9
2	Arunachal Pradesh	22.7	43.4	46.1	50.1	52.5
3	Assam	799.7	814.5	829.5	843.5	861.3
4	Bihar	6844.8	7197.1	7774.9	8288.4	8711.1
5	Chattisgarh	1164.1	1208.6	1231.6	1277.3	1373.6
6	Goa	61.2	67.8	66.6	54.3	51.4
7	Gujarat	10314.6	11112.2	11690.6	12262.4	12784.1
8	Haryana	7040.2	7441.7	7901.4	8381.3	8974.8
9	Himachal Pradesh	1138.6	1150.8	1172.2	1282.9	1329.1
10	Jammu & Kashmir	1630.6	1614.7	1950.9	2273.4	2376.1
11	Jharkhand	1679.0	1699.8	1733.7	1812.4	1893.8
12	Karnataka	5718.2	5997.0	6120.9	6344.0	6562.2
13	Kerala	2790.6	2654.7	2711.1	2649.8	2520.3
14	Madhya Pradesh	8837.8	9599.2	10779.1	12148.4	13445.3
15	Maharashtra	8733.7	9089.0	9542.3	10152.6	10402.2
16	Manipur	80.0	81.7	82.2	79.0	78.8
17	Meghalaya	80.5	82.2	83.0	84.0	84.0
18	Mizoram	13.6	15.3	20.5	22.0	24.2
19	Nagaland	78.7	80.6	75.7	77.0	79.4
20	Odisha	1724.4	1861.2	1903.1	1930.5	2003.4
21	Punjab	9724.3	10011.1	10351.4	10774.2	11282.1
22	Rajasthan *	13945.9	14573.1	16934.3	18500.1	20849.6
23	Sikkim	42.2	46.0	50.0	66.7	54.4
24	Tamil Nadu	7004.7	7049.2	7132.5	7243.5	7556.4
25	Telengana			4207.3	4442.5	4681.1
26	Tripura	118.0	129.7	141.2	152.2	159.6
27	Uttar Pradesh	23329.6	24193.9	25198.4	26386.8	27769.7
28	Uttarakhand	1478.4	1550.2	1565.4	1655.8	1692.4
29	West Bengal	4859.2	4906.2	4961.0	5038.5	5182.6
30	A&N Islands	21.5	14.2	15.6	15.4	16.1
31	Chandigarh	44.0	44.4	44.0	43.2	36.4
32	D.& N. Haveli*	11.0	11.0	8.5	8.5	7.5
33	Daman & Diu	1.0	0.8	0.8	0.8	0.6
34	Delhi*	286.6	284.3	280.1	280.8	279.1
35	Lakshadweep	2.2	6.1	4.2	3.3	3.2
36	Puducherry	47.2	47.3	47.6	48.0	48.3
	All India	**132430.59**	**137685.89**	**146313.55**	**155490.51**	**165404.38**

Source: State/UT Animal Husbandry Departments

"-" *not received/not available*

**estimates are projected on the basis of existing growth rates and previous year estimates due ta non-availability af data Note: estimated number of animal of rural and urban area are taken together*

Table A4: Estimates of Egg Production during 2012-13 to 2016-17 (numbers in lakh)

SN	States/UTs	2012-13	2013-14	2014-15	2015-16	2016-17
1	A&N Islands	741.32	1193.12	861.18	989.10	1032.27
2	Andhra Pradesh #	222973.83	227874.76	130958.24	141743.16	158274.36
3	Arunachal Pradesh	438.69	400.02	417.26	427.31	495.21
4	Assam	4709.58	4717.34	4727.94	4740.48	4770.75
5	Bihar	8371.86	9308.19	9844.95	10021.04	11116.68
6	Chandigarh	170.27	172.69	169.28	166.66	154.12
7	Chhattisgarh	13704.06	14330.30	14731.73	15028.45	16637.69
8	D.& N. Haveli *	73.00	72.99	72.99	72.99	72.99
9	Daman & Diu	20.00	12.98	19.46	17.83	17.83
10	Delhi *	-	-	-	0.00	0.00
11	Goa	457.87	59.67	74.52	352.09	292.19
12	Gujarat	14558.39	15550.74	16564.99	17215.92	17940.34
13	Haryana	42342.66	43590.99	45789.80	49133.39	52139.05
14	Himachal Pradesh	1069.39	1075.48	1084.34	811.67	958.99
15	Jammu & Kashmir	6715.41	6649.19	4957.63	2309.47	2305.29
16	Jharkhand	4238.95	4444.99	4663.17	4832.84	5103.37
17	Karnataka	36773.33	41300.99	43968.40	47660.42	50671.45
18	Kerala	22375.28	24768.77	25036.11	24424.82	23443.83
19	Lakshadweep	139.99	129.27	125.53	143.91	146.88
20	Madhya Pradesh	8710.78	9671.00	11775.55	14414.28	16939.63
21	Maharashtra	45661.07	48314.57	50792.31	52858.26	54774.17
22	Manipur	1162.19	1163.81	1129.37	1037.40	992.00
23	Meghalaya	1028.18	1049.36	1056.99	1063.66	1063.90
24	Mizoram	352.02	362.31	377.33	391.13	408.07
25	Nagaland	617.98	223.34	352.77	464.52	397.35
26	Odisha	23229.84	23609.35	19245.00	19273.00	19744.74
27	Puducherry	112.89	112.95	113.32	113.50	116.34
28	Punjab	37911.01	43375.57	42642.21	44218.23	47825.57
29	Rajasthan	10334.90	11902.98	13202.01	13852.98	13632.52
30	Sikkim	146.00	99.35	57.53	101.57	68.49
31	Tamil Nadu	119333.55	141235.38	159253.15	161251.99	166823.99
32	Telangana			106185.33	112058.23	118186.35
33	Tripura	1565.17	1794.28	1979.49	2160.84	2294.26
34	Uttar Pradesh	17073.67	18122.15	20775.69	21928.52	22889.49
35	Uttarakhand	3079.14	3369.74	3697.42	3906.51	4119.12
36	West Bengal	47114.91	47460.12	48135.68	60108.19	65536.49
All India		**697307.2**	**747518.8**	**784838.7**	**829294.4**	**881385.8**

