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Major Emitting Sources from the Livestock Sub-sector: Trends in India and Mitigation Opportunities

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Abstract

The Agriculture, Forestry and Other Land use (AFOLU) sector comprises of greenhouse gas (GHG) emissions from agriculture practices, livestock, and changes in forest and land use. The three sub-sectors of AFOLU are: 1. Aggregate Sources and Non-CO_2 Emissions Sources on Land1, 2. Livestock, and 3. Land.

GHG emissions from the livestock sub-sector include emissions due to enteric fermentation in herbivores and manure management practices. Between 2005 and 2018 emissions from livestock sub-sector increased at a CAGR of 0.01 per cent, whereas the growth in emissions between 2012 and 2018 was at a CAGR of 0.07 per cent. Projections indicate that livestock emissions will be approximately 222.68 million tonnes[2] CO_2e by 2030 (using 2005 to 2018 CAGR). Various factors such as flock size, weight of animal, diet, manure management practices and topography influence GHG emissions from this sub-sector. This paper studies the emission trends and projections up to 2030 of the livestock sub-sector and suggests the best practices that can support mitigation of GHG emissions for this sub-sector.

Keywords

GHG emissions, climate change, enteric fermentation, manure management, methane emissions

Introduction

Agriculture, Forestry and Other Land use (AFOLU) sector comprises of greenhouse gas (GHG) emissions from agriculture practices, livestock, and changes in forest and land use. In 2018, net AFOLU emissions contributed around 5.78 per cent in total economy-wide emissions (GHG Platform India, 2022).

The livestock sub-sector emits GHG emissions due to two key reasons: 1) enteric fermentation process in herbivore animals, and 2) animal manure management practices.

The GHG Platform India analyses show that in 2018 at the national level, the total livestock emissions contributed to around 7.5 per cent[3] of total economy-wide emissions and ~63 per cent of gross emissions of AFOLU sector (i.e. excluding Land sub-sector). These numbers are close to India's Third Biennial Update Report (BUR) analyses (for 2016), wherein livestock contributed 9.87 per cent and 61.28 per cent to economy-wide and gross AFOLU sector emissions, respectively (MOEFCC, 2021). In terms of total methane emissions of India, livestock emissions contributed to around ~48 per cent; this was followed by total Waste sector emissions (~20%) and emissions from rice cultivation (~15%) (GHG Platform India, 2022).

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[1] The sub-sector called 'Aggregate Sources and Non-CO_2 Emissions Sources on Land' includes emissions from Rice Cultivation, Agriculture Soils, and Biomass Burning in Cropland and Forestland.

[2] Million tonnes CO_2e = million tonnes of Carbon dioxide equivalent

[3] It may be noted that in 2018, the contribution of livestock to economywide emissions was higher than that of net AFOLU sector emissions to economywide emissions. This was because net AFOLU emissions are calculated after subtracting CO_2 removals from the land sub-sector from gross (i.e. positive) emissions.

Livestock emissions grew at a CAGR of 0.01 per cent from 222.26 million tonnes of CO_2e (in 2005) to 222.47 million tonnes of CO_2e (in 2018)[4]. The business-as-usual (BAU) projections for 2030 (using CAGR between 2005 and 2018) suggest that livestock emissions would be approximately 222.68 million tonnes CO_2e (as shown in Figure 1).

