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Role of Co-Operative Network For the Management of Bovine Female Infertility Disorders in Gujarat

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ABSTRACT

The co-operative network in Gujarat, India, has given the livestock sector a new direction for growth. The co-operative sector's dairy husbandry department not only deals with treatment of ill animals but conducts extensive management programmes for infertility. Various programmes like fertility improvement programmes, calf rearing programme, ration balancing programme, productivity enhancement programme, village awareness progress, and training of artificial inseminators are in operation for fertility enhancement. The present review describes the impact of these programmes on fertility based on collected data from various co-operatives of Gujarat

Introduction

The socio-economic status in rural India has improved owing to huge livestock resources. Both livestock and agriculture production are fundamentally coupled and inter-dependent for food security. The value of the livestock sector was about Rs. 8,11,847 Cr during year 2015-16, which is approx. 28.60% of agriculture and allied sector's output (Central Statistics Office (CSO); Annual Report- 2017-18, Department of Animal Husbandary). The livestock keeping provides livelihood and thus plays an essential role in India's economy.

There are about 300.00 million bovines in the country, as per the 19th Livestock Census (Fig. 1). The livestock share in agricultural GDP has increased to 30% from 14% in the last decade. The livestock segment has role in employment generation and socio-economic security to dairy farmers with an annual rate of 4%. Milk production rose to 209.96 million tons (MT) during 2020-21 from 198.44 MT in 2019-20 in India, accounting for 21% of the global output, According to Food and Agriculture Organization Corporate Statistical Database (FAOSTAT). The compound annual growth rate (CAGR) of livestock was 7.93% from 2014-15 to 2020-21. The livestock product exports were 2.1% (₹449 billion) of the total export earnings during 2020-21. The stake of the livestock sector in the Gross Value Added (GVA) of the agriculture and allied sector has increased from 24.38 to 30.87% between 2014 and 2021. The Periodic Labour Force Survey (PLFS) during July-2019 and June-2020 revealed human resources engagement in animal rearing and mixed farming are between 2.85 and 1.58, respectively,

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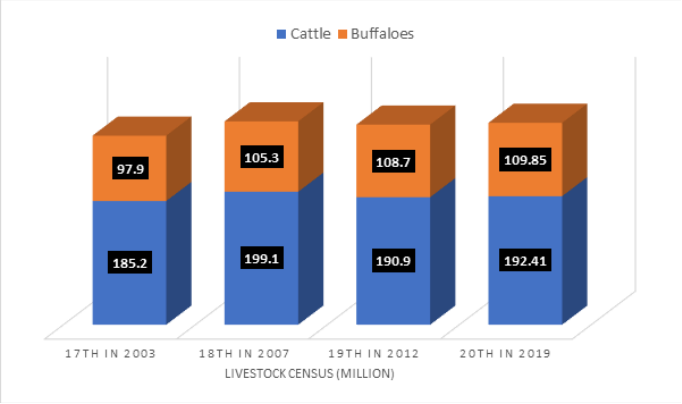

Fig. 1. Livestock population (Millions) of India

Livestock status and milk map of Gujarat

Gujarat is the country's fourth largest milk producer (Table 1), with only five percent livestock population (Table 2, 3). Gujarat contributes more than seven per cent to the national Gross Domestic Product. Agricultural output grew at a higher annual rate than the all-India (2005-06 to 2012-13).

(Basic Animal Husbandry & Fisheries Statistics, GOI, 2019-20)

The livestock is a primary/secondary income source for approximately 43 lakh families in Gujarat. Livestock output at constant prices was reported at 141 billion in 2011-12, of which milk contributes about 86% (122 billion). The livestock sector comprising milk, meat, egg, dung, and others, contributes five percent of the total GDP of Gujarat, or 23% of the agriculture and allied sectors (Dairying in Gujarat, A Statistical Profile, 2013). Milk production is one of the most significant producers of dairy husbandry for supporting livelihood in the state.

The Amul federation of Gujarat, comprised of eighteen unions, has more than 36 lakh livestock farmers from 18,700 villages procuring an average of 211 lakh liters milk/day which is 20.0% higher than last year (2016-17) (https://amul.com/files/pdf/GCMMF-sales-Turnover-2017-18-01042018-English.pdf). Gujarat contributes 7.75% of milk to the total milk production of India. This contribution is from 17 co-operative dairy unions and 25 private dairies. These unions collect 3.45 billion liters of milk from 30 lakh producers affiliated with more than 15,000 Primary Milk Co-operative Societies. Despite the active dairy sector in most of the districts, some still need to be brought into the active dairy network.

Milk production

The vital livelihood of millions of Indian rural families made India the highest milk producer in the world. Small, marginal and landless farmers/laborers produce most of the milk in the country. The several measures to increase the productivity of livestock initiated by the government have resulted in increased milk production from 102.6 million tonnes (Tenth Plan, 2006-07) to 127.9 million tonnes (Eleventh Plan, 2011-12). Milk production during 2015-16 and 2016-17 is 155.5 and 165.4 MT, respectively, showing an annual growth rate of 6.37%. The 198 co-operative dairy unions have covered about 16.30 million farmers of 1,77,314 village-level dairy co-operative societies and procured an average of 428.40 lakh kg milk per day during the year 2016-17, with an increase of 13.20% compared to 2015-16. Milk production in the country has arisen to 209.96 MT in 2020-21 from 146.31 MT in 2014-15 (Fig. 2). Milk production grew at a compound annual growth rate of about 6.20% from 2014-15 to 2020-21 in the country.

