Ninth Dr C.M. Singh Memorial Lecture, 2021

on

Glorious Saga of Indian Livestock Sector Vital for Food and Nutrition Security

By

Prof. (Dr) A.K. Srivastava

Azadi Ka Amrit Mahotsav

Jointly Organised by

Dr C.M. Singh Endowment Trust, Bareilly, UP and
DUVASU, Mathura, UP

Dr C. M. Singh: A Brief Profile

Dr C.M. Singh, was born in a remote village in Distt. Jaunpur (UP) on 30th November, 1922. He obtained BVSc degree from Bihar Veterinary College, Patna and MS, PhD from MSU, East Lansing, USA. Dr C.M. Singh was an eminent Veterinary Pathologist and Microbiologist and has made outstanding contributions in understanding animal diseases mainly listeriosis, salmonellosis, mycoplasmosis, bovine lymphosarcoma and slow viral respiratory diseases. He was an excellent teacher and researcher. Later, when he joined as Dean at Haryana Agricultural University, Hisar and Director, Indian Veterinary Research Institute, Izatnagar, Bareilly, UP he proved himself as an able administrator and distinguished veterinary educationist. His vision and thoughtful plans converted post-independent IVRI of 5 Divisions into 21 Divisions of National Institute of International fame. Due to enormous extension of research infrastructure during Five Year Plans to meet the need of farmers and industry, IVRI, Bangalore Campus was developed for Foot and Mouth Disease vaccine R&D. High Security Animal Disease Laboratory at Bhopal (now NIHSAD) was an institution of his visionary planning, is presently engaged in diagnosis of a number of infectious exotic diseases including bird flu. From IVRI, four separate ICAR research Institutes namely Central Avian Research Institute, Izatnagar, UP, Central Institute for Research on Goats, Makhdoom, Mathura, UP, National Institute of High Security Animal Diseases, Bhopal, MP and Directorate of Foot and Mouth Diseases, Bhubaneswar, MP were developed for poultry and goat production and animal disease diagnosis. His significant contribution in development of Department of Pathology and Bacteriology at Veterinary College, Mathura and IVRI as a whole is a true testimony to his dynamic stewardship. IVRI is known as Mecca for Veterinarians, owing to its uniqueness in integrating research, disease investigation, extension, technology development and teaching. After superannuating, he did not sit idly. He felt the need to reform the Veterinary Education in this country and was instrumental in creation of Veterinary Council of India and National Academy of Veterinary Sciences. He was Founder President of these two prestigious national organizations. Dr C.M. Singh had collaboration and interaction with international agencies like-FAO, WHO, UNDP, SIDA, DANIDA, etc. He attended a number of international seminars and symposia on epidemiology and zoonotic diseases in different parts of the world. He guided several eminent veterinarians for their masters and doctoral programmes in the disciplines of Pathology, Bacteriology and Virology. As a person, Dr Singh was simple, honest and hardworking with no time for personal comfort and family affairs. He was a great visionary. Some people called him, "Doyen of Veterinary Profession", while others considered him as "bhismpitamah", "karmyogi" or "purushottam" and "preranashrot".

During his last visit to this IVRI on 10th January, 2005, scientists of twin Institutes at Izatnagar had the opportunity to listen and meet him. He is still remembered for his talk on philosophy of life interspersed with verses of the Holy Gita. Dr Singh left his world for his heavenly abode journey on 27th July 2005 in UK after a prolonged illness. His demise was great loss to the veterinary profession of this country as well as his family. His dream to establish Indian Council of Veterinary Research is still not fulfilled. It will be best homage to him, if we can achieve this objective for betterment of veterinary profession.

Editors: Drs R. Somvanshi and P.K. Shukla

Published By: Dr R. Somvanshi Hony. Secretary, Dr C.M. Singh Endowment Trust, A-366, Rajendra Nagar, Bareilly (UP), M: 9837658052 E-mail: dr.rsomvanshi@gmail.com, Website: cmset.org