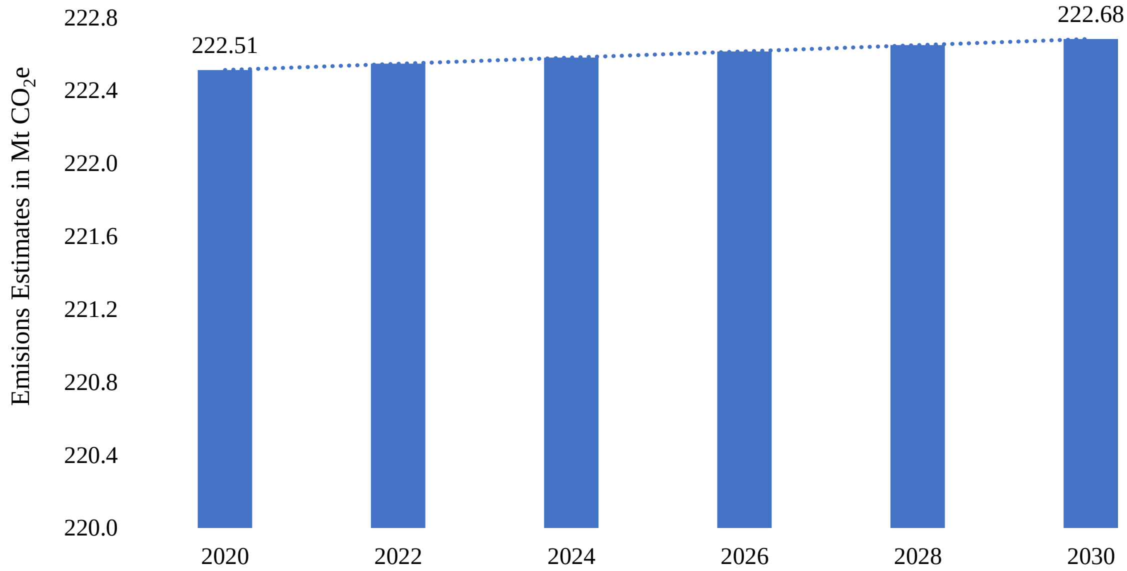

Figure 1: India's livestock emission projections (BAU) till 2030

In the case of enteric fermentation, the number of animals is the key determinant of emissions i.e. bigger the flock size higher will be the emissions. Diet impacting aspects like, the average body weight of the animals, gross energy intake and topographical differences are the other factors that play a role in methane emissions. It may be noted that in 2018, almost 88 per cent of emissions from the livestock sub-sector were due to bovines. Out of this 88 per cent emissions from bovines, on an average, ~41 per cent emissions were due to indigenous cattle, ~42 per cent due to buffaloes and the remaining ~17 per cent due to crossbred cattle.

For manure management emissions, the key factors determining emissions are the type of decomposition conditions – aerobic or anaerobic, besides the flock size. Methane emissions from manure management tend to be smaller than the methane emissions from enteric fermentation. Further, nitrous oxide emissions from manure management vary significantly between the types of management systems used. Manure management emissions grew at a CAGR of 0.16 per cent between 2012 and 2018 from 20.69 million tonnes CO_2e (2012) to 20.90 million tonnes CO_2e (2018).

During the COP26 (Glasgow, 2021), the Hon'ble Prime Minister of India, announced that India will reach net zero by 2070. Assuming this goal is for GHG net-zero (and not just for CO_2 net zero), it is imperative that the highest contributor of methane i.e. the livestock sub-sector is managed with climate-conscious precepts. It may also be noted that the global warming

[4] Estimated using IPCC methodology following the Common Reporting Framework as also followed by GHGPI and NATCOM. Activity data was sourced from [Livestock Census data.]

potential[5] of methane is 21 times higher than that of CO_2 (Intergovernmental Panel on Climate Change, 2007) (MoEFCC, 2012). Therefore, we must look at climate-smart livestock practices, like, better feed additives, promoting a balanced mix of indigenous and crossbred cattle, etc. The paper will bring forth this discussion in detail and dwell on the aforementioned issues and their plausible solutions.

Agriculture, Forestry and Other Land use (AFOLU) Sector Trend

Figure 2 depicts the GHG trend analysis of emissions from AFOLU sub-sectors.