Table 1: Top ten milk producing states during 2012-13 to 2020-21 (in 000 tonnes)

Sr. No	States	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
1	Uttar Pradesh	23330	24194	25198	26387	27770	27770	29052	30519	31864
2	Rajasthan	13946	14573	16934	18500	20850	20850	22427	23668	25573
3	Madhya Pradesh	8838	9599	10779	12148	13445	13445	14713	15911	17109
4	Gujarat	10315	11112	11691	12262	12784	12784	13569	14493	15292
5	Andhra Pradesh	12762	13007	9656	10817	12178	12178	13725	15044	15263
6	Punjab	9724	10011	10351	10774	11282	11282	11855	12599	13348
7	Maharashtra	8734	9089	9542	10153	10402	10402	11102	11655	12024
8	Haryana	7040	7442	7901	8381	8975	8975	9809	10726	11735
9	Bihar	6845	7197	7775	8288	8711	8711	9242	9818	10480
10	Tamilnadu	7005	7049	7132	7244	7556	7556	7742	8362	8759

Table 2: Detailed classification of livestock female population (000's) in Gujarat from 2003-07 and 2012-19

Cattle						
A. Crossbred	**2003**	**2007**	**% increase**	**2012**	**2019**	**% increase**
(1) Under 1 year	93359	177515	90.14	323129	659282	104.03
(2) 1 to 2.5 years	88058	180669	105.17	362569	677438	86.84
(a) In milk	250787	397177	58.37	732208	1400482	91.27
(b) Dry	67108	127799	90.44	230633	438358	90.07
(c) Not calve even once (with other)	21833	47544	117.76	85622	94692	10.59
(d) Total (a to c)	339728	572520	68.52	1048463	1933532	84.42
(3) Total Female	521145	930704	78.59	1734161	3270252	88.58
B. Indigenous						
(1) Under 1 year	570676	632155	10.77	791051	927684	17.27
(2) 1 to 3 years	585999	632402	7.92	1148960	888382	-22.68
(3) Over 3 years						
a) In milk	1405897	1334414	-5.08	1910247	1584675	-17.04
(b) Dry	713589	669140	-6.23	867115	799497	-7.80
(c) Not calve even once (with others)	222311	249579	12.27	315120	176406	-44.02
(d) Total (a to c)	2341797	2253133	-3.79	3092482	2560578	-17.20
(4) Total Female	3498472	3517690	0.55	5032493	4376644	-13.03
Buffaloes						
(1) Under 1 year	1089584	1363308	25.12	1950283	2104664	7.92
(2) 1 to 3 years	1151730	1564758	35.86	1953765	2234038	14.35
(3) Over 3 years						
(a) In milk	2793530	3040460	8.84	3534030	3823293	8.09
(b) Dry	1143732	1349517	17.99	1544788	1487793	-3.69
(c) Not calve even once (with other)	294828	439395	49.03	566933	359983	-36.50
(d) Total (a to c)	4232090	4829372	14.11	5645751	5671069	0.45
(4) Total Female	6473404	7757438	19.84	9549799	10009771	4.82

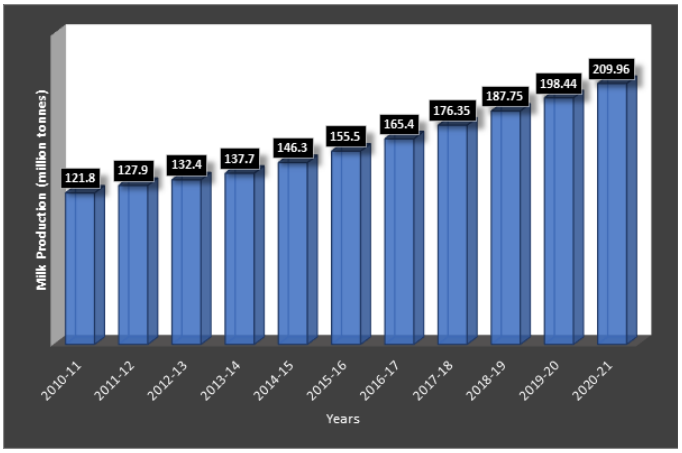

Fig. 2. Annual milk production (million tonnes) during 2010-11 to 2020-21

The daily milk consumption was 1077gms/person in 1970 and 427gms/person in 2021. The per capita availability of milk has reached a level of 355 gms/day during the year 2016-17, which is more than the world average of 302 gms/day.

The Fertility

The term fertility refers to an ability of a dam to deliver a normal healthy calf in a defined period (Arthur, 1982). Dairy cows should be pregnant at an optimal interval after calving for the most profitability and sustainability in the dairy industry (Sakaguchi and Minoru, 2011). There has been an increase in milk production per cow and

Table 3: Number of animals in milk during 19th & 20th livestock census

Category		19th Census 2012 (In million)	20th Census 2019 (In million)	% Change
Buffaloes	**In-Milk**	36.57	38.16	4.34
	Dry	14.48	13.01	-10.19
	Milch Animal (In-Milk+Dry)	51.05	51.17	0.22
Exotic/Crossbred Cattle	**In-Milk**	13.30	20.00	39.80
	Dry	5.12	5.67	10.80
	Milch Animal (In-Milk+Dry)	19.42	25.67	32.20
Indigenous Cattle	**In-Milk**	29.65	31.98	7.87
	Dry	18.48	16.53	-10.53
	Milch Animal (In-Milk+Dry)	48.13	48.51	0.81

https://static.pib.gov.in/WriteReadData/userfiles/key%20results.pdf

a decline in fertility over the past five decades (Walsh et al., 2011). Infertility and reduced fertility cause a reduction in the number of lactations that may account for 10 to 30 per cent (Erb and Martin, 1980). Infertility is complex and multifactorial, hence can't be assessed alone from other sub-clinical diseases and disorders, however Ahmed (2014) has summarized the causes of infertility in cattle and buffaloes (Fig. 3). Many factors, including bull, method of insemination, cow, and conditions of herd management influencing fertility, are widely reviewed and investigated. Particular attention is paid to factors related to the conditions of herd management, viz., climate, season, herd size, housing system, choice of a bull, hygiene at the time of calving, the interval between parturition and first insemination, estrus detection, insemination time, nutrition, selection, and culling criteria (De Kruif, 1978). Reproductive performance influences the profitability of dairy farms either by increasing or decreasing milk yield, culling rate, and the market price of dairy cows. It can be affected by genetic makeup (hereditary), external factors (environment and management: malnutrition, lack of follow-ups, stress), and their interactions (Abraham, 2017). The disorders during the peri-parturient period, viz., hypocalcemia, retained placenta (RFM), mastitis, and lameness, negatively impact the cow's subsequent fertility. Supplementing vitamins, minerals, trace elements, etc., is vital in preventing such disorders during the peri-parturient period (Wilde, 2006). The post-partum negative energy balance (NEB) also leads to adverse outcomes and is a significant element contributing to the pathogenesis of infertility (Walsh et al., 2011).

