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Improving Animal Production, Productivity and Economic Gain to the Farmers through Increasing Coverage of Artificial Insemination in India

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ABSTRACT

Data from authentic sources i.e. Government Annual Reports, published research papers and various cooperative organizations of the country were collected and analyzed using ARIMA (Auto Regressive Integrated Moving Average), ADF (Augmented Dickey-Fuller Test) to arrive at definite conclusions for the scientific fraternity in the field of Animal Reproduction. The sole objective for giving information is to get the momentum of developmental activities further in one of the most important technologies i.e. Artificial Insemination (AI) which has changed the country from a milk deficit to a milk surplus and taken the nation on top of the milk producing countries of the world with 209.9 million tones followed by USA, Pakistan, China and Brazil. Presently India is performing 81.9 million AI's annually with a lower conception rate of about 35% in 2021. Per capita milk availability per day, Productivity, AI coverage, Expansion of AI, Conception rate, Milk production growth rate, Milk processing status, Milk prices and Farmer's gain per litre of milk produced have been 427 ml, 5.65 litres, 30%, 16 million farmers, 35%, 5.8%, 20.50% of the total milk produced in the country, Rs 35/litre for cows and Rs.52 /litre for buffaloes, respectively. Hence, the profitability of the fluid milk for farmers is negligible considering the current market infrastructure in the country. It is concluded from the study that the AI programme must be continued in campaign mode till it reaches about 80% of the breedable bovine population with a continuous programme of producing High Genetic Merit (HGM) bulls in the country and their availability to semen stations for semen production which will answer the future need of the nation.

Key words: ARIMA, ADF, Artificial Insemination, Breedable, HGM.

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INTRODUCTION

Artificial insemination (A.I.) is one of the most important biotechnological tools which has changed the entire scenario of animal husbandry in India from a milk deficit to a milk surplus country since 1998 to till date and remained at the top of milk producing countries in the world. Currently, India is producing 209.9 million tonnes of milk

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in 2020-21 (DAHD, GOI, 2021) followed by the United States of America with 97.76 million tonnes, Pakistan with 44.29 million tonnes, China with 34.87 million tonnes and Brazil with 33.74 million tonnes annually (GOI, 2020-21). India's milk production is currently growing at the rate of 5.81% in 2020-21 whereas global milk production reached 860 million tonnes in 2020-21 and growing at the rate of 1.4% annually (GOI, 2021). Based on estimates of population growth and increase in urbanization for the next four decades, it is anticipated that India needs around 600 million tonnes of milk per year to fulfil the demand for milk and milk products. This means that India's milk production needs to grow at the rate of 8.56% annually for the next 40 years (NAP, 2021-22). The demand for milk has been rising not only due to an increase in per capita consumption, but also from the enlargement of milk consuming population base (Development of Dairy Sector, 2020). If we see the last decade i.e. 2010-2020, we could reach 30% A.I. coverage in India from 19% with a low conception rate of about 35% whereas it is 80% coverage in the USA and Europe with a good conception rate of about 60-65%, hence we failed in utilizing the potential of this technology till date even then it has shown its visible impact in the country in terms of improvement in genetic potential of livestock and improved milk production.

The government of India has recognized A.I. as a very effective tool for improving the genetic potential of indigenous and non-descript breeds and also for milk production with the launch of the Intensive Cattle Development Project (ICDP) in 1964, this technique reached into the field, looking into the results it became the policy of government in following years and continued till now and improving year after years and closely associated with milk production. India was producing about 17 million tonnes of milk in 1951-52 which was growing at the rate of 1% annually and the trend remained till 1970 without much change but with the launch of Operation Flood Phase-I onward A.I. was adopted in a big way to boost milk production in the country and today we are producing 209.94 million tonnes in 2020-21. It has been possible due to the improvement in the productivity of our animals which was 2.9 litres per animal/day in 1990-91 and reached 5.65 litres and 6.14 litres/animal/day in 2020-21 and 2021-22, respectively.

ARTIFICIAL INSEMINATION AND MILK PRODUCTION

A.I. has contributed a lot to the genetic improvement of livestock vis-a-vis improvement in milk production, it has gone a long way from about 19 million A.I./year in 2001 to 81.9 million in 2021-22. It is predicted that it would reach to 82.19 million A.I. in 2024-25 and milk production of about 255.778 and 269.05 million tonnes annually in 2024-25 and 2025-26, respectively (Fig. 1 & 2 and Table 1& 2); A.I^{s}. = (R^2 =09967), milk production (R^2=0.9456).

PER CAPITA AVAILABILITY OF MILK PER DAY

Per capita availability of milk was meagre when India became independent and more than 50% human population was malnourished. Most of the population being vegetarian, milk and milk products are means of source of protein in our diet but milk availability was only 130ml per capita/day in 1951-52 which was insufficient to meet the daily requirement, with the improvement in the number of A.I.^{s}, it grew about 178 ml in the early '90s (1991-92), 217 ml in 2000-2001, 273 ml in 2009-10 and reached to 427 ml in 2019-20 and it is well above the world's average of 392 ml per capita/day and it is predicted to reach 512.69 ml per capita in 2025-26 in India (Fig. 3 and Table 3) Per capita milk availability closely followed number of A.I^{s}. performed in India (R^2=0.9567).

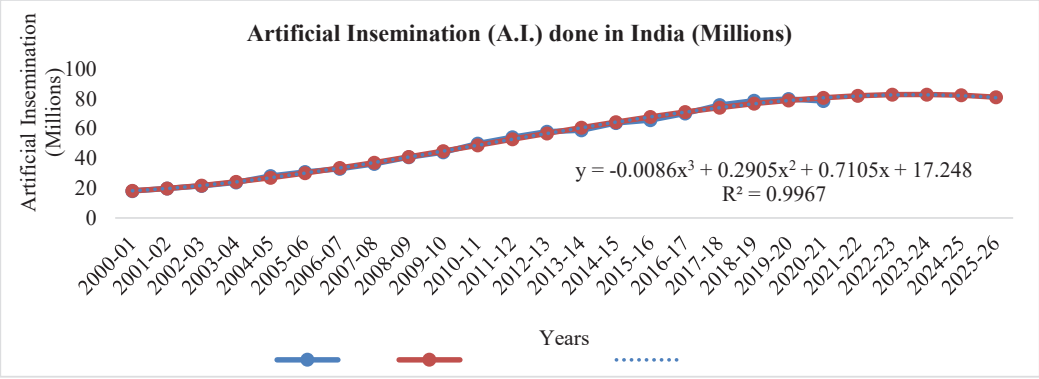

Fig 1: Artificial insemination (A.I.) done in India (Millions)

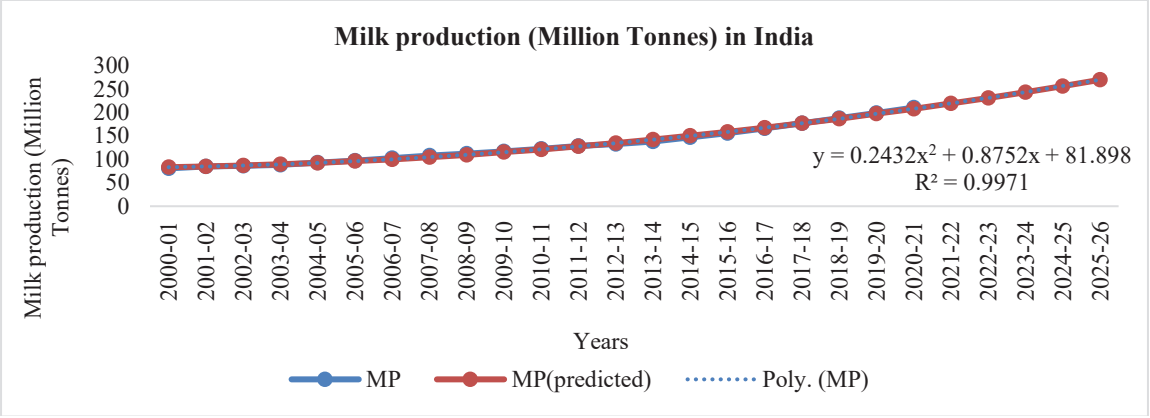

Fig 2: Milk Production (Million tonnes) in India

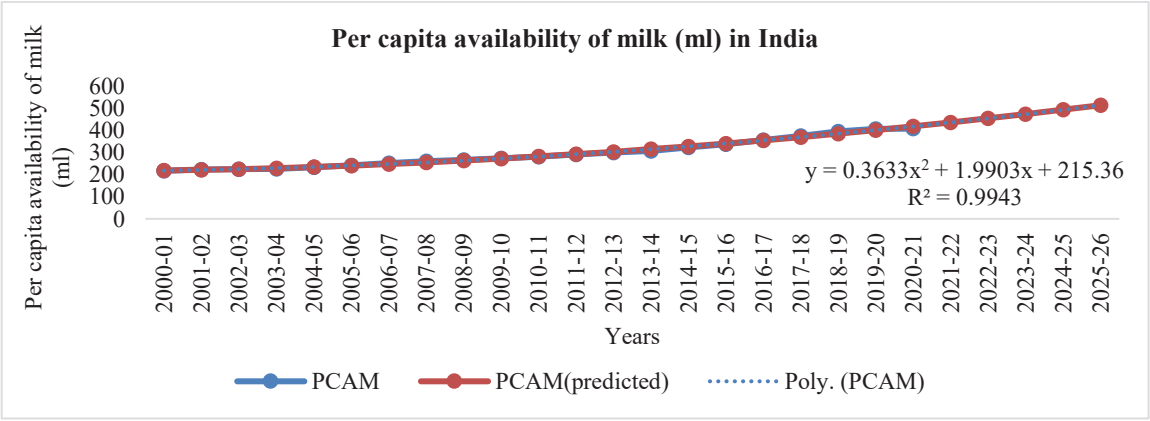

Fig 3: Per capita availability of milk (ml) in India

Table 1: Artificial insemination (A.I.) done in India (Millions)

Years	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
AI	18.1	19.8	21.5	23.8	028.2	30.9	32.9	36.2	40.7	44	49.8	54.1	57.8
AI (Predicted)	18.2404	19.7622	21.7618	24.1876	26.988	30.1114	33.5062	37.1208	40.9036	44.803	48.7674	52.7452	56.6848

Years	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26
AI	58.8	63.6	65.6	70.1	75.6	78.7	79.7	78.5	-	-	-	-	-
AI (Predicted)	60.5346	64.243	67.7584	71.0292	74.0038	76.6306	78.858	80.6344	81.9082	82.6278	82.7416	82.198	80.9454

Table 2: Milk Production (Million tonnes) in India

Years	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
MP	80.6	84.4	86.2	88.1	92.5	97.1	102.6	107.9	112.2	116.4	121.8	127.9	132.4
MP (Predicted)	83.0164	84.6212	86.7124	89.29	92.354	95.9044	99.9412	104.4644	109.474	114.97	120.9524	127.4212	134.3764

Years	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26
MP	137.7	146.3	155.5	165.4	1076.3	187.7	198.4	209.9	-	-	-	-	-
MP (Predicted)	141.818	149.746	158.1604	167.0612	176.4484	186.322	196.682	207.5284	218.8612	230.6804	242.986	255.778	269.0564

PRODUCTIVITY OF ANIMALS

Productivity of animals was major concerns in the country as it was below 2 kg/animal/day after India became independent, with the launch of key village scheme for increasing the supply of breeding bulls in the country and setting up bull breeding farms in major cattle tract was the most important component of A.H. development programmes during 1951-1966. Later on, this scheme was made more comprehensive by the inclusion of better feeding, breeding and disease control. However, milk production could grow at the rate of 1% only from 1951 to 1970. The productivity got wings with the launch of operation flood in 1970 (Phase I, 1970-80) and further extended to Phase II (1981-85) and Phase III (1985-96), which lead India to the top of the milk production and productivity became about 3 kg/animal/day in 1990-91, 4.74 kg, 5.65 kg and expected to reach 6.14 kg in years 2011, 2020-21 and 2021-22 (Fig. 4 and Table 4), so it is great to jump in terms of productivity also (Srivastava and Kumaresan, 2015) but still it is far below the average of the USA or other major milk producing countries of Europe i.e. about 30 kg and 26 kg, respectively (Basic statistics, DAHD Annual reports 2015-16, 2019-20, 2021-22).

A.I. COVERAGE, EXPANSION AND CONCEPTION RATE

Systematic development planning had started in 1951 in our country and Animal Husbandry improvement was recognized well at that time to strengthen rural economy. In spite of many efforts, coverage of breedable population in bovines grew very slow i.e. 19% of breedable bovine population only during 2010-11 which could reach to 30% in 2020-21 and expected to reach 35.01% and 36.14% by 2024-25 and 2025-26, that means still 70% bovine breedable females are bred with scrub bulls of unknown genetic merit though we have one of the largest network of A.I. in the country i.e. 1 lakh A.I. centres catering the need of the farmers (Fig.5 and Table 5).

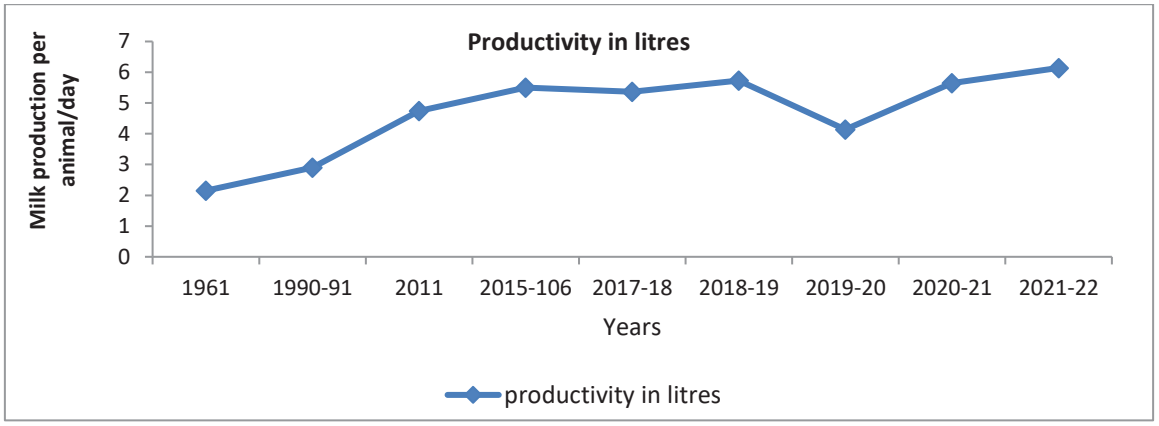

Fig 4: Milk Productivity in Litres

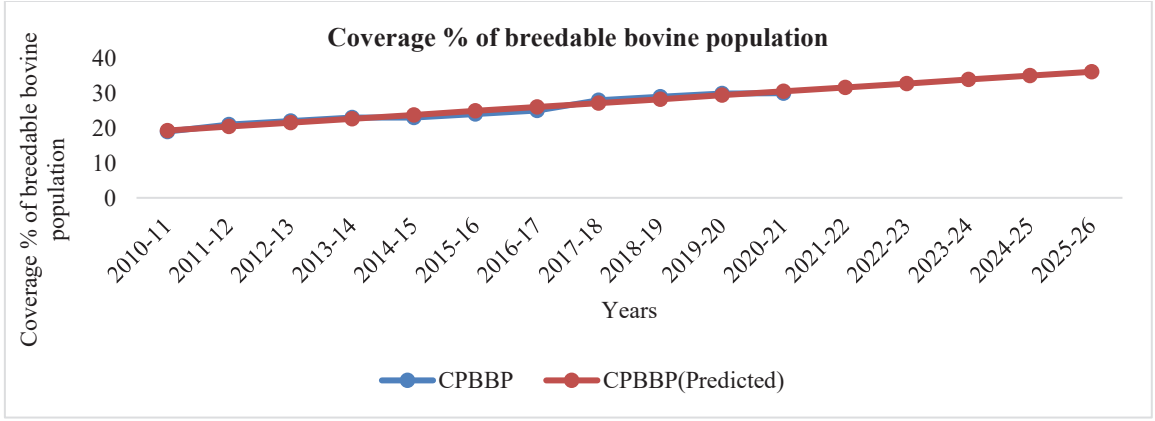

Fig 5: AI Coverage (%) of breedable bovine population

Table 3: Per capita availability of milk (ml) in India

Years	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
PCAM	217	222	224	225	233	241	251	260	266	273	281	290	299
PCAM (Predicted)	217.7136	220.7938	224.6006	229.134	234.394	240.3806	247.0938	254.5336	262.7	271.593	281.2126	291.5588	302.6316

Years	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26
PCAM	307	322	337	355	375	394	406	427	-	-	-	-	-
PCAM (Predicted)	314.431	326.957	340.2096	354.1888	368.8946	384.327	400.486	417.3716	434.9838	453.3226	472.388	492.18	512.6986

Table 4: Productivity of Animals

YEAR	1961	1990-91	2011	2015-16	2017-18	2018-19	2019-20	2020-21	2021-22
Productivity of animals (Litre)	2.15	2.90	4.74	5.50	5.37	5.73	4.14	5.65	6.14

Table 5: Coverage (%) of breedable bovine population

Years	**CPBBP**	**CPBBP(Predicted)**
2010-11	19	19.2816
2011-12	21	20.4052
2012-13	22	21.5288
2013-14	23	22.6524
2014-15	23	23.776
2015-16	24	24.8996
2016-17	25	26.0232
2017-18	28	27.1468
2018-19	29	28.2704
2019-20	29.9	29.394
2020-21	30	30.5176
2021-22		31.6412
2022-23		32.7648
2023-24		33.8884
2024-25		35.012
2025-26		36.1356

Present outreach of different development schemes is about 1.86 lakh villages benefitting 16 million farmers which is envisaged to cover 2.57 and 3.2 lakh villages in 2022 and 2024, respectively which would be covering 20 million, and 22 million farmers respectively in the country. It is now expected to cover 50% of bovine breedable population and 70% by the end of 2024 and 2028 due to the adoption of A.I. in campaign mode in the country since the launch of NADCP in 2019 to boost the animal product export from the country but different statistical models predict around 36% A.I. coverage in near future. The conception rate inspite of many efforts could reach 35% in the country (DAHD, 2020) which is far below other major European countries and the United States of America where it ranges from 60-70%, hence it is another area where our intellect is required to concentrate for at least 50% conception under field conditions.

ANNUAL MILK PRODUCTION GROWTH RATE

Milk production could grow only at the rate of 1% during the pre-operation flood period i.e. before 1970 from 1951 but the launch of operation flood in 1970 which continued till 1996 led the country to the top of the milk producing countries in the world. Milk production growth reached 5.01% in 2011-12 amounting to about 127.90 million tonnes of milk production, again it went down to 3.54% and 3.97% in 2012-13 and 2013-14 then it saw a constant growth rate of over 6%till 2018-19 (Fig. 6 and Table 6) but due to outbreak of COVID-19, it plunged to 5.69% which quickly regained to 5.81% in 2019-20 and 2020-21, respectively, even then the country maintained its position of top ranking in the world (annual report DAHD, 2021-22). It has been largely contributed by increased coverage of A.I. followed by a boost in milk production.

MILK PROCESSING

With the increased number of A.I. and more coverage, milk production lead to a surplus milk and presently 52% of the total milk produced in the country is considered as surplus milk which is available for sale and 48% is consumed at the producer's level or sold in a village or nearby villages. To date we could develop milk processing facili-

ties for 20.5% of the total milk produced in the country i.e. about 10.3% by cooperative dairies and 10.2% by private dairy industries which means farmers are not having good access to organized milk marketing which forced them to sell their milk locally fetching lesser prices making the milk less remunerative to them, thus the farmers are not encouraged if they are having 1-3 animals/household It is now planned by GOI to support the states to develop milk processing facilities so as to process at least 50% of the total milk produced by 2024.

Therefore, it is planned to increase milk processing facilities by cooperatives from 10-20% and by private industries from 10-30% or about 50% by the end of 2024 in the country.

MILK PRICES AND FARMERS GAIN

Since there is no separate mechanism of milk collection system for cow and buffalo milk by the dairy cooperative societies in the country, hence majority of the milk available in the market is sold as mixed milk with about 4% fats which has been being purchased from the farmers by cooperatives at average rate of Rs 30 per litre in 2010 and reached to Rs 35/litre milk in 2022 from the rural area, whereas buffalos milk purchased at the rate of Rs 50/litre which reached to Rs 52/litre during the same period (Fig. 7 and Table 7). Farmers gain would be about Rs 4 (Four Rupees only) out of 1 litre of milk produced in the country if he/she excludes labour charges and other infrastructure expenditure, hence keeping 1-3 animals/household is not profitable to the farmer looking into the productivity of the animals in the country except consuming at producer's level. Prevailing rates of animal feed in the market, price of moderately good feed/concentrate rate from cooperating or private industry versus prices of milk purchased from farmers by cooperatives, farmers will hardly get Rs 4 only per kg of milk produced. Hence, looking into widening the gap day by day between prices of milk/litre vs feed cost by different agencies, it would become remunerative if the animals are kept more than 5 per household considering the present productivity of animals in the country i.e. 5.65 litres per animal/day.

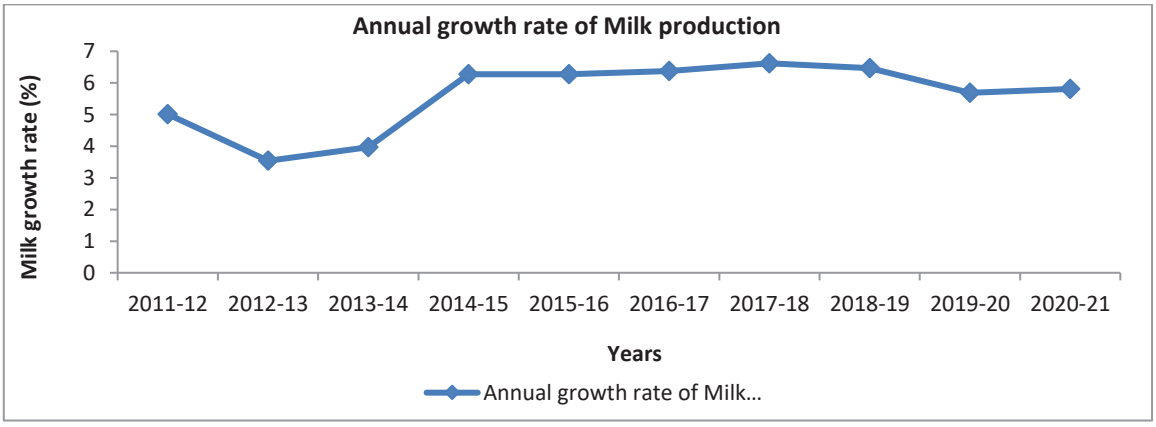

Fig 6: Annual growth rate of milk production

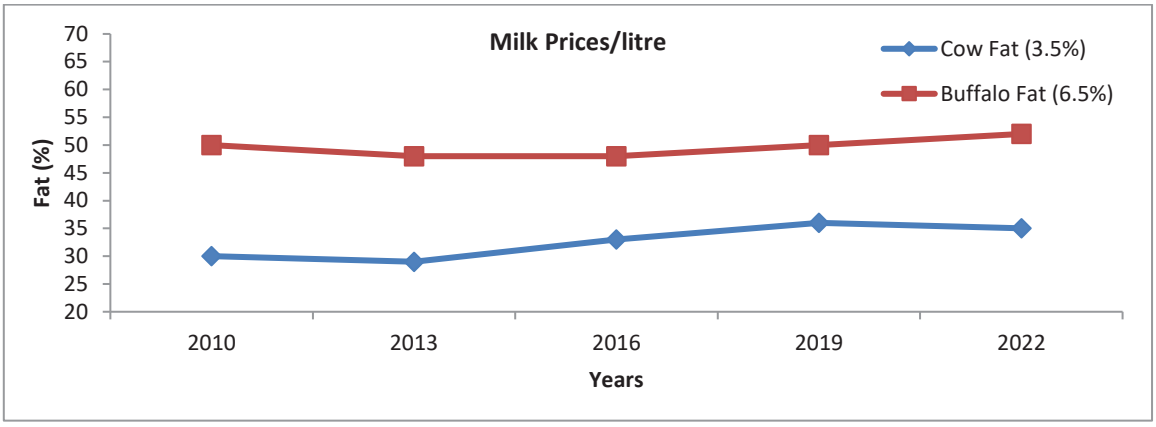

Fig 7: Milk prices/litre (Cooperative)

Table 6: Annual growth rate of milk production

Years	Annual growth rate of Milk production (%)
2011-12	5.01
2012-13	3.54
2013-14	3.97
2014-15	6.27
2015-16	6.27
2016-17	6.38
2017-18	6.62
2018-19	6.47
2019-20	5.69
2020-21	5.81

Table 7: Milk prices/litre (Cooperative)

Years	Cow Fat (3.5%)	Buffalo Fat (6.5%)
2010	30	50
2013	29	48
2016	33	48
2019	36	50
2022	35	52

CONCLUSIONS

Hence, there are following suggestions for sustaining better growth of Animal Husbandryand remunerative prices of milk in near future.

1. Continue A.I. programme in campaign mode till it reaches around 80% of breedable bovine population in the country.
2. Focus on production of High Genetic Merit (HGM) bulls in continuous manner to supply these bulls to semen stations.
3. Selection of HGM bulls at very early stage of growth using molecular tools.
4. Strengthen bull production programme through embryo transfer technology in a continuous manner.
5. Increase coverage of A.I. with the inclusion of more villages especially aspirational districts of the country.
6. Increase the installed capacity of milk processing both at the cooperative and private industry levels.
7. Concentrate research work on crop residues to provide cheaper sources of animal feed and fodder for better feeding of animals
8. Devise mechanisms for better milk prices to the farmers per litre of milk produced by direct linkage to urban areas and the parallel development of milk products.
9. Give fresh triggers to increase fodder cultivation in campaign mode for better fertility and production.
10. Encourage farmers to use sexed semen for better progenies and for more females.

CONFLICT OF INTEREST

The authors have no conflict of interest.

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