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Invited Mini Review Article

Climate-smart livestock production: An approach for sustainable and resilient meat sector

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Abstract

Meat plays a vital role in supplying nutrition to large populations, while farming also provides a livelihood for billions. To continue feeding the global human population of 9 billion in 2050, a healthy, sustainable, and resilient approach must be adopted using already limited resources. As meat production and consumption have a greater economic, societal, and environmental impact, the livestock, as well as the meat sector, should take adequate measures in efficient utilization of land, soil, water, energy, and other resources and also handling and disposal of waste generated in the various points of the value chain. Creating awareness among all the stakeholders of the meat value chain will overcome the complex challenge while ensuring global food security and safety for the future.

Key words: Climate change, Meat Sector, Sustainability, Water efficiency, Waste utilization

Highlights

- Food, energy, and water are pillars of sustainable development.
- Livestock & fisheries account for a major share of GHG emissions.
- Sustainable and climate-smart practices must be adopted.

INTRODUCTION

Meat plays a significant and universal role as a central part of many diets, cultures, and religions. However, the unsustainability of meat consumption and production methods needs prompt attention and action. Meat consumption has become one of the most controversial debates of the past decade. Concerns over animal welfare, climate change, loss of biodiversity, and health issues have increasingly fetched criticism to meat industries. The COVID-19 pandemic has further revealed the lack of resilience in our global food system, with supply chain disruptions adversely affecting the most vulnerable populations. Globally one in seven humans are undernourished. The livelihood of more than 500 million people living in emerging nations depends entirely or largely on farm animals. Around 821 million people are undernourished mainly of proteins and micronutrients that are readily available in animal-sourced foods (FAO, 2019). Hence, global production and consumption of meat continue to surge as demand is driven upward by population growth, individual economic gain, and urbanization. Meat consumption is here to stay and is expected to grow by 50% in the coming decades to a market valued at USD 1.8 trillion by 2040 (Gerhardt *et al*., 2020).There is an opportunity to evolve meat production towards a healthier future for both humans and the planet. Much of this demand will be attributed to middle/low-income countries (e.g., China, India, and Africa) where demand for animal-sourced foods is increasing at a much faster pace. Two hundred million Indians still cannot afford three square meals a day and India is experiencing "Protein Inflation" (Naveena *et al*., 2020). In 2022, among 121 nations, India ranked at number 107 with a serious category in the global hunger index. 38.4% of children have stunted growth,

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57% of children with vitamin-A deficiency, and 40% of people are anemic (Naveena *et al*., 2020). India produced 8.80 million tonnes of meat in the year 2020-21 and it is expected that by 2030, the country needs around 12.1 MT in the most likely scenario. Both in India and also globally, meat production and consumption is increasing over the years and it will continue to increase owing to greater demand for animal-sourced proteins.

The food and agricultural sector offers major solutions for hunger and poverty eradication. Animal-sourced proteins must be targeted toward sustainably providing a healthy diet without compromising ecology and the environment. This involves commitment from Government, Industries, and stakeholders including consumers. The sustainability of the livestock and meat sector is ensured through climate-smart production technologies wherein livestock and the environment interact with each other. Climate-smart production involves increasing productivity, reducing greenhouse emissions, and enhancing resilience through optimal land, water, and energy usage.

Livestock sector and water usage

Agriculture uses approximately 70% of the available freshwater supply, and roughly 30 percent of global agricultural water goes into livestock production. More than 90% of the water used in livestock production is used for feed production. These figures may be true for developed countries wherein livestock are mainly fed with grains and concentrates. However, under Indian conditions with the majority of livestock rearing activities under extensive or semi-intensive conditions mainly fed with green fodder or hay and or/agricultural by-products, the aforesaid water footprint values may not be applicable. As per Industry reports in India, each water-buffalo slaughtering and processing consumes around 100 litres of water and each kg of hygienic chicken processing consumes around 5-8 litres/kg in India (Naveena *et al*., 2020).

Moreover, meat sector exclusively can't be blamed when the water footprint per 100 g of proteins produced from food is calculated. The average water footprint per 100 g of protein for rice, cheese, or milk is much higher than for meat foods (Fig.1).