In short factors that determine fertility are:

F = Farmer

E = Estrus detection

R = Ration to animal

T = Time of insemination

I = Inseminator

L = Low semen quality

I = Infection

T = Treatment effectiveness

Y = Yield status of an animal

Genetic Interactions affecting fertility are as follow (VanRaden et al., 2007):

1. Lethal recessive genes that includes
   a. CVM (Complex Vertebral Malformation) aborts pregnancy 30-280 days
   b. DUMPS abort an embryo at ~45 days
   c. New defect causes loss at ~5 days
2. Inbreeding reduces fertility
3. Crossbreeding improves fertility: 1.8% increase in pregnancy rate

Infertility is a matter of serious concern in Indian livestock. The buffalo's low reproductive efficiency remains a significant global economic problem with higher incidences (Kumar et al., 2009). Anestrous and repeat breeding is the most serious reproductive problems, affecting 30-40% of the total bovine populations resulting in the annual loss of 20-30 MT milk, which translates to the annual loss of nearly Rs. 50,000 crores. The increased open days of one estrous cycle cause production loss of 20-25 days in addition to treatment costs, labor, etc. (Chakurkar et al., 2008). Besides being non-productive, such animals also share fodder and water resources and contribute an immense burden to the livestock owner. All these substantially reduced the financial returns due to the reduced number of pregnancies and lactations.

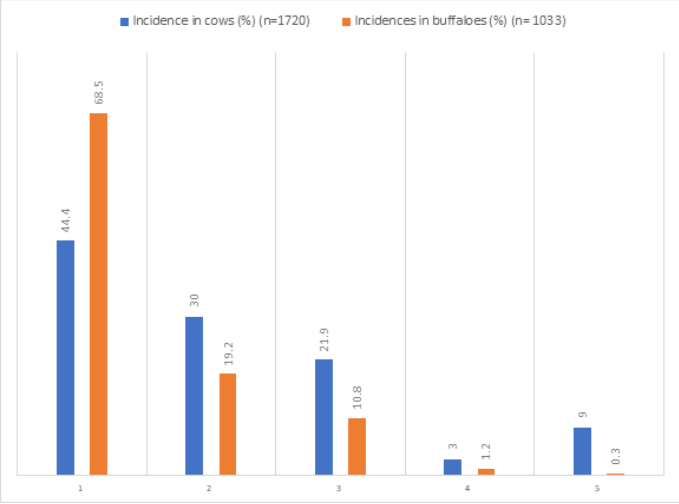

Fig. 3. Causes of infertility described by Ahmed (2014)
1-Inactive ovaries; 2-Endometritis; 3-Silent heat; 4-Pyometra/Hydrometra/ Mummified foetus; 5-Ovarian cyst

Considering the above facts, Gujarat Milk Marketing Federation (GCMMF) Ltd. conducted an internal animal census in 2005 in which it was found that the population of non-productive animals, i.e., 4.41 lakhs NPG Dry (Non-Pregnant Dry) & 4.8 lakhs NPG NECO (Non Pregnant-Not Even Calved Once) animals increased enormously. The 24% of the total animal population was either NPG NECO or NPG dry animal, hence non-productive. On a conservative estimate cost of Rs.15,000 per animal, assets worth Rs.1,38,150 lakhs were non-productive. Considering the expenditure of just Rs. 20.00 per day per animal, these animals are inducing a burden of Rs. 67,233 lakhs per year. Survey data results served as a stimulus for GCMMF to take the initiative and start fertility enhancement programs in milk sheds of member unions. To make the dairy industry more profitable in milk shed areas of Gujarat, the GCMMF has chosen several plans of action, including a fertility improvement program (FIP), productivity enhancement program (PEP), calf rearing program (CRP), ration balancing program (RBP), area specific mineral mixture, farm consultancy service, vaccination, refresher training to the A I workers, village awareness program (VAP) and other efforts to improve fertility are implemented with a modus operandi as discussed below.

Fertility Improvement Programme

The Fertility Improvement Programme (FIP) is designed & implemented by GCMMF to improve the fertility of infertile/unproductive animals in target villages. It is being implemented in 10 member Unions of GCMMF. Presently twelfth phase of FIP is under implementation. The NECO (Not Even Calved Once) and NPG- dry animals are registered by ear tagging and specially treated repeatedly by an expert team of Veterinary Doctors in four rounds of fertility improvement camps in a year. Besides this, mineral mixture and deworming are also given to each infertile animal registered under FIP during the camps. All animals of the village are also covered under deworming and vaccination campaigns. Apart from this, to improve the energy balance of animals, two bags of cattle feed are also provided to the farmer.

Fertility Improvement Programme: Activities to be undertaken

1 Selection of village dairy co-operative societies (VDCS): The village level dairy co-operative societies are being selected to implement FIP.
2. VAP & revisit of AI module: The village awareness programme is conducted, followed by evaluating artificial insemination activities in the selected dairy co-operative.
3. Baseline survey of selected DCSs: The survey regarding animal population, including NPG dry and NECO dairy animals, is undertaken in the selected dairy co-operative societies.
4. Mass deworming campaign: All the dairy animals in the selected dairy co-operatives are dewormed on a mass basis.
5. Tagging and registration of animals: All the NPG dry and NECO dairy animals will be registered by ear tagging.
6. Fertility camp at village level: Expert team of Veterinary Doctors in four rounds of fertility improvement camps in a year treats all the NPG dry and NECO dairy animals registered.
7. Increase mineral mixture supplement: The livestock owners in the selected dairy co-operatives are motivated to use the mineral mixture to feed their dairy animals.
8. Mass vaccination campaign: The mass vaccination of foot and mouth disease (FMD) and haemorrhagic septicemia (HS) is also carried out in the selected villages. Further, immunization against Brucella is also mandatory in these villages.
9. Urea straw treatment demonstration
10. AI refresher training: The refresher training for artificial inseminators is also one of the key features of FIP, to enhance the conception rate and thereby improve fertility.
11. Extension education program: The livestock owners of the selected villages are educated about dairy husbandry practices, i.e., feeding, watering, housing, milking, and reproduction.
12. Networking of VDCSs: Providing computers and software to the societies for data recording and analysis.

