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Understanding Implications of Dairy Sector Development to Sustainable Development Goals (SDGs)

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UNDERSTANDING IMPLICATIONS OF DAIRY SECTOR DEVELOPMENT TO SUSTAINABLE DEVELOPMENT GOALS (SDGs)

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Abstract

Various policy mechanisms are available to support the positive effects of the Sustainable Development Goals (SDGs) and reduce the negative outcomes of economic activities on the environment through effective interventions. To preserve the integration of dairy development strategies and practices with SDGs, this paper examines the key relationships involved in this process by major stakeholders and observes critically some of the initiatives undertaken during the phases of executing the National Dairy Plan-I (NDP-I). The paper narrates how the dairy sector can actively help achieve sustainability goals recommended by the UN resolutions using the field data received from the Socio-Economic Survey of NCAER, carried out during the year 2019 for the National Dairy Development Board (NDDB).

Increased demand for dairy products adds pressure on ecosystems, biodiversity, and the dairy sector faces greater competition for capital, labour, land, water, and energy. On the other hand, increased milk production could prompt the emergence and spread of communicable diseases. In this count, NDP-I has reportedly helped expand the milk yield through effective cattle, buffalo breeding programmes, and scientific feeding methods that have enhanced the availability and affordability of feed and fodder. The programme extended the benefits of collective bargaining capacity for the landless, marginal, and small producers through the cooperative arrangement along with measures for sustaining milk production through village-based milk procurement systems (VBMPS), which has unequivocally boosted the share of the organised market and has contributed income-generating dairy activities for the poor and marginalised section of society.

Keywords: National Dairy Plan-1 (NDP-I), Greenhouse Gases (GHGs), Sustainable Development Goals (SDGs), Poverty, Dairy Cooperative Societies (DCSes), Gini Coefficient, Methane Emissions, Ration Balancing Programme (RBP), Milk Producers' Institutions (MPI), New Generation Cooperatives (NGCs), Bulk Milk Chilling Units (BMCU), Village Based Market Procurement System (VBMPS), Liquid Nitrogen (LN), Artificial Insemination (AI)

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1. Introduction, Background, and the Context of the Present Study

Dairy activities play a key role in improving the lives of millions in rural India by generating income and employment, and strengthening the ownership of assets to enable rural households to achieve their livelihood objectives besides providing reliable supplies of milk and dairy products to the population of the country as a whole;

During the last seven decades, the introduction of new technologies under various dairy development programmes has facilitated a major expansion and modernisation of the dairy sector. The livestock sector contributes more than 28 per cent of the total agricultural GVA and 4.9 per cent of the total GVA, and the livestock sector accounts for a significant contribution to these figures.

According to the 20th Livestock Census, the cattle population in 2019 was 192.49 million, signifying a rise of about 0.8 per cent from 190.9 million in the 19th Livestock Census in 2012. This increase was mainly driven by an increase in cross-bred cattle leading to a higher milk yield and also by a higher share of cows in the indigenous cattle population. While the overall number of milch animals increased by 6 per cent, female cross-bred cattle accounted for a major share of this rise, going up by 39 per cent, from 33.76 million in 2012 to 46.95 million in 2019. The indigenous female cattle population also rose by 10 per cent from 89.22 million in 2012 to 98.17 million in 2019, whereas the buffalo population increased by 1.06 per cent, from 108.7 million in 2012 to 109.85 million in 2019. Cross-bred milch animals contributed around 28 per cent to India's total milk production of 188 million tonnes in 2019.

Milk production in India too grew at more than 4 per cent compounded annually during 1991-2011, surpassing the growth rates in the global dairy output and India's own foodgrain production (BIRTHAL and NEGI, 2012). This phenomenal success is attributed to a Government initiative, Operation Flood (1970-1996) and its intense focus on dairy development activities. As part of that initiative, rural milk shed areas were linked to urban markets through the development of network village cooperatives for procuring and marketing milk. Aggregate milk production and productivity were also enhanced by ensuring the availability of veterinary services, artificial insemination (AI), feed, and farmer education.

At the national level, income from livestock accounts for an average of about 12 per cent of the income earned by agricultural households from farm and off-farm activities, viz., the cultivation of crops and livestock. In fact, marginal and small farmers with landholdings of up to 5 acres, who together constitute about 87 per cent of all farmer households in the country, derive as much as 29 per cent of their total income from livestock as compared to a corresponding figure of only 7.5 per cent for large farmers with landholdings of above 10 acres.

Several policy mechanisms are used in the dairy sector to secure the positive effects of SDGs and lessen the negative outcomes through interventions. In order to support the integration of livestock policies and practices with Sustainable Development Goals (SDGs), this paper examines the key linkages involved in the initiatives under the National Dairy Plan-I (NDP-I) and recommends how the sector can dynamically help achieve sustainability goals.

The dairy sector also empowers rural women and members of the SC/ST community by providing them greater opportunities for collective participation in markets; improving the efficiency of use of natural resources; broadening access to clean and renewable energy along with supporting sustainable economic growth. In the true sense of its term, this sector stimulates smallholder entrepreneurship, reduces inequality gaps, and promotes quality consumption with sustainable production patterns. Simultaneously, it increases the resilience of households to climate shocks and brings together multiple stakeholders to

achieve all these goals. The dairy sector invests in programmes that provide knowledge and skills. The use of technology and other improvements in production and marketing introduced in the dairy sector created employment opportunities for youth, particularly women, and the economically weaker sections including landless labourers in the rural areas.

The dairy sector is continually finding new ways to optimize efficiencies in water and energy use by lowering the operating costs for dairy farms. By using animal manure as inputs in crop production, and establishing feed efficiencies, farmers are ensuring improvements in yield as also reducing their environmental footprint. Dairy farmers use manure not only as fertilizers but also to generate biogas for clean energy. This is especially beneficial in rural areas as a cheap source of energy, which otherwise may prove to be an environmental hazard.