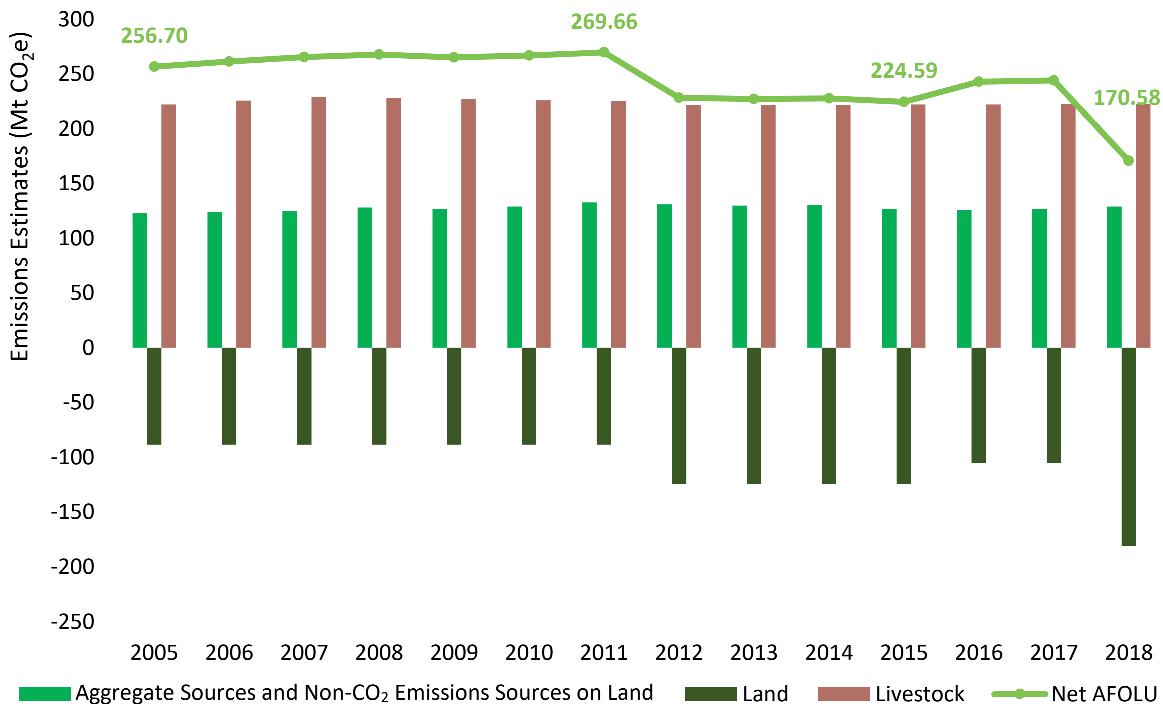

Figure 2: AFOLU sector Emissions (2005-2018)

Livestock sub-sector held the major share (~63%) of gross AFOLU emissions. The remaining emissions arising from rice cultivation, agriculture soils and others contributed around 37 per cent to the gross emissions of AFOLU (w/o land sub-sector)

Livestock

Within the livestock sub-sector, enteric fermentation was by far the dominant contributor to GHG emissions and accounted for around 90 per cent of the sub-sector emissions. In 2018, of the total livestock emissions of 222.47 million tonnes CO_2e, around 202 million tonnes of CO_2e were emitted due to enteric fermentation. Figure 3 shows the trends of emissions from the livestock sub-sector from 2005 to 2018.

[5] Global Warming Potential (GWP) values for Methane (CH4) in the AR6 Report of IPCC is higher than the values given in AR2 Report of IPCC. However, India uses AR2 GWP values to compute the necessary calculations for its national communications (NATCOM & BURs) to the UNFCCC