13. Computer training for AI workers
14. Computer training for the FIP team
15. Data entry by specific software

Implementation process of FIP

1. Awareness programme, registration & tagging of the unproductive animals in first – the camp, diagnosis and treatment, and data entry.
2. Registration & tagging of the unproductive animals – diagnosis, treatment, and data entry in the second camp.
3. The third and fourth camp: Only diagnosis, treatment, and data entry.

Tables no. 4, 5, 6 and 7 show the success rate of Banas, Sumul, Baroda, and Dudhsagar dairy. The overall average success rate is more than 70% in all these co-operative dairies of Gujarat state.

Table 4: Animals registered and success rate of Banas dairy under fertility improvement programmes

Years	Registered			Pregnant		
	NECO	DRY	TOTAL	NECO	DRY	TOTAL
(2009-10)	3889	3027	6939	2768 (71.17%)	2359 (77.93%)	5147 (74.17%)
(2010-11)	4165	3208	7373	2861 (68.69%)	2478 (77.25%)	5339 (72.41%)
(2011-12)	2652	4320	6972	2058 (77.60%)	3030 (70.13%)	5088 (72.98%)
(2012-13)	1907	3609	5516	1482 (77.71%)	2546 (70.54%)	4028 (73.02%)
(2013-14)	3609	1907	5516	2546 (70.55%)	1485 (77.87%)	4031 (73.08%)
(2014-15)	23623	18725	42348	16939 (71.71%)	14537 (77.63%)	31476 (74.33%)
(2015-16)	22620	12745	35365	16251 (71.84%)	10414 (81.71%)	26665 (75.40%)
(2016-17)	25130	18400	43530	18081 (71.95%)	14613 (79.42%)	32694 (75.11%)
(2017-18)	29600	20004	49604	20494 (69.24%)	16003 (80.00%)	36497 (73.58%)
2018-19	982	1365	2347	641 (65.27%)	774 (56.70%)	1415 (60.28%)
2019-20	1318	1612	2930	886 (67.22%)	917 (56.88%)	1803 (61.53%)
2020-21	31619	39305	70924	22311 (70.56%)	23807 (60.56%)	46118 (65.02%)

Table 5: Animals registered and success rate of Sumul dairy under fertility improvement programmes

FIP year	No of registered animals	Conception rate (%)
First	13,099	82.20
Second	14,750	80.20
Third	14,796	80.00
Fourth	12,675	80.00
Fifth	10,068	79.00
Sixth	7,546	78.00
Seventh	39,011	78.00
Eighth	22,494	76.60
Ninth	25,727	75.00
Tenth	37,225	72.9
Eleventh	41,011	71.95
Twelfth	47,822	72.04
Thirteenth	39,393	71.46

Source: https://www.sumul.com/fertility-improvement-programme.html (28/01/2023)

Table 6: Animals registered and success rate of Baroda dairy under fertility improvement programmes

Year	Registered animals	Pregnant animals	Result
2007-08	4617	2907	63%
2008-09	6199	4506	73%
2009-10	5298	3831	72.31%
2010-11	5115	3654	71.43%
2011-12	4526	3327	73.50%
2012-13	4297	3236	75.30%
2014-15	8277	6289	75.98%
2015-16	6605	4762	72.10%
2016-17	5236	3856	73.64%
2017-18	6453	4799	74.37%
2018-19	6600	4776	72.36%
2019-20	6941	5278	76.04%
2020-21	7183	5704	79.40%

Source:https://barodadairy.in/fertility-improvement-programme/(28/01/2023)

Table 7 Animals registered and success rate of DudhSagar dairy under fertility improvement programmes

Particulars	2010-11	2011-12	2012-13	2014-15	2015-16
DC covered under the Program	121	114	116	246	290
Total animals	81541	69577	155886	307966	272588
Breedable population	67680	57947	109744	213893	165179
Dry & NECO animals	7514	7128	19993	30213	21888
Registered animals	7025 (93%)	6992 (98%)	8568 (43%)	25585 (85%)	18512 (85%)
Pregnant animals	5622 (80%)	5667 (81%)	6915 (81%)	20232 (79%)	14809 (80%)

Source: http://www.dudhsagardairy.coop/animal-husbandry/projects/fip/ (23/03/2019)

Table 7: (Cont..) Animals registered and success rate of DudhSagar dairy under fertility improvement programmes

Particulars	2016-17	2017-18	2018-19	2019-20	2020-21
DC Covered under the Program	250	364	363	364	364
Total Animals	359004	361020	452322	358205	512294
Breedable Population	264248	262810	332264	272350	329673
Dry & NECO Animals	30730	45380	44849	44527	45405
Registered Animals	21321 (69%)	31775 (70%)	33248 (74%)	31976 (72%)	32379 (71.31%)
Pregnant Animals	17084 (80.1%)	25364 (79.8%)	26490 (79.7%)	25219 (78.90%)	24817 (76.60%)

Source: http://www.dudhsagardairy.coop/animal-husbandry/projects/fip/ (28/01/2023)

Table 8: Causes of infertility identified during fertility improvement camps by Banasdairy (2014-15)

Condition	Buffalo (n=30360)	Crossbred Cattle (n=30108)	Indigenous Cattle (n=3128)
Endometritis	0.029%	0.043%	2.78%
Small inactive ovary	2.28%	2.37%	0.223%
Follicular cyst	0.112%	0.109%	0.223%
Luteal cyst	38.58%	0.139%	18.60%
True anestrous	1.49%	0.179%	8.12%
Infantile genitalia	3.41%	18.56%	5.30%
Silent oestrus	36.93%	12.02%	45.62%
Hydrometra/mucometra	14.44%	5.89%	16.30%
Repeat breeding	0.058%	41.13%	0.12%

Table 9: Survey on 1000 farmers from selected co-operative villages after completion of four phases of fertility improvement programme in Banaskantha

Activity	Before FIP (%)	After FIP (%)
Feeding cattle feed (CF) to animals	77.95	95.0
Feeding CF to milk animals as per their milk production	41.18	85.86
Feeding at least 1kg. of CF / dry animal / day	29.4	67.3
Feeding at least 1 kg. of CF for growing heifer / day	29.85	66.77
Feeding Mineral Mixture (MM) to adult animals	32.07	77.11
Feeding MM to calves	25.5	64.66
Feeding urea treated fodder	21.20	30.80
Vaccinating animals time to time	77.0	96.0
Deworming to animals	70.57	96.62

Table 10: Survey on 457 farmers from selected co-operative villages after completion of four phases of fertility improvement programme in Banaskantha

Statement	Can't say (%)	Not agree (%)	Agree (%)
FIP has increased your awareness related to fertility and breeding	3.7	3.3	92.0
After awareness fertility of your animals has increased	9.9	6.1	84.0
After FIP you have started using more cattle feed per animal	5.9	12.7	81.4
After FIP you have started using more mineral mixture	8.5	21.2	70.3
FIP have increased milk production of animals	12.0	13.4	74.6
FIP have improved overall health of animals	10.9	6.2	82.9

The expert team of veterinary doctors of Banas Dairy identified that silent estrus was a major factor followed by cystic ovarian disease and true anestrus-small inactive ovaries after infertility in dairy animals of Banaskantha district (Table 8). Dudhsagar dairy stated that through this programme, they have been able to reduce NPG-Dry &NECO animals from 24 to12%.