As regards the environmental impacts, the SDGs create a cohesive framework to find ways to minimise the environmental degradation and endeavors to reduce greenhouse gases (GHGs). Protecting natural resources allows farmers not only to grow their businesses but also to safeguard their lands.

While livestock production relates directly or indirectly to each of the SDGs, the linkages with some goals and targets are stronger than with others. These relationships are often defined by a two-way linkage in which, on the one hand, the development of the sector helps achieve some targets; while, on the other, the achievement of a target also creates the right conditions for more sustainable development of the sector (Table 1).

Table 1: Identification of the Related Areas of SDGs with NDP

SDGs	Target	Link between NDP Activities and the Specific SDGs	Nature of the Impact of NDP on the Specific SDGs
Goal 1	Reducing poverty	India's dairy development approach, based on a smallholder production system linked to an institutional network with significant contributions from women, helps address Goal 1 in reducing poverty. Dairy income acts as remunerative support to cushion against the failure of crops. Chiefly landless workers and small and marginal farmers are covered under NDP which helps raise their income status above poverty. Moreover, above 60 per cent of the BPL community has benefited from NDP.	Direct impact as dairy development opens up avenues for improvement in income from milk-producing households that include the landless and poor.
Goal 2	Zero hunger	Increased livelihood opportunities through dairying and synergies between crop production and dairying help improve both the purchasing power of the population and the availability of food.	Indirect impact by improving income levels from milk production and sale.
Goal 3	Good health and well-being	A better income through dairy activities ensures better consumption that reduces nutritional deficiency while ensuring good health and well-being. The proportion of the population with access to basic amenities could be a worthy indicator.	Direct impact due to increased production of milk, a nutritious food item.

SDGs	Target	Link between NDP Activities and the Specific SDGs	Nature of the Impact of NDP on the Specific SDGs
Goal 4	Quality education	Education is not directly linked to NDP. However, NDP necessitates imparting training and implementation of an awareness programme related to the domain activities.	Indirect impact, through imparting of training on the operation and management of dairy sector activities at both the farm level and the processing and distribution levels; both improve the skill levels of workers in the sector.
Goal 5	Improving gender equality	Women's involvement in dairy activities has expanded due to NDP schemes through various awareness and training programmes, which have helped improve mobility, status, and recognition for women in the NDP areas as reflected in the Socio-Economic Survey (SES) of NCAER.	Direct impact as it provides income-earning opportunities for women in rural households.
Goal 6	Clean water and sanitation	Although this is not directly linked to NDP, access to clean water and sanitation is imperative in order to ensure the procurement of quality milk.	Significant potential for an indirect impact through its impact at the local level by raising the participation of households in collective efforts at local development.
Goal 7	Affordable and clean energy	Proper dung management and emphasis on biogas usage in the NDP areas is closely linked to access to affordable clean energy.	Direct impact as it creates opportunities for the utilisation of dung of dairy animals in producing biogas for domestic uses.
Goal 8	Ensuring inclusive economic growth	NDP has helped enhance the importance of the milk business through better procurement (VBMPS), strengthening the business by providing Bulk Milk Coolers (BMCs) to the District Cooperative Society (DCS), which has provided decent work opportunities and thereby contributed to economic growth.	Direct impact, as the programme generates opportunities for the landless and poor among the rural population to enable them to earn income through milk production.
Goal 9	Industry, innovation, and infrastructure	Dairy activities emerged as an industry and the implementation of Artificial Insemination (AI) with other forms of breed development mechanisms and infrastructure provision (such as setting up of a semen station) have brought about a significant change in the NDP areas.	The modernisation of the dairy sector at the farm level, input supply level, and processing and distribution levels necessitates innovative approaches and supply infrastructure of high quality.
Goal 10	Preventing rising inequality	Since the landless, small, and marginal farmers have benefited the most from NDP, it has helped reduce inequality in the project areas as compared to areas that did not receive the interventions.	Dairy cooperatives provide equal access to farmers irrespective of how much milk they supply.
Goal 11	Sustainable cities and communities	This goal is not directly linked to NDP.	No significant linkage was found.

SDGs	Target	Link between NDP Activities and the Specific SDGs	Nature of the Impact of NDP on the Specific SDGs
Goal 12	Responsible consumption and production	NDP has improved the consumption of milk, which, in turn, has helped reduce nutritional deficiencies. It has also increased production through measures like breed development, fodder development, RBP, and VBMPS that have helped optimise production and channelise them through the market mechanism.	The dairy production process entails the adoption of feeding practices that raise the potential for conservation of land; the use of a collective approach to marketing also helps improve the quality of the product and reduce cost.
Goal 13	Lowering methane emission	India's model of milk production is based on feeding crops, residues, and agricultural by-products and using family labor to add value to resources, which otherwise have limited alternative economic value. In India, buffaloes account for nearly 50 per cent of milk production and their average methane emissions are lower than the regional average for buffaloes. The RBP as part of NDP has also helped reduce methane emission from the ruminants through better and balanced intake of feed and green fodder development that has ultimately helped contain the emission of greenhouse gases (GHGs).	Adoption of feed mix that leads to a reduction in methane emissions in the dairying sector.
Goal 14	Life below water	This goal is not directly linked to NDP.	No direct linkage observed.
Goal 15	Sustainable use of terrestrial ecosystems and land	India's milch herd comprises a number of indigenous breeds of both buffaloes as well as cows, which helps address Goal 15 in terms of halting the loss of biodiversity.	The dairy sector can help in promoting the more sustainable use of natural resources by adopting practices as noted under SDGs 12 and 13.
Goal 16	Inclusive societies and institutions	NDP induces strong institutional linkages of various institutions like DCS, MPI, and NGCs.	Through its significant impact on SDGs 1, 5, 8, and 10, dairy development, which is the primary aim of NDP, contributes to the achievement of SDG 16.
Goal 17	Partnership to achieve goals	NDP has successfully collaborated with different village-level institutions for ensuring the success of the NDP programme that eventually benefited the targeted population belonging to the deprived segments of society.	NDP requires collaboration with a range of stakeholders, through which it can play an important role in enhancing its contribution toward the achievement of the SDGs.