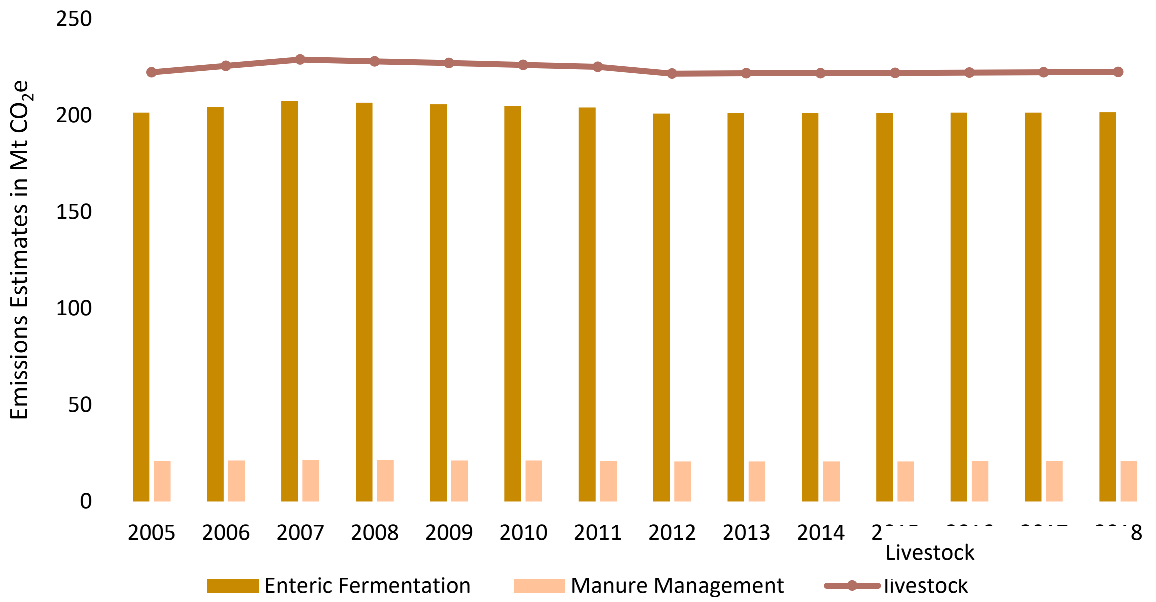

Figure 3: Emission Trends from the livestock sub-sector (India, 2005-2018)

Further, the share of emissions from bovines, both dairy and non-dairy animals, of the overall livestock sub-sector emissions was around 88 per cent as shown in Figure 4.[6]