Ninth Dr C.M. Singh Memorial Oration, 2021

on

Glorious Saga of Indian Livestock Sector Vital for Food and Nutrition Security

By

Prof. (Dr) A.K. Srivastava

President

National Academy of Dairy Sciences (India)

and

Member

Agricultural Scientists Recruitment Board

Department of Agricultural Research and Education

Ministry of Agriculture and Farmers' Welfare, Govt. of India New Delhi

delivered virtually at

Dr C.M. Singh Birth Centenary Year Webinar

30th November 2021

at DUVASU, Mathura, UP

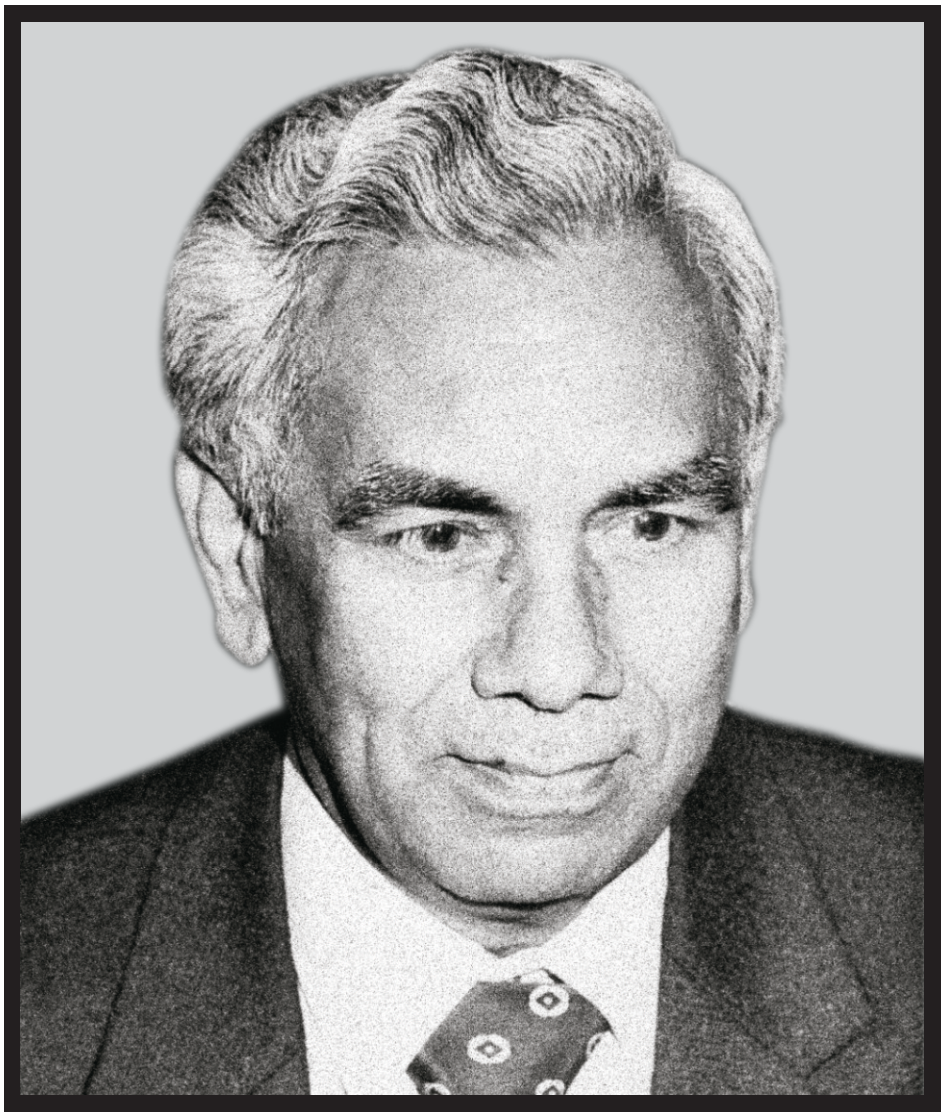
Jointly Organized by

Dr C.M. Singh Endowment Trust, Bareilly, UP

and

DUVASU, Mathura, UP

Ninth Dr C.M. Singh Memorial Lecture, 30th November, 2021
DUVASU, Mathura, UP



Dr C.M. Singh

(30-11-1922- 27-07-2005)

Glorious Saga of Indian Livestock Sector Vital for Food and Nutrition Security

Prof. (Dr) A.K. Srivastava
President, National Academy of Dairy Sciences (India)
Member, Agricultural Scientists Recruitment Board,

Department of Agricultural Research and Education,
Ministry of Agriculture and Farmers Welfare, Govt. of India, New Delhi
aksrivastava.asrb@gmail.com; memberas.asrb@gmail.com

