



Global livestock development: Policies and vision

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ABSTRACT

Owing to the anthropogenic pressures, the global food system is undergoing significant changes. Due to increasing human population forecasted, more than 9 billion by 2050, there is an increase in the food demand and consumption by whole population. The world as a whole is undergoing several transformative changes. Growing population, changing lifestyles, expanding urbanization and accelerated climate changes are forming novel challenges for the global livestock system. Day-by-day due to continuous changes in food consumption patterns, i.e. increased demand for cattle products, resulting from urbanisation, rising affluence, and nutritional and environmental concerns are influencing what we eat, who consumes it, and how much we eat more than ever before. The dual burdens of nutrition, i.e. either overconsumption or malnutrition, along with the need to alleviate the climate change effects, are shaping research priorities, influencing policy, and changing people's perceptions of food in different ways. The livestock industry is a fast-paced industry. It is changing in developing nations as a result of the rapidly increasing demand for animal products. Demand for cattle products is stagnant in industrialised countries, while many production techniques are improving their efficiency and environmental sustainability. Human population expansion, wealth growth, and urbanisation have all influenced demand for products of livestock in the past, and the production response in various livestock systems has been linked to science and technology and rises in animal population. Rivalry for natural resources, notably land and water, as well as competition between food and feed, will progressively effect output in the future. Recognition of United Nations (UN) 2030 Agenda for Sustainable Development as a broad framework that directs growth of the global livestock sector.

Keywords: Climate change, Food system, Livestock industry

Globally, livestock sector is a major pillar for food system and a contributor to poverty reduction, food security and agricultural development. Around 1.7 billion cattle, 2.2 billion sheep and goats, and 25 billion poultry exist today on Earth i.e. six chickens, one goat, sheep or cow for each two people on the planet (FAO 2020). According to the FAO, 40% of the global value of agricultural output is contributed by livestock. It also backs roughly 1.3 billion people's livelihoods, and their food and nutrition security.

Simultaneously, there is a wide scope to improve livestock sector practices so that they are more sustainable, more equitable and pose less risk to animal and human health (World Bank 2020). Livestock systems make a major contribution to national economies worldwide. The value of livestock production accounts for 40 and 20% of total agricultural output in developed and developing countries respectively. The size of population in the middle-income bracket will exceed 600 million (about 30% of the total population) by 2050. It is projected that by 2050, the calorie consumption will reach 3000 kcal/cap, with rise in the share

of animal-based calories from the current level of 8% to 16%.

As per the Organisation for Economic Cooperation and Development (OECD) as well as the Food and Agriculture Organization of the United Nations (FAO), livestock sector has been one of the fastest-growing agricultural sectors in developing nations (OECD and FAO 2017). The world has seen a tremendous global development in the production and consumption of animal products in recent decades, leading to increased need for livestock and livestock products, owing to a growing global population, rapid urbanisation, and rising income growth. According to FAO expectations, livestock sector will give around 50% of global agricultural output in value terms in coming decades, owing to improvements in technology especially in poultry and dairy production, availability of cheap fuel, and often subsidized feed grain, which have accelerated the sector's growth. Given this international window of opportunity, it is a necessity for coherent framework to enable to take advantage of it (Livestock Vision 2025).

Livestock sector undoubtedly can make a significant contribution in preventing people from falling into poverty, but the sector's ability to lift them out of it is more debatable. In developing countries, smallholders not having more than

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1 hectare of land, own around 1.3 tropical livestock units, and absorb roundly one unit of own house labour in a day. Therefore, the capacity of smallholders to exploit their factor endowments to generate income is limited. Thus, in order to transform rapid livestock growth into poverty reduction, there is need to watch out for policies on the expanding the size of the sector in the economy, increasing its growth rate and the involvement of poor in that growth; the capacity of producers to access factors of production; the capacity of workers to connect to new job prospects, as well as the possibility for customers to benefit from more competitive prices, safer foods, and quality diets.

The livestock industry can help in multiple ways in ending all types of malnutrition as well as hunger. It includes increasing the direct consumption of nutritious food derived from animals; assisting in the generation of income; employment creation; income generation as well as revenue generation; foreign exchange; and providing the world with sufficient and supplies milk, meat, eggs and dairy products, and of primary commodities used for clothing, bedding and other household items. However, the industry will face a new set of interrelated issues. Increased demand for animal-source foods increasing the pressure on ecosystems and biodiversity and livestock producers will be up against more competition for capital, labour, land, water and energy (FAO 2018). Long market chains in the livestock sector employ at least 1.3 billion people worldwide and directly support the livelihoods of 600 million poor smallholder farmers in developing countries (Thornton *et al.* 2006). Keeping livestock is a key risk-reduction approach for vulnerable populations, and cattle are important sources of nutrients and traction for smallholder farmers planting crops (Fonseca *et al.* 2009). The livestock sectors current economic value to agriculture is considerable, accounting for 34% of all farm gate production value in 2016 (FAO 2020). The human connection to livestock is also undeniably intimate.

Rapid population hike, expansion and income growth in developing countries have resulted in increase in food demand of animal origin. The expanding urbanization and rising incomes have raised a wide range of important issues linked to national food-security, including dietary preferences (higher demand for livestock products), consumption of more processed foods and crowding out of peri-urban agriculture which plays a significant role in the supply of perishable commodities (FAO 2012). Fortunately, along with challenges, the developments in livestock science are creating new avenues for tackling the challenges in livestock sector. The resulting demand stems from changes in billions of people's diets, and it could create opportunity for many rural poor to increase their income. With the use of these demand and need, governments and industry must prepare for this continuing transformation with long-run policies and investments, that will satisfy consumers demand, improve nutrition, growth of income opportunities to needy and lessen environmental and public health stress. Within the livestock sector, both global as well as domestic demand for dairy and meat products is

also rising, thereby creating investment opportunities in this sector in the domestic, regional and global markets. Besides milk, meat and poultry products and by-products, livestock provides source for raw material particularly for leather, carpet and woollen cloth industries (Livestock Vision 2025).