Source: United Nations, NCAER.

In order to address the increasing challenges in the dairy sector and simultaneously promote gender equality, a central sector scheme named National Dairy Plan I (NDP-I) was launched and implemented during the period 2011-12 to 2018-19. The two primary development objectives of this scheme were to increase the productivity of milch animals and thereby increase milk production to meet the rapidly growing demand for milk, and to

provide rural milk producers greater access to the organised milk sector market while maintaining the critical equilibrium needed to achieve the SDGs. In order to fulfill these objectives, the NDP-I focused on several key areas like fodder management, re-vegetation of degraded land due to over-grazing and over-exploitation; setting up of semen stations for genetically improved high-yielding variety of milch animals including bulls, which contributed to many ways in achieving the SDG goals.

In this context, an effort has been made here to examine the link between the objectives and outcomes of NDP-I and the 17 broad SDGs. As may be seen from Table 1, NDP, with its focus on achieving dairy development, has many relations with the SDGs. This chapter focuses on the following seven SDGs, which have close linkages with several of the NDP-I objectives:

1. Goal 1: Reducing poverty;
2. Goal 5: Improving gender equality;
3. Goal 8: Ensuring inclusive economic growth;
4. Goal 10: Preventing rising inequality;
5. Goal 13: Lowering methane emissions;
6. Goal 15: Propagating the sustainable use of terrestrial ecosystems and land; and
7. Goal 16: Promoting inclusive societies and institutions.

India's dairy development approach, based on a model connected to an institutional network with a significant contribution from women, helps address Goal 1 of reducing poverty, Goal 5 of improving gender equality, Goal 8 of ensuring inclusive economic growth, Goal 10 of preventing rising inequality, and Goal 16 of promoting inclusive societies and institutions.

India's model of milk production is based on feeding crops, residues, and agricultural by-products and using family labour to add value to resources, which otherwise have limited alternative economic value. In India, buffaloes account for nearly 50 per cent of milk production, and their average methane emissions are lower than the regional average for buffaloes. This model contains certain elements such as dependence on buffaloes for lower methane emissions and avoiding the use of land for feeding animals, which help address Goal 13 in terms of a lower average per unit of methane emission as compared to the regional average, and Goal 15 in terms of propagating the sustainable use of terrestrial ecosystems and land. India's milch herd comprises a number of indigenous breeds of both buffaloes as well as cows, which helps address Goal 15 in terms of halting the loss of biodiversity. Furthermore, the findings of the NCAER survey results have also been incorporated for the purpose of analysis.

2. Goals 1, 5, and 8: Reducing Poverty, Improving Gender Equality, and Ensuring Inclusive Economic Growth

Dairy plays a catalytic role in strengthening the assets used by rural households, enabling them to achieve their livelihood objectives, and increasing the resilience of families to cope with shocks. The possible indicators from the NDP-I survey, related to poverty eradication, are presented in Table 2, which shows the current status of involvement of households in poverty reduction and livelihood activities, and the availability of basic amenities as per the NDP-I Survey, 2019.

Table 2: Indicators Impacting SDGs 1, 5, and 8

Indicators	Treatment vs. Non-Treatment	Before/After	Percentage Coverage
(i) Households with milch animals	Project village	Before the project	49.4
		Currently (2019)	52.6
	Control village	Before the project	38.5
		Currently (2019)	43.9
(ii) Change in share of households engaged in dairy activities	Project village	Before the project	77.1
		Currently (2019)	81.0
	Control village	Before the project	47.2
		Currently (2019)	54.0
(iii) Contribution of dairy milk production to incomes of households (% reported as very significant)	Project village	Before the project	43.7
		Currently (2019)	59.4
	Control village	Before the project	30.0
		Currently (2019)	36.9
(iv) BPL households rearing milch animals	Project village	Before the project	
		Currently (2019)	61.0
	Control village	Before the project	
		Currently (2019)	58
(v) Tap drinking water	Project village	Before the project	
		Currently (2019)	48.7
	Control village	Before the project	
		Currently (2019)	42.5
(vi) Electricity grid connection	Project village	Before the project	
		Currently (2019)	94.1
	Control village	Before the project	
		Currently (2019)	97.5
(vii) Toilet inside the premises	Project village	Currently (2019)	83.3
	Control village	Currently (2019)	80.2
(viii) LPG connection	Project village	Currently (2019)	88.0
	Control village	Currently (2019)	84.4
(ix) Households with TV	Project village	Currently (2019)	61.5
	Control village	Currently (2019)	55.5
(x) Women's participation in dairy activities (increased)	Project village	Currently (2019)	66.0
	Control village	Currently (2019)	49.6
(xi) Women's position in household decision-making improved (% reported)	Project village	Currently (2019)	76.8
	Control village	Currently (2019)	63.8
(xii) Women's mobility outside households improved (% reported)	Project village	Currently (2019)	74.1
	Control village	Currently (2019)	64.1

Source: NCAER field data.

Note: For conducting the survey of beneficiary households, the NCAER team selected 15,000 sample households from a total of 420 tehsils and 1260 project villages. In addition, 3,000 households from 252 selected control villages were also surveyed to obtain a comparative insight into the impact. The sample villages were selected from the tehsil-wise percentage villages covered under the particular NDP intervention. For the selection of the control villages, a Similarity Index was developed.

The first four indicators, viz.: (i) households with milch animals; (ii) change in share of the households engaged in dairy activities; (iii) contribution of dairy milk production to the households' income; and (iv) BPL households rearing milch animals, may be considered as relevant national indicators for eradicating extreme poverty at the lowest income strata of the society.