But livestock's direct and indirect usage of freshwater is only one of the central water-related challenges facing animal production, another is waste management and disposal. United Nations defined Sustainable Development Goal (SDG) 6 aims to find ways to produce more food while using less water – one of the great challenges of our times. Given the large water footprint associated with livestock production, improving water-use efficiency throughout the production system is important to achieve SDG 6.

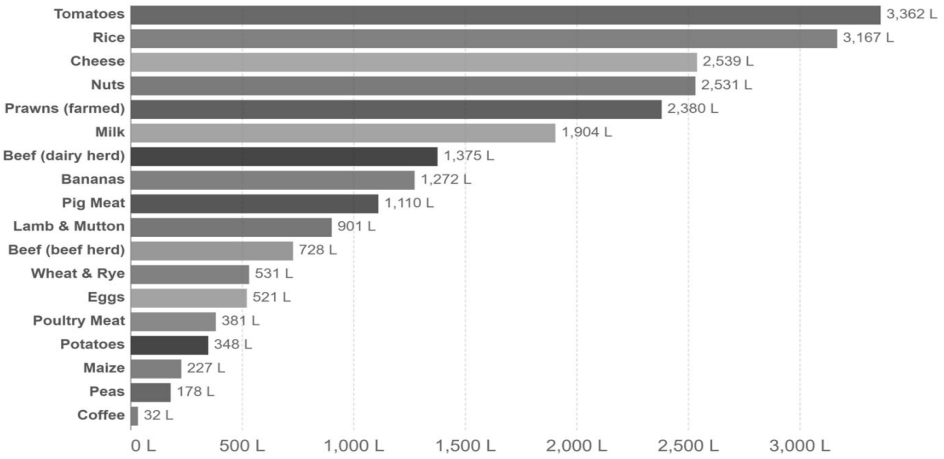

Fig. 1. Freshwater withdrawals (liters) per 100 grams of protein (Poore and Nemecek, 2018)

Livestock sector and environment

According to the Food and Agriculture Organization of the United Nations, livestock including dairy contributes about 14.5% of global greenhouse gas emissions (mainly carbon dioxide, nitrous oxide, and methane), whilst providing 28% of the protein in diets. As per the Greenhouse Gas Emission (GHG) platform report in the year 2013, in India 63% of greenhouse gas emission is contributed by the energy sector, 26% by industries, and 7% by agriculture, forestry, and other land use sector (AFOLU), whereas 4% from water (Kumar and Aravindakshan, 2022). Eighty percent of AFOLU contribution comes from rice cultivation and livestock.

Typically, foods of animal origin have a higher environmental impact than plant-based food. Lamb and cheese both emit more than 20 kilograms of CO_2-equivalents per kilogram. Poultry and pork have lower footprints but are still higher than most plant-based foods, at 9.87 and 12.31 kg CO_2-equivalents, respectively (Fig. 2).

Nevertheless, each stage of the supply chain -processing, transport, packaging, and retail - account for a small share of emissions. almost one-quarter - 26% - of food's emissions come from food that is lost in supply chains or wasted by consumers (Fig. 3). Almost two-thirds of this