The main objective of this paper is to analyse global livestock policies and visualize global livestock and structure the new vision and growth of global livestock development. The main objectives of the paper are to analyse the status of the past and present global livestock, to visualize global future livestock and to frame research vision and approaches for global livestock

MATERIALS AND METHODS

The study is based on meta-analysis of status of the livestock policies and vision at global level. The status is for the developing as well as for developed countries in the world for the livestock sector challenges and opportunities. The data used for the study was taken from the different countries of the continents and directly from the continents of universe. The primary data and important information's of livestock collected from Food and Agriculture Organization (FAO), World Bank, World Economic Forum (WEF), United Nations (UN), International Food Policy Research Institute (IFPRI), Organisation for Economic Co-operation and Development reports, with the primary sources, secondary sources and different websites have also been used for the data collection. The data was mainly related to the livestock, i.e. cattle, sheep, goat, and poultry from all animals. Suggestions and areas for policy action in different areas of livestock are also discussed in this article.

RESULTS AND DISCUSSION

Livestock has the biggest influence on alleviating poverty and hunger. Malnutrition affects 43% of persons in rural India who do not own even a single animal. The addition of one cattle or buffalo to their assets lowers the prevalence of hunger by 16 and 25% points, respectively (Table 1). Only 14% of persons who owned one cattle and one buffalo were observed as underweight. The addition of one cattle or buffalo to a city also had a major influence on the proportion of malnourished individuals. With numerous aims of diversifying agriculture, generating income, and

Table 1. Impact of livestock on alleviation of hunger and poverty in India

Livestock	Per cent of population			
	Rural		Urban	
	Hunger	Poor	Hunger	Poor
Cow	31	25	29	42
Buffalo	26	18	20	33
Cow and buffalo	14	8	7	4

Source: IARI-FAO/RAP study (2001) based on 50th NSS Round (1993–94).

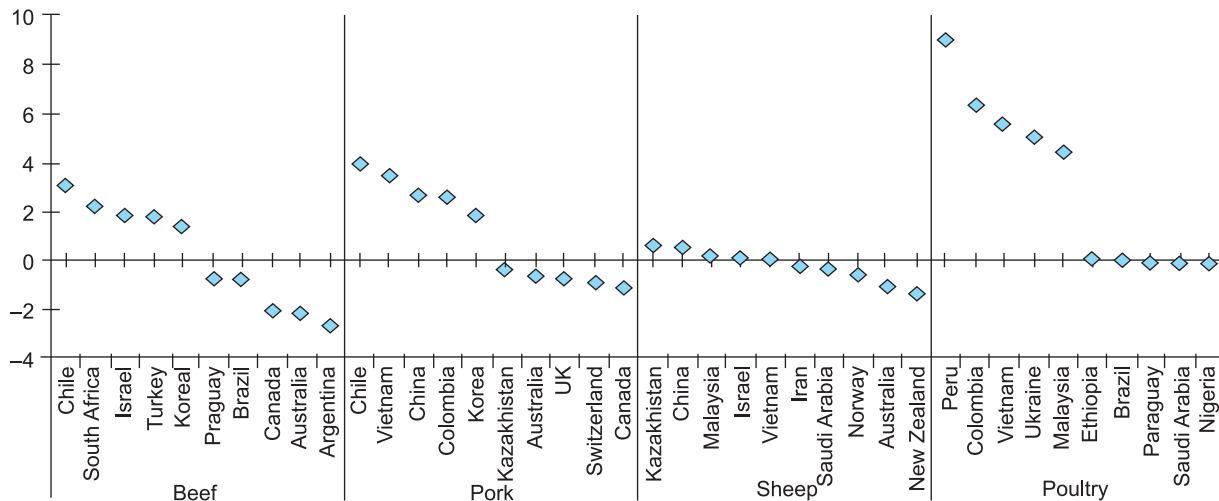


Fig. 1. Top five countries increase/decrease in per capita consumption by different meat types. Source: OECD/FAO (2020), “OECD-FAO Agricultural Outlook”, OECD Agriculture statistics (database), <http://dx.doi.org/10.1787/agr-outl-data-en>.