The percentage of households with milch animals has been increasing in both the project and control villages. Before the start of NDP-I, 49 per cent of the households had milch animals, which increased to 53 per cent on completion of the project. Similarly, there were positive changes in the share of households engaged in dairy activities. In the project

villages, 77 per cent of the respondents reported positive changes before the commencement of the project, which went up to 81 per cent on completion of the project. It was also observed that the productive activities performed by the female members of the households were increasing after the implementation of the project. Further, the contribution of dairy income to the incomes of households has been significant.

About 44 per cent of the respondents from the project villages reported that the contribution of dairy income to the total household income, which was already noteworthy before the project, had gone up to 59 per cent on completion of the project. About 60 per cent of the BPL households that were rearing milch animals indicated that the households were engaged in remunerative activities, which, *inter alia*, helped reduce income poverty.

The relevant indicators for assessing the “proportion of the population living in households with access to basic services” are: (i) tap drinking water; (ii) electricity grid connection; (iii) toilet inside the premises; (iv) LPG connection; and (v) households with TV (Table 1).

The Socio-Economic Survey (SES) conducted by NCAER found that about half of the sample households had access to tap drinking water in the project villages whereas the corresponding figure of sample households in the control villages was about 43 per cent. Secondly, electricity grid connections had reached over 95 per cent of the households in both the project and control villages. Third, more than 80 per cent of the households had toilets inside the premises in both the project and the control villages. Fourth, 88 per cent and 84 per cent of the households in both the project and control villages, respectively, owned LPG connections. The ownership of TV by households is a symbol of social status. About, 62 per cent and 56 per cent of the households in the project and control villages, respectively, owned TV sets.

Throughout the developing world, women and girls in rural areas are deeply involved in dairy production. However, women dairy farmers typically face greater challenges than men, including economic, social, and institutional barriers. The interventions under NDP-I helped in reducing poverty and empowering women in a number of ways. Under NDP, the specific focus has been on gender integration at all three levels, that is, at the farmer’s level, functionary level, and institutional level. The following steps were being taken under the project for ensuring greater inclusion of women: (i) promoting the formation of new Women Dairy Cooperative Societies (DCSes); (ii) improving enrolment of women members in the existing and new DCSes; (iii) increasing involvement of women in leadership roles as members of management committees and on boards of milk unions; (iv) including more women as field functionaries and gender integration in all the training and capacity building programmes; (v) ensuring participation of women in capacity building programmes; and (vi) providing advisory services directly to women beneficiaries. The NCAER SES identified a few more possible indicators, viz., (i) facilitating greater participation of women in dairy remunerative activities; (ii) improving the position of women in household decision-making; (iii) ensuring women’s mobility outside the households; and (iv) increasing enrolment of women members in the existing and new DCSes.

The survey found that 66 per cent of the women participated in dairy remunerative activities in the project villages as compared to 50 per cent of their counterparts in the control villages. Secondly, about 77 per cent of the respondents reported an improvement in women’s position in household decision-making in the project villages as compared to a corresponding figure of 64 per cent in the control villages. About 74 per cent and 64 per cent of the women reported an improvement in women’s mobility outside households in the project and control villages, respectively, and 49 per cent reported enrolment of women members in the existing and new DCSes.

Goal 8 seeks the promotion of sustainable economic growth and full and productive employment. The dairy sector also has the tremendous potential to create jobs and reduce inequality, thereby directly contributing to SDG 8 in promoting inclusive and sustainable

economic growth, employment, and decent work for all. Dairying has become an important secondary source of income for millions of rural families and has assumed an important role in providing employment and income-generating opportunities, particularly for marginal farmers and rural women. The NCAER SES indicates that over the study period, there was a significant change in the income levels of farmers across gender in the project villages as compared to the control ones. It is pertinent to note that the incomes of landless labourers along with those of small and marginal farmers changed perceptibly during the course of the project, and by the end of NDP-I, the female members in the respondent households accounted for a higher percentage share of income from dairy activities as compared to their male counterparts. The impact of NDP-I thus emanated from improved income from dairy and milk-related products, as well as enhanced employment through an increase in wages and salaries.

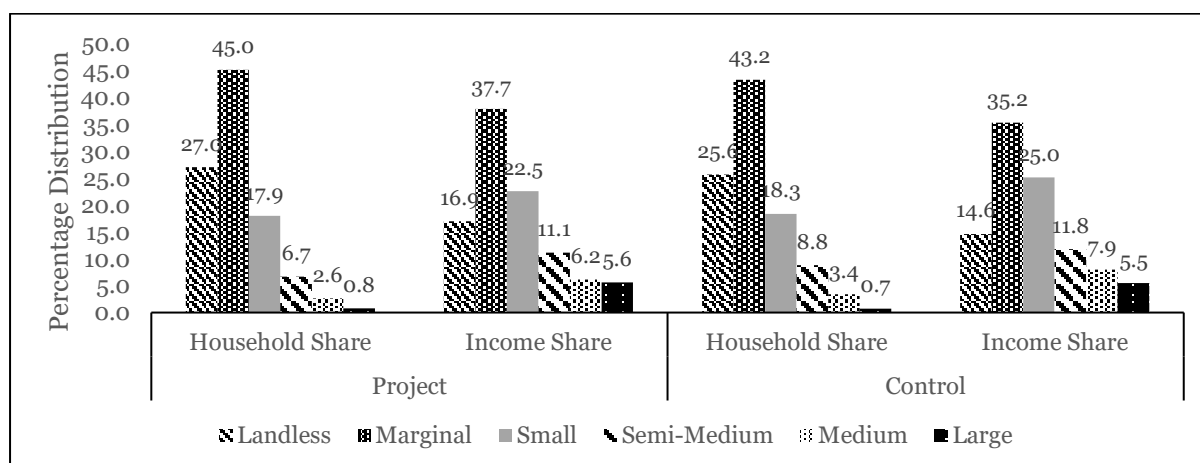
3. Goal 10: Preventing Rising Inequality

SDG 10 calls for reducing inequalities in income, as well as those deriving from sex, age, disability, race, class, ethnicity, religion, and opportunity, both within and among countries (UN, 2016c). SDG 10 is closely correlated to SDG 1 (elimination of poverty) and while there has been progress on poverty reduction over the past decades, the world continues to suffer from substantial inequalities. In this context, institutional reforms in the dairy sector can be very effective in stimulating smallholder entrepreneurship and closing inequality gaps. Dairy rearing is a potent catalyst for growth in smallholder income, growth, with relatively low investment, inputs, and labour costs.