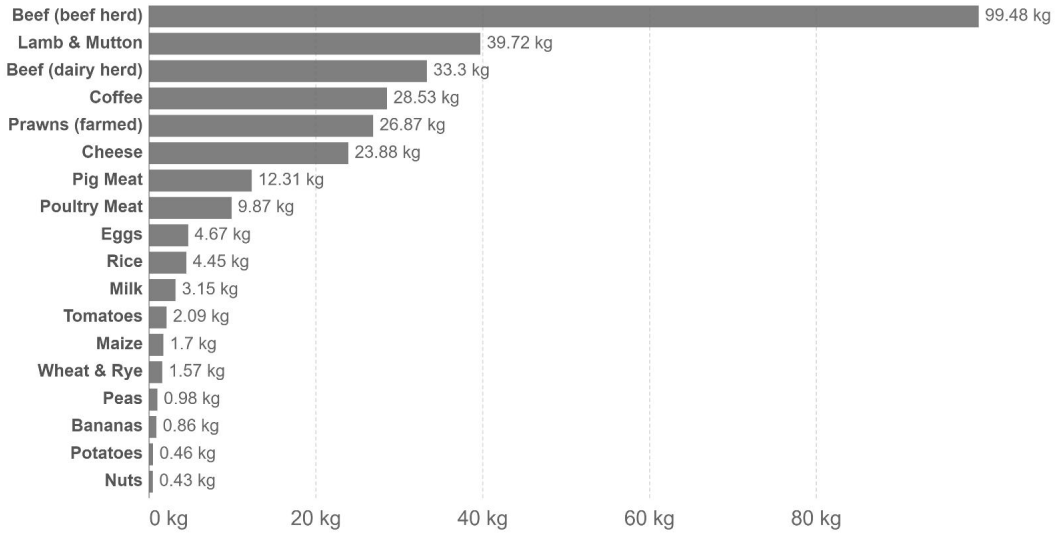

Fig. 2. Greenhouse gas emissions per kilogram of food product (measured in carbon dioxide equivalents) (Poore and Nemecek, 2018)

Fig. 3. Global greenhouse gas emissions from food loss and waste (Poore and Nemecek, 2018)

(15% of food emissions) comes from losses in the supply chain resulting from poor storage and handling methods; lack of cold-chain; and spoilage in transport and processing. The remaining 9% originates from throw-away foods by households and the industry.

Movement toward a sustainable and resilient production system

The water-use efficiency can be improved by reducing water use through upgrading irrigation technology and shifting towards mixed crop-livestock systems, thus increasing productivity (Herrero *et al.*, 2010). A holistic approach to wastewater management should also be adopted to maintain the quality and sustainability of water resources (synergy with SDG 6).

The livestock sector is held responsible for a major share of GHG emissions, however, considering other factors, the scenario becomes more favorable. SDG 7 encourages wider access to energy, and greater use of renewables. The livestock sector provides affordable, sustainable, and renewable energy to billions of people by converting manure into biogas. In remote areas, biogas-run refrigerators can help preserve the quality and shelf-life of perishable foods thus reducing food waste and enhancing nutrition and food security. Processing animal manure into biogas produces quality fertilizer through anaerobic digestion, which offsets the use of synthetic fertilizers and enhances soil fertility (Schouten *et al.*, 2012).

GHG emissions from the livestock sector can be significantly brought down by adopting technologies and practices that improve production efficiency – better feeding practices, animal husbandry, and health management of livestock.

In developed countries, about one-third of the world's cereal grain is fed to ruminants mainly for beef production (FAO, 2002). However, this can be avoided as ruminants gaze pastures in marginal areas and can easily be fed on hay, silage, and high-fibre crop residues unsuitable for human consumption. Around 70% of the grains used by developed countries are fed to animals. This will help to reserve agricultural fields for growing human food.

The productivity of ruminant animals can be enhanced by feeding local and smart supplements, which may encourage microbes in the rumen to grow quickly, use nitrogen and energy more efficiently, and provide better nutrition leading to improved productivity with proportionally less GHG emission (Eisler *et al.*, 2014).

Farmers should be encouraged to raise regionally appropriate animals for their better climate adaptation and disease resistance. Selective breeding practices will help to boost the production of animals adapted to local climates. Adoptive proper animal husbandry and welfare of animals will reduce the disease susceptibility of animals, improve productivity and reduce environmental impact.

Conclusion

Livestock can feed and sustain today's population and tomorrow's in a way that is sustainable, environmentally friendly, and economically inclusive. Animal-sourced proteins must be targeted toward sustainably providing a healthy diet. This involves commitment from Government, Industries, and stakeholders including consumers. The sustainability of the livestock and meat sector is ensured through climate-smart production technologies wherein livestock and the environment interact with each other. Livestock production systems need to evolve to meet some major concerns of 21st century societies and we believe that research can help guide that evolution.

Conflict of interest: Authors declare no conflict of interest

Author's contribution: RB: Writing- original Draft, acquisition of data; NM: Conceptualization; YG, MM, AS: Review and editing.

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