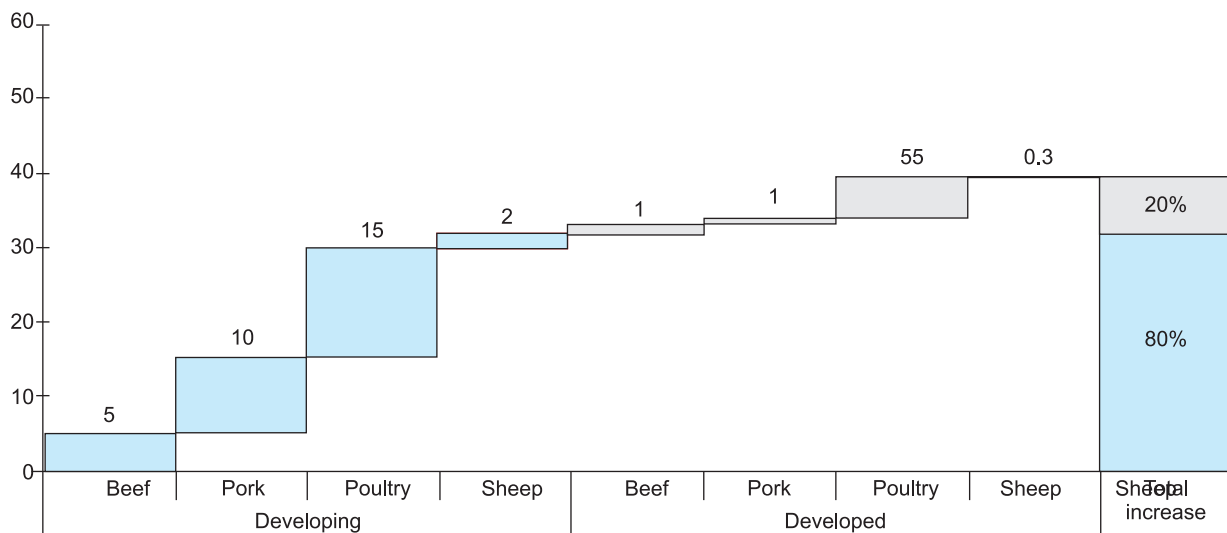


Fig. 2. Growth of meat production by region and meat type. Note: cwe is carcass weight equivalent, rtc is ready to cook equivalent. Source: OECD/FAO (2020), “OECD-FAO Agricultural Outlook”, OECD Agriculture statistics (database), <http://dx.doi.org/10.1787/agr-outl-data-en>.

supporting the nutritional security of low farm households, the livestock industry should be given significant attention (IARI 2020).

Global livestock sector: drivers and outcomes

Over the last 30 years, consumption of milk, meat, and eggs in low- and middle-income countries (LMICs) has gone by 3 times. Population growth, urbanization, income gains and globalization continue to fuel the “livestock revolution”, offering business opportunities for many livestock producers. According to the latest FAO projections, under a business-as-usual scenario, meat demand in LMICs will increase by further 80% by 2030 and by over 200% by 2050. Livestock agri-food systems are cranking up production to meet this demand and adapting to meet the changing culinary demands of a growing affluent and urbanised population in a globalized

economy. Livestock play important role in different sectors in the world. Livestock area having different opportunities and challenges needs to be modified as per the need and requirement as outlined in succeeding paragraphs.

Role of Livestock in food security and nutrition

The second Sustainable Development Goal (SDG 2) promises to end hunger, achieve food security and better nutrition, as well as the promotion of sustainable agriculture. With 8.6 billion people to feed in 2030, achieving SDG 2 requires a re-orientation of agri-food systems. Food security exists when everyone has physical and economic access to enough safe and nutritious food to meet their dietary needs at all times and food preferences to ensure an active and healthy life. However, approximately one in nine people suffer from hunger or are malnourished, and the figure is going to rise day-by-day. More number of people live in

low- and middle-income countries (LMICs), where around 13% population is undernourished. According to the FAO study, the rapidly growing world population will be consuming two-thirds more animal protein by 2050 than it does today. The BRICS (Brazil, Russia, India, China and South Africa) countries which account for more than 50% of the world's total population represent most of the animal protein demand (NRCM 2015).

Micronutrient deficiencies affect some 2 billion people globally. Deficiencies in zinc, vitamin A and iron lead to stunting, anaemia, compromised immune functions and impaired cognitive development. Critical micronutrients such as vitamin B₁₂, riboflavin, calcium, iron, zinc, and several essential fatty acids are abundant in animal source meals and are difficult to obtain in enough amounts from plant based diets alone. Healthy nutrition is particularly important during the first 1000 days of life, i.e. during pregnancy, lactation and early childhood. Including even modest amounts of animal source foods in diets adds much needed nutritional value. The total protein source from the livestock is around 51%, and from total livestock protein source 67% from milk and 33% from meat. Animal source foods currently comprise 39% of protein and 18% of calorie intake worldwide, but this is not equitably distributed. Poor people in LMICs often do not consume enough animal source foods, while others particularly in high-income countries (HICs) but increasingly in middle-income countries (MICs) – consume in excess of their dietary needs. Livestock contribute to food security on all scales. At the household level, livestock keeping ensures a well-balanced and nutritious diet and contributes to incomes. At communal level, the sector creates employment opportunities. At national and global levels, it helps provide the world's population with sufficient and reliable supplies of nutritious, affordable and safe livestock-derived food.

The population of India is projected to be 1.65 billion by 2050 with an average income of ₹ 4,01,839/cap, up from the level of ₹ 53,331/cap in 2010–11, with 50% people residing in the urban areas (Table 2).

Areas for policy action

- Promote healthy, nutritious diets for each and every human being on earth.
- Promote actions that simultaneously address the triple burden of malnutrition: food insecurity, undernutrition, and overweight and obesity.
- Make best use of human-inedible feed resources, minimize the use of human-edible food in production of livestock and inspire for the safe recycling of crop residues, agri-food industry by products and food wastes.

It shows that demand for pig meat, poultry meat, sheep meat, beef and veal were found to be marginally higher in developing countries compared to supply, whereas in developed and OECD countries a reverse trend was observed. The results reveal that growth rate of demand was marginally higher for pig meat, poultry meat, beef and

veal compared to supply growth rate in developing countries, whereas other crops and other countries have witnessed a reverse trend in growth rate.