As already stated earlier, NDP-I was basically designed to support the poorest sections of the rural economy in order to enhance their capability of remunerative earnings through dairy activities. The programme was well-intended as its coverage to the poorest strata impacted about 90 per cent of the landless labourers and small and marginal farmers.

The shares of households from the categories of landless and marginal farmers in the project villages, along with their respective income shares, as compared to those in the non-treatment villages for both categories are delineated in Figure 1.

Figure 1: Share of households and incomes among Land Categories in the Project and Control Villages



Source: NCAER field data.

After approximation of the Lorenz curve using data from the Socio-Economic Survey of NCAER, the Gini coefficient observed a value of 0.22 for the project villages and 0.24 for

the control villages. This critically reflects the positive effect of intervention in registering a lower level of inequality for the NDP-I villages in comparison to the control ones, thereby fulfilling one of the critical objectives of the SDGs. However, it may be noted that in the rural areas, the work-related categories were mostly overlapping, which impacted the estimation of the coefficient.

4. Goal 13: Lowering Methane Emissions

SDG 13 calls for urgent action to combat climate change and its impacts on the environment. The relationship between dairy and climate change affects dairy production, e.g., through the quality and availability of feed and forage, and the incidence and prevalence of animal diseases.

Global warming increases the atmospheric concentration of greenhouse gases (GHGs) and methane is one of the major sources of GHGs that comes from ruminant husbandry. According to the report of the Indian Network for Climate Change Assessment (INCCA, 2010), dairy contributes about 50 per cent of the total methane emitted by all the sectors in India. Ruminant animals lose 4-12 per cent of their gross energy intake in the form of methane, which is not only detrimental to the environment but also results in energy loss to animals.

Methane emission from dairy in India, especially after the adoption of NDP-I, was observed to be much lower than the estimates of the International Panel for Climate Change (IPCC), that is, 46 kg per animal per year (*Current Science*, Vol. 91, No. 10). The Ration Balancing Programme (RBP) implemented under NDP-I had the potential to improve milk production efficiency and reduce methane emissions. Animals fed on an imbalanced ration produce more methane per unit of dry matter intake due to lower microbial protein production and higher acetate¹ production, the main substrate for methane production. Studies conducted in the states of Gujarat, Uttar Pradesh, Andhra Pradesh, and Maharashtra specified that feeding a balanced ratio reduced methane emission by 15–20 per cent in lactating animals (IDF, 2011; Kannan, et al. 2010; 2011). The lessening in the methane emission observed in the studied regions is attributed to the balancing of nutrients, which might have changed the rumen fermentation pattern towards more microbial cell production and lower acetate and butyrate production.

Another study was carried out by Kundu, et al. (NDRI) on the impact evaluation of RBP on methane emissions in dairy animals in Punjab. The study observed that the average baseline emission was 22.40 g/kg milk yield, which was significantly reduced by 13.6 per cent ($p < 0.01$) after a balanced ration (19.36 g/kg milk yield) fed to lactating cows. Similarly, in buffaloes, feeding a balanced ration significantly ($p < 0.05$) reduced enteric² methane emission by 11.2 per cent (31.40 versus 27.87 g/kg milk yield). Balanced feeding reduced average methane emission (g/kg milk yield) by about 12.4 per cent in lactating cows and buffaloes.

Kannan and Garg (2009) carried out a study on 22 lactating Jaffarabadi buffaloes and 5 Gir cows under field conditions in Gujarat. Their study reported that the average methane emission reduction, in terms of gram per day and gram per kg DMI (Dry Matter Intake) was 14.14 per cent, and 11.56 per cent in lactating buffaloes, which was lower ($p < 0.01$) as compared to baseline emissions. The corresponding values for cows were 13.29 per cent and 10.87 per cent, respectively, and methane emission was also lower ($p < 0.01$ and $p < 0.05$) than the baseline emission.

A field condition study was carried out by Subhash, et al. (2016) in two villages in the

¹ Acetate is a major nutrient that supports acetyl-coenzyme A (Ac-CoA) metabolism.

² Enteric methane is one by-product of the digestive process of the ruminants and is expelled by the animal through burping (FAO).

Anand district of Gujarat on 37 early lactating cows and it was observed that balanced feeding reduced the average methane emission (g/kg milk yield) by about 15.21 per cent in experimental animals.

The above studies indicate that ration balancing programme (RBP) has the potential to improve milk production efficiency and reduce methane emissions with an increase in the net daily income of milk producers. Thus, the large-scale implementation of this programme can help in improving the productivity of milch animals in an environmentally sustainable manner.