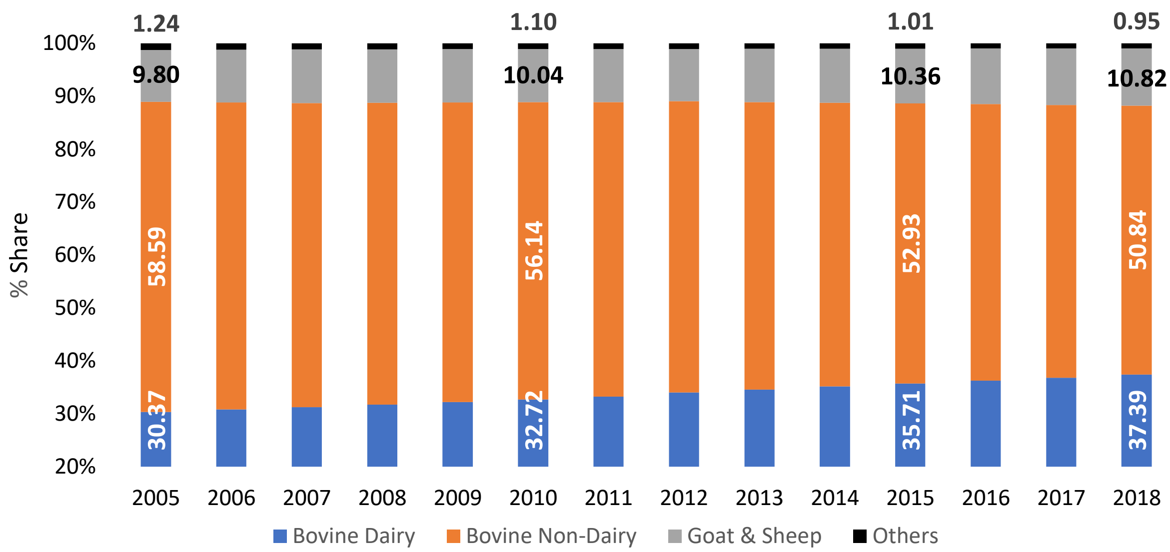

Figure 4: Livestock category-wise share to the sub-sector emissions (India, 2005-2018)

Spatially, the top 10 contributing states to livestock sub-sector emissions, accounted for ~74 per cent of India's livestock emissions, as is shown in Figure 5. Amongst the states, Uttar Pradesh accounted for the highest livestock emissions i.e. 36.62 million tonnes of CO_2e, followed by Rajasthan (21.30 million tonnes of CO_2e) and Madhya Pradesh (19.53 million tonnes of CO_2e.)

[6] The total number of indigenous cattle and buffaloes have significantly decreased between census 2007 and 2018.

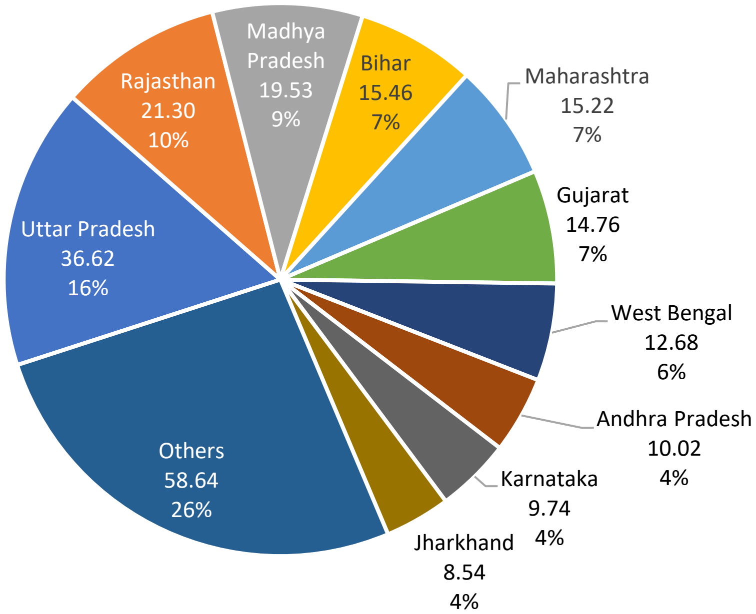

Figure 5: Contribution of top 10 states to India's livestock sub-sector emissions (2018)

In this context, it is important to discuss the mitigation options for enteric fermentation and manure management. However, mitigation options in both these cases cannot be pursued from a pure emissions reduction perspective due to their importance as activities that are quite an important part of the rural economy and India's food security. There are, however, co-benefits that accompany many of the possible mitigation strategies that can realistically be pursued to reduce emissions from both these human activities.

Possibilities of GHG reductions from Enteric Fermentation within the Livestock sub-sector

Cattle population comprises of crossbred cattle, indigenous cattle and buffaloes. Figure 6 shows emissions from these three categories of the cattle population. The emissions estimated between the years 1992 and 2018 showed that indigenous cattle and buffaloes were the main drivers of emissions from the livestock sub-sector.

Between 1992 and 2019 (census data), the population of indigenous cattle decreased by around 25 per cent, while the overall cattle population increased by ~5 per cent. Of the three categories of cattle, the indigenous cattle population was around 47 per cent of the total cattle population (2019 Livestock census data). If the country's population of indigenous cattle for the year 2018 had remained the same as 2005 level, the total emissions from the enteric fermentation would have been higher by 11.86 million tonnes of CO_2e or 16.29 per cent higher than the 2018's estimated value. Trends of cattle population is illustrated in Table 1.