Livestock in livelihoods and economic growth: Intensive production of livestock is booming globally, but small producers in LMICs are failing to participate fully in sector growth. Of the 770 million people surviving on less than USD 1.90 per day, about half depend directly on livestock for their livelihoods. Livestock reward their proprietors with a wide diversity of products, ranging from milk, meat and eggs to fibres, feathers, hides and skins. Livestock is a versatile asset that can be sold in a crisis. They increase total farm productivity in mixed systems by providing traction and fertilization and by turning crop residues into valuable protein. Sustainable intensification, by increasing livestock productivity whilst avoiding negative externalities, enhances livestock's contribution to people's livelihoods. Poverty, employment, and economic progress are all intertwined and, in LMICs, livestock are key to all three.

Now-a-days, the livestock sector accounts for about one-third of value addition in agriculture in LMICs, a proportion that increases as countries develop economically. Livestock contribute to reduction of poverty by building resilience and supporting the livelihoods of large numbers of rural people. They also create employment in livestock agri-food systems, stimulate demand for goods and services, and promote economic transformation by contributing to the development of human capital for other areas of the economy. However, alongside the benefits of livestock keeping, lie issues of fairness. Large numbers of low-income livestock keepers are women, yet they often have less access to productive resources and markets than men, preventing them from deriving significant benefits from their livestock. Child labour is common in the livestock sector, with young boys and girls tending herds and flocks instead of going to school. As livestock agri-food systems expand to meet demand, millions of smallholder livestock producers, efficient but not competitive are forced to abandon the business altogether.

Areas for policy action

- Promote supportable amplification of livestock farming in diverse, ensuring that productivity gains are equitable and not go for the expense of animal health and animal welfare, human health or the environment.
- Support value chains that are inclusive, safe and protective of the environment.
- Take an integrated approach to improving livestock agri-food systems. Lifting one constraint while leaving others in place is likely to generate limited returns.
- Create employment and alternative livelihood opportunities for farmers who choose or are forced to leave the livestock business.

Linking of human health to animal welfare and animal

Table 2. Demand side challenges in India in 2050

Driver	2010–11	2050	Implications
Demand side challenges			
Population, million	1224.6	1650 (+24%)	Changes in demography with Shift towards urbanization and higher income will lead to changes in dietary composition with increased consumption of meat, dairy, egg and fish products having higher water and carbon foot prints
GDP at PPP (US\$ billion)	4786 (WB) *	43180 (PWC) **	
Average annual income (/cap)	53331***	401839***	
Income distribution	Inequitable	Inequity may widen	
Urbanization (%)	31	55	
Calorie requirement (kcal/cap)	2500	3000+	
Source (Vegetables; Animal)	(92:8)	(84:16)	
Food price	Rising trend	Rising trend will continue	
Functional food	It is at the initial stage	Demand will grow	
Social concerns over new technologies	Very strong	Will decline with proper communication and counselling	
Food safety	Poor	Will improve	

Source: *World Bank (2014), **PWC, (2014), ***NCAP (2013).

Table 3. Demand and supply projections of meats (2018–2025)

Country	Unit	2018		2025		Growth rate of Projected (%)	
		P	C	P	C	P	C
<i>World</i>							
Beef and veal	Mt cwe	70.89	70.6	77.77	77.46	1.33	1.33
Pig meat	Mt cwe	121.53	121.34	131.00	130.80	1.08	1.08
Poultry meat	Mt rtc	119.32	119.32	131.26	131.26	1.37	1.37
Sheep meat	Mt cwe	15.08	15.11	17.44	17.43	2.10	2.06
<i>Developed countries</i>							
Beef and veal	Mt cwe	29.78	29.14	31.25	30.50	0.69	0.65
Pig meat	Mt cwe	44.73	41.38	46.08	42.18	0.43	0.27
Poultry meat	Mt rtc	49.34	46.58	52.58	49.38	0.91	0.84
Sheep meat	Mt cwe	3.32	2.67	3.61	2.78	1.20	0.58
<i>Developing countries</i>							
Beef and veal	Mt cwe	41.11	41.46	46.52	46.96	1.78	1.80
Pig meat	Mt cwe	76.80	79.96	84.92	88.62	1.45	1.48
Poultry meat	Mt rtc	69.98	72.74	78.68	81.87	1.69	1.70
Sheep meat	Mt cwe	11.75	12.44	13.83	14.65	2.36	2.36
<i>OECD countries</i>							
Beef and veal	Mt cwe	28.01	26.93	29.21	28.03	0.60	0.57
Pig meat	Mt cwe	42.39	39.64	43.63	40.53	0.41	0.32
Poultry meat	Mt rtc	47.66	44.67	51.00	47.31	0.97	0.82
Sheep meat	Mt cwe	2.65	2.00	2.87	2.06	1.15	0.42

Note: P, production; C, consumption; Mt CWE, Metric tonnes at carcass weight equivalent; Mt RTC, Metric tonnes at ready to cook. Source: OECD/FAO (2016). "OECD-FAO Agricultural Outlook", OECD Agriculture Statistics (Database).

health: Human health is closely linked to animal health and welfare and to that of the environment. This is the principle underpinning "One Health", whereby livestock agri-food systems are at the crossroads of human, animal and environmental health. Animal diseases constrain production and reduce livestock's contribution to resilient livelihoods, food security and economic development. For

example, the 2001 Foot-and-Mouth Disease (FMD) outbreak in the United Kingdom cost the economy about USD 14 billion, while the avian influenza outbreaks cost for year 2016 and 2017 may have surpassed that number. The global load of diseases of foodborne, many of which are carried by livestock products, was 33 million disability-adjusted live years (DALYs) in 2010. From that burden,

40% was borne by children below five years of age. Zoonotic illnesses that have the potential to become pandemic emerging from the growing interface between people, animals and the environment, pose an even greater threat.