Introduction

An old adage says that "Land rich in livestock will never be poor and land poor in livestock will never be rich". In India, livestock, dairying and poultry sectors are the backbone for livelihood, and food and nutrition security of rural masses. Apart from providing food products like-milk, egg, and meat, livestock sectors also generate sustainable employment and valuable supplementary income to the vast majority of rural households. Growing human population, increasing urbanization, rising domestic income and changing lifestyle of people in the country have further led to increase the demand for livestock products. This sector also contributes to several socio-economic spin offs-like mitigation of farmers' suicides, empowerment of rural women and protection of environment. Livestock sector also has strong backward and forward linkages, which in turn promote livestock-based food processing and leather industries. The value of output from livestock sector contributes more than one third of the total value of output from agriculture and allied activities. As per Govt. of India, the value of output from livestock sector at current price of 2017-18, was 33.25% of total output from agriculture and allied sector and at constant price it is 31.81%. The value of output from milk alone, contributes about 20 per cent in agricultural sector and this is more than the combined output value of all grains including wheat and paddy, and pulses, which makes milk as the single largest commodity (by value) among all agricultural produce. In India, the annual value of output of milk is more than 8 lakh crores as compared to 4.5 lakh crores of all grains including rice, wheat and pulses. Further, in coming 4-5 years, this sub-sector of agriculture is predicted to produce more than half of the total agricultural output in terms of value. The sector is also being considered to play a very promising role in the ambitious goal of the Government of India to double the farmer's income by 2022. In past few years, Indian economy has witnessed various signs of development. The share of Gross Value Added (GVA) of agricultural sector to total GVA has declined from 12.1 per cent in 2010-11 to 9.3 per cent in 2015-16, while that of livestock sector has remained constant at 4 per cent. The GVA of livestock sector to the Agriculture Sector has increased from 21.8% in 2011-12 to 25.7% in 2015-16 and then 33.25% in 2017-18. This illustrates the importance of livestock sector in Indian economy and clearly indicates that this sector is likely to emerge as an engine of agricultural growth in the coming decades.

Hunger, Undernutrition and Malnutrition: A Blot on Humanity

Global human population is growing at the rate of 1.1% per year and every year about 83 million people are being added to the world's population. The revised projections of the 2017 indicate that the global population will be between 8.4 to 8.7 billion in 2030 and between 9.4 to 10.2 billion in 2050. In April 2018, the world human population was 7.6 billion, of which the population of India alone was 1.35 billion accounting to around 18% of the total human population. According to a recent World Bank report, India accounted for the largest number of poor people in 2012, but its poverty rate was lowest among countries having large number of poor populations. In the given situation, ensuring food and nutritional security to the growing population is a bigger challenge to India.

Over the couple of years, it is assumed that hunger has been declining because of increasing global wealth but it is not true. The income inequality is increasing day by day, and hence the ability to access food has reduced for certain groups of people. As per the recent report of Times of India-Delhi "Learning with Times; why hunger around the world is rising again" (17/09/2018) it is estimated that in 2017, 10.9% of the world's population was undernourished. This translates to 821 million people, which is at the same level as that in 2010. The number of undernourished people has declined in China, India, Nepal and Sri Lanka but has increased in Pakistan, Afghanistan and Bangladesh. However, India still accounts for the world's largest population of undernourished people and is home to about one in every five undernourished persons. According to the recent estimate of UNO-FAO, around 854 million people worldwide are undernourished out of this about 200 million are in India. The undernourishment in Indian population can be seen from corresponding figures of average consumption of micronutrients. In the urban population, 56%, 60% and 83% of requirement of RDA of Zinc, Vitamin A and Iron is met while; the corresponding figures for rural population are 65%, 58% and 90%, respectively. This can also be very well co-related to the micronutrient deficiency (Zinc 48% and iron 12%) in Indian soils.

The Status of the child health of a country is considered as the important key indicator for measuring the access to nutritious food. Unfortunately, for India, the latest estimate shows that India is the home of more than 50% of the world's 'wasted' children (child underweight for his/her height) and more than 30% of the world's stunted children (child shorter for his/her age).

