LIVESTOCK-BASED PATHWAYS TO REDUCE METHANE EMISSION: ADAPTATION OF DAIRY FARMERS IN INDIA

Methane emissions from Indian livestock

- India is the largest milk producer (188 million tonnes) in the world with the highest cattle (192 million) and buffalo (110 million) populations.
- The per capita emission is 24.2 kg CH4/animal/year and the total GHG emission from livestock is estimated at 247 Mt of CO2 equivalent which includes 99.8% CH4 and 0.2% N2O.

Technological interventions of BAIF

- Use of semen from bulls of superior genetic potential to raise milk production with fewer dairy animals and use of sex-sorted semen to reduce male population in the herd.
- Inclusion of Harit-Dhara, an anti-methanogenic feed supplement.
- Dung management by adopting Integrated Renewable Energy and Sustainable Agriculture (IRESA).
- Support services for feeding, nutrition and health management

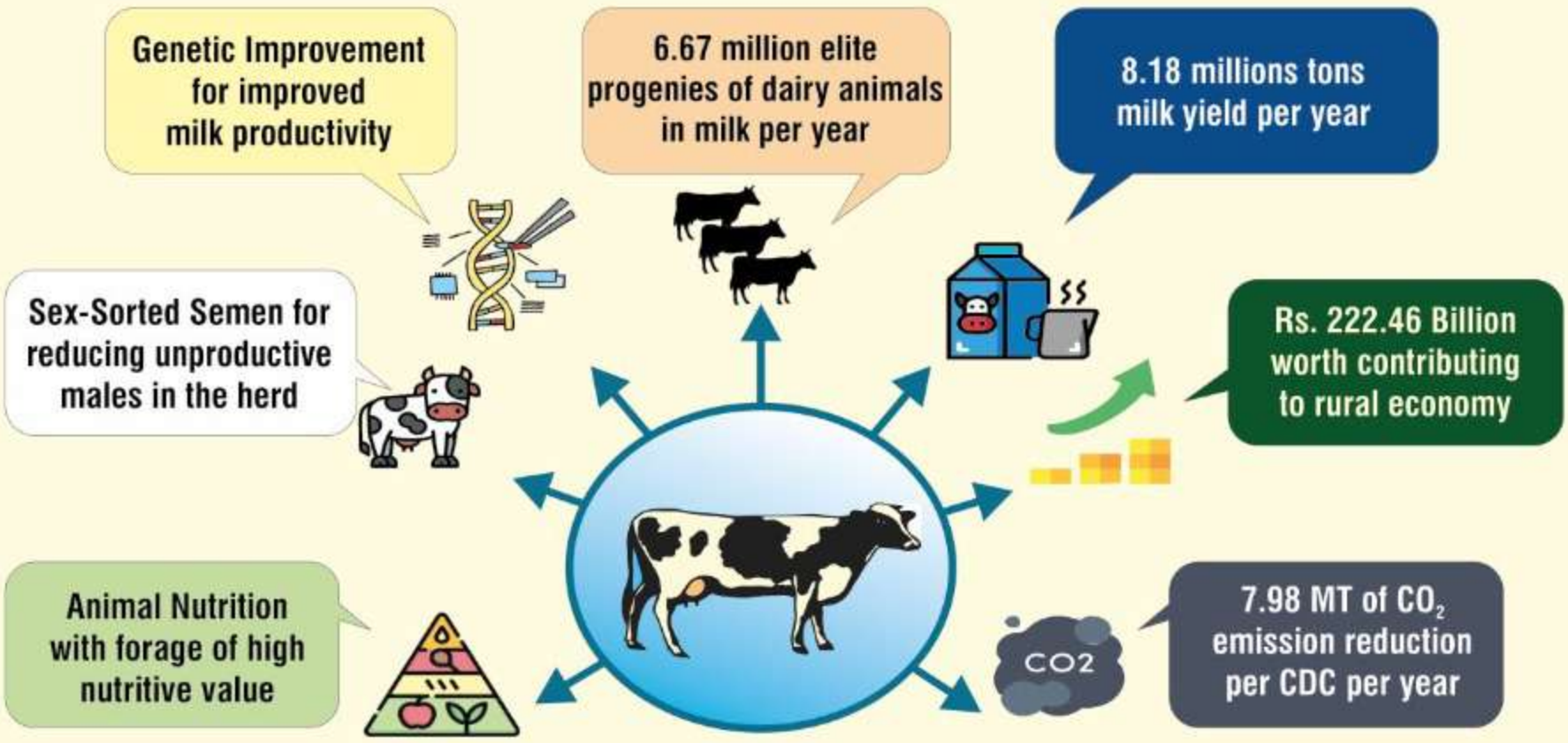
Breed Diversity

Door step AI service

Extension Strategy of BAIF

- BAIF's Cattle Development Centre (CDC) is the focal unit of intervention.
- More than 4000 CDCs in 14 states of India are in operation at present.
- Each CDC covers 10 villages, serving about 2500 female dairy animals consisting of indigenous and crossbred cows as well as buffaloes.
- Half of the CDCs are on a self-sustaining mode as farmers and gain significant levels of awareness on the climate smart dairy production technologies

Key Activities and Outcomes



Impacted SDGs

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Dung Management by Adopting Integrated Renewable Energy and Sustainable Agriculture (IRESA)