Good animal welfare requires not only disease prevention and veterinary treatment, but should also include appropriate shelter, management, nutrition and humane slaughter of livestock. With the growth in livestock production comes by an enlarged use of antimicrobials, to treat infections and to prevent disease and promote growth. Antimicrobial consumption by livestock is almost three times that in human medicine. Inappropriate use in livestock exacerbates the development of antimicrobial resistance (AMR) in livestock pathogens, which compromises treatment and readily spreads to the human population.

Areas for policy action

- Treat the animals as a priority in all livestock systems globally, as a means to improved animal husbandry and health.
- Support One Health approaches to tackle health threats of animal origin.
- Minimize the antimicrobials use in livestock production by improving husbandry practices and protecting animals from disease, in order to limit the sector's contribution to AMR.
- Promote multi-stakeholder dialogue, linking the public and private sectors, to address animal health and improve risk management.
- Promote improvements in production practices by investing in the sector, creating incentives for good husbandry practices and legislating against harmful husbandry practices.

Livestock, natural resource use, climate change and environment: Livestock are highly versatile, helping hundreds of millions of people to survive in marginal areas, withstand climate shocks and adapt to changing climatic conditions. But livestock are also the biggest user of agricultural land for feed and forages, drawing heavily on natural resources and contributing significantly to climate change. Livestock draw heavily on natural resources but they also have the potential to contribute to the conservation of biodiversity as well as genetic resources for food and agriculture.

If managed sustainably, livestock can contribute to important ecosystem functions, nutrient cycling, organic carbon sequestration in soil and maintaining agricultural landscapes. Grazing land covers about one quarter of the Earth's land area and accounts for some 70% of agricultural land. Approximately one-third of the crops produced globally used as livestock feed. Much of this crop and pastureland transferred from forest and much is degraded, both of which release carbon stocks into the atmosphere. Livestock-based agri-food systems consume a lot of water and contribute to biodiversity loss.

Beyond land-use change, livestock systems contribute

to greenhouse gas (GHG) emissions directly, mostly through enteric fermentation and manure. FAO has developed the Global Livestock Environmental Assessment Model (GLEAM) to support the livestock sector. It keeps on calculation on GHG emissions and livestock production in easy way. There are different versions access available for download for governments, private industries, different organisations, non-government organisations for the assessment of progress in the animal husbandry sector. (FAO 2016). It also contributes upstream, through the feed production and downstream in transportation, cooling, storage and processing of livestock products. Livestock systems have relatively low production efficiency. They leach nutrients into the water and air, as well as produce vast amounts of dung and waste. Only around 20% of nitrogen and phosphorus in crop and grass harvests given to cattle is consumed by humans. Many of the nutrients that are lost end up in groundwater and surface water, and are transported through freshwater to coastal marine systems.

One of the most important factor is the about the climate change. There is huge difference in the livestock and climate change and its impact is going on top for the farmers. It gives the more economic burden to the farmer and the livestock sector going to highly economical with less profit. And most important factor is that, social and economic impacts have not received enough attention in these assessments, although they are crucial for building convincing cases for change in the livestock sector (Mario and Philip 2013).

Areas for policy action

- Encourage for consumption and production of low carbon foods.
- Promote productivity improvements that reduce emission intensities from livestock.
- Restore the quality of pastures and increase the sequestration of soil organic carbon.
- Better integrate livestock into the circular bio economy by reducing waste and recycling carbon, nutrients and water.
- Follow up the decision of 23rd Session of Conference of the Parties (COP 23) to include agriculture in the United Nations Framework Convention on Climate Change negotiations (FAO 2018).

Livestock policy for sustainable development

Introducing sustainable stewardship labelling and certification schemes are needed. Facilitating least resistance pathways to sustainable food systems through the creation of environments that enable signalling and the remuneration for good management practices.

Regulating industry: Limiting excessive input use, the sale of non-therapeutic antibiotics, the animal products sale or feed linked to tropical deforestation and other important negative impacts among the processing and distribution stages.

Rebalancing consumption: Raising taxes on food items for populations at risk of overconsumption, and implementing programmes for improved nutrition, such as school feeding for the under consumers, or through nutrition labelling. Taxes may focus on ‘worst products’ or incorporate carbon and biodiversity costs, although care must be taken to not to reduce food access for the poor (Springmann *et al.* 2017, Allen and Hof 2019)

Vulnerable populations must be protected: Raising the productivity and incomes of poor through livestock systems, protecting the sovereignty of nomadic and indigenous peoples and lands, embedding the right to food in political and legal structures of countries, putting safety nets to protect the people most at threat from climate change and price shocks, and installing healthcare for those most at risk of zoonosis.

Creating circular livestock supply chains: Reduce competition for land between livestock and crop, with purpose of falling material waste and pollution (Mehtarabi *et al.* 2020).

Modifiers of future livestock production and consumption trends

Competition for livestock resources

Land: Livestock constitute a critical risk management mechanism in arid and semiarid settings. But, in many locations, population development is fragmenting rangelands, making it more difficult for pastoralists to obtain the feed and water resources that they have enjoyed in the past. Grazing systems will increasingly generate ecosystem goods and services that can be exchanged in the future, but it’s unclear how this will affect future cattle output from these systems. Because two-thirds of the world’s population lives in mixed crop livestock systems, they will continue to be crucial to future food security.