Source: State/UT Animal Husbandry Departments

Includes Telangana till 2013-14
"-" not received/not available
*estimates on basis of existing growth rates / previous year estimates due to non-availability of data.

Table A5: Estimated Egg Production from Commercial Poultry Farms (numbers in lakh)

SN	States/UTs	Desi Fowls 2015-16	Desi Fowls 2016-17	Improved Fowls 2015-16	Improved Fowls 2016-17	Desi Ducks 2015-16	Desi Ducks 2016-17	Improved Ducks 2015-16	Improved Ducks 2016-17
1	Andhra Pradesh	-	-	1,33,098.5	1,49,168.0	-	-	-	-
2	A&N Islands	6.4	11.6	250.8	254.0	-	-	14.9	18.6
3	Arunachal Pradesh	-	-	-	-	-	-	-	-
4	Assam	-	-	-	-	-	-	-	-
5	Bihar	-	-	220.5	607.0	-	-	-	-
6	Chandigarh	-	-	163.5	151.5	-	-	-	-
7	Chhattisgarh	-	-	12,680.7	14,222.9	-	-	-	-
8	D.& N. Haveli	-		-		-		-	
9	Daman & Diu	-	-	-	-	-	-	-	-
10	Delhi	-		-		-		-	
11	Goa	-	-	285.4	247.0	-	-	-	-
12	Gujarat	-	-	14,804.1	15,666.7	-	-	-	-
13	Haryana	-	-	48,996.9	51,994.9	-	-	-	-
14	Himachal Pradesh	-	-	226.0	384.3	-	-	-	-
15	Jammu & Kashmir	-	-	126.4	123.2	-	-	-	-
16	Jharkhand	-	-	2.6	17.8	-	-	1.2	6.1
17	Karnataka	-	-	43,193.8	45,877.3	-	-	-	-
18	Kerala	-	-	28.0	38.4	3.8	4.6	-	-
19	Lakshadweep	-	-	16.7	17.1	-	-	-	-
20	Madhya Pradesh	-	-	9,931.3	11,829.9	-	-	0.8	0.9
21	Maharashtra	-	-	40,806.5	43,603.1	-	-	0.3	0.6
22	Manipur	-	-	-	-	-	-	-	-
23	Meghalaya	-	-	-	-	-	-	-	-
24	Mizoram	-	-	9.5	10.2	-	-	-	-
25	Nagaland	-	-	1.2	0.3	0.4	0.1	0.7	0.1
26	Odisha	-	-	16,614.4	17,042.1	-	-	-	-
27	Puducherry	-	2.8	-	2.8	-	.	-	-
28	Punjab	172.8	-	29,357.6	47,264.4	-	-	-	-
29	Rajasthan	-	-	9,247.9	11,138.1	-	-	-	-
30	Sikkim	-	-	9.8	7.9	-	-	-	-
31	Tamil Nadu	-	-	1,55,693.6	1,60,767.8	-	-	-	-
32	Telangana	-	-	1,04,835.2	1,10,899.9	-	-	79.0	81.8
33	Tripura	-	-	12.0	8.7	-	-	1.5	0.6
34	Uttar Pradesh	-	-	14,751.6	16,021.3	-	-	-	-
35	Uttarakhand	-	-	3,139.4	3,290.9	-	-	-	-
36	West Bengal	-	-	12,421.5	16,328.3	-	-	-	-
	All India	**179.2**	**14.4**	**650925.2**	**716985.7**	**4.15**	**4.73**	**98.29**	**108.73**

Source: State/UT Animal Husbandry Departments

Note : estimated production of egg from rural and urban area are taken together

Table A6: Estimated Egg Production from Backyard Poultry Farms (numbers in lakh)