As per the farmer's feedback survey (Table 9, 10), there is an appreciable improvement in all vital animal husbandry practices, i.e., cattle feed and mineral mixture, vaccination, and deworming. The further survey also revealed positive outcomes of infertility camps of fertility improvement programs in terms of improved fertility, milk production, and health of animals. So, it was decided to continue fertility improvement programs in the Banaskantha district.

The fertility improvement project revealed that the most common causes of infertility relate to feeding and management. The priority is to minimize the degree and period of negative energy balance during early lactation by restricting body condition at calving so that feed intake is not impaired. The second priority is to provide good quality diets that meet the animal's energy and nutrient requirements within its appetite limits. When these priorities have been addressed, diet composition can be altered to manipulate metabolic hormones, particularly insulin, which helps to coordinate ovarian function. The early resumption of estrous cycles by enhancing follicular growth can be achieved by increasing insulin concentration (Garnsworthy et al., 2008). Macro minerals are involved in the acid-base status of the dairy cow and influence calcium metabolism that helps to improve dry matter intakes and reduce negative energy balance in the post-calving period, as well as prevent hypocalcemia. Vitamin E and zinc effectively prevent mastitis, which occurs predominantly in the first weeks of lactation, through enhanced antioxidant function and keratinization of the teat canal (Wilde, 2006). Heat stress challenges dairy cows' reproductive performance through various altered physiological means, including altered follicular development, lowered estrus activity, and impaired embryonic development (Jordan et al., 2003).

The conception rate obtained in FIPs ranged from 65 to 85 per cent. It also created awareness among animal owners regarding feeding and managing the farm animals, which led to improved reproductive performance of the animals and hence fertility. The villages not included under FIP are covered under general infertility camps for treating infantile animals.

Productivity Enhancement Program

The Productivity Enhancement Program (PEP) was launched, covering the NECO and NPG animals not included under FIP. PEP aims to reduce AFC (Age at first calving), reduce the inter calving period and increase milk production. The animals are registered at the time of AI. Pregnancy diagnosis performed at three months. Deworming and vaccination are compulsory for registered animals. Artificial insemination (AI) workers are trained in the housing, feeding, and management of animals at different stages of pregnancy. The AI workers must educate animal owners and record all work performed (data entry).

The Table 11 and 12 shows the outcome of productivity enhancement programme of Banasdairy and Dudhsagar dairy, respectively.

Calf rearing programme (CRP)

Delayed age of puberty/maturity and long inter-calving intervals are considerable economic losses in cattle and buffalo breeds due to long periods of unproductive feeding. It is possible to advance the age of puberty and reduce the inter-calving interval through supportive schemes such as calf rearing (A report of the Advisory Committee on Animal Husbandry & Dairying, 2009). Poor feeding during calves' prenatal, neonatal, and post-natal stages leads to higher age at first calving (AFC) and overall loss of productive life. Optimal nutrition for the calves beginning from the prenatal stage is vital for proper growth

Table 11 Outcome of productivity enhancement programme of Banas dairy

Year		**2014-15**				**2015-16**				**2016-17**		
DCSs		130				579				579		
		Buff	CB	Kan		Buff	CB	Kan		Buff	CB	Kan
Animal registered	Calf	5006	7281	1090	Calf	1697	2471	447	Calf	2179	3457	732
	Heifer	10360	10059	1030	Heifer	10112	6034	790	Heifer	8469	8199	867
	Adult	24456	29260	4608	Adult	9152	10283	2116	Adult	8944	12219	2453
Total		93150				43102				47519		
	Total	**Buff**	**CB**	**Kan**	**Total**	**Buff**	**CB**	**Kan**	**Total**	**Buff**	**CB**	**Kan**
A I done	40971	15820	22536	2615	47740	17097	27141	3502	38010	13436	21623	2951
P/D +ve	18961	7511	9941	1509	19811	4064	14822	925	20931	7617	11412	1902
Animals Calved		18912				15999				14737		
Female Calf		5010				6533				5848		
Female Calf died		86				127				130		
Year		**2017-18**				**2018-19**				**2019-20**		
DCSs		1231				1231				1231		
Animal registered		**Buff**	**CB**	**Kan**		**Buff**	**CB**	**Kan**		**Buff**	**CB**	**Kan**
	Calf	1433	2414	1084	Calf	2054	3571	767	Calf	6320	7488	2080
	Heifer	15415	8383	1419	Heifer	19356	15110	1987	Heifer	22351	12606	2399
	Adult	15859	14448	4380	Adult	31595	31579	7533	Adult	45025	45483	10146
Total		**64865**				**113552**				**153898**		
	Total	**Buff**	**CB**	**Kan**	**Total**	**Buff**	**CB**	**Kan**	**Total**	**Buff**	**CB**	**Kan**
A I done	34366	11649	19240	3477	75891	33232	34562	8097	162794	69062	77487	16245
P/D +ve	16519	5467	9042	2010	30750	12939	14604	3207	68821	29772	31294	7755
Animals Calved		16381				16092				41819		
Female Calf		7173				7184				17599		
Female Calf died		420				254				642		

DCSs-Dairy Co-operative Societies; Buff-Buffaloes; CB-Crossbred; Kan-Kankrej; P/D-Pregnancy; AI-Artificial Insemination