Some of Africa’s and Asia’s higher-potential mixed systems are already suffering resource constraints, but there are a variety of solutions available, including efficiency gains and intensification choices. Biofuels will compete for land more in the future, owing to ongoing worries about climate change, energy security, and other revenue sources for agricultural people (Herrero *et al.* 2010). India is a land-scarce country with only 0.13 ha land/cap (in 2010–11), which stands to get reduced to 0.09 ha/cap by 2050, simply due to increase in population (ICAR 2015)

Water: Freshwater resources are quite rare globally, accounting for approximately 2.5% of total water resources. (MA 2005). Groundwater is particularly crucial in water supply, between 1.5 and 3 billion people rely on it for drinking, and water levels in some areas are steadily falling (Rodell *et al.* 2009). By 2025, 64% of the world’s population would be living in water stressed basins, up from 38% currently (Rosegrant *et al.* 2002). Future increases in animal numbers will certainly increase the demand for water, especially in the manufacture of livestock feed. In North American grasslands, one cubic metre of water can generate anywhere from 0.5 kg to 5 kg of dry animal feed, depending

on the system (Peden *et al.* 2007). It is expected that water-use efficiency would increase and groundwater withdrawals for irrigation would grow at a slower pace but still increase by almost 45% by 2050. In medium-term, the economic growth is projected to continue at fairly sustained rates of 7–10%. Due to food feed- fuel conflict, the livestock rearing would be an intensive system with considerable reduction in numbers with simultaneous increase in productivity to meet the production targets (ICAR 2015). According to a study by the International Food Policy Research Institute, 45% of the total GDP (US\$ 63 trillion) will be at risk due to water stress by 2050 (Rosegrant *et al.* 2005).

Biodiversity: Plant and livestock biodiversity, which is so important for long-term productivity, is under attack. Because only four crops provide nearly 60% of world food, the rate of extinction is frightening, resulting in a loss of genetic diversity among farmed species. The genetically uniform systems are extremely vulnerable to external shocks under extreme weather conditions and emerging diseases and pathogens. Since 1900s, about 75% of crop diversity has been lost from the farmers’ fields. Similar is the case with livestock where the number of indigenous breeds with better adaptability, disease-resistance and feed-use efficiency is declining. Conservation and improvement of such breeds are foremost important (ICAR 2019).

Climate change: Climate change could have a significant impact on the global livestock industry. Livestock production systems will be impacted in a variety of ways, and productivity will inevitably shift. Climate change affects livestock production and will create the situation under out of control. Simultaneously, animal food chains constitute a significant source of greenhouse gas emissions, accounting for roughly 18% of global anthropogenic emissions (Steinfeld *et al.* 2006). Increasing seawater acidity and rising river water temperature will affect fish breeding, migration and harvest. Livestock has historically served as a backup plan in the event of a natural disaster, and it is more dependable than crops. However, technological advancements would be required to enable them to adapt to climate extremes (ICAR 2015).

Pandemic diseases in animal: Animal diseases and invasive alien aquatic organisms does not recognize physical and political boundaries. Globalization of commodity and food trade has increased the bio-security risk, which threatens food security. The spread of Severe Acute Respiratory Syndrome (SARS), blue tongue and avian flu in the livestock sector, and emergence of contagious human diseases from animals and the current epidemic of highly pathogenic avian influenza (HPAI), in densely-populated livestock-production areas around cities increase the production risks and present a major challenge to ensuring food security in the world (ICAR 2015).

Socio-cultural modifiers: Although it is frequently unclear how social and cultural drivers of change play out in respect to impacts on livestock and livestock systems, they are having a significant impact on livestock systems in specific regions. Livestock play a variety of roles in

human society. They make a significant and direct contribution to food security and human health. The addition of moderate amounts of cattle products to the diets of impoverished and undernourished individuals, particularly children, can have significant physical and mental health advantages (Neumann *et al.* 2003).

Technology drivers: Technology advancements in livestock sector and food sector will be characterized by the increasing convergence across bio, nano and info technologies. Innovations in the industrial sector will strongly influence advanced technology in agriculture, livestock and food processing, bringing in robotics and automatization in the food and agricultural sector. Mechanization of farm operations through energy-efficient and environment-friendly devices will compensate for the growing shortage of farm labour. Nanotechnologies, genetically modified organisms (GMOs), nutraceuticals and nutrigenomics have been introduced in the market, their impact on social organization environment, pandemic diseases risks, and human health remain to be ascertained. (ICAR 2015).

Vision for livestock sector

- (i) Recognition of United Nations (UN) 2030 Agenda for Sustainable Development as a broad framework that directs growth of the global livestock sector.
- (ii) A sector whose diversity and multiple functions are recognized and accounted for in policymaking.
- (iii) The livestock sector acts as a vehicle for poverty reduction and contributes to food security through sustainable intensification and market access for smallholder producers, as well as contributing strongly to economic growth in LMICs.
- (iv) Best use is made of human inedible feed resources and use of human edible feed in livestock production is kept to a minimum.
- (v) Healthy diets are available to all and are actively promoted, seizing the specific benefits of animal source foods for growth and cognitive development but discouraging excessive consumption.
- (vi) The climate impact of livestock is greatly reduced, with more efficient value chains reducing emission intensities and sequestration of soil organic carbon in pastures and rangelands optimized through restoration. Water is used efficiently in livestock production and it is better incorporated into the circular bio economy through recycling of nutrients and energy from livestock waste and use of recycled food waste.
- (vii) Globally the animal welfare is a priority in all livestock systems. Animals are treated with respect to satisfy ethical and consumer demands and as a means to improved animal husbandry and health.
- (viii) Animal disease constraints are lifted as a drain on productivity, income and animal welfare. A One Health approach should be widely adopting to address the interface between human, animal and

environmental health. Public health threats stemming from livestock production and sector dynamics food safety, and antibiotic resistance, are minimized by best practices adoption and a strong capacity to monitor and react to threats at all levels.