SN	States/UTs	Desi Fowls 2015-16	Desi Fowls 2016-17	Improved Fowls 2015-16	Improved Fowls 2016-17	Desi Ducks 2015-16	Desi Ducks 2016-17	Improved Ducks 2015-16	Improved Ducks 2016-17
1	West Bengal	29494.9	30353.2	12971.1	13480.7	4742.0	4872.3	478.7	502.1
2	Kerala	8077.2	6017.1	15046.6	16128.1	696.6	693.5	572.7	562.1
3	Maharashtra	10620.8	9784.3	1430.6	1386.1	-	-	-	-
4	Bihar	6780.7	7191.1	2466.2	2714.8	404.7	440.4	149.0	163.3
5	Andhra Pradesh	6442.7	6730.1	1517.0	1663.7	204.0	210.1	480.9	502.5
6	Telangana	5998.8	6001.7	1134.4	1170.3	10.9	11.9	0.0	20.8
7	Uttar Pradesh	3737.3	3699.7	3310.9	3038.9	86.3	90.3	42.5	39.4
8	Tamil Nadu	5558.4	5980.7	-	-	-	75.5	-	-
9	Madhya Pradesh	3703.4	4188.3	778.1	918.1	0.7	2.3	-	-
10	Jharkhand	3671.2	3927.6	871.3	868.0	237.5	235.7	49.1	48.1
11	Karnataka	3094.8	3231.5	1371.8	1562.7	-	-	-	-
12	Assam	3278.9	3411.9	136.4	176.8	1204.4	1035.5	120.9	146.6
13	Odisha	2204.8	2238.4	363.1	371.7	87.0	88.7	3.6	3.9
14	Rajasthan	3079.2	2031.9	540.0	462.6	-	-	-	-
15	Chhattisgarh	1788.0	1882.5	498.7	471.6	57.3	57.2	3.6	3.6
16	Tripura	898.1	975.6	768.2	804.7	364.2	382.5	116.9	122.2
17	Gujarat	2411.9	2273.6	-	-	-	-	-	-
18	Jammu & Kashmir	1693.1	1681.6	449.8	439.5	40.2	60.4	-	0.7
19	Meghalaya	863.7	895.5	175.9	155.7	23.2	12.4	0.9	0.3
20	Manipur	309.8	287.3	475.0	458.6	95.1	91.2	157.5	155.0
21	Uttarakhand	234.1	245.4	533.1	582.9	-	-	-	-
22	A&N Islands	439.0	374.9	178.3	249.2	75.9	69.9	23.9	54.2
23	Himachal Pradesh	275.0	285.8	310.7	288.9	-	-	-	-
24	Punjab	346.2	561.2	14341.7	-	-	-	-	-
25	Arunachal Pradesh	283.6	380.0	143.7	115.2	-	-	-	-
26	Mizoram	260.6	265.7	121.1	132.2	-	-	-	-
27	Nagaland	263.4	214.9	159.7	158.0	16.9	14.6	22.4	9.2
28	Haryana	102.6	107.0	33.9	37.2	-	-	-	-
29	Lakshadweep	16.6	16.9	100.3	103.9	2.3	2.1	8.0	7.0
30	Puducherry	57.0	57.0	56.6	53.8	-	-	-	-
31	Sikkim	65.7	60.6	26.1	-	-	-	-	-
32	Goa	51.2	34.9	15.5	10.3	-	-	-	-
33	Chandigarh	3.2	2.6	-	-	-	-	-	-
34	Daman & Diu	-	-	17.8	-	-	-	-	-
35	D.& N. Haveli	-		-		-		-	
36	Delhi	-		-		-		-	
All India		**106105.6**	**105390.3**	**60343.2**	**48003.9**	**8349.1**	**8446.4**	**2230.7**	**2340.9**

Source: State/UT Animal Husbandry Departments

Table A7: Estimates of Meat Production *{in 000 tons)*

SN	States/ UTs	Cattle 2015-16	Cattle 2016-17	Buffalo 2015-16	Buffalo 2016-17	Sheep 2015-16	Sheep 2016-17
1	Andhra Pradesh	-	-	79.83	87.12	139.26	177.94
2	Arunachal Pradesh	9.48	10.15	1.84	1.66	0.53	0.38
3	Assam	3.16	3.20	0.10	0.11	1.47	1.53
4	Bihar	34.54	32.02	68.31	74.29	1.65	1.87
5	Chhattisgarh	-	-	-	-	1.20	1.49
6	Goa	0.04	0.09	-	-	-	-
7	Gujarat	-	-	1.19	1.33	0.56	0.50
8	Haryana	-	-	-	-	6.87	6.63
9	Himachal Pradesh	-	-	-	-	0.93	0.99
10	Jammu & Kashmir	-	-	6.05	6.06	17.19	19.59
11	Jharkhand	-	-	3.19	2.99	1.32	1.36
12	Karnataka	27.93	41.34	14.94	9.52	28.55	22.59
13	Kerala	146.73	146.05	110.16	106.07	-	-
14	Madhya Pradesh	-	-	23.54	25.78	0.73	0.81
15	Maharashtra	1.82	-	139.86	165.43	11.32	14.97
16	Manipur	8.54	8.65	4.23	4.52	0.10	0.11
17	Meghalaya	23.63	22.63	0.61	0.56	-	-
18	Mizoram	4.01	5.07	0.12	0.20	-	-
19	Nagaland	11.51	8.50	5.58	4.41	-	-
20	Odisha	-	-	-	-	16.18	15.52
21	Punjab	-	-	130.96	124.49	2.84	3.12
22	Rajasthan	-	-	22.48	24.83	46.03	57.32
23	Sikkim	0.84	1.55	0.71	0.29	-	-
24	Tamil Nadu	43.70	43.16	0.99	2.57	36.48	45.23
25	Telangana	-	-	87.68	96.03	135.36	145.53
26	Tripura	-	-	-	-	-	-
27	Uttar Pradesh	-	-	846.19	694.64	15.77	17.32
28	Uttarakhand	-	-	4.05	4.01	2.16	2.22
29	West Bengal	11.56	13.97	16.88	13.94	17.59	17.94
30	A&N Islands	0.09	0.08	0.06	0.05	-	-
31	Chandigarh	-	-	-	-	0.24	0.21
32	D.& **N.** Haveli	-		-		-	
33	Daman & Diu	0.16	0.17	-	-	0.36	0.39
34	Delhi	-		41.36		-	
35	Lakshadweep	0.04	0.04	-	-	-	-
36	Puducherry	1.55	1.26	0.10	0.09	0.83	0.89
	All India	**329.34**	**337.91**	**1611.01**	**1450.98**	**485.52**	**556.44**