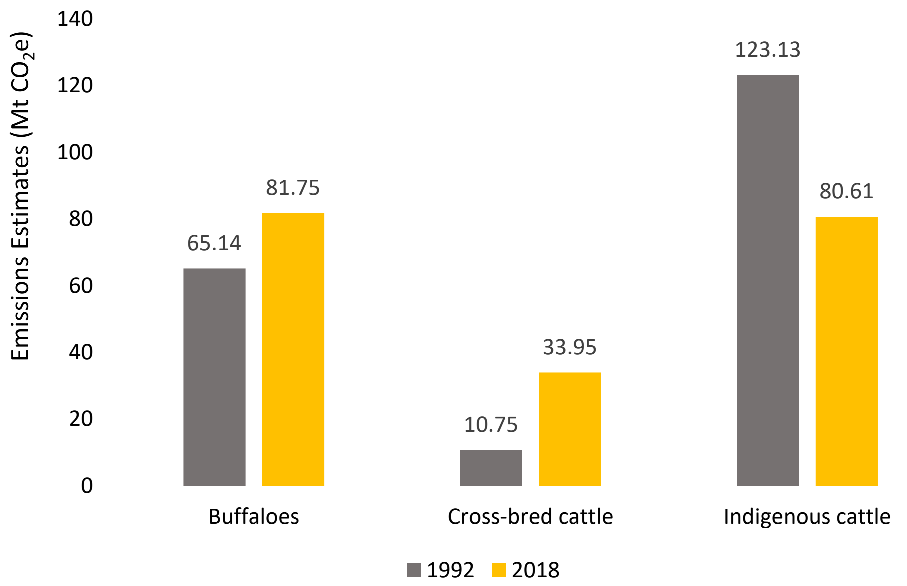

Figure 6: Emissions estimates of the Bovines between the year 1992 and 2018
(Source: Major Emitting Sources from Livestock and Aggregate Sources and Non-CO2 Emissions from Land: Trends in India and Mitigation Opportunities, Vasudha Foundation)

As seen in Table 1, the population of indigenous cattle steadily dropped from 189,369 thousand heads in 1992 to 141,763 thousand heads of cattle in 2019 (Department of Animal Husbandry & Dairying, 2019). In 2018, 42.5 million tonnes of CO_2e were avoided due to the decline in the population of indigenous cattle with respect to 1992 levels. Thus, improving the productivity of cattle while at the same time reducing emission potential and keeping a check on headcount of low yield variety can be an important aspect of mitigation that would also have important environmental as well as socio-economic benefits. However, there may be limits to how much the flock of indigenous cattle will continue to decline autonomously. Thus, there may be a need to intervene directly in the management of indigenous cattle in the context of the rural economy.

Table 1:Total Population of Indigenous cattle, Cross-bred cattle and Buffaloes

Year of Cattle census (Department of Animal Husbandry & Dairying, 2018)	Total Population of Indigenous cattle (in thousands)	Total Population of Cross-bred cattle (in thousands)	Total Population of Buffaloes (in thousands)
1992	189,369	15,215	84,206
1997	178,782	20,099	89,918
2003	160,495	24,686	97,922
2007	166,014	33,086	105,342
2012	151,170	39,732	108,702
2019	141,763	51,410	109,852

There are additional mitigation opportunities that are available in the Indian context, especially for dealing with enteric fermentation from cattle. Many studies across the globe illustrate various techniques and practices to reduce enteric fermentation. Potentially suitable strategies for the Indian context include:

1) Feed additives – various feed additives can reduce methane emissions in cattle
    a) Tannins – adding plants containing condensed tannins has been shown to effectively reduce methane emissions from cattle by 13-16 per cent. The effect can vary based on plant species used and care must be taken to prevent a reduction in diet digestibility, therefore, animal productivity. Tannins can also reduce excess loss of nitrogen through urine, which ultimately reduces nitrous oxide losses (Arango, et al., 2020), (Panchasara, Samrat, & Islam, 2021).
    b) Fats and oils – including fats and oils in diet can reduce methane yields by up to 40% depending on the dosage. Just a per cent increase in oil intake can reduce methane production by 3.5 per cent. However, high concentration of free fat can have detrimental effects on the rumen microbial population (Arango, et al., 2020), (Panchasara, Samrat, & Islam, 2021), (Llonch, Haskell, Dewhurst, & Turner, 2017).
    c) Nitrate – feeding nitrate can lead to substantial reductions in methane emissions (5-30 per cent) but care needs to be taken to prevent nitrate toxicity in the long run (Llonch, Haskell, Dewhurst, & Turner, 2017).
    d) Chemical inhibitors – can help improve energy efficiency in cattle and can potentially reduce GHG emissions by up to 91 per cent (Arango et al., 2020)
    e) Ionophores – including ionophores in diet improves energy efficiency and lowers the risk of rumen bloat while reducing GHG emissions between 5 to 30 per cent (Llonch, Haskell, Dewhurst, & Turner, 2017).
2) Improved forage species and pasture management- Plant breeding has long been used to improve the feeding value of forage crops, reduce the environmental footprint of cattle production and increase livestock productivity. High quality pasture has been shown to lower methane yield by 12 to 51 per cent as compared to traditional low-quality grazing systems (Arango, et al., 2020).

3) Seaweed – feeding livestock many seaweeds – red, green or brown marine macroalgae – has been shown to reduce methane production by 40 per cent to 98 per cent when added to feed in various proportions varying from 1 to 5 per cent. Seaweed also has additional benefits such as improved fertility and reduced oxidative stress for livestock (Panchasara, Samrat, & Islam, 2021), (Vijn, et al., 2020).

4) Improved herd management – improves the health and lifespan of cattle, while ensuring higher offspring survival as well as a balanced mix of high and low-yield cattle.

5) Smart livestock farming – helps in monitoring animal grazing in open pastures or location in big stables, detecting air quality and GHG emissions, monitoring offspring in animal farms to ensure their survival, growth and health (Arango, et al., 2020), (Panchasara, Samrat, & Islam, 2021).

Assuming that in pursuit of all these strategies, even if 25% of emissions reduction is achieved, India could reduce 55.44 million tonnes of CO_2e emissions of methane in 2030 with respect to Business As Usual projections.

However, there are, primarily two sorts of barriers that inhibit the pursuit of such emissions reductions. These are:

1. Livestock sub-sector is dominated by the unorganized sector with millions of individuals having small flocks. Further, these individuals often do not rear cattle for producing marketable products, but do so for subsistence. Thus, the incentives for increasing the productivity of cattle are limited.

2. While pursuing emissions reduction from cattle would result in higher productivity of the animals due to improvements in their diet, the additional costs incurred in pursuing such strategies would not be completely offset by increased productivity. In a sector, which is perhaps already depressed due to relatively low prices of its commodities, expecting India's animal husbandry sector to absorb the additional costs of emissions reduction would be impractical (Sirohi, Michaelowa, & Sirohi, 2007).

Conclusions

The livestock sub-sector contributed to ~7.5% of total economy-wide emissions and ~63% of gross AFOLU emissions in 2018. Between 2005 and 2018, emissions grew at a nominal rate of 0.01% and have been projected (BAU scenario) to increase to 222.67 million tonnes CO_2e by 2030. There are multiple possibilities to reduce emissions that can be realized within the livestock sub-sector with multiple environmental and economic co-benefits. In order to do so, however, there is a need to reach out to the farmers and pastoralists of India who are economically and socially vulnerable. Technical and financial support will enable them to take advantage of the economic as well as environmental benefits of livestock rearing, making it less emission-intensive than it is at present.

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