Number of Undernourished (Million)

Country	2004-06	2015-17	Per Cent Change
India	253.9	195.9	-22.8
China	206.0	124.5	-39.6
Pakistan	35.9	39.5	10.9
Bangladesh	23.8	24.8	4.2
Afghanistan	8.3	10.5	26.5
Nepal	4.1	2.8	-31.7
Sri Lanka	3.6	2.3	-36.1

Source: FAO Report: The State of Food Security & Nutrition in the World, 2018

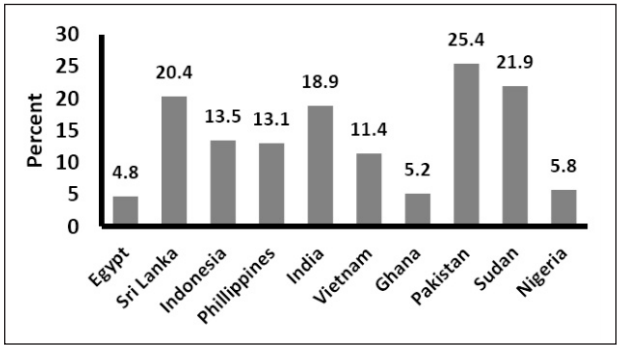
Not only in India, in whole developing world, the malnutrition in infants and young children is one of the most serious health problems. It influences the normal physical and mental growth and development that resulted in increased mortality and morbidity. Across the world about 32 per cent of children below the age of 5 years suffer from being underweight and 39 per cent from stunting.

Among the developing countries, 44.2% children in India are underweight followed by Vietnam (33.1%) and Pakistan (31.6%). Asia and Africa continents have the highest share of all forms of malnutrition viz. stunting, wasting and obesity. As per the National Family Health Survey of India, 55 per cent of children living in rural areas suffer from malnutrition while the corresponding figure for urban areas is 45 per cent. As per another report 43% of Indian children under 5 are suffering with malnutrition followed by Bangladesh (41%), and Afghanistan (31%). About 58 per cent (urban: 56% and rural: 59%) of Indian children aged between 6 and 59 months are anaemic, and the prevalence of low birth weight (LBW) is nearly 30%.

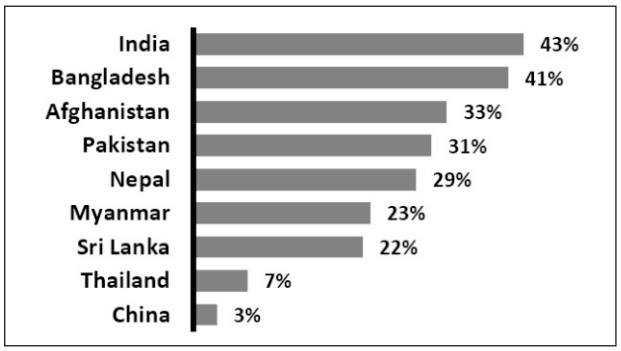
The poor state of malnutrition in Indian children could be attributed to the lack of diversity in food and lesser emphasis on complementary feeding. During complementary feeding, most of the mental and physical developments occur, therefore, introduction of semi-solid milk foods along with breast milk must be provided for adequate nutrients to the children for the rapid phase of growth and development. Poor feeding practices as well as lack of suitable complementary foods are responsible for under-nutrition to children. More than 100 million children under 5 years are unable to realize their full socio-economic and human potential. Only 23% of Indian toddlers and infants get a balanced diet. Educating women can help change that.

According to UNICEF-WHO-WBG Joint Report (2017), across the world, number of stunted children decreased from 198.4 million to 154.8

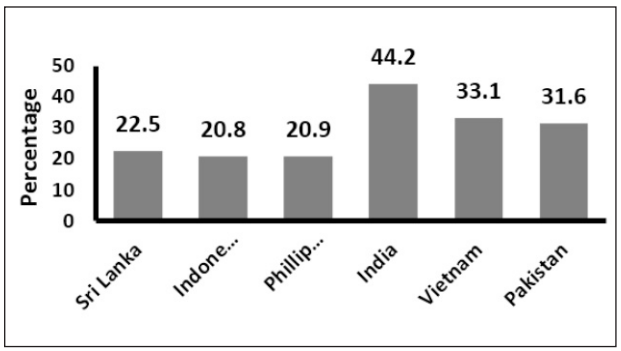
Undernourishment in Total Population: India vs Neighbouring Countries