Source: State/UT Animal Husbandry Departments

"-" *not received/not available*

Note: estimated production of meat from rural and urban area are token together Source: State/UT Animal Husbandry Deportments

Table A8: Estimates of Meat Production *(in 000 tons)* Contd..

SN	States/ UTs	Goat 2015-16	Goat 2016-17	Pig 2015-16	Pig 2016-17	Poultry 2015-16	Poultry 2016-17
1	Andhra Pradesh	43.16	47.57	2.57	2.08	301.47	317.80
2	Arunachal Pradesh	2.23	2.40	4.87	5.33	0.42	0.57
3	Assam	14 .54	14.60	17.49	18.72	8.00	8.69
4	Bihar	77.74	85.38	72.48	79.38	47.02	53.32
5	Chhattisgarh	9.14	10.86	1.65	2.10	29.39	34.71
6	Goa	3.40	3.33	0.91	0.85	3.53	2.93
7	Gujarat	1.16	1.01	0.23	0.09	30.80	30.41
8	Haryana	6.35	6.24	7.13	6.86	382.45	407 .75
9	Himachal Pradesh	2.37	2.25	0.12	0.11	0.58	1.05
10	Jammu & Kashmir	12.10	14.74	-	-	39.74	44.71
11	Jharkhand	17.87	18.71	17.62	19.00	10.71	12.67
12	Karnataka	19.51	28.65	22.13	19.85	83.54	87.12
13	Kerala	19.72	21.17	14.41	6.80	175.02	188 .76
14	Madhya Pradesh	21.28	23.96	1.50	1.67	22.78	26.41
15	Maharashtra	54.98	102.50	17.02	44.66	450.11	517.45
16	Manipur	0.25	0.28	6.61	6.85	6.55	7.06
17	Meghalaya	1.33	1.37	11.39	13.84	4.17	2.61
18	Mizoram	0.09	0.13	7.50	7.37	1.84	2.03
19	Nagaland	0.76	0.67	17.14	17.01	0.94	0.78
20	Odisha	65.01	69.48	8.74	9.14	74.83	82.37
21	Punjab	7.18	8.00	0.86	0.96	108.08	112.07
22	Rajasthan	75.63	73.98	12.87	15.57	22.92	8.40
23	Sikkim	0.08	0.18	0.27	1.01	3.95	1.36
24	Tamil Nadu	48.26	52.24	2.88	2.11	412 .15	427 .53
25	Telangana	53.98	58.30	2.98	3.17	262.06	288.00
26	Tripura	1.65	1.77	11.23	12.43	24.48	25.48
27	Uttar Pradesh	130.78	143.60	90.91	137.06	334.23	353.49
28	Uttarakhand	9.67	10.15	3.13	3.16	8.58	8.86
29	West Bengal	226.24	232.09	30.26	30.78	383.80	397.16
30	A&N Islands	0.10	0.12	0.37	0.48	4.28	4.32
31	Chandigarh	0.45	0.40	0.30	0.33	-	-
32	D.& N. Haveli	-		-		-	
33	Daman & Diu	-	-	-	-	-	-
34	Delhi	11.08		-		17.37	
35	Lakshadweep	0.06	0.06	-	-	0.68	0.32
36	Puducherry	4.78	4.94	-	0.01	7.35	7.43
All India		**942.91**	**1041.11**	**387.55**	**468.80**	**3263.81**	**3463.65**

Source: State/UT Animal Husbandry Departments

"-" *not received/not available*
Nate: 1. Meat production from young and adult animals has been considered separately during 2015-16
2. estimated production of meat from rural and urban area are taken together