5. Goal 15: Sustainable Use of Terrestrial Ecosystems and Land

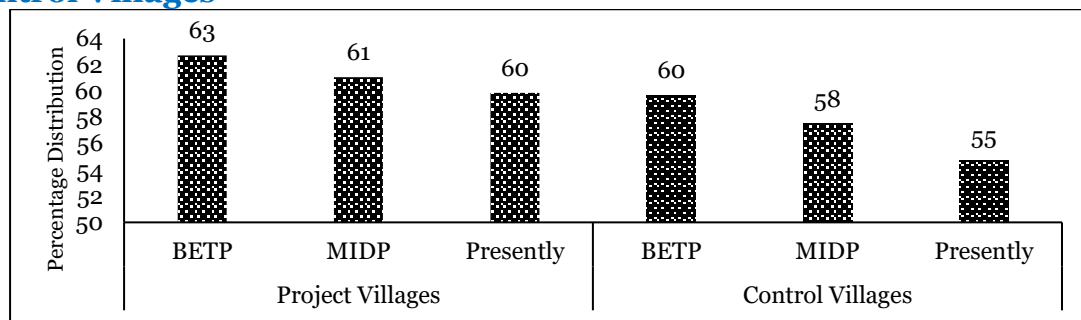
SDG 15 focuses on reducing degraded natural habitats and fighting biodiversity loss. Across the globe, natural resources are deteriorating, ecosystems are under stress, and biological diversity is getting depleted. While the dairy sector plays a part in biodiversity reduction, land degradation, and deforestation, it also provides invaluable services that protect, restore, and promote the sustainable use of terrestrial ecosystems, combat reverse land degradation, and halt biodiversity erosion. The various schemes and programmes implemented under NDP-I attempted to ensure that the balance of the ecosystem is maintained. The credible link between Goal 13 and the impact of the NDP-I intervention has been summarised as follows.

To ensure the conservation, restoration, and sustainable use of terrestrial and inland freshwater ecosystems and services in forests, wetlands, mountains, and drylands by 2030, NDP-I aimed at improving the productivity of fodder crops and common grazing lands, by conserving surplus green fodder to enhance its availability during the lean period. Some of the focused areas of operation under NDP-I were aligned with the fundamental realms of the SDGs. Under the Fodder Development Programme of NDP-I, certified fodder seeds were promoted to increase fodder production. Field demonstrations of mowers, silage making, and biomass storage silos are being carried out to popularise these technologies among farmers. The Socio-Economic Survey of NCAER indicates that fodder development activities are observed to be more significant in the NDP-I villages as compared to the non-NDP ones. Efforts were also made to re-vegetate grazing land, which is imperative for the growth of cattle.

Animal waste is a major environmental concern, as it releases large quantities of carbon dioxide and ammonia into the environment, which could contribute to acid rain and the greenhouse effect. As a result of dung management in the villages where NDP-I was implemented, the use of biogas and slurry pits showed an increase in the project villages as compared to the control ones, reflecting greater awareness about and transition towards the attainment of the SDGs (NCAER-SES). It is essential to build effective drainage outlets for animal sheds for ensuring better management of residuals and hygiene. Over the years, there has been a substantial reduction in '*kutch*' drainage and an increase in '*pucca*' cemented drainage for releasing wastewater from the cattle sheds. The NCAER SES reveals that there was a marked reduction in households using drainage to open areas during the project, falling from 49 per cent of the households before implementation of the project in the treatment area to 39 per cent on completion of the project. As regards the use of 'inland freshwater ecosystems', the NCAER SES reports that about 49.0 per cent of the households in the project villages were using tap water as compared to 43.0 per cent of the households in the control villages. Consequently, the percentage of households using wells was about 11.0 per cent in the project villages as compared to 13 per cent in the control villages. This indicates that the increase in income from dairy activities in the project villages due to the implementation of NDP-I enhanced the capacity of the households to opt for tap water connections.

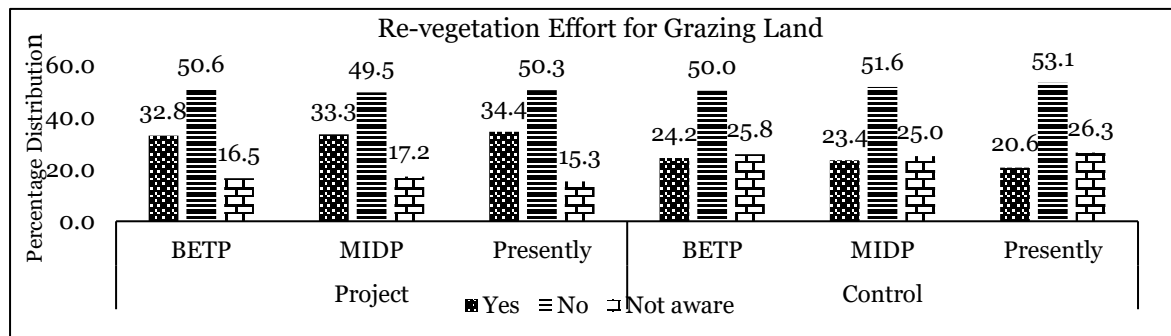
One of the crucial mandates of the SDGs is to combat desertification, restore degraded land affected by drought and floods and strive to achieve a land degradation-neutral world by 2030. The Socio-Economic Survey of NCAER observed a decline in the availability of common grazing land in both the NDP-I and control villages (Figure 2). The major reason for this decline has been the allotment of common grazing lands by the government for various other activities. NDP-I aimed at re-vegetation of the degraded grazing land due to over-grazing and over-exploitation by strengthening the institutional arrangements at the village level (Figure 3). The success achieved by NDP-I in terms of the re-vegetation completed in the project and control villages is shown in Figure 4.