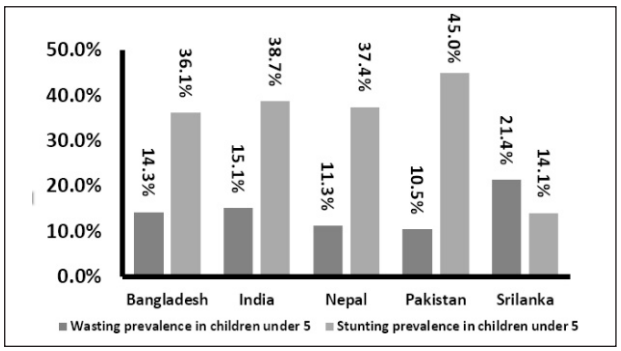
Malnutrition in Children Under 5 Years: India Vs Neighbouring Countries



Children Underweight: India vs Neighbouring Countries



Malnutrition in Children in the Indian Subcontinent



million during last two decades while children suffering from wasting diseases increased from 30.4 million to 52 million. Addressing the burden of wasting will require a multipronged approach, including prevention, early identification, and treatment. Children with low weight-for-height (wasting) have an increased risk of mortality. In 2017, about 7.5% of children under 5 years were affected by this form of undernutrition, with regional prevalence ranging from 1.3% in Latin America to 9.7% in Asia. Malnutrition is the leading cause of death worldwide in children under the age of five and accounts for deaths of 2.6 million children every year and it leaves millions more life-long impairments.

Levels and Trends in Child Malnutrition

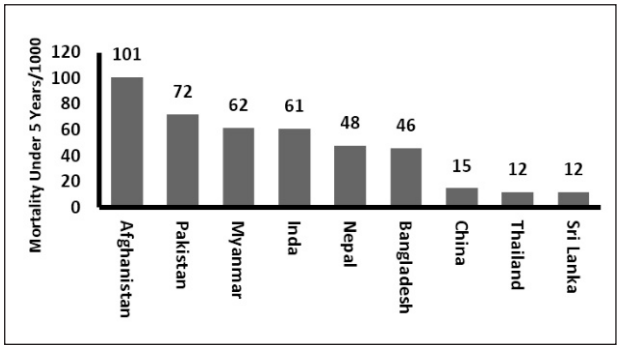
Region	Number (Million)		
	Stunted	**Overweight**	**Wasted**
World wide	155	41	52
Latin America and Caribbean	6	4	1
Africa	59	10	14
Asia	87	20	36
Oceania	0.5	0.1	0.1

Source: UNICEF, WHO, WBG Joint Report (2017)

The mortality rate of children under 5 years of age in India is reported to be decreased from 114.2/1000 to 61.3/1000 during past 25 years while India is at 12th position for new born mortality rate with 25.4/1000 live births (Global Nutrition Report, 2016).

Here, it is very pertinent to mention that, in India, despite glorious data on food production, a national survey indicated that more than 70% of Indian population consume less than 50% of the RDA of micronutrients. In India, a significant percentage of adult population is also vulnerable to hidden hunger. A very high mortality occurs due to coronary heart-diseases (CHDs), cancer and diabetes, all related to diet and life-style. Obesity and overweight prevalence in India have also shown considerable increase during the past two decades. According to the surveys of the National Nutrition Monitoring Bureau in 9 states; 7.8% men and 10.9% women are overweight or obese when a cut-off value of BMI 25 is used. However, currently a lower BMI of 23 is suggested, because above BM1 23, the susceptibility to hypertension increases. With this cut off value of BMI of 23, the percentage of overweight and obesity were reported to be 17.2 in men and 19.2 in women. One fourth of Indian adults have hypertension, and 5-6% have impaired glucose tolerance or diabetes. These statistics may be taken as alarm bells, and an urgent action is needed to reduce the burden of under-nutrition. Further, action is also required to control diseases-like obesity, diabetes, hypertension, cardiovascular disorders, cancer and arthritis. India is considered to be the diabetic capital of the world. Lower middle-income group has been

Death Rates for Children Under 5 Years: India Vs Neighbouring Countries



observed with highest increase in obesity cases with 53% prevalence, followed by low-income group (37%) and high-income group (12%). Due to lack of diversity in Indian food basket people often deprived off the nutrients from the diet. Presence of anti-nutrients and inhibitors in many staple foods further affect the bioavailability of certain key nutrients. The other possible reasons for infant malnutrition are; (i) Decreasing breast feeding, which deprived the children for strengthening of critical immune system and growth promoting bio-actives, and (ii) Lesser emphasis on weaning (nutritionally inadequate and inappropriate). Health concerns are attributed to poor nutrition in low-income segments of the population, whereas the well-off strata of the society need to address the health issues primarily due to the changing life-style, food habits and unhealthy behaviour.