Table 12: Outcome of productivity enhancement programme of Dudhsagar dairy

Sr. No	Year	No. of Village	No. of Camps	No. of Cases	Regis-tration	Total AI	PD +Ve	Calving	No. of Animal in which ICI Reduce	No. of Animal in which AFC Reduce
1	2010-11	226	452	23906	191554	51755	2438	661	-	-
2	2011-12	226	452	22987	182073	82205	21309	12664	-	-
3	2012-13	392	1176	54244	52957	108027	35330	26378	-	-
4	2013-14	377	1131	47844	59598	118068	43986	39334	6113	-
5	2014-15	400	276	8298	56273	90353	47129	32656	11000	480
6	2015-16	395	0	0	27372	72079	17920	22556	5488	465
7	2016-17	350	0	0	32703	55560	25913	16401	3557	427
8	2017-18	400	0	0	42328	56171	27896	18291	3438	517
9	2018-19	280	0	0	32694	34975	11255	16544	3444	542
10	2019-20	224	0	0	28512	36528	12917	13638	2993	551
11	2020-21	254	0	0	42172	40647	13038	15414	2780	648

http://www.dudhsagardairy.coop/animal-husbandry/projects/pep/ (28-01-2023)

Table 13 The number of calves enrolled in Calf rearing programme with achieved targeted age at first calving, Banas dairy

Year	Buff		Local		CB		Total	
	Total	AFC achiever	Total	AFC achiever	Total	AFC achiever	Total	AFC achiever
2014-15	2	1	2	1	16	15	20	18
2015-16	13	5	6	2	144	111	163	118
2016-17	55	37	16	12	360	202	431	251
2017-18	97	91	37	17	432	249	566	357
2018-19	137	71	14	14	338	134	489	219
2019-20	687	470	337	261	1232	418	2256	1149
Total	991	675 (68.11%)	412	307 (74.51%)	2522	1129 (44.76%)	3925	2112 (53.80%)

and development, allowing them to fully express their genetic potential for milk production and reproductive efficiency during their entire life span. A program to prevent the new occurrence of NECO animals, the Calf Rearing Programme, was undertaken in collaboration with the Gujarat Livestock Development Board (GLDB) Gandhinagar, especially in the tribal area.

Calf rearing is a follow-up to the productivity enhancement program at Banas Dairy. Total 3925 calves were registered between 0 and 15 days of age upto 2019-20 (Table 13). Deworming of all enrolled calves at the age of 10 to 15 days using Liq. Piperazine followed by deworming every month using Tab. Albendazole. The Calf starter is provided to the farmer from 11 to 90 days (Total 50 kg @ 370/ 10 kg bag with Rs.1000 subsidy). From the 91st day, total 11 kg of the mineral mixture was provided to the farmer free of cost in two rounds. If the calf reaches the targeted age at first, the animal owner is provided with five bags of Banas Cattle Feed free of cost as an incentive. The targeted age at first caving for CB heifers should be under 30 months, and for Buffalo and indigenous cows, heifers should be under 40 months under the calf rearing scheme.

The calf rearing program for Kankrej calves was initiated in Banas dairy; till December 2017, 60 villages were covered under the program, and the average daily gain in Kankrej calves after seven months was 407 grams.

The details of calf rearing programme undertaken by Dudhsagar dairy is depicted in Table 14. The Dudhsagar dairy achieved 32 per cent pregnancy rate (http://www.dudhsagardairy.coop/animal-husbandry/projects/crp/; 24/03/2019)

Ration balancing programme (RBP)

The success of any dairy industry relies on reproductive management. The production of a calf each year is the daydream of every dairy farmer. The achievement of this dream is challenged by the sexual maturity of heifers, expression of overt estrus symptoms, heat detection,

Table 14: The number of calves enrolled in Calf rearing programme, Dudhsagar dairy

Sr. No	Year	No. of Village	Calf Registered	Supply Milk Replacer at 50% Subsidy Rate (Kg)	Supply Calf Starter at 50% Subsidy Rate (Kg)	Calving Take place in Calf of this Project with Reduce age at First Calving
1	2014-15	271	3394	38000	169700	177
2	2015-16	268	3334	33340	166700	556
3	2016-17	277	5447	58000	272350	583
4	2017-18	360	6660	66600	333000	416
5	2018-19	441	8518	89000	425900	715
6	2019-20	409	6462	64000	323100	871
7	2020-21	475	9540	106000	477000	836

(http://www.dudhsagardairy.coop/animal-husbandry/projects/crp/; 28/01/2023)

timed insemination with disease-free semen, maintenance of pregnancy, calving types, calf health, dam health after calving, post-partum cyclicity cycling, etc.

The quantity of feed/fodder offered to animals must meet the requirements. However, based on traditional knowledge, farmers feed their animals on crop residues, locally available ingredients, and/or seasonally available fodders. They rarely include mineral mixtures or insignificant quantities of the mineral mixture in animal diets. The excess or ad lib fodder offering may also result in fodder wastage. The inadequate fodder supply leads to an imbalance of protein, energy, and minerals in the ration (Table 15). It results in sub-optimal milk production with higher costs, poor health, and infertility in farm animals. Therefore, it is necessary to educate farmers on feeding balanced ration.

Table 15: Impact of inadequate dietary nutrient intake on reproduction in cattle (Corah, 1988)

Pointers	Impact on Reproduction
Insufficient energy intake	Delayed puberty, Suppressed estrus and ovulation, Suppressed libido and spermatozoa production
Insufficient protein intake	Suppressed estrus, low conception, fetal resorption, premature parturition, weak offspring
Vit. A deficiency	Anestrus, low conception, abortion, weak offspring, retained placentae, impaired spermatogenesis
Phosphorus deficiency	Anestrus, irregular estrus
Selenium deficiency	Retained placenta
Copper deficiency	Depressed reproduction, impaired immune system, impaired, ovarian function
Zinc deficiency	Reduced spermatogenesis

Balancing the level of various nutrients for an animal from available feed resources to meet its maintenance, production, and reproduction requirements is popularly known as a Ration balancing programme. The implementing agencies provide the necessary facilities, such as a personal digital assistant loaded with NDDB's Ration Balancing Programme (RBP) software, a weighing balance, measuring tape, and ear tags with an applicator, to the local resource person (LRP) for this purpose. The details of action and outcome of RBP undertaken by Banas dairy and Dudhsagar dairy is depicted in Table 16-19.

The LRP is trained in the local language by the implementing agency for the effective use of the software, and this training involves the following steps:

1. The nutrient status of the animal is assessed based on feeding practices, the level of milk production, milk fat%, body weight, lactation stage, and pregnancy status.
2. Locally available feed's composition: The NDDB software contains a database of the chemical composition of different grains, oil cakes/meals, brans, Cannes, by-products of agro-industry, green fodders, grasses, crop residue, tree leaves and mineral supplements available in various parts of the country.
3. Nutrient requirement of animals: The total nutrient requirement (dry matter, crude protein, total digestible nutrients (TDN), calcium, and phosphorus) of an animal are assessed by the software based on the feeding standards commonly followed in India.
4. Formulating the cheapest ration using locally available resources: Based on the composition of available feed resources and nutrient requirements of the animals, the least-cost ration is formulated by the software within the given nutritional and available resource constraints.
5. The least-cost ration is prepared and offered to the animals by the farmers under LRP supervision. The

ration is re-formulated by the LRP upon the change in feed resources.

The local resource person (LRP) revisits the milk producer and records the various observations about the quality and quantity of milk, the cost of milk production before and after the program implementation, and the increase in the net daily income per animal.

Table 16: Trainings for local resource persons under RBP by Banas Dairy

Year	No. of LRP Trained (RBP -10 Days)	No. of Programme
2013-14	133	8
2014-15	144	9
2015-16	75	6
2016-17	9	1
2017-18	1675	12
Total	2036	36

The ration for 25.82 lakh milch animals from 31488 villages has been formulated under the RBP. The 117 RBP sub-projects have been approved under RBP till December-2017.

Table 17: The impact of ration balancing programme, Banasdairy

Sr. No.	Parameters	Impact
1	Increase in milk production (Kg/animal/day)	0.18
2	Increase in milk fat (%)	0.10
3	Reduction in average cost of ration (Rs./Animal/day)	-12.83
4	Increase in net daily income (Rs./Animal/day)	18.00
5	Any other noticeable impact	• Improvement in health and reproductive efficiency • Increase in lactation length and shorter inter calving period of animals

Table 18: Targets and achievements under ration balancing programme, Dudhsagar dairy, Mehsana

Key Performance Indicator (As per approved Sub Project Plan)	End of the Project Target	Cumulative Target and Achievement	
		Target till March 2016	Actual till April 2016
Villages to be covered	400	400	400
Number of milch animals to be covered	40000	40000	40108
Producer members to be covered	13000	13000	23332
Number of LRPs to be inducted	480	480	423
A number of Technical Officers to be appointed	2	2	2
Number of Trainers to be hired	2	2	2

Table 19: Impact of ration balancing programme, Dudhsagar dairy, Mehsana

Particulars	Before RBP	After RBP	Change
Milk (kg/day)	8.68	8.84	0.17
Fat (%)	4.93	5.03	0.11
Cost of feeding (Rs./Day/animal)	156.6	140.7	-15.89
Increase in net daily income (Rs./Animal)			24.25

http://www.dudhsagardairy.coop/animal-husbandry/projects/rbp/

Ration balancing advisory services would help to improve productivity and reproductive efficiency by re-appropriating the available feed resources and using the mineral mixture. The performance records of animals captured online in INAPH indicate that RBP increased 0.27 kg in average daily milk yield and 0.10% in milk fat, along with a reduced feeding cost of Rs. 2.36/kg of milk in feeding cost. Ultimately milk producers benefitted from an increase in net daily income by Rs.26 per animal (National Dairy Development Board, Annual Report, 2016-17). Powder Banas Pashu Sanjivani contains bypass fat to prevent negative energy balance in high-producing animals.

Area specific mineral mixture

Supplementation of the mineral mixture is obligatory to improve productivity and reduce infertility. The national dairy development board (NDDB) completed the mineral estimation (mapping) program in the majority of dairy states, and presently co-operative unions are producing area-specific mineral mixtures. This area-specific mineral mixture is available to milk producers at a low cost.

Farm consultancy service

To educate the farmers on feeding and management practices and to solve the infertility problems in farms producing more than 100 liters of milk/day. The Banas dairy initiated the farm consultancy service (Table 20) with the following objectives.

1. Involve & retained large milk producers in the business
2. Reduce age at first calving & the inter calving period by calf rearing.
3. Minimize problems of repeat breeding in a large farm.
4. Make farmers self-sufficient with the training of AI.

5. To improve milk productions per animal at minimum cost & make this business more profitable & viable.
6. To make the herd free from zoonotic diseases.
7. To enhance the income of farmers by improving scientific knowledge.
8. Clean milk production awareness.
9. Live demonstration of animal husbandry (AH) activities

Table 20: Operational areas and number of farms in consultancy service provided by Banasdairy

Sr. no	Centre	Running Farms	New Farms	Total
1	Palanpur	163	33	193
2	Vadgam	366	38	404
3	Dhanera	463	32	495
4	Danta	57	12	69
5	Deesa	60	4	64
6	Tharad	12	6	18
7	Bhabhar	2	2	4
8	Khimana	17	2	19
9	Thara	5	1	6
10	Suigam	0	1	1
11	Pathawada	13	0	13
12	Lakhani	51	0	51
Total		1209	131	1337

Consultancy should be provided at monthly interval to a fixed date

Health & gynecological status are recorded.

1. Scientific animal management through-
2. Deworming
3. Vaccination as per schedule
4. Loose housing
5. Supplementary feeding
6. Use of chaff-cutter
7. Clean milk production
8. Manure pit management
9. Calf Rearing
10. Treatment of NECO &repeat animals as well as ill animals at farm level

Outcome of farm consultancy:

1. Farmer use mineral mixture – 92%
2. Farmer use vaccination - 93.5%
3. Farmer use dan – 8%
4. Farmer use bypass fat - 59%
5. Farmer having milked machine -45.49%
6. Farmer having open yard - 20.07%
7. Farmer having cooling system-73. 64%
8. Farmer adopts to feed chaffed fodder-84. 80%

Vaccination

Bovine brucellosis, endemic in almost all the states of India, can be prevented over time by one-time vaccination of all eligible female calves between 6-8 months. As per the survey done by Brahmabhatt et al. (2009), the highest (23.26 %) prevalence of brucellosis was found in the Ahmedabad district, while prevalence was 20.51% in Anand, 7.40% in Vadodara, and 16.67% of Kaira districts of Gujarat.