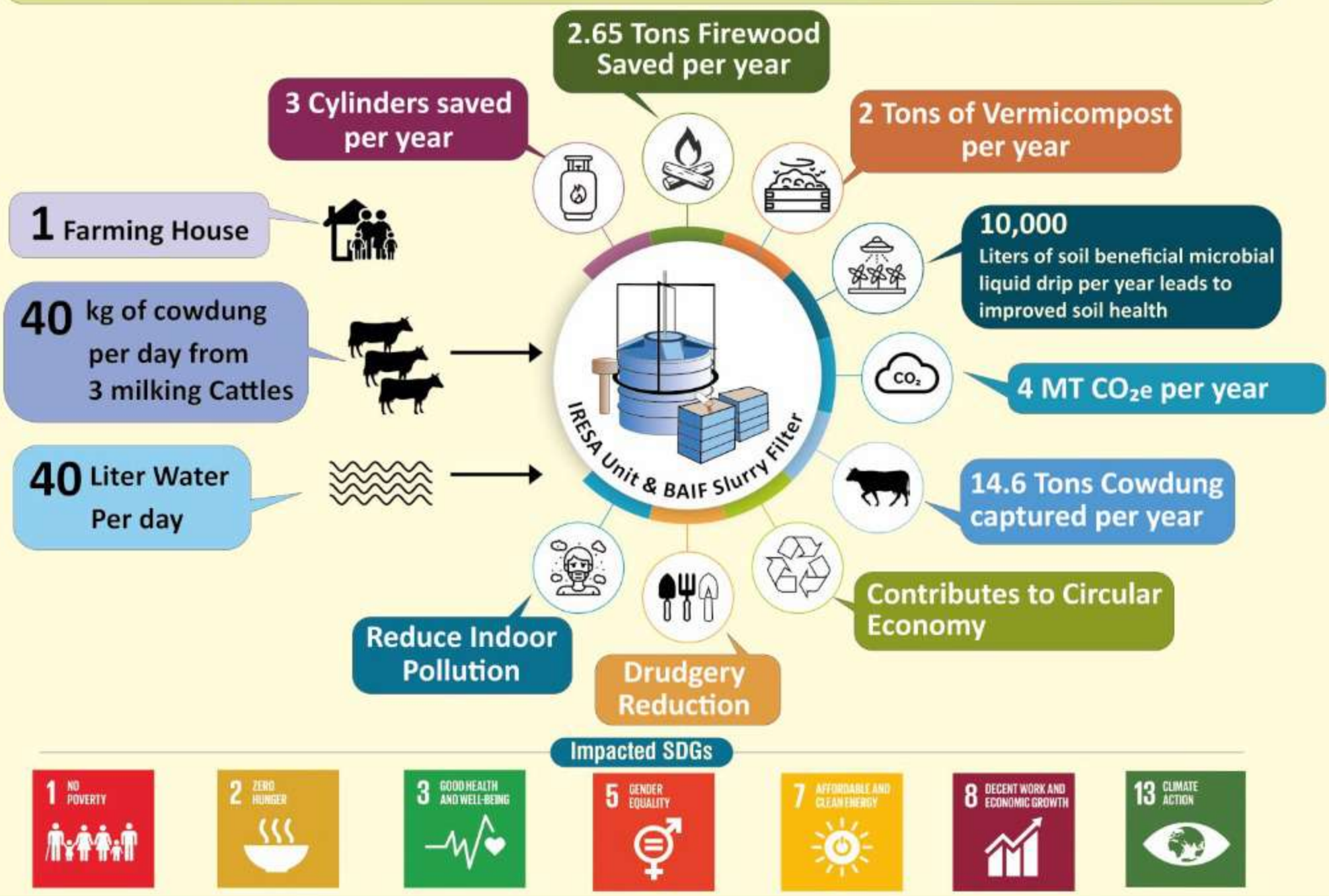
Dung management

- Proper manure utilization through Biogas Digesters
- Bio PROM (Phosphate Rich Organic Manure) production
- Vermicomposting
- Adopting proper composting methods

Need Statement

- 18% of gross national emissions from livestock and agriculture
- Low quantity and quality of milk production
- 58% of GHG emissions from the livestock; Cattle & buffalo highest source
- 20.5 million farmers dependent on livestock for income
- Constraint in feeding, breeding, health & management of cattle

IRESA – An Integrated renewable energy and sustainable Agriculture system (per unit)



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LIVESTOCK BASED PATHWAYS FOR METHANE EMISSION REDUCTION AND ADAPTATION OF SMALL DAIRY HOLDING FARMERS IN INDIA

Livestock production is backbone of Indian Agriculture and source of employment in rural areas for centuries which plays an important role in Indian economy. India possesses one of the largest livestock populations in the world, which is more than 535.82 million with the top position in cattle (192.48 million), and buffalo (109.8 million). In spite of India's position as the highest producer of milk, the average annual milk yield from cattle and buffalo is only 1400 kg as against the world average of 2600 kg per lactation. Major emissions from livestock are in the form of methane. Methane has a global warming potential 28 times that of CO_2 (Garnsworthy *et al*., 2019). Enteric methane contributes 80 per cent of methane emissions by ruminants, and manure decomposition contributes 20 per cent solely from livestock. (Knapp *et al*., 2014). There is increasing pressure on