Figure 2: Percentage Share of Common Grazing Land in the Project and Control Villages



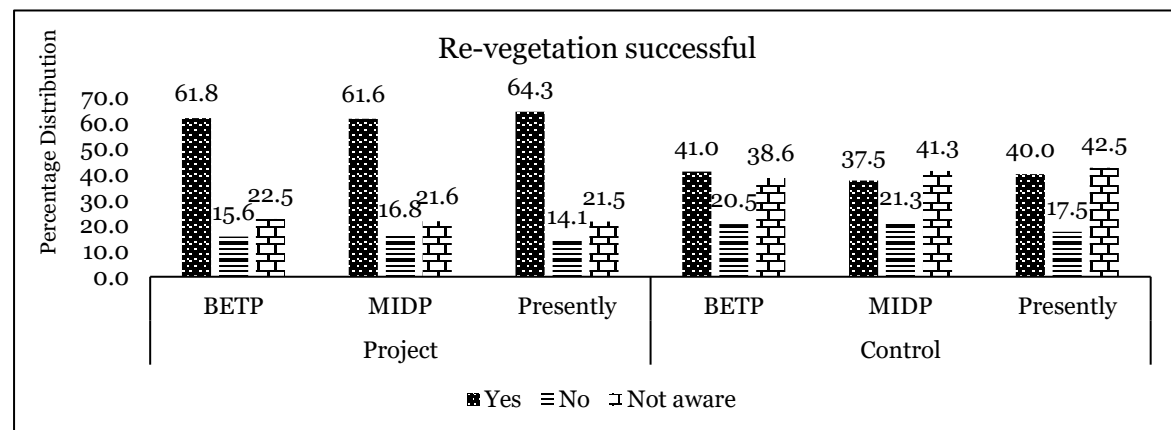
Source: NCAER field data.

Figure 3: Re-vegetation in Selected Project and Control Villages



Source: NCAER field data.

Figure 4: Achievement of Re-vegetation Efforts in Selected Project and Control Villages



Source: NCAER field data.

Another mandate of SDG 15 is to promote fair and equitable sharing of the benefits arising from utilisation of genetic resources and enable appropriate access to them. The intervention towards the production of high genetic merit (HGM) bulls, semen production, and the pilot model for door-to-door AI delivery services resulted in a higher share of crossbred cows in the project areas, whereas the share of indigenous cows and buffaloes was higher in the villages without project intervention. Further, the share of crossbred cows in the milch animal population increased in the project areas more sharply than in the comparable non-treatment villages (NCAER Study, 2019).

In view of the NDP-I intervention and its overall impact, a 'big increase' in income was reported by more than 21 per cent of the households in the project villages as compared to 16.8 per cent of the households from the non-intervention villages. A 'small increase' in income was attained by more than 50 per cent of the households in the project villages as compared to a corresponding figure of only 27.5 per cent in its counterpart. Among the social groups, 28 per cent, 36 per cent, and 32 per cent of the SC, ST, and OBC households respectively in the project villages reported a higher contribution of dairy to their total household incomes while the corresponding proportions of such households were comparatively lower in the non-intervention villages. The proportion of households in the project villages reporting an increase in income due to more than two hours of involvement in dairy activities was 77 per cent as against only 53 per cent in the control villages. (NCAER-NDDDB Study). At the national level, the increase in the share of the livestock sector GVA to the agriculture sector GVA has gone up from 21.8 per cent in 2011-12 to 28.4 per cent in 2017-18 which largely be attributed to the effective implementation of various NDP-I initiatives.

6. Goal 16: Promoting Inclusive Societies and Institutions

SDG 16 emphasises on the promotion of inclusive societies and institutions as a crucial constituent for re-aligning with the objectives of the SDGs. Societies and institutions are the major sources of outreach for a targeted impact through the delivery of welfare services to the poor and marginalised sections of society.

The Village-Based Milk Procurement System (VBMPS) under NDP-I aims at providing rural milk producers greater access to organised milk processing activities by forming and strengthening Dairy Cooperatives Societies (DCSes) and Producer Companies. Apart from the formation of new societies, existing societies/cooling points are also being strengthened by providing them with village-level capital assets like Bulk Milk Coolers (BMCs), milk cans, etc. Strengthening of the DCSes and producer companies through Data Processor-based Milk Collection Units (DPMCU) and Automatic Milk Collection Units (AMCU) has resulted in greater transparency and fairness in milk procurement operations while the installation of BMCs has given farmers more flexibility in terms of both increasing the quantity as well as improving the quality of milk. The Socio-Economic Survey of NCAER shows that 65.6 per cent of the project villages had DCSes within the village and 9.6 villages had societies in the adjacent villages.

Dairy cooperatives are the crucial channel for marketing, buying milk at a price objectively based on the quality of milk determined by various testing facilities available in the societies. The project villages were found to be better equipped with milk testing facilities as compared to the villages without NDP-I. Most of the dairy processed products, cattle feed, AI services, and mineral mixtures were being provided at reasonable prices to the dairy cooperative members in the villages. In most of the cases, the payments for these services were being settled by the DCSes against the payments to be made to the dairy farmers. However, the level of support in such cases was proportionate to the amount of milk procured and the amount due for payment. This was found to be common across the states of Punjab and Gujarat and was also used as a strategy to prevent dairy farmers from shifting to middlemen from the DCSes.

It was observed that some people were entirely dependent on the growth of the cooperatives for sustenance. However, loss of accountability at the village level can be detrimental to the basic foundation of the cooperatives. In the case of Bihar, for instance, the lack of access to infrastructure at all levels has somewhat hindered the progress of the dairy sector. To enhance the procurement of milk, NDDDB envisaged mobilisation and institution building through the promotion of new Milk Producers' Institutions (MPI) and New Generation Cooperatives (NGCs), which would have to be registered subsequently as Producer Companies under the Companies Act. The field data of NCAER observed that around 20 per cent of the Project villages and 7 per cent of the Control villages have NGCs.

BMCs are observed to be crucial for strengthening the value chain. A better substitute to the present collection system is cooling of milk immediately after milking in Bulk Milk Chilling Units (BMCU) which has become popular in the recent past because it not only helps in increasing the shelf-life of milk but also provides a systematic and simple way of procuring milk from the untapped remote areas. Project villages are better off in terms of the availability of BMC facilities and Genset facilities for uninterrupted operations of BMC as compared to the villages without intervention.

The various State Federations (SFs) remained the key to the impact on markets and profitability concerning NDP-I interventions. The role of the State Milk Federations (SMF) is changing due to the demand-driven market for milk in India. For instance, federations are competing for new markets with the removal of restrictions associated with milk shed areas and also the expansion of existing markets in the backdrop of rising industrialisation and urbanisation.