- (viii) In areas where sector growth is rapid, measures are in place to address externalities, particularly in terms of equity, animal and public health, animal welfare and environmental outcomes (FAO 2018).
- (ix) Average losses of livestock perishable commodities are very high now. By 2050, these losses are expected to be reduced significantly due to better use of technology and establishment of value chains.
- (xi) Improvement in disease reporting system in animal, improvement in data quality of animal, improved infrastructure facility for research on epidemiology, disease forecasting, animal diseases based on economics, research on emerging and reemerging zoonoses (NIVEDI 2015)
- (xii) Enhancing value, safety and income through food processing, viz. milk, meat and fish, which are all perishable in nature. Multi-disciplinary and multi stakeholder research for agri-commodities, especially post-harvesting engineering, horticulture, dairy, livestock and fish, would be required. Some important issues needing attention are development of intelligent cool chain systems to transport produce from farm to retailer; adaptive control of storage conditions with biological sensors; rapid detection of food adulterants, fungal and bacterial toxins and other contaminants, using bio-sensors/nano-bio-sensors/molecular markers; application of robotics, artificial neural networking, nutri-genomics, non-destructive or online testing techniques in livestock sector.
- (xiii) There is a need to focus on the livestock and fishery sectors, where research in frontier areas such as stem cells, pharmacokinetics and nutrigenomics, transgenic animals, proteome analysis, bio-sensor applications, targeted nano-delivery of drugs, *in vitro* fertilization-Embryo Transfer technique (IVF-ETT), and other techniques can be used to improve system efficiency. (ICAR 2015).

Achieve better transformation in sustainable livestock sector

- (a) Take a holistic approach to promoting the long-term viability of livestock systems, taking into account social, economic, health, and environmental factors.
- (b) Work by consensus and joint action, through multi-stakeholder dialogue where the voices of each stakeholder are equally heard.
- (c) Build, implement and disseminate tools and guidelines to facilitate the identification and adoption of different sustainable practices. These must be based on evidence and implementation monitored, reviewed and continuously improved.

- (d) Strengthen capacity in support of sustainable practices and provide enabling conditions.
- (e) Develop and support institutions and policies fostering sustainable livestock. This will require investment in the sector, creating incentives for good husbandry practices and legislation against harmful husbandry practices (FAO 2018).

The livestock sector plays crucial role in the process of economic development of world. Globally, livestock sector is a major pillar for food system and a contributor to poverty reduction, malnutrition, hunger, food security, and agricultural development. The livestock industry is a fast-paced industry. In order to transform rapid livestock growth into poverty reduction, there is need to watch out for livestock policies. Future demand for livestock products be met through sustainable intensification in a carbon-constrained economy.

Some indications have been given to the increasing pressures on natural resources like water and land. There is huge competition for the utilization of the land for food and feed production. There is also major contribution of the industrialization of livestock production which causes the problems of air and water pollution. In developing countries, there is equal contribution of the industrialisation as well as the effect due to livestock sector and in these countries population is under high risk. Adapting to climate change and reducing greenhouse gas emissions will likely raise manufacturing costs in many locations. The industrialization of cattle production is either complete or continuing a pace in many countries of the world, both developed and developing. The rising demand for livestock products remains a major source of poverty alleviation and economic prosperity. Increasing regulation to govern contracts along food commodity chains, including accepting and guaranteeing collective rights and community governance, as well as boosting social protection and ties to metropolitan areas. The results found that developing countries have to concentrate and follow strategic action to meet the future demands of the pork, mutton, chevon, beef, poultry meat, and veal, whereas developed countries have to concentrate more to meet the future sugar demands.

Due to continuously increasing human population, there will be an increase in the food demand in coming year with safe foods, and quality diets. To achieve global polices in future, we have to ensure best use of human-inedible feed resources, take an integrated approach to improving livestock agri-food systems, developed value chains of the livestock product, apply one health approaches to tackle health threats of animal origin, reduced greenhouse gases from animal food chains. To achieve a sustainable livestock sector, the future vision should be a holistic approach in promoting the long-term viability of livestock systems, taking into account social, economic, health, and environmental factors. Livestock sector policies need to address a host of economic, social, environmental and health objectives in both developed

and developing countries. Improve communication and policy coherence between the public, private bodies, industry, academia and NGOs.