livestock production systems to reduce their greenhouse gas (GHG) emissions. In India, buffalo and cattle contribute at least 85% of total methane emissions from livestock. However, they are vital to food security in India and the livelihoods of 85 million smallholder farmers. Smallholder dairy productivity remains low meaning that GHG emissions per unit of product are high (3.4 kg CO_2/kg milk in cattle and 2.4 kg CO_2/kg milk in buffalo and there is potential for major improvement. The amount of methane emissions is mainly affected by feed type, feed intake, ambient temperature, rate of consumption of feed, the balance of nutrients in the feed for microbial growth and the balance of micro-organisms that develop (bacteria, protozoa and fungi) which largely depend on the chemical composition of diet. Several other indirect factors like emissions from feed production, energy consumption for various activities under livestock also contribute to the GHGs.

BAIF Development Research Foundation is a non-Government organization (NGO) established during 1967, and registered under Bombay Public Trust Act of 1950. The Institution aims at using degraded natural resources like land, water, livestock and vegetation for developing programs leading to economic and qualitative improvement in economically disadvantaged sections of the rural society. BAIF is committed to a holistic livestock development particularly to improve the milk production and provide sustainable livelihood to the rural poor. Various technological initiatives under BAIF programmes are contributing for mitigation in reducing GHG emissions as well as better adapted to changing environmental conditions.

1. Mitigation strategies

a. Efficient reduction of enteric emission through feed supplements

Feed conversion efficiency can be enhanced by increasing the energy content and digestibility of feedstuffs so that less feed is converted to methane and more is utilized as product output. Methane emissions from livestock are mainly a result of enteric fermentation and eructation of methane represents a loss of energy to animals. It can be reduced by increasing starch levels or the use of additives or modifying the diet in such a way that the diet is adjusted to meet the nutritional needs more closely. There should be balance between proteins, starch and fiber in the diet, these have an influence on the production of methane and nitrous oxide gases. The anti-methanogenic supplement Harit-Dhara product developed by National Institute of Animal Nutrition and Physiology (NIANP), Bangalore and commercialized through Agrinnovate-ICAR by using tanniferous natural phyto-sources. The feeding of Harit-Dhara product at the recommended level does not affect the nutrient intake and digestibility. The

feeding of Harit-Dhara leads to an increase of 0.4-0.5 kg milk/day through the methane emission up to extent of 17 to 20%. BAIF has established the facilities to produce the Harit-Dhara and supplying to farmers through its CDCs.

b. Herd optimization using Sex sorted semen and higher production potential animals

Sex Sorted Semen provide the choice to select the sex of the calf to the dairy farmer with 90 % assurance. The additional heifer calves will help to expand the genetically improved dairy herd in a faster pace. The herd of high producing animals will be raised by eliminating the birth of male calves on one hand and low producing cattle and buffaloes. The BAIF Sex Sorted Semen facility produced a total of 1.34 million Sex Sorted Semen doses from 9 Indigenous breeds (Gir, Sahiwal, Tharaparkar, Red Sindhi, Red Kandhari Rathi, Khillar, Gaolao and Deoni), HF and Jersey Crossbred, Pure HF and Jersey, and 4 buffalo breeds (Murrah, Jaffarabadi, Mehsana & Pandharpuri). Over 1.1 million sex sorted semen doses were supplied to BAIF field programme, government agencies as well as other breeding agencies. Cumulatively, over 0.37 million doses of Sex Sorted semen inseminations were performed through BAIF CDCs with 44.3 % conception rate and with 91 % female calf birth. Thus birth of 193000 male calves is reduced with equal number of high producing female animals. The use of sexed semen will result in increased availability of available feed and fodder resources to the high milk producing dairy animals. The overall reduction in the population will ultimately result in less production of methane and other GHGs.

c. Grassland management for mitigation in the catchment and adaptation through better fodder availability

Most of the common properties earmarked for community pastures are heavily denuded and devoid of vegetation. Development of community pastures through soil and water conservation, introduction of fodder herbs, shrubs and trees and protection from stray grazing, will not only enhance the supply of superior quality fodder but also improve the ground water table and micro-climate. Fodder production management to enhance livestock production through cultivation of improved fodder varieties and silage making will ensure the improved digestibility and ultimately reduced methane emission from the Livestock. BAIF developed nutritionally rich, fast growing with high biomass fodder varieties like BNH-10, BNH-11, BNH-14& BNH-16 and BAIF Bajra No.1,5, 7 & 8 are widely cultivated in various agroclimatic conditions in India.

d. Dung Management

Emissions in livestock occur due enteric fermentation in rumen and manure which are rich in methane. Hence, proper manure utilization should be implemented by storing of manure in solid form to decompose or capturing methane from manure decomposition in Biogas digester to produce renewable energy. BAIF had extensively promoted more than 2000 biogas in its field programme. Gas generated from this unit is sufficient for 5-6 family members to use for domestic purpose like cooking. The digested slurry can be used as manure to crops or fish ponds. After continuous research and development in filters, BAIF have established a 5G filter technology to get solids and liquid separation. The “Integrated Renewable Energy and Sustainable Agriculture (IRESA)” approach involves a complete package comprising a portfolio of activities around the central theme of household-level biogas units. IRESA is a combination of biogas + BAIF slurry filters. The slurry is further used to produce Phosphate Rich Organic Manure (PROM) and Vermi compost. This helps reduce emissions by replacing fossil fuels,

avoiding methane slips from manure, adding carbon in soils, producing green fertilizers and enabling carbon reuse. The IRESA programme also has tremendous potential of earning carbon credits. The carbon credits can be earned through the following:
IRESA reduces dependency on firewood, LPG and kerosene for cooking and lighting purpose. One IRESA unit (Capacity: 2 m^3 biogas unit) can replace 12 LPG cylinders per year or 2 LPG cylinders + 2555 kg firewood per year.
The use of PROM also helps in significantly reducing the use of agrochemicals which leads to emission reduction.

2. Adaptation strategies

a. promotion of indigenous hardy breeds in their respective tracts with increased production potential of these breeds.

BAIF is pioneer in providing quality breeding services to cows and buffaloes at the doorsteps of the small and marginal farmers, using frozen semen of superior sires in the country. The Cattle development Centre (CDCs) covers 2000 breedable dairy cows and buffaloes in a cluster of 10-15 villages headed by a locally trained Artificial Insemination (AI) technician who is engaged in motivation and awareness creation, regular follow up, technical guidance, timely preventive health care and supply of critical quality inputs. Presently BAIF operates through 4379 CDCs across 321 districts in 14 states and provide breeding services to 3.3 million small and marginal farmers in 89558 villages with around 5.2 million AI per annum. The programme created assets in the form of 6.76 million genetically improved cows and buffaloes born under this programme yielded 8.81 million tons of milk, contributing Rs. 222.46 billion to the rural economy. BAIF has experience of breed characterization of Khillar, Dangi, and Kathani cattle as well as conservation of Krishna Valley in Karnataka, Gir in Gujrat and Tharparkar cattle breeds in Rajasthan. Reductions in total methane emissions are dependent on a sufficient decrease in total low producing indigenous animal numbers. Such a reduction may be an approach to methane mitigation.

b. Use of genomics for identifying the adaptive traits in changing climate

The indigenous cattle breeds have evolved over centuries and become locally adapted to the environments prevailing in the breeding tracts. The indigenous breeds have acquired specific adaptations and gene combinations, viz, disease resistance, adaptation to harsh climatic conditions, and exploitation of poor-quality feeds. Indigenous cattle resources are under threat of erosion due to reasons such as mechanization of agriculture, absence of scientific breed development efforts. The loss of breeds can lead to loss of its unique adaptive attributes, which are the results of complex interactions between the genotype and the environment. BAIF implementing a project on genomic studies which will help in understanding the genetic diversity among the indigenous breeds within the population and selection of the animals for future breeding which subsequently helps to conserve and improve the breed on a long-term basis. Genomic studies will identify genetic markers associated with traits that enhance animal resilience, such as disease resistance, heat tolerance, and feed efficiency. By selectively breeding animals with these desirable traits, farmers can develop more resilient and adaptable livestock populations over the time period. Genomic selection will hasten the process of elite animal selection based on reproductive efficiency. This can result in faster genetic progress and more resilient offspring over the time span.

Several strategies required for smallholder dairy farmer awareness and capacity building and adoption of various management practices to reduce the methane emissions. While there are productivity benefits, the outcomes that don't directly enhance milk yield are currently not tradable in carbon markets. Hence the above-mentioned initiatives under BAIFs programmes have the potential of generating carbon credits.

Different challenges and solutions to climate mitigation and adaptation have been highlighted in the film – how does this resonate with the situation in India?

In Indian situation, the major challenges are poor quality feed and fodder resources, high population of unproductive animals, low production potential of dairy animals, improper dung management, environmental stress, etc