Table A9: Estimates of Wool Production during 2012-13 to 2016-17 *(in 000 kg.)*

SN	States/UTs	2012-13	2013-14	2014-15	2015-16	2016-17
1	Andhra Pradesh#	5030.50	5036.83	778.23	788.63	791.62
2	Arunachal Pradesh	17.78	21.55	24.23	35.70	58.25
3	Bihar	267.45	270.60	278.42	240.16	280.87
4	Chhattisgarh	106.61	105.95	115.53	90.15	87.29
5	Gujarat	2663.96	2578.06	2577.41	2282.65	2267 .32
6	Haryana	1369.96	1390.41	1428.69	702.17	691.22
7	Himachal Pradesh	1649.33	1654.99	1663.07	1408.87	1475.00
8	Jammu & Kashmir	7680.61	8709.70	8371.01	6865.65	7265.51
9	Jharkhand	158.89	156.13	160.76	165.82	177.65
10	Karnataka	8019.89	7754.53	8821.44	8191.42	6588.25
11	Madhya Pradesh	442.23	466.34	483.83	442.39	406.22
12	Maharashtra	1502.61	1538.62	1385 .78	1389 .89	1406.65
13	Punjab	557.73	557.73	460.89	472.69	489.64
14	Rajasthan	14007.18	15026.77	14463.36	13414.61	14321.27
15	Sikkim	1.00	1.00	-	-	-
16	Tamil Nadu	1.09	1.83	1.20	1.36	2.08
17	Telangana			4422.97	4562.41	4658.11
18	Uttar Pradesh	1456.10	1472.55	1493.71	1264.98	1286.10
19	Uttarakhand	399.89	440.14	468.93	513.33	538.24
20	West Bengal	722.08	725.17	740.40	748.47	753.07
All India		**46054.87**	**47908.88**	**48139.88**	**43581.34**	**43544.37**

Source: State/UT Animal Husbandry Departments

 # Includes Telangana till 2013-14

"-" *not received/not available*

Source: State/UT Animal Husbandry Departments

Annexure A10: Strategic Road Map for Transforming Goat Sector

1. Strategic Road Map for Goat Herd Size Management

Challenges	Recommended Plan of Action	Potential Partners
• Lack of knowledge of goat rearing as an important income generating activity • Lack of resources (credit, labor, insurance, health service) to expand the herd size	• Actively promote awareness on goat enterprise as an income generating activity • Incentives to promote backyard and commercial goatery (credit, insurance). • Technical support for regular veterinary services	• Animal Husbandry Departments (AHD) • NGOs • Research Institutes • Veterinary Universities
Policy Directives • Support for goat rearing on technical and financial aspects. • Training of producers about best practices in goat herd size management given feed and fodder resources and availability of household labor and shelter • Provision of institutional credit and insurance for goat sector to increase herd size		

2. Strategic Road Map for Goat Housing

Challenges	Recommended Plan of Action	Potential Partners
• Rearers lack information on best design and materials for goat sheds.	• Conducting awareness campaigns on appropriate goat housing management	• AHD • NGOs • Research Institutes • Veterinary Universities
• Lack of space for developing a separate shed for goats.	• Enhance awareness for a separate goat shed.	• NGOs • AHD
• Limited resources to develop a goat shed	• Financial assistance from banks be fuelled in.	• Financial Institutes/NABARD • AHD • Various schemes of state and central government
Policy Directives • Support for appropriate goat housing in form of technical and financial input • Training of producers about shed design using local materials		

3. Strategic Plan for Breed Development

Challenges	Recommended Plan of Action	Potential Partners
• No Policy for Goat Breeding	• Development of sound breeding policy for goat supported by well researched evidence • Emphasis on meat and milk breeds • Conserving genetic resources of the state	• Research Institutes • Veterinary Universities • Government Breeding Farms • AHD
• Limited research and outreach of scientific breeding practices	• Promote investment in research to explore newer options like A.I and Embryo Transfer Technology • Distribution of Jamunapari and Barbari semen to veterinary hospitals, dispensaries and farmers.	• Research Institutes • AHD • Government breeding Farms

Poor Grass-Root Breeding Practices: • Superior quality bucks being slaughtered instead of being utilized for breeding • Lack of adequate extension services to promote good breeding practices.	• Promotion and implementation of Selective Breeding practices • Community-based genetic improvement programme for the local breed • Incentives/premiums for superior bucks and breed savior awards for best buck production • Identification and promotion of high potential bucks according to the agro climatic conditions of the regions. • Selective slaughter needs to be practiced	• Veterinary Institutes • Government Schemes • AHD • NGOs • Government Breeding Farms
• Lack of access to good quality breeding bucks at the farmer level	• Support to government, private initiatives to enhance supply of breeding bucks also explore options for PPP mode • Promotion of private breeding farms and incentives for buck production and link to small holders • Support NGOs to develop the linkages between government farms/entrepreneurs and goat rearers	• Government Breeding Farms • Research institutes • Private Entrepreneurs • NGOs • AHD
Policy Directives • Development of sound breeding policy for goat supported by well researched evidence • Focus on breed improvement by Selective breeding with best bucks of same breed • Cross breeding in selected areas supported by well researched facts • Technical support to government and private farms for ensuring production and supply of good quality breeding bucks • Support to AHD/Research institutes/NGOs for farmer awareness on good breeding practices • Support infrastructure for AI		

4. Strategic Road Map for Goat Health Services

Challenges	Recommended Plan of Action	Potential Partners
• Lack of preventive healthcare measures like timely vaccination and deworming leading to high prevalence of diseases and high mortality rates	• Increasing awareness among farmers on the need for vaccination and deworming by initiating campaigns through mass media. Provision of preventive timely vaccination • Monitoring and control measures for migratory goats (quarantine and cross border disease transmission	• AHD • CAHWs • NGOs • KVKs • Research Institutes
• Lack of manpower with the AHD to extend services to small ruminants • Limited supply of quality inputs (vaccines and medicines)	• Develop regulatory framework and incentives for non-state actors (CAHWs), to increase outreach of preventive and first aid health services to goats • Ensuring timely supply of quality vaccines and medicines.	• CAHWs • Private Sector • NGOs