A field pilot project was conducted by NDDB on Infectious Bovine Rhinotracheitis (IBR) control using an inactivated vaccine in three states to create awareness of IBR vaccination. Brucella and IBR vaccination status in jurisdiction of Banasdairy is shown in table 21. The pre and post-zero-monitoring studies on the shedding of the virus, differentiation of infection, and vaccination antibodies were monitored in all the animal identification through ear tags. It was confirmed that the vaccine was safe, and no reduction in milk yield was recorded after vaccination.

Refresher training to the AI workers

Banas dairy has established a "Shri Galbabhai Dairy Training Center" costing Rs 27.00 lacs to impart the training. The training programs have been started since 8-10-1984 at this center, being managed by NDDB. Primarily, training on artificial insemination, first-aid treatment of animals, administration, accounting, and working of the milk society, etc., are provided at this center. Besides Banaskantha district, milk societies employees from other milk societies of Gujarat state are also trained at this center (Table 22). The Dudhsagar dairy, Mehsana, deputes the AI workers to Veterinary College, Sardarkrushinagar, for refresher training, improving the overall AI conception rate in their mixed area.

Village Awareness Programme (VAP)

To improve the fertility Village Awareness Programme (VAP) conducted in all villages to provide scientific knowledge regarding feeding and management and to make awareness of farmers regarding calf rearing, deworming, vaccination and breeding. All villages are provided with posters containing information on feeding, breeding, and management.

Animal health care is most important for economic growth. In Gujarat state, for veterinary Services, 675 Veterinary Dispensaries, 45 Mobile Veterinary Dispensaries, 27 Branch Veterinary Dispensary, 552 First aid veterinary Centers, 33 Veterinary polyclinics and 1 High-tech Veterinary polyclinic and one Biological Product Station-Gandhinagar are working at present. Further,

Table 21: Brucella and IBR vaccination status in jurisdiction of Banasdairy

	Vaccination				
Name of Vaccination	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**
Brucellosis	176281	53811	39521	73380	76633
IBR	-	-	9990	10076	
FMD	9,11,190	11,59,882	11,02,552	12,23,487	13,48,423
HS	8,96,865	9,45,916	10,20,557	10,93,551	10,97,870

Table 22: Refresher training arranged at GDCTC, Banasdairy

Year	**of Programme**	**Number of programmes**	**No. of Participants**
2013-14	A I Refresher-05-Days	5	92
2014-15	A I Refresher-05-Days	1	23
	A I Refresher-02-Days	29	568
2015-16	A I Refresher-05-Days	16	496
2016-17	A I Refresher-05-Days	6	123
2017-18	A I Refresher-03-Days	12	231
2018-19	A I Refresher-03-Days	11	542
Total		80	2075

120 Mobile Animal Disease Diagnostic Laboratory Ambulance Van cum Veterinary Dispensaries are established & attached with veterinary Dispensary. A New Scheme of "Mobile Veterinary Dispensary (MVD) per 10 Villages" was established in the year 2015-16. Under this scheme, 460 MVD came into existence. This scheme aims to provide veterinary services at the village level through the mobile vehicle in every ten villages of respective Veterinary Dispensaries by the different prescribed routes. For the control of emerging diseases of livestock, 18 Diseases Diagnostic Units, 2 Epidemiology Units, and one Foot and Mouth typing unit are also working in the State. However, all these facilities are insufficient to create awareness among livestock owners. The various co-operatives are also conducting the village awareness programme.

Obstacles in current FIPs

The technologies developed in breeding, feeding, and management has yet to reach most livestock rearers efficiently. Extension and agriculture are state subjects, and states are not bound to adopt central government policies. There ought to be more strict monitoring cells on breeding policies. Many technologies need to be targeted to the needs of smallholding livestock owners. Moreover, the adoption of advanced technologies in feeding management and health coverage is low as most of our livestock owners are resource-poor (National Academy of Agricultural Sciences, New Delhi, 2013). The indiscriminate use of antimicrobial agents to treat uterine infection has invariably resulted in resistant bacterial infection (Arora et al., 2002). The cost of drugs and hormones used in the fertility-enhancement programme is high. These drugs and hormones are imported and hence costly. Our country is rich in recombinant technology and peptide synthesis expertise, yet we continue to be dependent on imports. It is reasonable to expect a significant improvement in increasing fertility at the national level once the country produces these drugs indigenously.

Conclusions

FIP proved an eye-opener for farmers. They learned that cows and buffaloes could reproduce well following good management, feeding, and necessary treatment during FIP. FIP has improved animal fertility & thereby, productivity by reducing the incidence of NPG NECO & NPG Dry animals. FIP has converted non-performing assets (non-productive animals) to productive assets. FIP, CRP, farm consultancy, and other initiatives have worked as change agents by creating awareness in target producer members for adopting improved livestock-rearing practices.

On the other hand, PEP helps the farmers continue the economic benefits of maintaining a cow and buffaloes. Farmers should be educated about improper feeding practices that result in altered hormonal/metabolic states in an animal and, ultimately, reproductive disorders. As optimum reproductive performance is fundamental for efficient and profitable livestock production; therefore, all livestock

improvement programs should seek to boost reproductive efficiency. It can be achieved by focusing on rapid body growth and early onset of cyclicity in heifers, efficient estrus detection techniques, transition management, and insemination at the proper time with fertile bull semen.

Future prospects

Awareness programs on better feeding of animals need to be conducted vigorously. There is a need to reduce herd size by culling unproductive animals and ensuring optimum feeding. There should be standard literature for farmers and education programs for all farmers. Establishing fodder banks through Dairy Federations and public-private partnership (PPP) mode can be helpful during scarcity. The fertility index of breeding bulls at the semen station should also be considered for deciding on bulls for collection at the semen station. AI workers should be transformed into a strong workforce of Para veterinarians capable enough to handle fertility camps in groups under veterinarians. Herbal and Homeopathic remedies can be explored for fertility improvement and to overcome antibiotic resistance. Indigenous pharmaceuticals should produce economically affordable veterinary drugs and hormones. Adequate and efficient diagnostic facilities/ tests for reproductive disorders should be devised.

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