Milk Unions (MUs) primarily work under the overall guidance of the SFs and are responsible for the procurement and processing of milk. The level of dependency and autonomous functioning of the MUs vary across the states. Although guided by the SFs on certain aspects, the MUs follow their own set of approaches to increasing the participation of the producers. The MUs of some of the districts have tried to innovate, such as in the case of the Banaskantha Milk Union, which has introduced numerous pioneering schemes. Banaskantha in Gujarat is situated in a desert area with a lack of scope for industrialisation. The local people here joined actively in the integrated business of milk by initiating cooperative activities through MUs. It has not only invested in training and capacity-building but has also coordinated its activities with other government schemes, apart from initiating some of its own schemes.

The participation of the SC/ST population in dairy activities is dependent on several factors related to the development of dairying across regions. The feedback received from stakeholders from the States revealed a common pattern, wherein major concerns are linked to limited understanding of dairying and lack of access to monetary resources like seed capital, credit, and the absence of alternative sources of income. However, the families already involved in dairying have not reported any kind of grievance faced at the DCSes level.

The type of participation, however, is mostly determined by education levels, prevailing gender dynamics as well as the opportunities available in the region. Some of the MUs in Karnataka (for example, Kolar) have encouraged the training of female workers as artificial insemination (AI) technicians. On the other hand, in states like Punjab, a shift in the use of migrant labour for work purposes has been observed. Among members of the lower socio-economic categories, women have continued to play an important role in dairying at both the household and DCSes levels.

Among various breed development processes, AI is one of the most effective practices available to dairy farmers for improving the productivity and profitability of their business on a long-term basis. In AI, a few superior-quality bulls are efficiently used to expand the breeding coverage for a large number of dairy cows, apart from their location. The usage of AI services in the project villages went up from 59 per cent to 67 per cent in the NDP-I

villages as per the SES survey of NCAER, while it went up from 26.3 per cent to 33 per cent in the villages without intervention. It is also observed that AI constituted a major part of the application for cross-bred cows in the project villages (45%).

Five major service providers have been providing AI services to the dairy farmers in the study area. Nearly 22 per cent of the project villages had availed of the service from milk cooperative workers and government veterinary doctors followed by private veterinary doctors (21.2%) and mobile AI technicians (18.2%). In the non-intervention villages, the major AI service providers were private veterinary doctors (38.2%), followed by government veterinary doctors (23.5%) and milk cooperative workers (19.1%), respectively. The AI services were also being provided by Government veterinary hospitals and dispensaries. Some of the states had integrated the AI services provided by the veterinary department with the other service providers in the field. The MUs too were taking interest in the provision of AI services in the village, though their intervention was partial in terms of providing training and ensuring the supply of liquid nitrogen (LN) and semen doses to the AI service providers. The quality of AI services through the use of semen doses provided by the MUs was reportedly adequate.

A major impediment to the growth of the livestock sector is the prevalence of diseases like Foot and Mouth Disease (FMD), Peste des Petits Ruminants (PPR), Brucellosis, Anthrax, Hemorrhagic Septicemia (HS), Black Quarter (BQ), Classical Swine Fever (CSF), Ranikhet Disease (RD), and Avian Influenza (AI), among others, adversely affects animal productivity with a higher rate of illness and mortality. The presence of diseases discourages domestic and foreign investment in the livestock sector. It was observed that during the pre-project period, serious diseases were common in 51 per cent of the project villages and 53 per cent of the control villages. However, as a result of various animal disease control-related programmes and interventions, this incidence was reduced to 46 per cent in the project villages and 42.1 per cent in the control villages. The veterinary departments across states have not been able to raise the service delivery system up to the expectation of the dairy farmers in most of the states.

7. Conclusion

Dairy development in India is based on a small-holder production system model linked to an institutional network with a significant contribution from women. This sector, therefore, helps address various SDGs, including Goal 1 in reducing poverty, Goal 5 in improving gender equality, Goal 8 in ensuring inclusive economic growth, Goal 10 in preventing rising inequality, Goal 16 in terms of promoting inclusive societies and institutions, Goal 13 in achieving lower average per-unit methane emissions as compared to the regional average, Goal 15 in facilitating the sustainable use of terrestrial ecosystems and land, Goal 13 in bringing down the average per unit methane emissions as compared to the regional average, and Goal 15 in terms of ensuring the sustainable use of terrestrial ecosystems and land.

The demand for dairy products in India is likely to grow positively in the coming years, driven by higher incomes and greater nutritional awareness among a significant portion of the population. The demand for processed and packaged dairy products too is increasing in urban areas. In many parts of the country, however, consumers still prefer unpacked and unprocessed milk delivered by a local milkman because of its taste and the perception of freshness. The price sensitivity for milk is high and its demand is strongly linked to price changes.

Dairying involves activities coordinating quality animals, human resources, technical skills, land, capital, credit, infrastructure, and other inputs relevant to the value chain. The quality of animals is critical in determining the volume of milk output and productivity. NDP-I has reportedly helped increase the milk yield through effective cattle and buffalo breeding programmes and scientific feeding methods that have enhanced the availability and affordability of quality feed and fodder. Following effective AI breeding intervention, the

proportion of high-yielding breed cows has gone up in the NDP-I villages through the semen stations along with procurement, production, and distribution of breeding inputs through capacity building programmes that involve women's role in cattle rearing.

Before NDP-I, raising the productivity of milch animals was one of the major challenges due to frequent occurrences of diseases like foot and mouth, black quarter infection, influenza, etc. which affected the health of the in-milk cattle, thereby lowering the rate of yield. The situation has considerably changed through intervention, following which the growth of milk production has gone up significantly. Along with measures for sustaining milk production and dairy activities, NDP-I, through village-based milk procurement systems (VBMPS), has boosted the share of the organised market which was earlier dominated by an informal market that exploited the producers in most cases. The programme also extended the benefits of collective bargaining capacity for the landless, marginal, and small producers.

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