• Inadequate cold chain management infrastructure.	• Establishment of cold chain infrastructure by involvement of Private sector /PPP by incentivizing them.	
• The training of community resource person for last mile delivery for small ruminants is not under legal standards.	• Regulatory and legal framework must be rolled out for community animal health workers and minor veterinary services. • Establishing monitoring system • Support institutions for training CAHWS • Formulate specific training modules for CAHWS	• AHD
• Missing disease surveillance and reporting system	• Establish call centers and a toll free number facility • Adopt disease mapping framework	• AHD • Research Institutes
Policy Directives • Strong support to preventive and curative health services provision • Ensuring support to medicines and vaccines required • Strengthening veterinary institutional infrastructure and human resources is required notifications for the minor veterinary services is required for the legal procedures of community animal health workers. • Control and eradication of diseases and creation of disease free zones by conducting vaccination campaigns • Strengthening disease diagnosis, surveillance and forecasting mechanism in state • Control and regulation of movement of animals within state and also along the borders to control the disease spread		

5. Strategic Road Map for Goat Feeding Practices

Challenges	Recommended Plan of Action	Potential Partners
• Fodder scarcity and depletion of Common Property Resources (CPRs)	• Promote sustainable use of CPR by involving community in management.	• NGOs • AHD • Local Bodies
• Lack of information about balanced feeding practices to improve goat productivity.	• Increase awareness and training of goat keepers about importance of balanced feeding of goats. • Incentives/ subsidy for promotion of private players for production and supply of concentrate/ feed supplements, fodder supply	• AHD • NGOs • KVKS
• Availability of quality inputs (like feed, mineral supplements) at village level is a major challenge	• Promote fodder trees cultivation • Establish fodder banks, feed and mineral mixture units	• Government Schemes • AHD • NGOs • Private Sector
Policy Directives • Promotion of good quality fodder production by establishment of fodder seed banks • To improve the common property resources in rural areas jointly by institutional support and community involvement • Subsidy and incentive for the private players for feed supply • Promote better feeding practices including supplement feeding to goats		

6. Strategic Plan for Improving Goat Marketing

Challenges	Recommended Plan of Action	Potential Partners
• Selling goats at suboptimal age	• Awareness regarding optimum age for selling goats	• AHD • NGOs • Goat Traders
• Prevalence of traditional practice of selling goat through estimation by touch/eye rather than actual weighing; no separate price mechanism for different breeds/sex and quality of goats	• Awareness/supporting fair marketing practices like selling by weighing • Develop market regulations and premium prices for good quality bucks • Developing market information system to enable the producers have sufficient information about goat prices • Online/ e-marketing platforms for goats and other livestock • Awards for good quality goats/bucks	• NGOs • APMC Markets • Gram panchayats • Market players
• Selling of goats is completely under informal marketing • Non-existent/Inadequate market infrastructure	• Bring goat marketing under the aegis of APMCs as done in some states • Developing organized goat markets and infrastructure development	• APMC Markets • NGOs • Private traders/Processors
• Missing linkages between goat rearers and traders/processors • Poor market linkages such as lack of transport facilities	• Organizing the farmers into groups for collective marketing Strengthening backward and forward linkages for goat value chain • Enhance awareness regarding and support investments in marketing facilities	• NGOs • Private traders/Processors

Policy Directives

- Bring livestock marketing in the formal sector under the aegis of Agricultural Produce Marketing Committee (APMC)
- Developing livestock market infrastructure
- Strengthening regulations for fair and transparent pricing
- Promote transparency in market prices for goats and incentives for good quality bucks
- Use of modern techniques like online or e marketing of goats for live goat markets to target special events like Eid, Pujas

7. Strategic Plan for Improving Goat Processing

Challenges	Recommended Plan of Action	Potential Partners
• Lack of hygienic practices due to open slaughter and waste disposal system in existing slaughter houses.	• Upgrade the open slaughter shops to closed shops with elevated infrastructure. Efficient waste disposal system • Training and capacity building of butchers and incentives to modernize their infrastructure and assistance for waste disposal system	• AHD • NGOs

• Missing infrastructure to process goat products leaving slaughter houses underutilized for small ruminants slaughtering.	• Develop cold chain infrastructure for meat processing sector	• State Government Schemes • Ministry of Food Processing Industries (MOFPI)
• Lack of consumer awareness about processed goat meat	• Undertake consumer awareness campaigns about processed and hygienic meat	• NGOs
• Cumbersome licensing procedures is a constraint for private sector investments in establishing slaughter houses	• Establishment of goat processing industry by involvement of private sector/ PPP/ cooperative/ farmer producer organizations (FPO) • Replace single window system for layers of licenses	• Regulatory Authority • Government Schemes
• Negligible value addition of goat products for meat and milk	• Provide market incentives to goat entrepreneurs in the form of training and financial support to set up processing plants.	• Government Schemes • AHD
Policy Directives • Impose ban on open slaughter/ strengthen implementation • Capacity building of butchers and upgrade the open slaughtering to improved closed slaughter with elevated structures and proper waste disposals • Strengthening of organized slaughter houses/processing units for goats • Encouraging private sector to invest in goat processing in state • Promotions of producers to do processing by means of farmer producer organizations. • Encourage entrepreneurs for commercial goat farming • Enhance the link between the producers groups and butcher associations/processing players for better forward and backward linkage		