REFERENCES

- Agriculture at a Crossroads. (Eds) B D McIntyre, H R Herren, J Wakhungu and R T Watson pp. 307–376. Island Press, Washington, DC.
- Allen A M and Hof A R. 2019. Paying the price for the meat we eat. *Environment Science Policy* **97**: 90–94.
- Fonseca J, C Narrod, Mark W Rosegrant, Maria Fernandez, Anushree Sinha, Jackie Alder, Helal Ahammad, Charlotte de Fraitore, Bas Eickhout, Jorge Fonseca, Jikun Huang, Osamu Koyama, Abdallah Mohammed Omezzine, Prabhu Pingali, Ricardo Ramirez, Claudia Ringler, Scott Robinson, Phil Thornton, Detlef Van Vuuren, Howard Yana-Shapiro, Kristie Ebi, Russ Kruska, Poonam Munjal, Clare Narrod, Sunil Ray, Timothy Sulser, Carla Tamagno, Mark van Oorschot, Tingju Zhu, R S Deshpande and Sergio Ulgiati 2009. *Looking into the future for agriculture and AKST* (Agricultural Knowledge Science and Technology).
- FAO. 2018. *Shaping the future of livestock sustainably, responsibly, efficiently*. 10th Global Forum for Food and Agriculture (GFFA), Berlin.
- FAO. 1999. The state of world fisheries and aquaculture 1998. Rome.
- FAO (Food and Agriculture Organization). 2012. Towards the Future We Want, Food and Agriculture Organization of United Nations, Rome.
- FAO. 2001. The State of Food Insecurity in the World, 2001. FAO, Rome.
- FAO. 2001a. Assessment of the World Food Security Situation. Committee on Food Security, Twenty-seventh Session, document no CFS:2001/2. FAO, Rome.
- FAO. 2001c. Biotechnology in Food and Agriculture. FAO. <http://www.fao.org/biotech/stat/asp>
- FAO. 2001d. Mobilising Resources to Fight Hunger. Committee on World Food Security, Twenty-seventh Session, document no CFS:2001/Inf.7. FAO, Rome.
- Food and Agriculture Organization Report 2020. <http://www.fao.org/faostat>.
- Food and Agriculture Organization Report. 2013.
- Hanley N, Shogren J and White B. 2001. *Introduction to Environmental Economics*. Oxford University Press.
- Herrero M. *et al.* 2010. Smart investments in sustainable food production: revisiting mixed crop-livestock systems. *Science* **327**: 822–25.
- Immordino G. 2003. Looking for a guide to protect the environment: The development of the precautionary principle. *Journal of Economic Surveys* **17**(5): 629.
- Indian Council of Agricultural Research Vision 2050 (ICAR) 2015. pp. 1–34.
- Indian Agricultural Research Institute 2020. Agriculture Policy: Vision 2020.
- Leonard D K. 2006. The political economy of international development and pro-poor livestock policies. PPLPI Working Paper No. 35. FAO, Rome.
- Livestock Report 2006. FAO <http://www.fao.org/docrep/015/an894e/an894e00.pdf>.
- Livestock vision 2025 Private Sector-Led Growth. pp 5–58.
- M A. 2005. The millennium ecosystem assessment, ecosystems and human well-being: Scenarios, vol. 2. Island Press,

- Washington, D C.
- Meharabi Z, Gill M, Wijk M V, Herrero M and Ramankutty N. 2020. Livestock policy for sustainable development. *Nature Food* **1**(3): 160–65.
- Neumann C G *et al.* 2003. Animal source foods improve dietary quality, micronutrient status, growth and cognitive function in Kenyan school children: background, study design and baseline findings. *Journal of Nutrition* **133**: 3941–49.
- Norton R D. 2003. *Agricultural development policy: Concepts and experiences*. Food and Agriculture Organization of the United Nations. UK, John Wiley & Sons Ltd.
- NCAP (National Centre for Agricultural Economics and Policy Research) 2013. NCAP Vision 2050, National Centre for Agricultural Economics and Policy Research, New Delhi.
- NIVEDI. 2015. ICAR-National Institute of Veterinary Epidemiology and Disease Informatics, Vision-2050. PP 1–18.
- NRCM. 2015. National Research Centre on Meat Vision-2050. 1–28.
- OECD and FAO. 2017. *Agricultural Outlook 2017–2026*. Paris. OECD Publishing. http://www.oecd-ilibrary.org/agriculture-and-food/oecd-fao-agricultural-outlook-2017-2026_agr_outlook-2017-en.
- Peden D, Tadesse G and Misra A K. 2007. Water and livestock for human development. *Water for food, water for life: a comprehensive assessment of water management in agriculture*, ch. 13. D. Molden. London, UK: Earthscan; Colombo: IWMI.
- PWC (Price Water Cooper). 2014. Projections from Price Water Cooper <http://www.theguardian.com/news/datablog/2011/jan/07/gdp-projections-chinaus-uk-brazil#img-1>, Downloaded on July 2, 2015.
- Rodell M, Velicogna I and Famiglietti J S. 2009. Satellite based estimates of groundwater depletion in India. *Nature* **460**: 999–1002.
- Rosegrant M W, Cai X and Cline S A. 2002. *Global water outlook to 2025, averting an impending crisis. A 2020 vision for food, agriculture, and the environment initiative*. IFPRI and IWMI, Washington, DC.
- Rosegrant M W, Sulser T B, Ringler C, Cline C S A and Msangi S. 2005. *International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT): Distributed Version 1.0*. IFPRI.
- Steinfeld H, Gerber P, Wassenaar T, Castel V, Rosales M and de Haan C. 2006. *Livestock's long shadow: Environmental issues and options*. FAO, Rome, Italy.
- Springmann M. 2017. Mitigation potential and global health impacts from emissions pricing of food commodities. *Nature Climate Change* **7**: 69–74.
- Tietenberg T. 2003. *Environmental and natural resource economics*. Sixth edition, Addison Wesley.
- Thornton P K *et al.* 2006. *Mapping climate vulnerability and poverty in Africa*. Nairobi, Kenya: ILRI. <http://www.dfid.gov.uk/research/mapping-climate.pdf>.
- World Bank 2020. *Moving towards sustainability: the livestock sector and the world bank*. <https://www.worldbank.org/en/topic/agriculture/brief/moving-towards-sustainability-the-livestock-sector-and-the-world-bank>
- World Census of Agriculture 2000.
- World Bank. 2014. GDP per capita, PPP (current international\$), Washington DC, [ata.worldbank.org/indicator/NY.GDP.PCAP.PP.CD](http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD).