



National Dialogue on Sustainable Growth and Development of Indian Dairy Sector

16-17 December, 2022



Proceedings and Recommendations



Trust for Advancement of Agricultural Sciences (TAAS)

Avenue II, IARI Campus, Pusa, New Delhi 110012

Website: www.taas.in



Indian Council of Agricultural Research (ICAR)

Krishi Bhawan, Dr Rajendra Prasad Road, New Delhi 110001

Website: www.icar.org



National Dairy Research Institute (NDRI)

Karnal 132001, Haryana

Website: www.ndri.res.in



National Academy of Dairy Science, India (NADSI)

NDRI, GT Karnal Road, Karnal 132001, Haryana

Website: www.nadsi.org



Indian Dairy Association (IDA)

IDA House, Sector IV, RK Puram, New Delhi 110022

Website: www.indairyasso.org



Uttar Pradesh Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan (DUVASU), Mathura

Website: www.upvetuniv.edu.in



Ministry of Agriculture & Farmers Welfare (MoA&FW)

Krishi Bhawan, New Delhi 110001

Website: www.agricoop.nic.in



International Livestock Research Institute (ILRI)

NASC Complex, New Delhi 110001

Website: www.ilri.org



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Organized by

Trust for Advancement of Agricultural Sciences (TAAS), New Delhi

Indian Council of Agricultural Research (ICAR), New Delhi

National Dairy Research Institute (NDRI), Karnal

National Academy of Dairy Science, India (NADSI), Karnal

Indian Dairy Association (IDA), New Delhi

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For copies and further information, please write to :

Secretary
Trust for Advancement of Agricultural Sciences (TAAS)
Avenue II, Pusa Campus, New Delhi - 110012
Ph.: +91-11-25843243; +91-8130111237
E-mail: taasiari@gmail.com; Website: www.taas.in

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Acronyms and Abbreviations

3Cs	Cattle, Cloud, and Consumer
ABRC	Artificial Breeding Research Complex
AgGDP	Agricultural GDP
AI	Artificial Insemination
AI	Artificial Intelligence
AMR	Anti-microbial resistance
CIRB	Central Institute for Research on Buffaloes
CIRG	Central Institute for Research on Goats
DUVASU	Uttar Pradesh Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan
EBVs	Estimated Breeding Values
ETT	Embryo Transfer Technology
FMD	Foot and Mouth Disease
FTA	Free Trade Agreement
GHG	Greenhouse Gas
GS	Genomic Selection
HS	Haemorrhagic Septicaemia
ICAR	Indian Council of Agricultural Research
IDA	Indian Dairy Association
IDF	International Dairy Federation
IDS	Indian Dairy Sector
IFPRI	International Food Policy Research Institute
IFS	Integrated Farming System
ILRI	International Livestock Research Institute
IVF	<i>In vitro</i> Fertilization
IVF-ET	<i>In vitro</i> Fertilization and Embryo Transfer

IVRI	Indian Veterinary Research Institute
MoFAH&D	Ministry of Fisheries Animal Husbandry and Dairying
NADSI	National Academy of Dairy Sciences-India
NDDB	National Dairy Development Board
NDRI	National Dairy Research Institute
NIAP	National Institute of Agricultural Economics and Policy
NLM	National Livestock Mission
NPCBB	National Project for Cattle and Buffalo Breeding
NRCC	National Research Centre on Camel
OPU	Ovum Pick-up
PPR	Peste des petits Ruminants
RKVY	<i>Rastriya Krishi Vikas Yojana</i>
SDGs	Sustainable Development Goals
TAAS	Trust for Advancement in Agricultural Sciences
VoP	Value of Production

National Dialogue on Sustainable Growth and Development of Indian Dairy Sector

BACKGROUND

The role of dairying for livelihood, food and nutrition security of millions of people in India is well recognized. As per the FAO 2011 estimates, each USD invested in India gives a return of USD 4.7 when invested in livestock sector as compared to USD 3.6 in agriculture and USD 2.9 in manufacturing and service sectors. One of the major breakthroughs in Indian Dairy Sector has been the White Revolution ensuring higher milk production, animal protein security and fight against malnutrition. Soon after independence, India accelerated the pace and emerged as the largest producer of milk in the world- touching 222 mt in 2022-23, and is expected to touch 628 mt by 2047 due to increasing demand for dairy products by the growing population, and increasing purchasing power and focus on nutrition. Presently, India produces 24 per cent of the total milk produced globally. With the rise of human population, climate change, faster globalisation, and reduction in the cultivable land, Indian dairy sector, despite the multi-faceted challenges and shortfalls, has shown its sustainability in Indian perspective. The dairy sector facing several constraints may not be able to meet the requirement of milk and milk products for such a large population of India in the coming decades and hence, there is an urgent need to revisit the existing dairy sector. The Indian dairy industry has grown at a remarkable pace and has the potential to ensure milk and dairy security for the world. Now, there is a need to focus on breed improvement in mission mode to achieve the goal of increasing productivity to 10 litre instead of 2.5-3.0 litre per cattle today. The Indian dairy industry market is worth Rs 13 lakh crore, which is projected to be more than Rs 30 lakh crore by 2027.

In India, over 70 million households are directly dependent on dairying for their livelihood. Among them, 75 per cent are small and marginal producers with average herd size of 2-8 bovines. Dairying is considered a great support to farmers not only during normal but under adverse situations. Dairy farmers do get a steady income even in extreme conditions such as flood, drought and pandemics. During 2020-2022, despite COVID-19 pandemic, the Indian dairy sector was the least affected one and showed its resilience.

During 2018-19, the value of milk was more than the value of all foodgrains and pulses. This made milk as the largest economic commodity in Indian agriculture. Also, the dairy sector is growing at much faster rate as compared to other agricultural sub-sectors. The milk production increased from 17 mt during 1950-51 to 222 mt in 2022-23. The growth rate of milk production globally is 1.3 per cent, whereas in Indian dairy sector, it had been around 6 per cent since 2014-15. It is forecasted that by 2028, the demand of milk in India would be around 246 mt, while the supply will be around 276 mt. The per capita milk availability in India is around 444 g, higher than the ICMR recommendation (280 g/person/day), which is higher as compared to the world per capita milk availability of 229 g/day. According to nutrition experts, a healthy person needs 380 ml of milk everyday. Considering the spoilage, the per capita production should be around 420 ml per day. India has crossed this important milestone in 2020-21 and the production is above the recommended level. We have to look for developing markets for our milk overseas and for that we need to focus on improving the quality of milk. It is the technological interventions which resulted in increase in the milk production (1,235.3% rise) and not the number of livestock (24 and 153% rise in cattle and buffalo population, respectively) from 1951 to 2019, depicting the glorious journey of Indian dairy sector. The major milch animal population comprises 20 per cent indigenous cattle, 32 per cent crossbred/exotic cattle and 45 per cent buffaloes.

In spite of significant developments in the Indian dairy sector, the available data regarding the milk production and consumption followed by processing is very interesting. Out of the total milk production, about 48 per cent is consumed as fresh liquid milk and 52 per cent of the surplus milk is transported to non-production areas, out of which 50 per cent is handled by the unorganized sector, 20 per cent by cooperatives and 30 per cent by private organized sector. Only 5 per cent of the total milk is used for value-addition in India, whereas, more than 90 per cent of the total milk enters organized commercial channel in developed nations. In India, dairy processing shows a higher skewness from region to region; for example, Gujarat state alone accounts for 46 per cent. According to the 20th Livestock Census (2019), there was 39 per cent increase in crossbred female cattle, 10 per cent indigenous female cattle, and the number of milch animals has gone up by 6 per cent. However, the total number of indigenous cattle has decreased during 2012 to 2019. India has 193.5 million cattle, 109.9 million buffaloes and 148.9 million goats. However, the milch population includes crossbred cattle (25.67 million), indigenous cattle (48.51 million), buffaloes (51.17 million) and goats (69.65 million). This milch population together yielded 222 mt of milk during 2022-23.

India has the world's largest and best buffalo germplasm. *Murrah* breed of India is known to be the best milch buffalo in the world. In India, the buffalo

population has increased steadily from 43.4 million in 1951 to 109.9 million by 2016, reflecting preference for buffaloes among the milk producers. India has 53 cattle, 20 buffalo, 40 goat and 44 sheep breeds selected during the past over 100 years and globally emerged as one of the largest home of livestock. In India, the dairy production system is diverse and can broadly be divided into four categories i.e., pastoral system, semi-intensive or crop-livestock production system, peri-urban dairying and intensive or industrial production system. This is an added advantage for Indian dairying because all breeds of animals are not suitable for rearing under a particular production system. As compared to other countries, the cost of milk production in India is relatively low, as per the IFCN report, in 2014, the cost of milk production ranged from USD 4.5 per 100 kg milk in extensive farming systems in Cameroon (where beef is the major output and milk is a side product) to USD 118 per 100 kg for an average sized dairy farm in Switzerland. The average cost of milk production over all countries is around USD 46/100 kg milk, whereas the cost of milk production in India was INR 30.74/litre (2021) Genetic erosion and low productivity of indigenous breeds are serious problems of national concern, which warrants urgent measures to be taken for their conservation and improvement. The advances in artificial intelligence (AI), sensor- and gene-based and digitised technologies and user-friendly software packages in livestock management have made the task easier to acquire and interpret the data continuously without human intervention. Real time data used for monitoring the animals may be incorporated into decision support systems.

CONSTRAINTS AND CHALLENGES

The major constraints the dairy sector is currently facing include: (i) large population of non-descript cattle and buffalo with low productivity; (ii) huge gap between requirement and availability of feed and fodder; (iii) adverse impact of climate change, drought and heat on milk production and quality; (iv) infectious and non-infectious diseases, nutritional deficiencies and metabolic diseases: poor animal health, frequent outbreaks of transboundary diseases, shortage of vaccines and diagnostics, and large number of diseases being transmitted from animals to human (zoonotic diseases); (v) infertility/sub-fertility, silent-heat and reproductive diseases and disorders in dairy animals; (vi) late sexual maturity of both male and female bovines; (vii) limited availability of high quality male germplasm (breeding bulls, as well as frozen quality semen, sexed embryos/semen); (viii) increasing infertility among crossbred animals; (ix) low processing and value-addition of milk; and (x) inadequate value-chains.

In India, the backbone of dairying is the smallholder farmers contributing to over 70 per cent of total milk production. In recent years, there has been

a shift in the taste and preferences of consumers. As such, it is being realized that without much transformation in the existing milk production and processing system, it may be difficult to meet the demand for quality and value-added milk and milk products in future. Consumers are now spending more money on milk and milk products as they have become more health and quality conscious. With an increase in life expectancy, the proportion of older people is increasing, demanding special dairy products. Moreover, globally with technological advances, the demand for designer and nutritional dairy products with medicinal and health benefits has increased, including in India. While bovine milk is the most dominant dairy food in the world, non-bovine (e.g. goat, sheep and camel) milk is also considered an important source of nutrition and medicine. Sheep and goat milk is very rich in vitamins and minerals and is also suitable for those who have allergy from cow milk.

India now needs to transform its dairy sector from subsistence to commercial/semi-commercial oriented sector. While promoting the commercialization and value-addition of dairying, there shall be an obvious need to protect the interests of smallholder dairy producers. Any mechanism which ignores livelihood issues would be inequitable and may not find general acceptance. Thus, to obtain the inclusive growth, boosting the smallholder dairying as a whole and promoting commercial dairying in identified regions would ensure sustainable economic development through dairying. In contrast, the milk processing in the country is at primitive stage. The total share of organized sector in cooperatives, Government as well as in private sector is very less, leaving a lion's share of the milk in the hands of the unorganized sector. In order to meet the growing domestic demand, the dairy sector must increase its competitiveness, also by bringing a qualitative transformation in the unorganized sector, which incidentally meets the entire demand for traditional dairy products. Further, there is also an urgent need to bridge the quality gaps in dairy production and processing, to make its presence felt in international market, while defending its domestic market from imports. The country needs to equip itself with technological and policy backup to cope up with futuristic dairy developments. Private investment in the dairy sector is growing fast which may adversely impact the smallholder dairying. Thus, we need to have a mechanism/legislation in place that protects the interests of large number of smallholder dairy producers while facilitating in scaling up of commercial farms.

The indigenous breeds of livestock are well adapted in their respective habitat, and are known for their drought tolerance, climate resilience, disease resistance, and could be a good option for enhancing the income of farmers. They have the ability to sustain productivity under adverse climate and low inputs supply, which makes them a crucial backbone of the country's rural economy and hence needs

to be protected and promoted. However, genetic erosion of indigenous breeds is a serious problem of national concern and warrants urgent measures to be taken for their conservation. The advances in sensor-based technologies and user-friendly software packages in livestock management have made the task easier to acquire and interpret the data continuously without human intervention. Real time data used for monitoring the animals may be incorporated into decision support systems. A strong research and development support is required to make precision dairying a reality. Further, rising demand for healthy and nutritious dairy products also requires technological backstopping in processing to increase the extent of milk processing and its value addition.

In India, we are struggling with first generation reproduction technologies (semen cryopreservation and artificial insemination), while in developed countries, third generation reproduction technologies (e.g. *in vitro* embryo production, *in vitro* fertilization-IVF, embryo transfer technology-ETT, ovum pickup-OPU) are being applied at farmers' level. We need to create needed infrastructure and expertise to use these advanced technologies. Further, to ensure the quality of frozen semen, it is right time to shift from traditional semen analysis to high technology-based semen quality control tests. In order to harness the potential of changing consumer preferences, the dairy industry will have to stand up to the expectations of the market and consumers' taste. Greater attention is needed to - bring out new and more consumer friendly products at reasonable costs, ensure food safety and quality, and enhance the processing capacity of the milk from 53.5 million tons to 108 million tons by 2025. The other policy issues which are important for dairy sector include: (i) identification and registration of all animals and dairy farms and linking them to better breeding facilities at their doorsteps, (ii) developing linkages between small dairy farmers and registered processing societies, private public companies to streamline processing and input supply management for sustainability, (iii) facilitation and promotion of "On-Farm Small Scale Milk Chilling" facility before selling the milk, and (iv) promoting collaboration across the supply chain. The coordination between producers, processors, packagers, distributors, and retailers among themselves, as well as with local and state authorities is very important to ensure sustainable dairy development in India.

Indian dairy sector is not only a contributor to National GDP (4.1 to 5%) and 26-30 per cent to Agricultural GDP (AgGDP) but also has dignified the socioeconomic status of farmers as well as dairy producers and establishing them as one of the benchmarks in the progress of India. Looking to the biodiversity and faster globalisation trends, numerous direct and indirect factors are now knocking the door of Indian dairy and threatening the pace of its growth. These limiting factors are alarming the policy makers, researchers, Government bodies and industries

to relook the existing trend in Indian Dairy Sector and reframe policies for its sustainable growth to maintain an increasing trend in milk production. Although India is the largest producer of milk in the world, but the Indian Dairy Sector is facing several constraints; that are questioning the viability and sustainability of dairy in coming future. High number of nondescript cattle population (59.3%) with low productivity, shortage of feed and fodder, high incidence of subclinical and clinical mastitis and reproductive disorders, delayed puberty, infertility among the crossbred animals, existing wide gap between the demand and availability of proven males/ male germplasm, low coverage of AI with untrained/ marginally trained AI technicians, poor animal health; existing, emerging/re-emerging and exotic/transboundary animal diseases like foot and mouth disease (FMD), *peste des petits ruminants* (PPR), brucellosis, haemorrhagic septicaemia (HS), tuberculosis, Johne's disease, anthrax, shortage of vaccines and diagnostic tools, microbial contamination and food-borne zoonotic diseases, rising incidences of antimicrobial resistance, antimicrobial residues, pesticides and aflatoxicosis.

Indian dairy sector is supporting a mammoth of 8 crore farmers mainly comprising small, marginal and landless laborers. More than 2 crore of farmers are organized in 1.94 lakh dairy cooperatives. By 2030, this sector is predicted to produce more than half of total agricultural output. In recent years, India showed 6.5 per cent growth in milk production against 1.3 per cent world growth. In early 1970s, India's milk production was 1/3rd of US and 1/8th of EU countries, and interestingly, today, it is twice the US and 25 per cent more than EU showing the golden saga of White Revolution and India's glorious journey of dairy sector. Milk is India's largest agricultural commodity, and the value of milk is more than the total value of all grains and pulses put together (2019-20). The value of only milk was >INR 8 lakh crore compared to INR 4.5 lakh crore of all grains + pulses and, therefore predicting to have higher potential for growth compared to other agricultural products. Factually, today White Revolution's contribution surpasses Green Revolution, and every 4th rupee generated in farm sector comes from milk and 3rd rupee from livestock sector.

In spite of COVID-19 pandemic, global climate change, limited investment from public and private sectors, Indian dairy sector has shown resilience and a constant and sustainable growth contributing 33-35 per cent in National AgGDP. Dairy sector never showed negative growth in any of the year during the long span of last 4.5 decades revealing the dynamism of Indian dairy sector and explaining its strengths. India has the mega-biodiversity of livestock with the largest bovine population in the world. There are more than 200 breeds of Indian livestock having the highest milk production with high growth rate. India is also the world's largest and leading buffalo germplasm holder.

To keep the Indian dairy sector sustainable and profitable, a number of strategies and policies need to be planned and implemented. In case of cattle tests for diagnosis of sub-clinical mastitis, early pregnancy diagnosis and handling metabolic disorders are also needed on priority. This will maintain the health of the animal and also reduce the cost of production besides enhancing the milk quality and quantity. Research has already been initiated for detection of estrus so as to have higher conception rates. In this race, electronic nose for estrus detection will be a boon for the dairy sector. In Indian prospective, delayed puberty of animals is a major hurdle in the economy of animal production and management. Strategies are required for suitable reduction of age of puberty both in male and female animals. The technological interventions will play a major role in making the dairy industry feasible, viable and sustainable in coming decades. Use of sexed-semen and sexed-embryos of elite animals, skewing the sex ratio depending on the need of the female or male animals, estrus synchronization, and use of hormonal interventions, and *in vitro* fertilization and embryo transfer (IVF-ET) will make the dairy sector sustainable. Coming decades will be the time of extensive use of biotechnological tools to improve the reproductive status of the animals along with their productivity. Timed AI with elite bull semen and wider coverage of AI will boost upgradation of nondescript low producing animals and also ensure faster dissemination of superior male germplasm. The emerging roles of reproductive physiology, clinical pharmacology, estrus biology and promising biotechnological tools cannot be ruled out in coming years. The genomic selection of animals along with prediction of bull and cow fertility during calf hood will reduce the cost of animal management and production. Genomic selection of animals will be the game changer in future animal production system. Along with this, making designer animals using CRISPR/CAS 9 genome-editing will boost animal production system. The introduction of genes for muscle growth will increase the muscle mass. The need of cost-effective quality vaccines and their timely availability will be the major issues in near future. Reduction in the gap between vaccine availability and demand, and improvement in the vaccine technology will play a pivotal role in sustainable dairy production system.

THE NATIONAL DIALOGUE

In view of the above, the Trust for Advancement in Agricultural Sciences (TAAS) New Delhi- a “Think Tank” and the Indian Council of Agricultural Research (ICAR), and Uttar Pradesh Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan (DUVASU) in collaboration with ICAR-National Dairy Research Institute (ICAR-NDRI), National Academy of Dairy Sciences-India (NADSI), Indian Dairy Association (IDA), Ministry of Fisheries, Animal Husbandry and Dairying (MoFAH&D), Gol, and International Livestock Research

Institute (ILRI), New Delhi organized a **National Dialogue on “Sustainable Growth and Development of Indian Dairy Sector”** on 16-17 December, 2022. A total of 96 diverse stakeholders from Central and State Governments, scientific institutions, ICAR institutes, SAUs, milk cooperatives, private milk processing industries, registered scientific societies, NGOs, FPOs, entrepreneurs, policy makers and farmers participated to discuss options to address and mitigate issues related to weakness and challenges; innovations that need to be scaled faster to enhance the production, processing and profitability of dairy farmers; and to suggest strategies, policies and technological options for production, processing, value-addition and marketing of diversified products both nationally and globally.

INAUGURAL SESSION

The program was started by lighting of lamp by the dignitaries on the dais, followed by *Jal Bhara* ritual for awareness about water conservation for future, *Saraswati Vandana* and University song. Sustainable growth and prosperity depend on how we think today about the future and formulate the policies for their implementation. An intellectual gathering of 96 delegates from various parts of the country including scientists, academicians, researchers, industrialists and policy makers from both government and non-government bodies discussed to formulate various strategies for sustainable dairy development and production. The dais was well set with the gracious presence of Dr RS Paroda, Chairman, TAAS; Dr Meenesh Shah, Chairman, National Dairy Development Board (NDDB); Dr H Rahman, Regional Representative South Asia-ILRI; Dr BN Tripathi, DDG (Animal Sciences), ICAR New Delhi; Mr Amit Vyas, MD, Kaira District Cooperative Milk Producers (KDCMP) Union Ltd (Amul Dairy); Dr Bhag Mal, Secretary, TAAS; and Dr AK Srivastava, Vice Chancellor and the host of the Dialogue.

Dr AK Srivastava, Vice Chancellor, DUVASU set the pace of the National Dialogue and flagged off the issue with his informative, thought provoking, futuristic and policy-based presentation regarding the Indian Dairy Sector. He highlighted the Indian dairy sector’s golden saga journey and also highlighted the prospectives and limitations of Indian dairy sector. India ranks first in the world in milk production (222 mt), and is likely to increase it to 266 mt by 2030. Still the milk productivity in India is much less compared to many other countries. Dr Verghese Kurien led Operation Flood (1970 to 1996) that resulted in White Revolution (WR) in the country almost at the same time as Green Revolution (GR) in late sixties. The cradles of success were evident as the country has policy support, efficient human resources and cooperative farmers. While GR led to household food security, WR also ensured nutritional security and helped in increasing farmers’ income. It links farmers to market overcoming the role of intermediaries; enhances cooperative movement; creates processing

and cool-chain linked to 700 cities around the country; and contributes towards Sustainable Development Goals (SDGs). The major challenge is to meet the nutritional requirement of a country where malnutrition is still prevalent, and impeding climate change and number of associated-factors are now questioning the sustainability of Indian Dairy Sector. However, the fact that the dairy sector stood tall during and after the COVID-19 pandemic, exhibited the strength of the Indian dairy sector (IDS) and also opened several doors to think for its further strengthening and sustainability. Fortunately, we have robust internal market where we need to bring in modernization especially on production management. Dr Srivastava was the right person to take the gathering into the glorious journey of dairy sector in India to its past, explaining its present and thinking about its future. The major focus of his address was to bring insights into the strategies which are required for the sustainable growth of Indian dairy sector. He highlighted three major areas which can help in sustainable growth of Indian dairy sector: (i) increasing demand of value-added products; (ii) reforms in the non-organised dairy farming, and (iii) technical and policy back-up which can be framed looking to the future needs.

Dr **BN Tripathi**, DDG (Animal Science), ICAR highlighted the success story of White Revolution. He emphasised the strategies which are required for the sustainable growth of Indian dairy sector considering the environmental security, social safety and trend in global climate change. He narrated about three major challenges that the Indian dairy sector is facing: (i) Greenhouse Gas (GHG) emissions, (ii) emergence of new animal diseases, and (iii) antimicrobial resistance. Further, several other problems, viz., availability of fodder, feed and housing of animals' also exist. He showed his concern about the non-descript livestock breeds (45%) which need attention. Conservation of animal biodiversity and climate resilient animal production system are the need of hour. It is also felt to improve local valuable breeds using new science of germplasm improvement, artificial insemination (AI), sexed- semen, and *in vitro* embryo technologies. He cited the example of the best breeds of Rajasthan and emphasized on the need to preserve, conserve and characterise them. A comprehensive national breeding policy is required in which cross-breeding as well as milk processing and value-addition policies with the help of State Governments are revisited. There should not be indiscriminate breeding and we have to make equilibrium. Third generation reproductive technologies along with genomic selection (GS) will improve the livestock production. A concern was felt about low lactation milk yield of Indian cows (987 kg/cow) compared to USA (2,200 kg/cow). There is need to find ways and means to increase milk productivity of cows at par with USA and other countries. Further, fodder production with reduced land size now requires technological intervention for the sustainability as well as concept of 'one health' must be looked for the overall improvement of the animal health and production.

Animal behaviour is also important and needs to be studied especially to detect heat in animals. In India a loss of INR 1.5 lakh crore per year is due to animal health associated diseases, which must be checked so as to boost the economy of animal production and management. Precision livestock farming will be a booster for the existing livestock system and will improve the livestock rearing system. Challenges associated with the export of meat and milk need to be reframed and made as per the norms of international trade exchange. He concluded that for the sustainable growth of the dairy sector, technology and their intervention in feeding, breeding and management will play major role. There is a need to have support of private dairy sector, FPOs, and entrepreneurs to boost dairy activities in the country.

Dr H Rahman, Regional Representative, South Asia, ILRI, New Delhi offered his special remarks on the theme and highlighted ILRI's achievements in livestock sector and how it has played a major role in the development of socio-economic security to the farmers and other stakeholders. ILRI works for the poverty alleviation, nutritional security and better livelihood for rural masses through livestock. He highlighted the major steps taken in the South Asia region for the dairy development and livelihood security, and specifically women empowerment. He further stated that 70 per cent soil fertility is strengthened by animals; and informed that the demand for animal source food will increase by 300 per cent by 2050, and livestock will be the major source of animal protein. The three major setbacks to the livestock sector which need proper planning are climate change, antimicrobial resistance and sub-clinical infections in animals. The emergences of silent pandemics are also of great concern for the livestock which need to be taken care of in future as the possibility of these infections in future is great. He further emphasised on the need to develop vaccine to reduce exotic diseases. In the end, he highlighted about the major constraints of livestock production system: (i) no MSP for dairy products, (ii) lack of cold storage facility for dairy products; and (iii) non-bovine milk not given importance and need research, marketing, and price fixation.

Amit Vyas, MD, KDCMP Union Ltd (Amul Dairy) highlighted about the technology driven growth of the Indian dairy sector and opined that, technology will play a major role in sustaining the future dairy production in India. He highlighted the technology-driven steps taken by the Amul in developing the dairy sector, which works on the principle of 3Cs (Cattle, Cloud, and Consumer). Amul has developed a technology-driven set-up across 800 villages and has created a huge data set for monitoring the livestock function and management. Amul has digitalised most of its functions and has achieved a reduction of 20 per cent in the construction of milk sheds. Digitalisation was also done in animal tagging, image processing, right data collection, AI and heat detection system, digital mapping of AI coverage, and success and animal health monitoring. There is a need to develop software

to ascertain exact timing of artificial insemination (AI) calls and pregnancy. Also, there is need to know sense of heat in animals. The use of battery-operated thawing units at the field level has substantially improved the quality of post-thaw semen and improved the conception rates. Use of camera-operated insemination guns has improved the process of semen deposition, insemination and overall improvement in conception rate. He also narrated the success storey of *Amul* in employing 800-1,000 village level resource persons especially para veterinarians who are the real caretakers of the animal health through a digital platform. He concluded by highlighting the use of technology in sustaining dairy sector through the use of sex sorted-semen, embryo transfer, control of sub-clinical mastitis with its early diagnosis, rain water harvesting for water conservation and use of non-conventional solar energy in sustaining the power requirement.

Dr Meenesh Shah, Chairman, NDDB of India and the Chief Guest highlighted the works, ethics and achievements of National Dairy Development Board (NDDB). He appreciated the golden saga of White Revolution and talked about the second / third White Revolutions so as to have a sustainable growth of Indian dairy sector. India is emerging as the 5th largest economy of the world and livestock will play a major role in achieving it. Farmer-centric production with cooperative chain in livestock will accelerate the pace. Procurement, processing and marketing of the milk are the issues to be addressed at national level so as to boost the dairy sector. He emphasised that India would become the 3rd largest economy by 2030 and high-income group country by 2047. Dr Shah mentioned that India's blue-print for Vision 2047 is ready and it is time when we need to effectively collaborate synergies to achieve it. He further stressed that by 2047, we must plan to increase bovine productivity by four times, increase Indian dairy exports to 15 per cent of total global dairy export, and build sustainable green practices to achieve COP26 targets. He further stated that India has a very prudent policy. It is the largest milk producer country (23%) of the world milk production, more than all European countries. The major challenges are higher percentage of animals with less milk yield, poor milk quality and lack of parameters to decide the quality of milk, poor disease diagnosis and management at large scale; inability to detect heat, puberty, and fertility, lack in animal breeding activities, calving intervals; and need to increase productivity specifically since it is too less compared to USA and several other countries. Also, there is need to develop indigenous technology for better semen, buffalo drop, and cow chips, etc.

The sustainability in Indian dairy sector can be achieved through increasing productivity of the low producing cows; increase in breeding population of animals; thrust on climate resilient animal production; use of reproductive technologies like sexed-semen, ovum pickup (OPU) and embryo transfer for sex skewing as well as faster propagation of germplasm; use of genomic chips for better selection of

animals; evaluation of genetic potential of animals and basing on these, selection and breeding of the animals; reduction in the feed cost of animals, utilisation of crop residues; and balancing ration as per the need of the area and animals so as to reduce the cost of feed and optimisation of production in animals. Also, emphasis on green fodder and alternatives like silage, fodder-based FPOs, high emphasis on ethno-veterinary practices so as to fight against antimicrobial resistance (AMR), use of cow dung for emission of green energy, National Digital Livestock Mission implementation, use of nonconventional energy, emphasis on solar energy and establishment of solar cooperatives in villages, biogas plant establishments and use of bioelectricity, social and environmental factors must be considered for the sustainable growth of the dairy sector, and improvement of the child health with dairy proteins. He further informed that NDDDB is working on dung also for its potential for fuel and fertilizers. He further emphasised for improving per unit productivity, working on sexed semen, value-addition, quality of life, and asserted that academia and government should work shoulder to shoulder.

Dr RS Paroda, Chairman TAAS highlighted the Indian dairy sector and its achievements in the past 50 years. He drew attention of the audience towards the current constraints in the dairy sector and how these constraints can be minimised through policies, research and their implementation. Earlier, India with begging bowl status-not even to produce more to feed masses- became self-sufficient in late sixties and early seventies through science-led Green and White Revolutions. He paid hearty tributes to Drs NE Borlaug, MS Swaminathan and Verghese Kurien for their outstanding contributions. Through its cooperative movement, NDDDB should make efforts and energize other Indian states also to take/follow Gujarat and Rajasthan business models. He argued that the focused policies and their timely implementation will make this sector sustainable. He asserted that there is need to re-look for mid-term correction. He was of the opinion for intervention of technologies in the livestock sector for its sustainability. Being the chairman of the TAAS and his long experience in this sector, he emphasized on certain critical issues which need to be addressed such as immediate attention to identification of non-descript animals and their conservation, improving efficiency of AIs, and value-addition so as to make the future well secured for the sustainable dairy sector. The issues included: (i) cold-chain for dairy products for long-term storage and processing; (ii) innovations in dairy sector which can be implemented with cost effectiveness; (iii) emphasis on small animal sector like sheep, goats for dairying; (iv) increasing the productivity of the low-producing animals through technological interventions; (v) non-descript breed upgradation through crossbreeding; (vi) indigenous animal rearing and management with better climatic adaptability and disease resistance; (vii) promotion of new science in terms of research and technology (R&T) in the dairy sector for better production;

shelter, farm and disease management; (viii) value-addition of dairy products; (ix) diversification and value-addition of milk and milk products; (x) translational research in the dairy sector for faster implementation; (xi) higher investment in animal science research and innovation; and (xii) National Livestock Mission for genomic selection of animals and reframing of the existing breeding policy of animals; and (xiii) policies for export of Indian dairy products. Dr Paroda expressed his desire to envision and foresee emerging national, regional and international scenarios in dairy sector using most appropriate approaches and effective strategies for sustainable dairy production system in India. He emphasised that we should go for climate-smart dairy farming. We need to think globally but act locally since we have to play our major role towards India becoming 5 trillion economy by 2030. He underlined for sustainable revolution, resilient system, better management, better extension system, improving productivity of breeds; producing mozzarella cheese from milk of indigenous buffaloes; use of new science; improved export with value-additions; need for organized livestock sector, insurance of animals; and for establishing an apex animal authority on the lines of PPV&FRA. He emphasised on the need to use altogether different methodologies suitable for each species, namely, cattle, buffalo, goat, camel, etc. Lastly, he urged the participants as well as institutions to design innovative action plan, policies and research documents to set the way forward for Indian dairy sector.

Dr Bhag Mal, Secretary TAAS proposed the vote of thanks to Dr RS Paroda, mentor for this dialogue, Dr AK Srivastava, VC, DUVASU for setting the context for discussion; Dr BN Tripathi, DDG (Animal Sciences), ICAR; Dr H Rahman, ILRI; Amit Vyas, MD, KDCMP Union Ltd (Amul Dairy); Dr Meenesh Shah, Chairman, NDDB and Chief Guest; and several eminent experts off the dais and participants. He felt grateful that the dignitaries have energized all participants to a great deal to further discuss threadbare options to address and mitigate issues related to weakness and challenges; innovations that need to be scaled faster to enhance the production, processing and profitability of dairy farmers; and to suggest strategies, policies and technological options for production, processing, value-addition and marketing of diversified products both nationally and globally.

KEYNOTE LECTURE SESSION

The Keynote Lecture Session was chaired by Dr RS Paroda, Chairman TAAS and co-chaired by Mr Meenesh Shah, Chairman NDDB. Dr AK Srivastava, in his keynote address “Growth and Development of Indian Dairy Sector: Way Forward” presented elaborate, extensive, and useful information about the challenges, constraints and the strategies and way forward for sustainable growth and development of Indian dairy sector. He opined that time is ripe to revisit IDS. A

White Paper needs to be developed suggesting the Way Forward. There is a need to strengthen *Rashtriya Gokul Mission* and National Livestock Mission (NLM) having focus on insurance, management, fodder seed production, and availability of feeds. Some of the key points and highlights of this presentation are summarised in following paragraphs.

Milk is India's largest agricultural commodity. The value of milk is more than the total value of all grains and pulses put together (2019-20). The value of only milk was > 8 lakh crores as compared to 4.5 lakh crore of all grains + pulses. In early 1970s, India's milk production was 1/3rd of US and 1/8th of EU countries. Today, it is twice that of the US and 25 per cent more than that of EU. By 2030, this sector is predicted to produce more than half of total agricultural output. In 2019-20, the growth in world milk production was 1.3 per cent, however in India, it was 6.5 per cent. At present, most of the dairy animals are in rainfed area. Livestock is the only source of bread earning to livestock keepers in these areas. Any adverse effect on this sector affects not only economy of the country, but also livelihood of millions of these farmer families. The role of dairying for livelihood and food and nutrition security of millions of people in India is well recognized. As per the FAO (2011) estimates, each USD invested in India gives a return of 4.7 USD when invested in livestock sector as compared to USD 3.6 in crops/horticulture and USD 2.9 in manufacturing and service sectors.

In India, over 70 million households are directly dependent on dairying for their livelihood. Among them, 75 per cent are small and marginal producers with average herd size of 2- 8 animals. Dairying is considered a great support to farmers not only during normal but under adverse situations also. Dairy farmers do get steady income even in extreme conditions such as flood, drought and pandemics. Despite the horrible COVID-19 pandemic, from December 2019 onwards, the dairy sector remained almost static and showed its resilience. It is also encouraging that overall contribution of livestock sector in National GDP is nearly 4.1 per cent. Livestock is contributing 33-35 per cent in National Agricultural GDP. Also, the dairy sector is growing at much faster rate as compared to other agricultural sub-sectors. Dairy sector never attained negative growth in any of the year during the span of 4.5 decades. Although, India is the largest milk producer in the world, it is surprising to note that it ranked 93rd in milk productivity. It is a challenge to dairy scientists who need to work judiciously for increasing milk productivity and for that they have to go for accelerated genetic improvement using advanced breeding methods, and reproduction technologies, strategic feeding, and controlling mastitis and other diseases.

About 50 per cent of milk produced in India is consumed as liquid milk. Value-addition is only in 5 per cent of total milk. The growth rate of milk production globally is 1.3 per cent, whereas in Indian dairy sector, it had been around 6

per cent since 2014-15. There has been 51 per cent growth in milk production from 2014-15 to 2021-22. In developed nations, more than 90 per cent of milk enters in organized commercial channel. In India, the processing capacity is highly skewed, with Gujarat alone accounting for 46 per cent. Dairy sector supports 8 crore farmers: mainly small, marginal and landless laborers. More than 2 crore of these are in organized dairy cooperatives. There are 1.94 lakh dairy cooperative societies in India. It has been observed that there is increase in crossbred and indigenous female cattle, with accompanying rise in milch animals. There is 39 per cent increase in number of crossbred female, 10 per cent in indigenous female cattle, and 6 per cent in milch animals. However, total number of indigenous cattle has decreased during 2012-2019. India possesses maximum buffaloes of the world (>50%) including 20 registered Indian buffalo breeds. Buffaloes are 20.4 per cent of total livestock population of India (2019); milch animal population comprised indigenous cattle (47%), and crossbred/exotic cattle (17%). As per the last livestock statistics (2016), India has 193.5 million cattle, 109.9 million buffaloes and 148.9 million goats. However, the milch population includes 25.67 million crossbred cattle, 48.51 million indigenous, 51.17 million buffaloes and 69.65 million goats. They yielded 198.4 mt of milk during 2019-20, that increased to 222 mt in 2022-23. Murrah buffalo breed of India is known to be the best in the world. In India, the buffalo population has increased steadily from 43.4 million in 1951 to 109.9 million by 2016, reflecting preference for buffaloes among the milk producers. As on date, India has 53 cattle, 20 buffalo, 40 goat and 44 sheep breeds, selected over 100 years. They are identified, characterized and registered. The unique feature of these animals is that they were developed and adopted under varying agroecology, climate and production systems. As compared to *Bos taurus*, breeds of *Bos indicus* are more sturdy and climate resilient and can thrive well under harsh environment and management conditions. In India, the dairy production system is diverse and can broadly be divided into four categories i.e., pastoral system, semi-intensive or crop-livestock production system, peri-urban dairying and intensive or industrial production system. This is an added advantage for Indian dairying because all breeds of animals are not suitable for rearing under a particular production system. As compared to other countries, the cost of milk production in India is relatively low, as per the International Fact-Checking Network (IFCN) report, in 2014, the cost of milk production ranged from USD 4.5 per 100 kg milk in extensive farming systems in Cameroon (where beef is the major output and milk is a side product) to USD 118 per 100 kg for an average sized dairy farm in Switzerland. In recent years, there has been a shift in the taste and preferences of consumers. Consumers are now sparing higher budget on milk and milk products as they have become more health and quality conscious. With an increase in life expectancy, the proportion of older people is increasing, and they

demand special dairy products. Moreover, globally with technological advances, the demand for nutritional dairy products with medicinal and health benefits has increased, including in India. While bovine milk is the most dominant dairy food in the world, non-bovine (e.g., goat, sheep and camel) milk is also considered an important source of nutrition and medicine. Sheep and goat milk is very rich in vitamins and minerals and is also suitable for those who have allergy from cow milk. Compared to cow's milk, goat's milk contains larger proteins and smaller fat globules in addition to more short and medium-chain fatty acids, which are beneficial to human being. India contributes 5.18 mt of goat milk in total world production of 15.5 mt. Camel milk also contains insulin-like protein that reduces the blood sugar and improves the insulin sensitivity in people with both Type 1 and Type 2 diabetes.

Milk is a wholesome complete food. It is like a one-stop shop for all important nutrients that body needs. Bovine milk is consumed by the majority of global population. Milk is the best natural food full of nutrition and nutraceuticals, and pharmacologically active molecules with health attributes. There is need to harness full nutritional and therapeutic potential of non-bovine (goat, sheep camel, donkey) and minor dairy bovine (mithun and yak) milk. The sector has huge scope for starts-up in value-added dairy products. He categorically stated that any plant-based beverage should not be named as milk, or even milk analogue or dairy analogue, as these can never mimic the "food matrix of milk, with fortification of nutrients. The milk is very well defined and the use of plant-based beverage as milk unnecessarily creates confusion in the mind of consumers. He further added that each missed heat delays calving by at least 21 days and implies a loss of at least 21 days of milk, and leads to a loss of at least INR 6,195/dairy animal for a farmer. The pregnancy rate has decreased, while the days open and requirement of AI/service per conception has increased. Life time reproductive efficiency is decreasing globally, average being 2.4 lactations in USA and Denmark. Long calving interval is due to poor estrus detection. In India, the overall artificial insemination (AI) coverage is 29.7 per cent; conception rate 35 per cent (developed nation 60-72%). In Brazil, coverage of AI is 100 per cent (23% after estrus detection and 77% fixed time AI). In India, most of AI is after estrus detection. India experienced huge economic loss due to infertility and diseases (46%), infectious diseases (32.00%) and 22 per cent from other diseases and calf mortality, etc. Repeat breeding and anestrus are two major reproductive disorders affecting 30-40 per cent of livestock. Assisted reproductive technologies and controlled breeding protocols offer immense scope to restore fertility. Infections that are naturally transmissible from vertebrate animals to humans and vice-versa are classified as zoonotic diseases. About 80 per cent rural population is always under threat of acquiring zoonotic diseases due to their intimate association with animals. Out of 1,415 human

pathogens, 868 (61%) are zoonotic and >60 per cent of existing human infectious diseases is zoonotic. Of the millions of enzootic viruses in animals, about 50 per cent have the potential to invade humans (SARS, MERS, Influenza, and Corona).

He emphasised on the major constraints currently being faced by the dairy sector which include: (i) high population of non-descript cattle and buffalo with low productivity, (ii) huge gap between requirement and availability of quality feed and fodder, (iii) adverse impact of climate change, drought and heat on dairy sector, (iv) dairy animal diseases: poor animal health, mastitis, FMD, brucellosis, frequent outbreaks of transboundary diseases; (v) shortage of vaccines and diagnostics and diseases being transmitted from animals to human (reverse zoonoses); (vi) infertility/sub-fertility and reproductive diseases and disorders in dairy animals; (vii) late sexual maturity of both male and female bovines; (viii) limited availability of male germplasm (breeding bulls, as well as frozen quality semen); (ix) increasing infertility among cross bred animals; (x) low processing and value-addition of milk; (xi) wide gap between demand and availability of proven males/male germplasm; (xii) mostly untrained/marginally trained AI technicians, no perfection of AI with frozen semen in goat, (xiii) poor animal health, mastitis, FMD, brucellosis; and (xiv) residues of antimicrobials, pesticides and aflatoxins in milk. Further, he suggested following strategies for dairy sustainability: (i) tools and protocols for enhancing reproduction and production in goats and sheep; (ii) protocol of artificial insemination (AI) in goat, sheep, and pigs are to be upgraded and out scaled; (iii) environment-friendly waste disposal; (iv) exploring the health attributes of non-bovine milk; (v) addressing the problem of zoonotic diseases and issues of AMR through animal's food; (vi) understanding rumen microbial diversity and manipulation of rumen archaea; (vii) fortification of crop residues; (viii) ensuring delivery of micro-nutrients at target sites; (ix) difficulty in meeting the demand for quality and value-added milk products without much transformation; (x) transforming from subsistence to commercial dairy farming, while protecting the interests of smallholders; (xi) boosting smallholders for inclusive growth as a whole and promoting commercial dairying in identified region; (xi) increasing the competitiveness by qualitative transformation in unorganized sector, also bridging the quality gap for their presence in international market while defending its domestic market from import; (xii) need to equip with policy and legislation backup to protect smallholders; and (xiii) coordination between producer, processor, packager, distributor and retailer among themselves as well as with local and state authorities. The presentation was like brain teasers for all the policy makers, researchers and entrepreneurs. He mentioned many invisible threats affecting the growth of dairy sector. As a dairy man, his outlook for ensuing good growth trend in dairy sector is very important, and really needs the attention of all to keep the sustainability in dairy sector.

TECHNICAL SESSION I: PROCESSING, VALUE-ADDITION, MARKETING AND POLICIES

The Session was Co-Chaired by **Dr BN Tripathi**, DDG (Animal Sciences), ICAR and **Dr Triveni Dutt**, Director, ICAR-IVRI, Izatnagar. **Dr Ravindra Kumar**, ICAR-CIRG Makhdoom and **Dr Meena Goswami**, DUVASU Mathura were the convenors. In this session, seven presentations were made which covered policy issues, value-addition and technologies of food safety, marketing chain for dairy sector along with prospective of budding dairy entrepreneurs.

Dr AK Singh, Joint Director (Research), ICAR-NDRI Karnal emphasised on the value-addition of milk and milk products in India as India lags behind all European and American countries. Value-addition of dairy and dairy products will not only increase the selling price of milk but also will improve the socioeconomic status of the farmers and make dairying profitable with sustainable growth. Value-addition will enhance the nutritive value of milk products and also their storage time. The export of value-added products can increase the profitability of dairying. The shelf-life increase will provide another boost for profit margin and benefit the dairying as a whole. **Dr Singh** also stated about the competitive nature of Indian dairy industry by adopting cost-effective state-of-the-art technologies to produce quality and safe products at par with international standard. Along with this, there is a unique opportunity of expanding the range of dairy products through consumer centric innovations. In the production and processing, there should be adaptation of green energy and resource minimization technologies. There is an urgent need of initiating collaboration/dialogues among R&D with nutritionists/medical professionals/industries so as to boost the value addition of milk products looking to the needs of human health.

Dr Rajan Sharma, Principal Scientist, ICAR-NDRI, Karnal deliberated on the quality and safety of dairy products. Being expert in the area of quality and safety of dairy products, he stated that India still lacks effective machinery system for the detection of various adulterants in dairy products and there is an immediate need of establishment of milk analytical units throughout the country. India needs stringent regulatory standards for milk quality and its enforcement aligning with the food safety parameters. He emphasised on more number of surveys regarding the milk quality, establishment of well-equipped analytical laboratories, research and development in the area of rapid tests required for determining the milk quality, enforcing Quality Mark Scheme, reframing the animal feed standards, educating the farmers regarding the milk quality and adulteration, aflatoxins in feed, usage of antibiotics, awareness regarding the emerging contaminants, packaging materials, polychlorinated biphenyls and dioxins.

Dr PS Birthal, Director, ICAR-NIAP, New Delhi spoke on “Enabling Policy Needs of Dairy Sector” and narrated the growth and development of dairy sector in India

highlighting major breakthroughs which have taken place in the past so many years. He stated that livestock is an engine of agricultural growth. It contributes 4.5 per cent to the national GDP and 33-35 per cent to AgGDP. Its share in GDP has remained around 5 per cent, but its share in AgGDP has been increasing. Share of livestock in agricultural growth- 32 per cent in 1990s, 40 per cent in 2000s, and over 50 per cent in 2010s. Value of production (VOP) of livestock is now more than the VOP of foodgrains. Milk is the largest agricultural commodity in physical and value term, and its VOP is more than combined VOP of rice and wheat. He opined that fodder, feed and extension program seem to be weak and need to be attended judiciously. Livestock builds resilience against climatic stress. Dr Birthal meticulously put forward the major constraints and challenges being faced by dairy sector in India.

Among others, he pointed out recycling of crop residue and ecosystem services. Livestock builds resilience against climatic stress. Growth in livestock is 1.4 times more pro-poor than the growth in crop sector. Livestock helps in escaping poverty, and are concentrated among marginal farm households. Livestock ownership is not bound by any property rights, and thus livestock are an ideal instrument for women empowerment. Women lack ownership of land, credit, markets, assets and technical information. Consequently, they face greater economic, social and institutional barriers, and frequently lack the means to fully engage in, sustain and upgrade their farming activities. When women have a greater control over livestock assets, they contribute to better food security for all family members and to the nutrition and education of their children. In India, women comprise about 70 per cent of the workforce in livestock production. Therefore, he advocated for strong policy formulations and their timely implementation. Harnessing pro-poor potential of dairying requires a big policy push to sustain the recent growth and to optimize number and increase productivity to meet the increasing demand for milk and milk products. GoI should invest more on livestock R&D; strengthen extension activities; and feed and fodder availability.

Dr Sunil Saroj of the International Food Policy Research Institute (IFPRI), New Delhi spoke on impact of traditional versus modern dairy value chains on food security. He pleaded for futuristic approach for dairy practices including the milk marketing system and urged the sectoral interventions to make the traditional dairy practices modernized and advanced. He emphasized on fostering adoption of single and multiple milk-marketing outlets for sustaining the dairy production system. Formal training and education in dairying is the need of hour for better dairy practices and sustainability. The participation of smallholder dairy farmers in milk marketing should be encouraged to enhance their net farm income and reduce expenditures. He mentioned about impact of traditional vs modern dairy value-chain and informed that 52 per cent of households do not sell the milk.

Major issues of concern are adulteration, contaminants and presence of microbes in the milk which need to be addressed. There is need to make arrangement of testing of milk and milk products. Modern dairy should have promotional benefits and these efforts should focus on joint adoption of more than one milk-marketing outlets and introduction of the advantages of diversifying milk-outlets should be taught to the dairy producers. The information, and extension bulletins, and dairy farming reports need to be made available in the remote areas with improved extension services, and extensive use of radio/television services to be promoted so as to reduce the barriers to entry based on farmer's caste and assets. The digital services must be taken into consideration for promotion of dairy practices and wider information dissemination to the stakeholders.

Dr Brijesh Yadav, Veterinary Physiologist, DUVASU Mathura in his lecture on "Road Map for Reducing Greenhouse Gas Emission by Dairy Animals" narrated about the effect of global climate change on the rumen microbiome. He expressed concern on the greenhouse gas (GHG) emissions from the animal system due to fermentation, and emphasized on the different strategies to reduce the GHGs especially the methane. He urged for a time and need dependent evaluation of rumen microbiome to find out how it is affected by the heat stress and how it will be affected in the future due to ongoing climate change. He narrated about the research findings reported for the reduction of methane production from the ruminant system and emphasised on testing the efficacy of anti-methanogenic compounds for long time and also their effect on quality of animal products and production system. He advocated the use of a combination of anti-methanogenic compounds rather than a single compound which is not enough for the reduction of methane. He also argued regarding the selection of animals on the basis of feed efficiency and microbial genome for methane mitigation. Alternatively, feed processing, high quality forage production and reduction in unproductive animals could be useful in reducing GHG emission from the livestock. Also, the area of manure management must be further researched for mitigating the GHG emission. As the Way Forward, he suggested identification of economic, effective and harmless anti-methanogenic feed additives; need to acquire data related to microbiome of different livestock species under different agro-climatic conditions. There is a need to have strategies for socially acceptable solution to decrease unproductive animals and manure management in terms of nitrous oxide emission for mitigating GHG emission. The farming communities must be familiarised for balancing the ration so as to have higher feed conversion, cost effectiveness in animal feeding, higher production output and better output in terms of economy of animal rearing.

Ms Nikki Pilania Chaudhary, Mango Dairies, Pilibhit (Uttar Pradesh) deliberated on processing, value-addition, marketing and policies and presented her experiences as a perspective entrepreneur. She was deeply concerned about the suffering

of farmers in general and dairy farmers in particular. She mentioned that the problem in dairy sector is not of lack of technology but of human capabilities and intentions, and right policies. We need to reach out to tradition agrarian/rural institutions that have existed for thousands of years and have proved their intelligence by survival. She strongly recommended the building up of a Rural/Agrarian Think Tank, and opined that dairy industry needs to move forward from aggregation of milk model. India should decide its own path in the dairy sector and we must not copy from other developed nation's policies and strategies for Indian dairy sector. We should think about our own policies looking to our needs and we should be strict on their implementation, monitoring and activating the feedback system. She narrated how the ban on cow-culling and menace of stray cattle have destroyed the farm economy. She advocated that there should be experts from dairy sector along with ground level entrepreneurs for the policy making so that a fruitful long-term result-oriented policy could be in place for the sustainable growth of Indian dairy sector. She emphasized that in milk processing, value-addition and marketing, the revolution emerges from within- district level creameries, local brands developed by farmers coming together as private company/FPOs/cooperatives where driving force are farmers themselves. For large private/co-operative players, enabling ecosystem rural Think Tanks, and rural entrepreneur incubators, etc. should be in place.

She pointed out the key requirements to establish model dairy farm as: (i) farmer ownership in value-chain; (ii) providing enabling ecosystem for efficient milk production; (iii) centrality of buffalo in profitable and sustainable dairy farming; (iv) sustainability-3Cs, viz. climate resilience in dairy animals, circular systems approach to reduce outside of farm inputs, and crop-tree-forage integration, through poplar (*Populus* spp.) tree-based agroforestry, and other trees. She concluded that farmers in general and dairy farmers in particular are suffering and that the problem in dairy is not lack of technology but of human capabilities and intentions which need to be addressed on priority.

Hitesh Rathi, a perspective entrepreneur from Aadvik Foods Pvt. Ltd, talked about sustainable growth and development of dairy in India and opined that creation of world class brands in dairy sector is the need of hour. There are only a few Indian brands which are globally known in dairy sector and that is why the global leaders are less attracted towards the Indian dairy products. This has also narrowed down the marketing of Indian brands and also posing a lower foreign investment in Indian dairy products. There is an urgent need of setting up of startups in the field of dairy products with adequate funding support from the government. He emphasized that the camel milk has a huge scope in the international markets. Single international standards based finished product, which is acceptable worldwide needs to be introduced. The technical institutions and

policy makers should work more closely with the business sector to understand and address the market needs. Introduction of rewarding systems and recognitions will motivate other people to venture into dairy. Integrity and traceability also play an important role in generation of marketing niche for dairy products. Extensive value additions should be made of dairy products for better profit margins. He firmly believes that Indian dairy sector can be successful with environmentally sustainable business. Policies should be such that it is a win-win situation for all stakeholders. Result-oriented and time-bound approach is a must for all specially policy makers, research institutes and coordinators. Changing lifestyle and food habits hint for different types of value-additions, and therefore value-additions to the milk and milk products must be taken care of. Conscious and careful approach by the farmers and business owners needs to be adopted so that the quality of milk and milk products are maintained up to the best standards and must be in the compliance of international market and exports.

The major points emerged from Technical Session I are given below:

- The livestock acts as an *ex ante* form of risk management and self-insurance against climatic and other shocks. Its growth is more pro-poor, pro-environment and supports gender empowerment and proper nutrition. There is a huge yield gap and under investment in this sector. Share of livestock in agriculture credits has never exceeded 6 per cent and information system for awareness of livestock owners is very limited. The market of processed dairy products is also under-developed, and the value chains and price of products is also not scientifically based. Overall life cycle productivity of superior indigenous animals is better as compared to crossbred animals. A big policy push is required to exploit its pro-poor potential and consumer demand.
- India leads in milk production with 23 per cent of global milk production and have 6 per cent growth rate, whereas level of processing in milk and milk products is around 35 per cent. Several traditional dairy products are available in the Indian food market providing better nutritional security and health benefits to consumers. Present day health-conscious consumers demand functional dairy products with disease preventing and health promoting properties like millet based composite dairy foods, organic milk, herbs incorporated dairy products etc. The application of Ayurveda knowledge with traditional skills and scientific technologies has to be developed with certification and branding that will help the progressive dairy farmers to fetch better price from elite consumers in the national and global food market.
- The quality and safety of dairy products is directly related to acceptability among the consumers. Only 20 per cent of the total milk produced is undergoing quality testing. Contaminants such as antibiotic, pesticides residues, aflatoxins are reported in milk collected from vendors in local market. There is a dire

need to regularize the quality standards for milk and dairy products, feed and fodder. Government bodies, viz. NDRI, NDDB and other private agencies have developed commercial kits for quality assurance of milk and milk products, which should be readily available to dairy farmers at lower cost. Development of related infrastructure, testing labs, policy and farmers awareness is also very much needed.

- Traditional dairy value-chain is affecting the food security in India. Around 51.8 per cent dairy farmers do not sell milk at all, whereas 14.7 per cent, 19.8 per cent, 9.7 per cent and 0.1 per cent is sold directly to household people, local traders, cooperatives and to all channels respectively as studied by multinomial logit model. Integration with modern milk marketing chains has a significant and positive effect on food security indicators. Diversification of milk outlets can lead to higher net return to dairy producers. Participation of dairy farmers in milk outlets also can improve their socio-economic status. The graph of global warming since last 40 years, shows a steep increase in temperature due to increased concentration of greenhouse gases in atmosphere. Curtailing of greenhouse gases like methane and nitrous oxide from animal production system is the need of hour. Various measures like use of anti-methanogenic compounds, plants secondary metabolites, ration balancing, etc. have been tried to mitigate the methane emission from ruminants. Ration balancing/feed management seems to be more practical and acceptable approach to reduce the methane production under Indian conditions. Manure is also a source of nitrous oxide and methane; therefore, proper manure management should also be considered. Conclusive research and government policy should be focused on this aspect.
- Startups in dairy sector should get proper institutional support, along with mentoring of the entrepreneur. There is a need to explore the potential of non-bovine milk from camel, goat, etc. in the Indian national food market. Veterinary extension system should also be strengthened and within the reach of farmers. The price of feed and fodder is increasing continuously. Dairy entrepreneurs should also get full technical, financial and policy support from government and allied organizations for their successful establishment.

TECHNICAL SESSION II: PRODUCTION AND MANAGEMENT

The session was co-chaired by **Dr MP Yadav**, Former Director and Vice Chancellor, ICAR-Indian Veterinary Research Institute (IVRI), Izatnagar, and **Dr RK Singh**, Former Director/Vice Chancellor, ICAR-IVRI, Izatnagar. **Dr SS Lathwal**, ICAR-NDRI Karnal and **Dr DN Singh**, DUVASU, Mathura were the convenors.

Dr Umesh Singh, Director, ICAR-Central Institute for Research on Cattle (CIRC), Meerut deliberated on the management and improving efficiency of dairy cattle. He stated that India with cattle population of 193.47 million ranks second next to Brazil and represents the highest contribution to national livestock wealth (36.04%) - 24.57 per cent increase from 1951 to 2020. Rich genetic diversity in India comprises 53 cattle breeds. Among 73.45 per cent of indigenous cattle population, only 29.47 per cent consists of recognized Indian breeds. More than 50 per cent of recognized cattle population consists of 4 breeds only. Dr Singh was highly concerned about the decline in indigenous cattle population in 20th livestock survey in comparison to 19th survey, while there was an increase in the population of crossbred animals. Among 26 per cent of CB/exotic cattle of India, 58.83 per cent are productive, while out of 74 per cent of indigenous/non-descript cattle, only 41.17 per cent are productive. For improving the production potential of dairy cattle, there is an urgent need to adopt selective breeding program by superior germplasm, use of artificial insemination (AI) using sexed-semen, and extensive propagation of superior germplasm using OPU, IVF and ETT. Interventions are needed to have strict control over the stray population of cattle for which sexed-semen may be effectively used. Policy formulation and dissemination of cattle development programs, viz. *Rashtriya Gokul Mission*, National Project for Cattle and Buffalo Breeding (NPCBB), etc. are now required to be operational at field level. He highlighted various constraints of cattle production and management like limited availability of superior germplasm, low AI coverage (30-35%), and poor conception by AI (2.5 AI per conception), ignorance of farmers about the details of semen, and presence of unregistered livestock practitioners for specialized work. While concluding, he suggested a number of strategies for improving the efficiency of dairy animals. He argued about the use of genomic selection (GS) by progeny tested bulls, wider availability of sex sorted semen, supply of superior germplasm at doorstep of farmers, nutrition management by providing balanced ration, health management, mitigation of anti-microbial resistance (AMR), effective utilization of feed and fodder resources, production of quality clean milk, value-addition of milk and milk products, evaluation of nutraceutical values of milk of indigenous cattle, formation of breed standards and societies, reducing the milk yield gap between the regions and breeds, improving feed efficiency using *omics* technologies, TMR, ration balancing, reducing the GHG emissions from the rumen fermentation using methane reducing additives/strategies and most importantly using effective ICT-based extension techniques. GS shortens the generation interval and increases the accuracy of selection at young age, tracks all the genetic variances and yields accurate estimated breeding value (EBVs) even without phenotypic evaluation of the candidates, can be used in non-pedigreed populations, and is effective in traits that are - sex-limited,

expensive to measure, and with low heritability. Average milk productivity in India is 50 per cent of world average (average yield 1,172 kg/cow) in comparison to world (2,200 kg/cow). Reasons for low productivity of indigenous cattle are - low genetic potential for milk production, poor nutrition, shortage of feed and fodder, poor quality of feed and fodder, non-scientific management practices, poor AI coverage and veterinary and extension services, and lack of large-scale organized breed improvement program. Strategies for increasing the milk productivity calls for upgrading non-descript cattle, necessity of breeding services, AI using superior germplasm, retain and increase the genetic variability, stray cattle menace - male calves, sexed semen, extensive propagation of superior germplasm- OPU, IVF, ETT. There is an overall 30 per cent (1 to 70% for different states) AI coverage in bovines in India. AI workers perform an average of 1.92 AIs/day which should have been at least 4 AIs/day; and also, there is limited use of indigenous bull semen (only 11% of total AI coverage). GHG emissions from dairy sector include 18 per cent of total anthropogenic emissions from livestock food chains, bovines contribute nearly 14.5 per cent, and a cow on an average releases between 70 and 120 kg of methane per year. It can be reduced by replacing the large number of low producers with lesser number of high yielding cattle, undertaking research to mitigate the methane emission from the animals, and nutrigenomics to alter the methane synthesis pathway without hampering the feed efficiency.

Dr RS Sodhi, MD, Amul India, Member of the Board of International Dairy Federation (IDF) and President of Indian Dairy Association (IDA) delivered his address on- Growth in Indian dairying: production and processing. Dr Sodhi stated that the livelihood of 100 million farmer families depend upon the dairying, and about 1.43 billion population use the milk and milk products as the major source of protein and minerals. The growth in milk production of India is 4.9 per cent, which is much greater than world average (1.9%) as well as other milk producing countries of world (USA 2.3%, EU 1.3%, The Netherlands 2.7%, Australia 0.5%). As per CAGR, every 25 years, the milk production of India is increasing three times and now the share of India in the global milk production is 24 per cent. The share of India in global milk production will increase to 45 per cent by 2047. Per capita demand of milk in India will increase @ 2.8 per cent CAGR to 852 g/day in the next 25 years. In next 25 years, milk production of India will reach 628 mt, while demand for milk and dairy products will increase to 517 mt. By 2047, India will have export surplus of around 111 mt. If the milk productivity reaches at par to US in due course of time, India can flood the entire world profusely with milk. One of the major challenges is to satisfy the need of nutritional security in terms of per capita milk availability for growing human population of India, which may be around 1.67 billion in next 25 years. He argued as to why India succeeded so spectacularly in dairy industry? It has been possible by harnessing

the collective power of our vast smallholder dairy ecosystem (the livelihood of 100 million families, mostly smallholder rural farmers depend on dairying) by creating the most efficient milk supply-chain in the world. He further highlighted that the sustainability of Indian dairy sector depends on the small farm system, which is more sustainable than large dairy farmers and therefore, high importance must be given to the small holdings with proper policies and rewarding system in place. The challenges in dairy sector are: (i) next generation not ready to work in dairying, (ii) significantly less productivity per animal, (iii) shortage of animal feeds, (iv) availability of analogue products, and (v) free trade agreement (FTA) is not in place. There is a huge scope of employment in organised dairy sector showing its worth for future employment and livelihood security. Small farm holdings are more beneficial to the landless and women workforce. He advocated for strong policies and their timely implementation at the grass-root level so as to boost dairy production and make the system sustainable. Use of technologies will be the major boost for dairy sector. Also, there is need to establish markets for processed dairy products at central and state level. He mentioned that around 60,000 persons will get employment opportunities if 1 million litre milk is procured through organized sector.

Dr Inderjeet Singh, Vice Chancellor, GADVASU, Ludhiana, delivered a talk on “Productivity Enhancement and Better Management of Buffaloes”. Dr Singh mainly focused on the delivery of best possible management practices for higher buffalo production during their different stages of life, viz. calf, heifer, and lactating animal. He strongly recommended that buffalo needs a very good management practice in terms of feeding, care and management. Effective summer management using various heat lowering components are the best for buffalo to fight against the summer stress. He deliberated his practical experiences in buffalo management gained at ICAR-Central Institute of Research on Buffalo (CIRB) Hisar, relating to feeding, housing, fertility, and health management; and dry cow therapy which helped in improving the production efficiency of buffaloes. His major concern was the lower budgetary provision for the buffalo R&D in the past several years by the ICAR. He summed up his presentation with few take home messages: (i) urgent need of fund allocation for buffalo development, (ii) establishment IVF lab in ICAR and state institutes, (iii) AICRP support in university system, and (iv) establishment of new Mission on Buffalo Development. He stated that when information on various parameters is available, one can accomplish management (33%), breeding (13%), feeding (17%), and health (10%). For better management in breeding, we need to have knowledge of heat detection, pregnancy diagnosis, bull selection, AI/Natural; about green fodder, silage, hay, concentrates, ration balancing, minerals, supplements, drinking water; for health- timely vaccination, deworming, preventing mastitis; and in housing animals- tie-stall/loose, watering,

feeding time, flooring, etc. The animal should have freedom to consume water and have comfortable bedding (17% increase in milking). Buffalo will play the major role in achieving sustainable growth in Indian dairy sector in future as well. He also recommended establishing the Indian Council of Veterinary Research (ICVR) at the national level.

Dr Smita Sirohi, Joint Secretary G-20, Dept of Agriculture & Farmers' Welfare (MoA&FW), Gol made a presentation "Economics in Indian and Global Dairy Sector". She mentioned about the priorities and action plans of G-20 for people, planet and prosperity. She also gave the information for sustainable development of dairy sector by agricultural working group to satisfy the nutritional requirements. She has also mentioned about the moto of G-20 -One Earth-One Family-One Future (*Vashudhaiv Kutumbkam*). Indian dairy sector is vulnerable and is highly affected by the diverse nature of agro-climates, agriculture, diverse milk procurement and processing systems, and milk marketing. Therefore, she stressed on looking critically to the Indian situation and policies for sustainable dairy development. She recommended for absolute grading not relative grading in dairying. She concluded that there is need of integration of policy priorities on small dairy in dairy research and marketing, development of digital platform, and importance of youth in agriculture to generate employment and income. She strongly recommended for establishing a digital platform for quantifying the sustainability of dairy farms and future strategies required for the sustainability of dairy sector. She specifically highlighted the value of non-bovine milk (goat milk and camel milk) and its potential in the Indian dairy sector which are not only having the big market value but will also serve as the game changer in economic upliftment of farmers and sustainability to the dairy sector.

Dr Mukul Anand, Veterinary Physiologist, DUVASU, Mathura made a presentation on "Strategies for Enhancing Goat Milk Production". With the financial assistance from RKVY, a state-of-the-art facility has been established in DUVASU for goat research. He stated that complexity is evident in goat milk production despite the highest number of goat population in India. Milk is an economic trait of goat, and nutraceutical values of goat milk are well established. But still we have not developed goat milk as a commodity to be sold in open market with an easy access and acceptability. Under this single roof, there are different sheds for animals at the DUVASU, Mathura. Bucks are used for semen collection which is cryopreserved and extensively used for AI. The major aim was to disseminate the superior germplasm of goats with faster pace and conservation of indigenous goat breeds. Along with this, a goat milk unit has been established for rearing of goats for milk production, collection and processing of milk and milk marketing. He questioned whether goat farming ever be called as 'Milk Industry'? We need to rethink and re-evaluate the mechanism, scientific research, farmers' production

system and their association. Hurdles experienced in increasing goat milk production include: (i) lower milk productivity, (ii) dispersed milch goat population, (iii) lack of scientific input, (iv) collection system, (v) limited market and its access, and (vi) customer acceptability. Scientific intervention is needed on: (i) selection of animal with high milk yield, (ii) balanced ration formulation with respect to milk production requirement, (iii) better housing and health management, and (iv) awareness among the producer and consumers.

He shared the success storey of the unit and how the unit is beneficial in helping small and marginal farmers for improving their livelihood. Along with this, he deliberated the various modalities of dairying in goats and how goat milk can be a better option instead of bovine milk. There is a wide scope and market for the goat milk due to its nutraceutical values and closeness to human milk in composition and function. He discussed about the genetic variability of goat germplasm along with importance of goat in nutritional security as well as improving the socio-economic status of goat farmers. He further focused on various hurdles and strategies in goat milk production in India and suggested that there is urgent need of establishment of: (i) goat mother farm, (ii) marketing facilities, (iii) adoption of conservation practices, (iv) breeding strategies, (v) use of assisted reproductive technologies, (vi) induction of business model, and (vii) awareness to the farmers, consumers and sellers about the importance of goat milk and milk products. Even though in India, goat is predicted as the future dairy animal, still there is lack of awareness among the people regarding goat milk production, processing and marketing. In his concluding remarks, he advocated for a strong collaboration between the policy makers, researchers and stakeholders for an effective planning and execution of goat model in India for sustainable growth with more profit to the farmers.

Dr A Sahoo, Director, ICAR-National Research Centre on Camel (NRCC), Bikaner spoke on “Prospects of Camel Milk Production” and stated that daily average camel milk production is estimated to be around ~2.5 litre/day during a lactation period of 12-18 months. Not all camels are milked (<20%) and there is enough potential to yield >10 litre/day. The yield could increase to 10-20 litre/day under improved feeding, husbandry practice, water availability and veterinary care. He also discussed the prospects of camel rearing, and management apart from camel milk production, processing and marketing in India. The reduction in the camel population in India is a matter of big concern but interestingly the percentage of milch camel is increasing continuously. Dr Sahoo discussed about the genetic diversity of camels, their milk production ability, and their potential in the milk market. He also informed that camel milk is rich in vitamin A, D, E, K and C, while it is low in cholesterol content and hence has high potential value for human nutrition. He emphasized about the medicinal properties of camel milk

to treat various diseases of human being like diabetes, tuberculosis, autism, abdominal pain, anti-cancerous effect, etc. He emphasized that owing to high medicinal value of camel milk, there will be a good future for camel in terms of milk production, processing, value-addition and marketing which will not only be an alternative to bovine milk but also fetch a good profit for camel milk producers. He concluded that there should be a system for identification of elite camel animals, procurement of their progeny to bring at bull rearing system for multiplication of elite germplasm after proper evaluation. The price of the milk needs to be determined species-wise, rather than on fat or SNF basis.

During the session, the following important points emerged:

- Small scale farmers will be the main players in future dairy production system, therefore, they should be of utmost priority in future roadmap for dairying.
- Technology will ensure sustainability, hence, extensive technological interventions in dairying are required.
- Value-addition of milk and milk products are required to make the dairy sector viable, profitable and sustainable.
- Non-bovine milk must have greater focus on research and higher investment to make the dairy sector sustainable. Proper breeding, feeding, management and timely disease diagnosis will serve as the three pillars of sustainable dairy sector.
- Milk and milk products must be globalised and higher fund allocation needs to be done to establish global market of milk.
- Establishment of cold-chains for milk and milk products along with MSP of milk and other dairy products will make the dairy sustainable.

PANEL DISCUSSION

Dr AK Srivastava, Vice Chancellor, DUVASU chaired the Panel Discussion on the Sustainable Growth of Dairy Sector. Dr Dilip Kumar Swain, Veterinary Physiologist, DUVASU acted as the convenor. At the outset, the chairman offered a brief overview of the session followed by the interventions by different panelists. There were eleven panelists, viz., Drs TK Datta, Praveen Malik, RK Singh, Manish Chateli, Pawan Singh, Arun Kumar Misra, Atul Saxena Vikas Pathak, Nitin Bhatia, Raka Saxena, and Rajesh Saini who made their interventions providing useful suggestions for the way forward.

Dr TK Datta, Director, ICAR-CIRB, Hisar extensively discussed the key issues in the present dairy sector especially in animal reproduction. He recommended to revisit breeding policy of animals, genomic selection (GS) of dairy animals

using genomic chips, wider coverage of artificial insemination (AI) with trained inseminators, quality semen with proven bull for AI, use of sex-sorted semen for skewing the sex ratio, development of suitable indigenous technology for sexing the spermatozoa of elite breeding bulls, use of assisted reproductive technologies like ovum pick up, *in vitro* fertilization (IVF), embryo transfer, animal cloning for faster and effective propagation of suitable and best germplasm with higher production potential, effective use of genome editing tools for higher disease resistance and higher muscle mass production, organised dairy procurement system and distribution, establishment of scientific milk processing units and a strong linkage between different institutes with government in formulation and execution of policies.

Dr Praveen Malik, Former Animal Husbandry Commissioner, GoI talked about the sustainability in the dairy sector, along with milk, and meat production and highlighted that both meat and milk will make the dairy sector viable and profitable. India is the largest exporter of buffalo meat which also needs to be taken as a component of sustainability. Smallholders' sustainability already exists in India. Policies should be framed in view of the prosperity and attracting manpower for more entrepreneurship in dairying to boost the dairy sector. There should be provision of subsidy in dairying for the private groups so as to attract more private investment in dairy sector which will enhance the possibility of employment. It should be managed through *Rashtriya Gokul Mission* and National Livestock Mission (NLM). The net investment in the dairy sector needs to be enhanced so as to power pack the dairy sector growth as well as more involvement of people in dairying. Waste management will play a major role and it should be subsidised so as to generate revenue from this. There is an urgency of commercialisation of agriculture-livestock associated technologies for their better utilisation and output through 'Agrinnovate India' There is a wider need of trained manpower for the faster dissemination of lab-based technologies for use in the field. Frozen semen boxes and frozen embryos need to be percolated in villages by hiring paid extension manpower for implementation. Along with the allopathy medicine, use of ayurvedic-homeopathic medicines needs to be enhanced to boost their growth in veterinary and dairy sector and also to fight against AMR and better health management of animals. Clean milk production, processing and hygiene in processing will be the deciding factors of future dairy milk production, export and sustainability. He also emphasized about silage technologies, lean period management, and hygiene, etc. and also the need to work holistically and not only on production side.

Dr RK Singh, Former Director, ICAR-IVRI, Izatnagar emphasised on financing of farm infrastructure for better management, and good animal husbandry practices ensuring safety and biosafety of dairy farms having elite animals. The loss of

production and the cost involved in animal health management is too high, therefore, strict biosafety measures must be taken in dealing with the animals. Financial assistance must be available to small farmers with ease of documentation for more and faster participation of farmers in dairy sector. He emphasised on the necessity to take care of animal health on top priority. Vaccination-associated losses have gone up and now a wider coverage of vaccination is required for which adequate facilities need to be developed for vaccine production, storage and effective distribution. He further stressed on the emergence of new diseases across the borders and neighbouring countries which affect the dairy health and production, hence there should be an intensive system of disease diagnosis and treatment in animals so as to check the spread of infectious diseases in animals.

Dr Manish Chatli, Director, ICAR-Central Institute for Research on Goat (CIRG), Makhdoom stated that for the sustainable growth of the dairy sector, goat milk is considered as a complement to the traditional bovine milk production. Goat milk production in India is 6.1 mt, which is around 40 per cent of world's share; 99 per cent is from smallholders. He emphasised on the need for commercial goat milk production, processing and marketing. For small scale procurement and processing of goat milk, mechanisation is required. Focus should be on production and commercialization of goat milk powder and goat milk cheese. Like the detection of bovine milk adulteration, kits are required for the field level detection of adulteration of goat milk. For sustaining the growth of the goat milk sector, business models are required to be developed for commercial goat farming. He further informed that there is great demand of goat milk powder, 92 per cent infant formulations are made from goat milk. Currently, goat milk cheese is in great demand, its import figure is of Rs 260 crore. He opined that goat milk can suitably be used as a source of non-bovine milk and in future, there is huge scope in goat milk market. Simultaneously, it gives big boost to the sustainable dairy sector in India.

Dr Pawan Singh, Scientist-in-Charge, Artificial Breeding Research Complex (ABRC), LPM, ICAR-NDRI, Karnal centered his discussion around the quality semen production and functional evaluation tests for good quality of semen. The males constitute 50 per cent of the herd, therefore, they should not be neglected if dairy sector is to have sustainability. To increase milk yield from 8 kg to 12-15 kg per animal, there is need for good germplasm with wider coverage of AI and supply of quality semen from tested bulls. AI with untrained professionals is the major concern behind economic loss due to failed AI responses and poor conception in dairy animals, hence, there is need for well-trained inseminators. Area specific micro-minerals and mineral mixtures are required for the fulfilment of mineral deficiency and improved reproductive efficiency among animals. Mineral mixture may be adapted as per the need of the area depending on local soil,

fodder and feed availability. Routine monitoring of mineral status of the dairy animals is highly essential to keep the semen production at optimal level along with milk production.

Dr Arun Kumar Misra, Head, Livestock Production Management, ICAR-NDRI, Karnal discussed on integrated farming system (IFS) for sustainable dairy production. He emphasized on the need and significance of this system in making dairy a profitable business and also for livelihood security. India holds around 15 per cent of the world's livestock population in 2 per cent of world's geographical area, resulting in a greater pressure on land. The average size of agricultural landholding in India is gradually shrinking from 2.28 ha in 1970-71 to 1.08 ha in 2015-16. It is difficult to achieve livelihood security and sustainability for these farmers with a single farm enterprise. These farms need multi-enterprise farming activities that are complementary and technically feasible in the interest of the productivity of the whole farming system. In integrated farming system (IFS) research, integration of land-based enterprises such as dairying, aquaculture, poultry, duckery, apiary, and field and horticultural crops within the biophysical and socioeconomic environment of the farmers is important to make farming more profitable and dependable. Location and commodity-specific IFS needs to be promoted. Integration of various enterprises helps in ensuring food, nutrition and livelihood security and also social, economic and environmental sustainability. For this reason, the IFS model has been suggested by several workers for developing small and marginal farms across the country. IFS aims least dependence on outside resources and efficient recycling of available farm resources, as in this system nothing is wasted and the by-product of one system becomes the input for other. Keeping these facts in view, the ICAR-NDRI has initiated the research work on developing dairy-based integrated farming system model for income enhancement of small farmers. The dairy production tends to be more complex than crop production because animals too often play a pivotal role in the overall farming system. Any constraint imposed on animal may also restrict the system as a whole. In general, the aims of dairy production in integrated farming systems are to: (i) raise productivity through better utilization of available resources, (ii) recycle and reuse farm waste within the system, and (iii) optimize the allocation of resources through rational management. The project is laid on an area of 1.0 ha with different sub-components, viz., cereal crops (0.4 ha), fodder crops (0.4 ha), dairy (cattle, 3; buffalo, 3; goats, 10), poultry (20 birds), fish pond and vermicompost pits (0.2 ha). The potentially important technologies that could make a significant increase in productivity in IFS need to be implemented.

Since the supply of green fodder throughout the year is a major challenge, emphasis needs to be given on production of quality green fodder and feeding strategies for dairy animals. Studies suggest that dairy-based IFS model increases

the production and profitability and also ensures the food and nutritional security through regular supply of milk and eggs round the year, and has potential to increase resource use efficiency and overall resilience of the production system. Hence, emphasis needs to be given on development of dairy based IFS module for different situations to fit into socioeconomic realm of small and medium farmers to provide income throughout the year on sustainable basis. Availability of key inputs and support services need to be strengthened and improved to enable the small and marginal farmers for dairy based IFS development. A favourable policy environment in terms of access to micro-credit and assured market will have to be provided for upscaling the developed models. The future of agriculture lies in dairy based integrated farming by marginal and small farmers depending upon the resource availability, and will definitely improve their livelihoods and standard of living.

Dr Atul Saxena, Director of Extension, DUVASU, Mathura focused on two major issues: (i) timely detection of oestrus, and (ii) proper time of ovulation and insemination. He mentioned that if proper nutrition is deprived, problem of ovulation, and mutilating hormone affecting development of oocytes will arise. Trained persons are required to carry out field level AI for improvement of reproductive efficiency of animals. The major concern is delayed puberty in the animals and strategies are required to reduce the age of puberty. Proper nutrition and hormonal interventions are highly essential for reduction of age of puberty. Extensive extension services are required for faster dissemination of scientific knowledge to the farmers. Proper digitalisation of animal data will improve the services to the animals. If we bring animals in reproductive cycle timely, we can increase milk production for life time. The sustainability of dairy sector can be achieved through better reproductive efficiency of animals with a very low incidence of sub-clinical infections. He also emphasised on robust and dedicated team efforts at farmers' doorstep.

Dr Vikas Pathak, Director of Research, DUVASU, Mathura highlighted about the productivity enhancement in dairy cattle which are low in production. Interventions are required for robust marketing of livestock products and value-addition. The MSP for livestock products and establishment of cold-chains for livestock products will boost the dairy sector. Value-addition will improve the economic value of products as well as improve the socio-economic status of farmers in dairying. Among others, he emphasized on strategy for utilization of by-products, strengthening milk collection system, proper marketing and pricing system. It is extremely important to know about the breed and the activities and plan for effective implementation accordingly.

Dr Nitin Bhatia, Vice President (Technical Services and Vet. Regulatory), INTAS Pharmaceuticals Ltd, Ahmadabad discussed the issues related to antimicrobial

resistance (AMR) and how this can be minimised so as to improve animal health and disease management. Greater thrust is needed on revisiting the breeding policy in animals so as to propagate the indigenous animals and cross-breeding can only be done in the local non-descript breeds to enhance animal production. We must have clear breeding policy in place. He further emphasised on branding, coordination among the stakeholders, and for standardisation and certification. There is an urgency of public awareness and integration and collaboration between various veterinary departments and institutions for development of suitable strategies for effective management of stray animals.

Dr Raka Saxena, ICAR-NIAP, New Delhi highlighted some of the issues which are of major concern for the sustainable growth of the dairy sector. She talked about the growth in gross value output of livestock sector (micro and macro) and correlation between farmers' income. The investment in livestock sector including livestock health management, and vaccines must be improved substantially to provide a faster pace for the growth of dairy sector. Market surveillance and market intelligence for dairy products must be taken care for increasing the dairy product selling and export. Export data need to be developed and monitored. The dairy product export potential must be explored to increase the profitable margin in dairying. Capacity building of farmers is required for their knowledge upgradation as well as creating awareness among the farmers to increase profitability. Also, there is need to tap the untapped potential of dairy sector. There should be policies in place for non-bovine milk- promotion, procurement, processing and marketing. There should be an accurate system for projection of Indian dairy sector along with its monitoring and revision of dairy sector needs. These will enhance the dairy production and result in sustainability of Indian dairy sector.

Dr Rajesh Saini, Additional Director, Government of Uttar Pradesh suggested six major issues which need to be focused for the sustainability in dairy sector- (i) genetic upgradation of non-descript low producing animals; (ii) management of infertility in dairy animals; (iii) conservation and propagation of elite dairy animals; (iv) surplus and required green fodder for dairy animals; (v) awareness regarding animal health and its management, and (vi) value-addition and pricing of milk products. Apart these, he further suggested to undertake on priority the AI activity in mission-mode with a target of 75 lakh (7.5 million). He highlighted the need of: sex-sorted semen for stray animal management and enhancing female calf production; use of synchronisation protocols for obtaining higher conception after inseminations; regular exercise to the dairy animals especially for the bulls kept for semen production; timed and wide scale vaccination against important existing, emerging and re-emerging infectious diseases; proper data recording; and value-addition of milk products with MSP for dairy products. This will serve as the route for success in dairying and pave the way for sustainable dairy system.

PLENARY SESSION

The Plenary Session was co-chaired by Dr RS Paroda, Chairman TAAS, and Dr BN Tripathi, DDG (Animal Sciences), ICAR, New Delhi. Prof. AK Srivastava, VC, DUVASU presented the Outcome of the Dialogue: A Way Forward. He expressed satisfaction for the scientific and policy related inputs provided by various eminent experts, policy makers, administrators, entrepreneurs and industrialists in making the Road Map for sustainable dairy production in future in Indian prospective.

Dr BN Tripathi offered his valuable remarks and highly appreciated the sincere efforts made during the Dialogue to frame future roadmap for sustainable growth in dairy sector. He opined for the early compilation of the recommendations suggested during the deliberations so as to reach to policy makers, researchers and development departments for their effective implementation. He also assured full support and cooperation of ICAR in the implementation of the recommendations for faster growth of Indian dairy sector.

In his concluding remarks, Dr RS Paroda, Chairman, TAAS stated that scientific deliberations during the dialogue by all learned experts from various sectors of dairy were extremely satisfying. He was immensely happy looking to the outcome of the dialogue and thanked the organizers for their support and highly appreciated active involvement of participants in the deliberations. He also felt happy about the outcome of dialogue and good recommendations of various sessions and the 'Way Forward' emerged. He emphasized on the implementation of specific strategies which need immediate attention at all levels for making a sustainable growth in the dairy sector. These included: (i) reframing the breeding policy of animals based on the priority of local non-descript breed upgradation and conservation as well as propagation of indigenous breed of animals; (ii) use of reproductive technologies for the faster propagation of best germplasm and elite animal production through assisted reproductive techniques; (iii) value-addition of dairy products, effective marketing and fixing the MSP for dairy products; (iv) intensive and exhaustive use of technology in automation of dairy sector with proper maintenance of database for dairy animal production; (v) thrust on climate resilient animal production system and reduction of GHG emissions from the ruminants; (vi) policy for dairy product export and widening the milk marketing channeling system; (vii) greater thrust on the non-bovine milk (goat, sheep, camel and donkey) and their value addition; (viii) farmer awareness regarding the dairying and practices with widescale extension programs; (ix) optimization of feeding and management of dairy animals for faster growth and reduction of age at puberty; and (x) early diagnosis of subclinical infections, rapid and proper diagnosis of animal health disorders and extensive coverage of vaccination.

Dr PK Shukla, Dean, College of Veterinary Science, DUVASU, Mathura profusely thanked the Chief Guest, Shri Meenesh Shah, Chairman, NDDDB; Dr RS Paroda, Chairman, TAAS; Shri Amit Vyas, Chairman, Amul Dairy; Prof AK Srivastava, VC, DUVASU; Dr BN Tripathi, DDG (Animal Sciences), ICAR; Dr H Rahman, Regional Representative South Asia, ILRI; other dignitaries on the Dais; all the Co-Chairs, Speakers, Panelists, Convenors; and participants for their gracious presence and active participation. He also expressed sincere thanks to all the Co-Organizers for funding support and to all the Committee Members for their help and cooperation in organizing this event successfully.

KEY RECOMMENDATIONS

I. Research and Development

1. Extensive technological interventions are needed in dairying to ensure sustainability of the sector. In this regard, there is an urgent need to intensify research on: (i) use of sexed-semen and sexed-embryos of elite animals for skewing the sex ratio, estrus synchronization, and use of hormonal interventions, multiple ovulation embryo transfer (MOET), and *in vitro* fertilization and embryo transfer (IVF-ET); (ii) biotechnological tools to - improve the reproductive physiology, clinical pharmacology, and estrus biology of the animals along with their productivity, genetic upgradation and faster multiplication of superior male germplasm; (iii) Electronic Nose for detection of silent heat in buffalo and crossbred cattle; (iv) achieving higher conception rate using elite bull semen; and (v) understanding the microbiome and reducing methane emission.
2. Increased research and development thrust is needed for commercial exploitation of non-bovine milk (goat, sheep, camel and donkey) along with required public awareness to generate their market demand in view of medicinal, nutraceutical, vitamin and micro-mineral properties. Use of efficient tools and protocols for enhancing reproduction and production in goats and sheep, and the protocol of AI in goat, sheep and pigs need to be upscaled and outscaled.
3. The indigenous breeds of livestock (cattle, buffalo, goat) are well adapted in their respective habitat and known for their drought tolerance, climate resilience, disease resistance, and ability to sustain productivity under adverse conditions, including the low feed requirement. Hence, both research and development (R&D) efforts must be intensified to improve their productivity matching to milk productivity in US.
4. An efficient management support is critical to make organised dairying a reality. Further, the rising demand for healthy and nutritious dairy products

would require innovations in milk processing and value-addition. State-of-the-art seamless laboratories and animal facilities in terms of biosafety/biosecurity, and multi-institutional/multi-sectoral collaboration would greatly help curbing adulteration and contamination of milk and milk products.

5. Considering the importance of microbiome in human and animal physiology, biology, pharmacology, nutrition, medicine and all other possible domains of science, it is high time to strengthen research in this emerging field under the One Health program.
6. The genomic selection (GS) approach along with prediction of bull and cow fertility at early calthood needs to be adopted to reduce the cost of animal management and production, a likely game changer in future. CRISPR/Cas-9 genome-editing innovation offers new option to develop disease resistant and designer animals as well as new quality vaccines and drugs. Besides genome-editing, there is a need to harness the potential of available technologies for vaccines, diagnostics, anti-microbial resistance, multi-omics, *next-generation sequencing* (NGS), nanopore sequencing and artificial intelligence (AI).
7. To ensure quality of frozen semen, it is right time to shift from traditional semen analysis to high technology-based semen-quality control tests. Frozen semen and frozen embryos need to be provided at farmers' doorsteps by employing youth as paid extension agents. To ensure this, trained professionals as paravets would be needed for which the research institutions and state agricultural universities (SAUs) have to initiate vocational short-term diploma/certificate courses as a matter of priority.
8. Considering the shortage of feed and fodder, Gol and state governments need to improve the availability of quality feed and fodder through regeneration of degraded and saline lands, amelioration of rangelands and grasslands; promoting hydroponic fodder/feed production as a supplement in areas lacking green fodder availability, and also promoting use of silage, hay making/feeding and vertical farming. The availability of certified and/or truthfully labelled (TFL) seed of fodder crops and grasses need to be ensured through the existing schemes of the Government. Development of improved feed and fodder varieties and hybrids also needs greater attention, for which funding support to research institutions and SAUs is urgently required.
9. In the present scenario of post COVID 19 era, animal health has to be given a central place as healthy animal will produce more as well as clean milk and meat, and help in reducing the impact of zoonotic diseases in humans and animals. Towards this, an utmost attention is required to control and eradicate the emerging/re-emerging transboundary infectious diseases of livestock.

II. Production and Management

10. A group of small-scale farmers having 8-10 animals each could be encouraged to establish farmer producer organizations (FPOs), needing support of the government for easy credit at low interest rate for creating good infrastructure and the required technical backstopping as well as hand holding by the institutions and SAUs. These FPOs are to be empowered with good knowledge for efficient and economical dairy production linked to both internal and global markets.
11. Greater thrust is needed for developing cost-effective, thermo-resistant, potent and universal vaccines and diagnostics against existing, emerging and trans-boundary infectious diseases. Also, there is a need to provide enabling environment for bridging the existing gap between vaccine demand and availability through accelerated production within country.
12. The trend of global warming has lately amplified the emission of greenhouse gases (GHGs) in the atmosphere. Hence, due attention is needed to improve better animal management and housing practices, and enhance the use of anti-methanogenic compounds, secondary metabolites, and ration balancing to reduce methane emission from ruminants. Manure is a source of nitrous oxide and methane., Hence, its efficient management using anaerobic condition, understanding rumen microbial diversity, and manipulation of rumen archaea to reduce methane production be addressed on priority.
13. Faster development of livestock and dairy enterprise urgently requires promotion of the best practices such as: (i) feeding chaffed dry fodder and silage for better digestion; (ii) providing comfortable bedding, shelter, adequate space and sunlight in the animal houses for increased milk production (almost > than 20 per cent); (iii) feeding concentrate after milking and not allowing animals to sit on the ground to reduce the chances of mastitis infection from ground contamination; (iv) wallowing of buffaloes, especially in summer as a guard against heat stress; (v) adopting SOPs for visitors to avoid infection and also for maintaining farm biosecurity; (vi) keeping newly acquired animals away from the stock for about four weeks to minimize chances of infection of new diseases; and (vii) value-addition of concentrate by crushing the grains, soaking in water, boiling, etc. to enhance digestibility, and availability of potable clean drinking water to the animals *ad libitum*.

III. Processing, Value-Addition and Marketing

14. Significant transformation is needed in the existing milk production and processing system to bridge the gap in production and meet the increasing demand for quality and value-added milk and milk products. While promoting the value addition and commercialization, there is an obvious need to protect

the interests of smallholder farmers. To meet growing domestic demand, the dairy sector essentially needs more competitiveness by bringing a qualitative transformation in the unorganized dairy sector. For exporting milk and other products, we also need to meet sanitary and phytosanitary measures (SPS) as specified under the WTO regime.

15. Concerted efforts are needed to meet health-conscious consumers' demand of functional dairy products with millet based composite dairy foods, organic milk, A 2 milk, low cholesterol milk/ghee, and herbs-incorporated dairy products, etc. The quality and safety of dairy products are directly related to acceptability among the consumers. Only about 20 per cent of total milk produced in India is quality tested for contaminants such as antibiotics, pesticides residues, aflatoxins and others. Enforcement of quality standards for milk and dairy products, feed and fodder as per Indian and international standards needs to be regularised. The commercial kits for testing the quality of milk and milk products developed by ICAR-NDRI, NDDDB, Amul and other private agencies need to be popularized and made available to dairy farmers at subsidized cost.
16. Around 51.8 per cent dairy farmers do not sell milk produced by them, while 14.7, 19.8, and 9.7 per cent milk is sold directly to household people, local traders, and cooperatives, respectively. Greater emphasis is, therefore, needed on value-addition of dairy products and their integration with modern milk marketing chains to have a positive effect on household food and nutrition security.

IV. Strategies and Enabling Policies

17. Veterinary/ livestock extension system in the country needs to be reoriented and adequately strengthened especially by involving youth and private sector. Services like: artificial insemination (AI), vaccination, de-worming, pregnancy detection, disease diagnosis, and medical treatment at farmers' doorstep are needed. Further, adoption of better animal management system with automation, digitalization, machine learning and use of artificial intelligence, algorithm, and metadata systems are essentially needed to keep pace with global dairy trends. Also, there is need to adopt ration balancing; feeding bypass protein, secondary plant compounds, condensed tannins, reduction in methane producing protozoa in the rumen; and selection of climate resilient livestock.
18. Urgent attention is needed to widen the marketing channel using blockchain system, also preferably fixing the MSP for milk and dairy products; and creating enabling policy for the export of dairy products.
19. Although dairying and animal husbandry sector accounts for 32 per cent of the total agricultural GDP and 4.10 per cent of National GDP, the combined

allocation on the veterinary and livestock research, education and extension remained under-invested and their combined allocation is not commensurate with its contribution to national economy. This imbalance now needs to be corrected soon to harness the existing potential of livestock sector.

20. Our traditional product *desi ghee*, having great nutritional and medicinal value in Indian diet, is presently taxed at 12 per cent compared to vegetable oil at 5 per cent. This anomaly needs to be corrected urgently. Analogues and vegetable oil-based substitutes of milk and plant origin proteins are also posing serious threat to the dairy industry. Therefore, it is imperative to urgently reduce GST on *desi ghee*. This will also reduce the burden on import of vegetable oil considerably.
21. We urgently need to equip ourselves with technological and policy support to cope up with futuristic dairy development. Private sector investment in the dairy sector is growing fast, which is likely to impact the smallholder dairy farmers to a certain extent. Thus, the interests of smallholder dairy producers, while scaling better organised commercial dairy farms, need to be protected.
22. There is a need to revisit the existing policies for both export and import of dairy products. In this regard, greater attention is required to promote value added and diversified milk and milk products for export including the non-bovine milk from camel, goat and equines. Production and export of Mozzarella cheese from buffalo milk as a specialty product must be explored in view of its high demand abroad.
23. Considering the unique attributes of our indigenous breeds of livestock, there is an urgent need to protect them by enacting soon an Act similar to that of Protection of Plant Varieties and Farmers Rights Act (PPV&FRA). This must be done on top priority in our national interest.
24. Dairy sector promotion requires that entrepreneurship in dairying as start-ups and FPOs are encouraged through proper institutional support and mentoring. Dairy entrepreneurs also need technical, financial and policy support from the government for their successful establishment. Dairy sector provides environmental services in the form of quality organic manure thus effectively reducing the use of chemical fertilizers, hence, this sector deserves incentives in the form of subsidized electricity, water, loan at low interest rate and other costly inputs such as vaccines, feeds and concentrates.
25. In order to harness the full potential of changing consumer preferences, the dairy industry has to gear up to meet the expectations of national and international markets. Greater focus should be now on to bring out new and more consumer-friendly products at reasonable cost while ensuring both food

safety and quality, and almost double the processing capacity of milk from presently 53.5 mt, in next 5-10 years.

26. Enabling policies are also needed on priority for: (i) identification and registration of all animals and dairy farms and linking them to better breeding facilities at farmers' doorsteps, (ii) developing linkages between small dairy farmers and registered milk processing societies, private-public companies to streamline processing and input supply management for sustainability, (iii) facilitation and promotion of On-Farm Small Scale Milk Chilling facility before selling milk, and promoting collaboration across the supply chain, (iv) tagging and numbering of registered animals using unique electronic number, and (v) provision of innovative farmer friendly insurance scheme for all the milking bovines in the country.
27. Buffalo contributes significantly to the Indian dairy sector through its quality milk and milk products. Buffalo rearing has advantage over cow as it can thrive well on inferior feed/fodder, is more cost effective and provides higher income to the smallholder farmers. There is a tremendous scope for the export of Mozzarella cheese made from buffalo milk and buffalo meat (Cara beef) also known as black gold. India has best buffalo breeds in the world. There is a great demand for Murrah buffalo for milk and lean meat in several countries; hence, it is high time to have a National Mission on Buffalo for its further development and recognition as global brand.
28. There is an urgent need to revisit and strengthen *Rashtriya Gokul* Mission and the National Livestock Mission (NLM) so as to lay greater focus on livestock management, fodder seed production, availability of feeds, vaccines, credit to FPOs for infrastructure including housing besides practicing climate-smart dairy farming. For promoting the growth of dairy sector, major provision of livestock insurance on par with crop insurance is a must to protect the farmers from major loss due to death of productive animals. Further, provision of subsidy needs to be made for dairy farmers for creating better housing infrastructure for the comfort of animals so critical for improving productivity.
29. Stray animals, mostly male calves, of late have become a major problem for the farmers. They roam freely, often destroy crops, spread diseases, and are also responsible for road obstruction/accidents. This has to be addressed immediately through enabling policies, while considering the socioeconomic and religious sentiments. Best option is to house them immediately in *gaushalas* and cattle homes managed by NGOs under the *Rashtriya Gokul* Mission by increasing its fund allocation significantly.

Technical Program

DAY 1 : FRIDAY, 16 DECEMBER, 2022

10.00-11.40

INAUGURAL SESSION

Chairman : RS Paroda, Chairman, TAAS

10.00-10.15 Welcome and Setting the Context AK Srivastava, VC, DUVASU

10.15-10.25 Special Remarks BN Tripathi, DDG (AS), ICAR

10.25-10.35 Special Remarks H Rahman, Regional
Representative- South Asia, ILRI

10.35-10.55 Remarks by Guest of Honour Amit Vyas, MD, KDCMP Union
Ltd. (Amul Dairy)

10.55-11.20 Address by Chief Guest Meenesh Shah, Chairman, NDDB

11.20-11.35 Remarks by the Chairman RS Paroda, Chairman, TAAS

11.35-11.40 Vote of Thanks Bhag Mal, Secretary, TAAS

11.40-12.10 *Tea/Coffee Break*

12.10-13.00 Keynote Lecture AK Srivastava, VC, DUVASU
Growth and Development of Indian
Dairy Sector: Way Forward

13.00-14.00 *Lunch Break*

14.00-17.30 TECHNICAL SESSION I : Processing, Value Addition,
Marketing and Policies

Co-Chairs : BN Tripathi, DDG (AS), ICAR
: Triveni Dutt, Director, ICAR-IVRI

Convenors : Meena Goswami, DUVASU
: Ravindra Kumar, ICAR-CIRG

14.00-14.20 Value Addition in Milk & Milk Products AK Singh, Head, Dairy Technology,
NDRI

14.20-14.40	Quality and Safety of Dairy Products	Rajan Sharma , Principle Scientist, ICAR-NDRI
14.40-15.00	Enabling Policy Needs of Dairy Sector	PS Birthal , Director, ICAR-NIAP
15.00-15.20	Impact of Traditional vs Formal Dairy Value-chains on Food Security in India	Sunil Saroj , Senior Research Analyst, IFPRI
15.20-15.40	Road Map for Reducing Greenhouse Gas Emission by Dairy Animals	Brijesh Yadav , Assoc. Prof., DUVASU

15.40-16.00 Tea/Coffee Break

16.00-16.20	Perspective of Entrepreneurs	Nikki Pilonia Chaudhary , Founder, Mango Dairies
16.20-16.40	Perspective of Entrepreneurs	Hitesh Rathi , Founder, Aadvik Foods Pvt. Ltd.

16.40-17.00 Discussion

DAY 2 : SATURDAY, 17 DECEMBER, 2022

09:30-11.00 TECHNICAL SESSION II : Production and Management

Co-Chairs : MP Yadav, Former Director and VC, ICAR-IVRI
 : RK Singh, Former Director and VC, ICAR-IVRI

Convenors : SS Lathwal, ICAR-NDRI
 : DN Singh, DUVASU

09.00-09.20	Growth in Indian Dairying: Production and Processing	RS Sodhi , MD, GCMF, AMUL
09.20-09.40	Managing and Improving Efficiency of Dairy Cattle	Umesh Singh , Director, CIRC
09.40-10.00	Productivity Enhancement and Better Management of Buffalo	Inderjeet Singh , VC, GADVASU
10.00-10.20	Strategy for Enhancing Goat Milk Production	Mukul Anand , Asstt. Prof., DUVASU

10.20- 10.40 Prospects of Camel Milk Production **Artabandhu Sahoo**, Director, ICAR-NRCC

10.40-11.00 Economics in Indian and Global Dairy Sector **Smita Sirohi**, Jt. Secretary, MoA&FW, Gol

11.00-11.20 Discussion

11.20-11.40 *Tea/Coffee Break*

11:40-13:20 **PANEL DISCUSSION : Sustainable Growth of Dairy Sector**

Chair : AK Srivastava, VC, DUVASU

Convenor : Dilip Swain, DUVASU

Panelists:

Praveen Malik, Former AHC, Gol

TK Datta, Director, ICAR-CIRB

RK Singh, Former Director and VC, ICAR-IVRI

Manish Chatli, Director, ICAR-CIRG

Rajesh Saini, Additional Director, Govt. of UP

Pawan Singh, Scientist-in-charge, ABRC, ICAR-NDRI

AK Mishra, Head LPM, ICAR-NDRI

Atul Saxena, Director of Extension, DUVASU

Vikas Pathak, Director of Research, DUVASU

Nitin Bhatia, Vice President, INTAS Pharmaceuticals

Raka Saxena, ICAR-NCAP

13.20-13.40 Discussion

13:40-14:20 **PLENARY SESSION**

Co-Chairs : **RS Paroda**, Chairman, TAAS

: **BN Tripathi**, DDG (AS), ICAR

Outcome of Dialogue - A Way Forward **AK Srivastava**, VC, DUVASU

Co-Chair's Remarks **BN Tripathi**, DDG (AS), ICAR

Concluding Remarks **RS Paroda**, Chairman, TAAS

Vote of Thanks **PK Shukla**, Dean, College of Vet. Sc., DUVASU

14.20-15.20 *Lunch*

List of Participants

1. **Dr Mukul Anand**
Assistant Professor, DUVASU, Mathura
Email: drmukulanandvet@gmail.com
2. **Dr Nitin Bhatia**
INTAS, Pharmaceuticals, Ahmedabad
Email: dr_bhatia@intaspharma.com
3. **Dr Amitav Bhattacharyya**
Associate Professor, DUVASU, Mathura
Email: amitav6@gmail.com
4. **Dr PS Birthal**
Director, ICAR-NIAP, New Delhi
Email: psbirthal@gmail.com
5. **Dr Manish Chatli**
Director, ICAR-CIRG,
Makhdoom, Mathura
Email: Director.cirg@icar.gov.in
6. **Ms Nikki Pilonia Chaudhary**
Founder, Mango Dairies, Pilibhit
Email: chaudharyfarms@gmail.com
7. **Dr Alok K Chaudhary**
Assistant Professor, DUVASU, Mathura
Email: dr.alokvet@gmail.com
8. **Dr Soumen Chaudhary**
Assistant Professor, DUVASU, Mathura
Email: chsoumenpharma@gmail.com
9. **Dr TK Datta**
Director, ICAR-CIRB, Hissar
Email: tirthadatta@gmail.com
10. **Mr Radhey Shyam Dixit**
Ananda Dairy Ltd., New Delhi
Email: rs.dixit@ananda.in
11. **Dr Triveni Dutt**
Director, ICAR-IVRI, Izatnagar
Email: triveniduttivri@gmail.com
12. **Dr MM Farooqui**
Professor, DUVASU, Mathura
Email: mmfarooqui64@gmail.com
13. **Dr Neeraj Gangawar**
Assistant Professor, DUVASU, Mathura
Email: neerajgangwarvet@gmail.com
14. **Dr Meena Goswami**
Assistant Professor, DUVASU, Mathura
Email: dr.goswami2008@yahoo.co.in
15. **Shri Rakesh Goyal**
Assistant Professor, DUVASU, Mathura
Email: goelrakesh21@live.in
16. **Dr Udit Jain**
Associate Professor, DUVASU, Mathura
Email: druditjainvet@gmail.com
17. **Dr Amit Jaiswal**
Assistant Professor, DUVASU, Mathura
Email: drakjaiswal@gmail.com
18. **Dr Shiv Prasad Kimothi**
Member, ASRB, New Delhi
Email: skimothi379@gmail.com

19. **Dr Ravindra Kumar**
Principal Scientist, ICAR-CIRG,
Mathura
Email: ravindra.srivastava@gmail.com
20. **Dr Vijay Kumar**
Assistant Professor, DUVASU, Mathura
Email: jaisvet@gmail.com
21. **Dr Pradeep Kumar**
Assistant Professor, DUVASU, Mathura
Email: drpkdiwakar@gmail.com
22. **Dr Muneender Kumar**
Assistant Professor, DUVASU, Mathura
Email: muneendra82@gmail.com
23. **Dr Avinash Kumar**
Assistant Professor, DUVASU, Mathura
Email: avinashbvc04@gmail.com
24. **Dr Anuj Kumar**
Associate Professor, DUVASU, Mathura
Email: anujduvasu@gmail.com
25. **Dr Priyambda Kumari**
Teaching Associate, Mathura
Email: priyambiochem@gmail.com
26. **Dr SS Lathwal**
Principal Scientist, ICAR-NDRI,
Karnal
Email: Surender.lathwal@icar.gov.in
27. **Dr Bhag Mal**
Secretary, TAAS, Avenue II,
Pusa Campus, New Delhi
Email: bhagml@gmail.com
28. **Dr Praveen Malik**
Former Animal Husbandry
Commissioner, Gol, New Delhi
Email: malikpdr@gmail.com
29. **Dr Mamta**
Assistant Professor, DUVASU, Mathura
Email: drmamta.vety@gmail.com
30. **Dr Bimlesh Mann**
ICAR-NDRI, Karnal
Email: bimlesh@icar.gov.in
31. **Dr BP Mishra**
Director, ICAR-NBAGR, Karnal
Email: Bpmishra_1@hotmail.com
32. **Dr AK Mishra**
Head LPM, ICAR-NDRI, Karnal
Email: mishraak17@yahoo.com
33. **Dr Vijay Pandey**
Professor, DUVASU, Mathura
Email: drvijaypandey@gmail.com
34. **Dr RP Pandey**
Professor, DUVASU, Mathura
Email: dr.rudrapandey@gmail.com
35. **Dr PN Panigrahi**
Assistant Professor, DUVASU, Mathura
Email: pnpvetmed@gmail.com
36. **Dr RS Paroda**
Chairman, TAAS, Avenue II,
Pusa Campus, New Delhi
Email: raj.paroda@gmail.com
37. **Dr Parul**
Assistant Professor, DUVASU, Mathura
Email: parulkaler@rediffmai.com
38. **Dr Vikas Pathak**
DUVASU, Mathura
Email: pathakvet@gmail.com
39. **Dr Archana Pathak**
Professor, DUVASU, Mathura
Email: archanapathak73@gmail.com

40. **Dr Ajay Prakash**
Professor, DUVASU, Mathura
Email: apsharmamathura@rediffmail.com
41. **Dr Atul Prakash**
Associate Professor, DUVASU, Mathura
Email: dratul2510@rediffmail.com
42. **Dr H Rahman**
Regional Representative-South Asia,
ILRI, New Delhi
Email: r.habibar@cgiar.org
43. **Mr Hitesh Rathi**
Founder, Aadvik Food Pvt. Ltd.,
Nagpur
Email: hitesh@aadvikfoods.com
44. **Dr A Sahoo**
Director, ICAR-NRCC, Bikaner
Email: Artabandhu.sahoo@icar.gov.in
45. **Dr Rajesh Saini**
Dept. of Animal Husbandry,
Govt. of Uttar Pradesh, Lucknow
Email: adgodhan2019@gmail.com
46. **Dr Sunil Saroj**
Sr. Research Analyst, IFPRI, New Delhi
Email: s.saroj@cgiar.org
47. **Dr. Atul Saxena**
DUVASU, Mathura
Email: dratulsaxena@rediffmail.com
48. **Dr Raka Saxena**
ICAR-NIAP, New Delhi
Email: rakasaxena@ncap.res.in
49. **Mr Meenesh Shah**
Chairman, NDDDB, Anand
Email: meenesh@nddb.coop;
anand@nddb.coop
50. **Dr Daya Shanker**
Professor, DUVASU, Mathura
Email: sachan_ds@rediffmail.com
51. **Dr Rajan Sharma**
Principal Scientist, ICAR-NDRI,
Karnal
Email: Rajan.sharma@icar.gov.in
52. **Dr Barkha Sharma**
Associate Professor, DUVASU, Mathura
Email: manubarkha@yahoo.com
53. **Dr Dushyant Sharma**
ICAR-IVRI, Izatnagar
Email: dushyant.sharma@icar.gov.in
54. **Dr PK Shukla**
Dean, College of Veterinary
Science, DUVASU, Mathura
Email: deanvetmtr@gmail.com
55. **Dr Amit Shukla**
Assistant Professor, DUVASU, Mathura
Email: princu.dr@gmail.com
56. **Dr Vinod Kumar Sidhu**
Professor, DUVASU, Mathura
Email: vinodsidhu@rediffmail.com
57. **Dr AK Singh**
Head, Dairy Technology, ICAR-NDRI,
Karnal
Email: Ashish.singh@icar.gov.in
58. **Dr Inderjeet Singh**
Vice-Chancellor, GADVASU, Ludhiana
Email: vcgadvasu@gmail.com;
inderjeet.dr@gmail.com
59. **Dr RK Singh**
Former Director, ICAR-IVRI,
Izatnagar
Email: rks_virology@rediffmail.com

60. **Dr Pawan Singh**
Principal Scientist and Head,
ICAR-NDRI, Karnal
Email: pawansinghdabas@gmail.com
61. **Dr Umesh Singh**
Director, ICAR-CIRC, Meerut
Email: director.circ@icar.gov.in;
usinghas@gmail.com
62. **Dr DN Singh**
Assistant Professor, DUVASU, Mathura
Email: drdeep25@gmail.com
63. **Dr Shanker Singh**
Assistant Professor, DUVASU, Mathura
Email: pshankervet@gmail.com
64. **Dr Renu Singh**
Assistant Professor, DUVASU, Mathura
Email: renuvet756@gmail.com
65. **Dr. Sanjeev Singh**
Professor, DUVASU, Mathura
Email: drsanjeevkumarsingh@gmail.com
66. **Dr Pawanjeet Singh**
Associate Professor, DUVASU, Mathura
Email: pjsingh33@rediffmail.com
67. **Dr Manish Kumar Singh**
Farm Manager, DUVASU, Mathura
Email: drmk Singh_1@rediffmail.com
68. **Dr Vinod Kumar Singh**
Assistant Professor, DUVASU, Mathura
Email: vet.vinodsingh@gmail.com
69. **Dr Ajay Pratap Singh**
Assistant Professor, DUVASU, Mathura
Email: drajay_vet@yahoo.co.in
70. **Dr Amit Singh**
Associate Professor, DUVASU, Mathura
Email: amitsinghext@gmail.com
71. **Dr Satendra Pal Singh**
Associate Professor, DUVASU, Mathura
Email: satsinpal21@gmail.com
72. **Dr Ashish Pratap Singh**
Ayurved Pvt. Ltd., Ghaziabad
Email: singh.asheesh23@gmail.com
73. **Ms Sweta Singh**
Teaching Associate, DUVASU, Mathura
Email: shweta.mis16@gmail.com
74. **Ms Parul Singh**
Teaching Associate, DUVASU, Mathura
Email: singhparul683@gmail.com
75. **Dr (Ms) Smita Sirohi**
Jt. Secretary, MoA&FW, New Delhi
Email: Smita.sirohi@gov.in
76. **Dr Rajneesh Sirohi**
Assistant Professor, DUVASU, Mathura
Email: vetsirohi@gmail.com
77. **Mr RS Sodhi**
Managing Director, GCMMF Amul,
Anand
Email: sodhi@amul.coop
78. **Dr AK Srivastava**
Vice-Chancellor, DUVASU, Mathura
Email: duvasuvc@gmail.com
79. **Dr Mukesh Srivastava**
Assistant Professor, DUVASU, Mathura
Email: vemduvasu@gmail.com
80. **Dr Ashish Srivastava**
Assistant Professor, DUVASU, Mathura
Email: ashishvetmat@gmail.com

- 81. Dr Umesh Srivastava**
Former ADG (Hort.), ICAR &
Consultant, TAAS
Avenue II, Pusa Campus,
New Delhi - 110012
Email: srivastavaumesh@gmail.com
- 82. Dr Dilip Swain**
Assistant Professor, DUVASU, Mathura
Email: dilip_swain@yahoo.com
- 83. Dr AK Tomar**
Director, ICAR-CSWRI, Avikanagar
Email: director.cswri@icar.gov.in
- 84. Dr BN Tripathi**
DDG (Animal Sciences), ICAR,
New Delhi
Email: ddgas.icar@nic.in
bntripathi1@yahoo.co.in
- 85. Dr Arvind Tripathi**
Associate Professor, DUVASU, Mathura
Email: arvindvet58@gmail.com
- 86. Dr AK Tyagi**
ADG (AN&P), ICAR, New Delhi
Email: amrishtyagi1963@yahoo.com
- 87. Ms Sadhna Tyagi**
Professor, CRA College, Sonipat
Email: sadhnatyagi1963@gmail.com
- 88. Dr Shalini Vaswani**
Assistant Professor, DUVASU, Mathura
Email: shalini_vet@yahoo.com
- 89. Dr Abhinov Verma**
Assistant Professor, DUVASU, Mathura
Email: abhinovverma281283@
gmail.com
- 90. Shri Amit Vyas**
MD, KDCMP Union Ltd. (Amul Dairy),
Anand
Email: amvyas@amuldairy.com
- 91. Dr MP Yadav**
Former Director and VC, ICAR-IVRI,
Izatnagar
Email: yadav_mp@hotmail.com
- 92. Dr Brijesh Yadav**
Associate Professor, DUVASU, Mathura
Email: drbrijvet@gmail.com
- 93. Dr Saravjeet Yadav**
Professor, DUVASU, Mathura
Email: yadavsarvajeet24@gmail.com
- 94. Dr RK Yadav**
Assistant Professor, DUVASU, Mathura
Email: rajan.vadya@gmail.com
- 95. Dr Sharad K. Yadav**
Professor, DUVASU, Mathura
Email: sharadyadav944@gmail.com
- 96. Dr Yajuvendra**
Assistant Professor, DUVASU, Mathura
Email: yuvionlysingh@gmail.com

Recent TAAS Publications

1. Policy and R&D Interventions to Increase Cotton Production and Industrial Growth - Policy Brief, March 2023.
2. National Symposium on Food, Nutrition, and Environmental Security: Towards Achieving SDGs - Proceedings and Recommendations, 29-30 August, 2022 (December, 2022).
3. Resilience in Dairy Farming - A Success Story by Nikki Pilania Chaudhary, November 2022.
4. National Dialogue on Innovations in Agricultural Extension: A Way Forward, 8-9 April, 2022 (September 2022).
5. Towards Secure and Sustainable Agriculture - Strategy Paper by Dr. R.S. Paroda, August, 2022.
6. Expert Consultation on Promoting Efficient Irrigation Technologies for Water Saving Across Scales and Sectors, 25 February, 2022 (May 2022).
7. Expert Consultation on Accelerating Export of Seed Spices: Challenges and Opportunities - Proceedings and Recommendations, 22 November 2021 (January 2022).
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25. Urgency for Scaling Agricultural Innovations to Meet Sustainable Development Goals (SDGs) - Strategy Paper by Dr. R.S. Paroda, April, 2019.
26. Tenth Foundation Day lecture on "Can India Achieve SDG 2 - Eliminate Hunger and Malnutrition by 2030" by Dr Prabhu Pingali, Professor in the Charles H. Dyson School of Applied Economics and Management at Cornell University, January 24, 2019.
27. Motivating and Attracting Youth in Agriculture - Strategy paper by Dr R.S. Paroda, November, 2018.
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30. Strategy for Doubling Farmers' Income - Strategy Paper by Dr R.S. Paroda, February, 2018.
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Trust for Advancement of Agricultural Sciences (TAAS)

Avenue II, ICAR-Indian Agricultural Research Institute (IARI)

Campus, New Delhi - 110012, India

Ph.: +91-11-25843243; +91-8130111237

E-mail: taasiari@gmail.com; Website: www.taas.in