8. **Strategic Plan for Goat Extension Services**

Challenges	Recommended Plan of Action	Potential Partners
• Focus of extension services is on large ruminants, small ruminants are largely neglected	• Promoting awareness campaigns, goat rallies and livestock fairs	• AHD • NGOs
• District level extension services being carried out through Krishi Vigyan Kendra are restricted only to a few select districts and concentrated for large ruminants.	• Capacity building of extension staff for goat related extension services across state by regular trainings, workshops and exposure visits	• Local villagers • NGOs • KVKs
• Limited use of ICT for developing extension services.	• Development of extension materials and dissemination through modern technology like call centers, helplines, mobile apps, SMS based system.	• Vaccine and pharmaceutical companies, KVK • I.T. companies
Policy Directives • Development of extension material for small ruminants • Strengthening of livestock extension system • Ensure effective dissemination of knowledge and technology to the target beneficiaries through extension services. • Promote use of technology and ICT in extension to increase the outreach of services • Promote engagement of NGOs and do their capacity building for extension services related to goats		

Annexure A11: Migratory Sheep Rearing in Northern Karantaka – Delineation of Constraints[11]

Sheep in India is traditionally maintained under extensive range management employing self or family labour on degraded public land, forest land and stubble (grazing on cropped land after harvesting). India ranks third in sheep and goat population (Livestock census, 2012). Sheep plays an important role in the livelihood of small & marginal farmers and agricultural labourers, as the small ruminants (sheep & goat) generate additional incomes, especially in the arid/semi-arid and mountainous areas, where crop and/or dairy farming are/is not economical. It not only provides the farmers food and nutritional security, but also acts as a mobile bank during their financial crisis. Sheep are traditionally raised under two systems: **stationary and migratory systems**. Migratory sheep rearing is common among the economically weaker sections of shepherd community, and is a traditional practice of some of the shepherd families.

Sheep are traditionally reared by pastoral communities of the area in different states - Andhra Pradesh, Telangana, Maharashtra Karnataka and Rajasthan. These communities rearing sheep have a strong and synergistic relationship with farmers along the traditional migratory routes, where their sheep flocks are penned on farmers' fields, helping in maintaining and improving the soil fertility. However, there are very few research studies on sheep farming by migratory shepherds.

The present study was conducted by the authors in 2017-18 in parts of northern Karnataka to understand a gamut of issues including gender perspectives among migratory shepherd families. The issues on which the study focused included socio-economic profile nature & types of problems, level of knowledge, and participation in various activities during migration, etc.

The study brought out, that migratory sheep rearing takes two forms – **semi-migration; and permanent migration**. In case of semi- migration, men migrate for 6-7 months from November to May of the following year, which is linked to the onset of dry season and withering of surface vegetation; and the termination is based on the onset of monsoon.

In case of permanent migration, the whole family including women and children migrate and are continuously on move for many years. In both types of migration, it was seen that usually 3-4 families move together which helps for easy management & security, besides facilitating sharing of flock management, whenever some need to visit their village or elsewhere on important works.

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Figure 1: Hungry sheep snipping at the fodder, thanks to their owner

Based on a field study, the following are observations in respect of migratory shepherd families:

i. Among the migratory shepherd families, nearly 55 per cent of men and women were in the age range of 35 to 55 years, and the other 45 per cent were in the age range of 18 to 35 years.

ii. Majority of the families (82.20 per cent) were illiterates, belonging to shepherd community (91.70 per cent). Other communities accounted for the remaining percentage**.**

iii. The average annual income of the family was Rs.2-3 lakh for a flock size of 200 sheep.

iv. The percentage of landless and marginal farmers were 43.90 and 45.40 respectively, indicating the poor status of land ownership among the migratory families.

v. For information regarding sheep rearing and health care of animals, the families depended on multiple sources. These included Pharmacists (100 per cent); family members (88.90 per cent), friends and relatives (66.70 per cent). This showed, that the relationship of the families with the Pharmacists is very strong.

vi. The participation of both men and women in extension activities was nil, and they never attended any training programme due to continuous migration and staying outside the villages along the migratory routes. Normally, the migratory families are not allowed entry into the villages.

vii. Apropos the position of knowledge vis-à-vis the recommended Veterinary Package of Practices by the state agricultural universities, for the sheep rearing family it was of middle level; and at the disaggregated level is was 85 per cent in case of men and 95.55 per cent in case of women.

viii. Both men (96.70 per cent) and women (82.80 per cent) were found to be involved in nutrition management and health management. However, breed management, housing management and marketing of sheep were mainly the forte of men. The entire spectrums of these activities were carried out by them.

ix. Majority (93.30 per cent) of migratory shepherds experienced problems in availing loan from banks, as they could not offer the collateral as sought for.

x. Migratory families do not wish /not inclined/not capable to educate their children, as it disturbs the evenness of their migratory life pattern. However, where there were two sons, one stuck to the family tradition, while the other stayed back with grandparents /cousins and attended school. During migration, it was not feasible to send their children to school as they stayed in a particular village for not more than 4-5 days at a time.

xi. The families were found to be deprived of all social contacts as they were normally not allowed to enter the villages.

xii. Health management of sheep was one of the major problems faced by the shepherds. The spend on procurement of medicines was too high. Due to lack of access to veterinary services along the migration routes they tend to depend on the local Pharmacist to suggest medicines for their entire migratory period of six months. Based on the Pharmacist's advice, they make bulk and indiscriminate purchases at the beginning of the migration. The Pharmacist would probably suggest medicines to his own advantage.

xiii. All the respondents (100 per cent) faced inadequacy or non-availability of grazing land and water hole for flock as well as for their own (domestic) consumption along the migratory routes.

xiv. In regards to marketing they faced an acutely inefficient market environment. These included non-availability of market for wool; markets when available located at distance (66.70 per cent), exploitation by middleman (62.20 per cent); and price volatility of live ruminants.

xv. All permanent migrating shepherds were found to be deprived of participation in co-operatives (even sheep cooperatives); and suffering from lack of knowledge/awareness about government projects/programmes related to sheep rearing.

xvi. Although rearing of the popular Deccani breed of sheep was common, shepherds were found to be shifting to non-wool breeds, because the cost incurred on shearing of the sheep is more than price fetched for the wool. This highlights the importance of creating an efficient marketing system for both wool and meat.

xvii. Sheep rearing is a family affair where, activities such as breeding, care of pregnant animals, care at lambing time & special feed to lambs, grazing, health care, feeding, watering, clearing of pens, collection and disposal of pellets, and marketing related activities are taken care of by men.

Whereas, activities like care of newborn, colostrums feeding and milking of sheep are done by women. Women also take care of the horses and dogs in the family accompanying the flock. Another important and time consuming job of a woman is readying and loading of the horses once every 4-5 days on move to the next place.

The study brought only that both men and women need to be trained in scientific management of sheep rearing with regards to their respective domains**.** Besides, appropriate and simple machinery are also required to help reduce drudgery and wastage and effect efficiency.

xviii. The migrating shepherds (both semi or permanent) were seen to be deprived of all extension services and institutional programmes, media contact, education and training, creating in them a sense of isolation from the society.

Off-campus extension activities should be designed for migrating shepherds along the migratory routes. Mobile extension services could be thought of. GPS (Global Positioning System) and Smart Phone based services can also be integrated into the service delivery system.

xix. The migratory routes of the shepherds were almost fixed. These routes can be identified to plan for grazing lands, feed & fodder, water, extension services, veterinary services, bank facilities, education to children etc. Developmental and promotional activities can be planned using funds available under MGNREGA, wasteland and watershed development programmes, besides those available under the schemes of the Ministry of Agriculture.

xx. Marketing of sheep was found to be dominated by intermediaries, depriving the migratory families of deriving remunerative prices. Being on the move, they do not have the needed time to visit efficient markets. A network of sheep markets can be developed at the APMCs under the provisions of APLM Act, 2017. There is also a need to integrate the small ruminants including sheep into agri-value system.

xx. Sheep milk, although nutritious is being wasted on account of age old beliefs. After feeding the family and dogs the excess milk is poured onto the ground, as tradition and culture do not permit its sale. This calls for attitudinal changes, so that a valuable product like milk is utilised to capture its value. Therefore, proper orientation, extension and marketing strategies for sale of milk would help, and supplement the incomes now accrued only from meat & wool.

xxi. Living conditions were extremely poor and were found exposed to vagaries of nature. To improve quality of life, technologies and tools suggested include fuel efficient cook stoves, proper tenting material & construction knowledge, solar lighting and heating facilities**.**

xxi. One of the major vulnerabilities came from lightening, endangering both human and animal life. The families need to be trained to protect themselves by using anti-lightening system/devices, like lightening rod.

The observations supra provided evidence to the commonly known and anecdotal challenges and constraints, that a migratory shepherd community faces. It establishes the existence of social and economic threats to the even and egalitarian life of a sheep rearing community. It is well worth to recognise the acute need for reorganising the migratory system of management (both semi-migratory and permanent systems) into more scientific and stall fed system. By taking advantage of the contemporary communication and transport facilities, it is possible to provide reverse mobility to the resources (feed, fodder, water etc.) in whose search the sheep are now led by the migratory families.

Figure 2: Children not in school, but with the sheep on migration

Figure 3: A woman family member preparing the horseback for the next journey

The sheep rearers can adopt stall-fed system, and benefit from stationery life, that brings in its wake access to all socio-economic windows. These include home, health, education, government economic & welfare activities for the families; and animal health services, extension activities, markets etc. for the sheep flock.

First human settlements began 10,000 years ago facilitated by domestication of animals followed by crop raising. It would amount to a travesty of human dignity and justice, if rearers of small ruminants like sheep & goat need to continue to be on their legs as migrants, certainly not in the twenty-first century.

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