New born Mortality (Deaths in first 28 days of life) Deaths Per 1000 Live Births

	Worst Countries		**Best Countries**	
1.	Pakistan	45.6	Japan	0.9
2.	Central African Republic	42.3	Iceland	1.0
3.	Afghanistan	40.0	Singapore	1.1
4.	Somalia	38.8	Finland	1.2
5.	Lesotho	38.5	Estonia	1.3
6.	Guinea-Bissau	38.2	Slovenia	1.3
7.	South Sudan	37.9	Cyprus	1.4
8.	Cote doloire	36.6	Belarus	1.5
9.	Mali	35.7	Republic of Korea	1.5
10.	Chad	35.1	Norway/Luxembourg	1.5

Iron deficiency is considered to be the commonest worldwide nutritional deficiency and affects approximately 20% of the world population. Women and young children are at great risk. 70% women and children are suffering from iron deficiency anaemia. According to National Family Health Survey (2016), prevalence of anaemia in India is 35.7% in underweight children, 38.4% in stunted children and 21% in wasted children. The problem of Fe deficiency is partly due to consumption of only plant-based diets, containing low levels of- poorly bioavailable iron. Further, iodine deficiency disorders, and vitamin A deficiency continue to be the public health problems, though prevalence of goitre has declined and blindness due to vitamin A deficiency has been eliminated. Vitamins B (riboflavin, folic acid and B12) deficiencies are still very common. Despite tropical sunlight, reports of vitamin D deficiency in adults and children are appearing. Osteoporosis in women, perhaps due to calcium and vitamin D deficiencies has become a public health concern. The National Family Health Surveys (2016) also show that there are marked interstate variations. The southern states, mainly Kerala, and Tamil Nadu, were better than states like- Bihar, Madhya Pradesh, Uttar Pradesh, Rajasthan, and Orissa. Interestingly, the State of Jammu and Kashmir has shown some improvement in women's health as judged by decline in anaemia from 60% to 54% between year 1995-96 and 2005-06, whereas in all other states anaemia in women has remained unchanged or increased over the same period.

Children born with low birth weight remain stunted and their learning capacity and ability to fight infection is also impaired. The nutrition of a child, during initial 1000 days is most important for his/

her whole life. Intrauterine malnutrition and consequently low birth weight and poor nutrition during initial 2-3 years, epigenetically predisposes the children to higher body fat and lower muscle mass (the lean fat babies). In later part of life, they are more susceptible to lifestyle related chronic disease like-the syndrome x (diabetes, hypertension, dyslipidaemia). This is more relevance to most of the developing country-like India, where many are born with low birth weight because of poverty and low maternal nutrition.

Role of Animals Derived Foods in Food and Nutrition Security

Globally, livestock (dairying, poultry and meat) food production has played the major role in providing food and nutrition security to billions of people. In future also, the most important role of National livestock sector would be to provide food and nutrition security to increasing population of India. Crop food production may be able to provide the food in terms of quantity but for nutrition security, India has to rely on dairying, poultry and meat sectors.

Milk Nutrients and Nutrition Security and Human Well-Being

Milk and milk constituents have gained prominence because of increasing scientific evidence pertaining to their health promoting and disease alleviating virtues. Significance of nutraceuticals assume altogether different dimension in our country where rapid rise in malnutrition and incidences of non-communicable diseases is posing newer challenges. It is costing not only 1-2% to National GDP, but adversely affecting the quality human resource as well. Among the functional foods dairy-based products occupy an important place, probably because of the well perceived health benefits associated with consumption of milk and milk nutrients. Milk, curd and ghee are the three dairy products which has been part of our all-social ceremonies and have also been mentioned for their disease preventing abilities in ancient literatures.

Milk accounts for 9.2% and 14.4% of protein intake in rural and urban areas, respectively. It is an important source of Ca, Mg, Potassium, Phosphorus, Iodine, Selenium, Vitamin A, D, B12, K, Riboflavin, Biotin, Pantothenic acid. Milk is a rich source of carotenoids which acts as anti-oxidant and improves the vision. It is an important source of SCFA which regulate the cell growth and demonstrate anti-tumour activity. Further, Butyric acid, a SCFA helps in fast multiplication of neurons. The lactose in milk act as prebiotic and responsible of development of brain. Role of milk nutrients specially the milk and whey minor milk proteins such as ?-lactoglobulin, ?-lactalbumin and lactoferrin, in modulating the immune system is well documented.

Further, casein, lactose and milk lipids are the major milk nutrients often serve as base materials for the production of metabolites having positive influence on physiological system and can be termed as nutraceuticals. Richness of milk protein particularly whey proteins, in sulphur containing amino acids-like cysteine and methionine assist in enhancing the level on natural antioxidant i.e. glutathione. Likewise, abundance of branched chain amino-acids facilitates the effective energy balance during exercises. Serotonin, a biomolecule production is also mediated by milk protein amino-acids. Further, milk bioactive peptides have antihypertensive, antioxidative, antithrombotic, hypocholestero-laemic, opioid agonist and opioid antagonist, mineral binding, antiappetizing, antimicrobial, immunomodulator and cytomodulatory effects. Bioactive lipids mediated compounds including

prostaglandins; leukotriene and thromboxane are produced in requisite amounts. Galactose, the hydrolytic product of lactose is essential for the development of vital organs including retina and brain. GMP, a by-product present in cheese whey modulates the bio-synthesis of cholecystokinin, the satiety hormone. Milk phospholipids have attracted the attention of researchers because of their effect on brain health.

Potential of Milk Nutrients for Nutritional Security

- Milk is whole some complete food. It is like one stop for all important and essential nutrients. It is an excellent source of quality proteins and good fat
- It is important source of Ca, Mg, P, K, Iodine, Se, Vitamin A, D, B12, K, Riboflavin, Biotin, B2, B3, B1, Pantothenic acid and Vitamin E
- Calcium present in milk helps in improving bone health, hypertension, and act as colonic anticarcinogenic
- Its calcium and Vitamin D content helps body to burn calories more efficiently and maintain a steady weight, while the healthy fat present in milk help to lower blood pressure
- Carotenoids present in milk are anti-oxidant and helpful in vision improvement
- SCFA (Butyric acid) are responsible for multiplication of neuron, regulation of cell growth and anti-tumour activity
- Lactose helps in development of brain. Lactulose which is formed during heat acts as prebiotic. It also controls chronic constipation
- Conjugated Linoleic acid and Omega-3 fatty acid are high in grass fed animals
- Milk and whey proteins' minor components and bioactive peptides have therapeutic values such as antihypertensive, antioxidative, hypocholestero-laemic, antimicrobial etc.
- Milk is also an excellent source of "Nutrients of Concern", which are under consumed in majority of population. These are Vit B12, K,D and Ca and which are not present in a number of common food
- Milk provides 18 of 22 essential nutrients
- The "Milk Matrix" is best example to understand that how so many nutrients and bioactive molecules interact with each other with their physical food structure and pharmacological action, to produce the overall effect on health
- Milk is an excellent source of quality proteins. It contains all 9 essential amino acids in high proportion (Methionine, Lysine, Phenylalanine, Threonine, Tryptophan, Leucine, Isoleucine, Valine and Hindidine) necessary for body function
- Milk whey proteins build, maintain and repair damaged muscle tissues very rapidly. It is most popular food supplement among athletes

- Consuming milk also corrects the A A deficiency in cereal-based diet, as it provides proteins with wide range of amino acids (in addition to 9 EAA)
- Milk fat is a notable source of energy and fat-soluble vitamins (Vitamin A, D, E and K). Further, the bioactive lipids are having several health attributes on human health.
- Milk fat is one of the most complex of all natural fats, containing about 400 different types of fatty acids. Many fatty acids are bioactive and has strong impact the health of human
- Milk fat globule membrane (MFGM) is a complex and unique structure primarily composed of lipids and protein, that surrounds milk fat globule. It is source of multiple bioactive compounds such as phospholipids: Phosphatidylcholine (lecithin), phosphatidylethanolamine (cephalin), phosphatidate, sphingomyelin etc., and glucolipids and glycoproteins
- Mounting clinical evidences suggest that MFGM is required in infants for structural and functional development and maturation of gut
- In infant, also essentially required for shaping the gut microbiota for immunity development
- Milk carbohydrate is mainly in the form of disaccharide simple sugar, lactose, which is around 5% in milk
- In GIT, lactose breaks down into glucose and galactose and these are absorbed into blood stream. In liver then galactose may be converted into glucose, if needed. As per recent study, lactose also helps in the absorption of calcium, Cu, zinc and other minerals, especially in infants
- Potassium helps the blood vessels to dilate and reduce the blood pressure. As such it helps to maintain the normal blood pressure
- Phosphorus also strengthens bones, as P and Vit D helps in absorption of Ca
- Milk contains tryptophan amino acid that brings good sleep. Tryptophan is converted into 5 HT or serotonin (hormone for mood, sleep, appetite pleasure and societal bondage)
- Serotonin also increases the blood level of melatonin, which brings good sleep. As such in some country, the milk taken after dinner is named "Night Milk"
- Lactoferrins are naturally found in milk protein in human and animal is an important host defence molecule and exhibits a diverse range of pharmacological functions. Its highest amount is found in colostrum but also also present in saliva, tears, mucus and bile

Potential of Meat Nutrients for Nutrition Security

- It is nutrient dense food
- Source of high biological value protein, iron, iodine, Vit A, B12 and B complex (thiamine, riboflavin, niacin, pyridoxine, biotin and pantothenic acid), Zinc, Selenium, Phosphorus, Iodine, Potassium, essential fatty acids including Omega-3 fatty acid

- Meat is not good source of essential fatty acids

PER and PDCAAS Values of Proteins from Various Food Sources

Protein Type	Protein Efficiency Ratio (PER)	Protein Digestibility Corrected Amino Acid Score (PDCAAS)
Whole Milk Protein	2.5	1.00
Whey Proteins	3.2	1.00
Casein	2.5	1.00
Egg	3.9	1.00
Peanut	1.8	0.52
Soy Protein	2.2	0.95
Beef	2.9	0.92

Nutritional and Health Benefits of Eggs

- Eggs are fairly high in quality animal proteins and contain all the essential amino acids that humans need
- Eggs are one of the few foods that should be classified as "Super food" or "Perfect food". They are loaded with nutrients, some of which are rare in the modern diet
- A single boiled egg contain (% of RDA): Vit A (6%), Folate (5%), Vit B5 (7%), Vit B12 (9%), Vit B2 (15%), phosphorus (9%, selenium (22%). It contains decent amount of Vit D, E, K, B6, and calcium and zinc, 6g proteins, 5g healthy fats and 77 calories
- Eggs are high in cholesterol, but eating eggs does not adversely affect cholesterol in blood of the majority of people. Eating eggs regularly increases the level of HDL
- Egg yolks contain large amounts of both lutein and zeaxanthin which significantly reduces the risk of cataracts and macular degeneration, two very common eye disorders
- Regularly eating eggs may promote weight loss, because eggs are highly satiating and may reduce calories intake later in the day

Animal Genetic Resources

Global population of cattle, sheep, goat, pig, chicken and buffalo have been estimated as 1511.02, 1238.72, 1177.35, 850.82, 25915.32 and 204.43 million in 2019 (FAO, 2019). Other livestock species domesticated so far include asses (50.58m), camel (37.51m), horse (59.04m), mule (7.94m), rabbit (299.95), turkey (428.25m), duck (1177.35m), and geese & Guinea fowl (362.13m). The global population of big five species (cattle, sheep, goat, pig and poultry) between 2012-19 indicated an increasing trend in chicken (26.6%), goat (15.1%), pig (10%) and cattle population (6.8%) but decreasing trend in sheep population (9.3%). The 2nd Report on Status of World's AnGR of FAO indicated that the world cattle population has reached to nearly 1.5 billion. Asia accounts one

third of global cattle population (highest in India and China 22% of world's cattle population).

Trend of population of major Livestock & Poultry species in India and World

S. No.	Species	World			India		
		2012	2019	Trend (%)	2012	2019	Trend (%)
1.	Buffalo	196.41	204.43	(+) 4.08	108.70	109.85	(+) 1.1
2.	Cattle	1427.28	1511.02	(+) 5.86	190.9	193.46	(+) 1.3
3.	Goat	951.43	1094.97	(+) 15.1	135.17	148.88	(+) 10.1
4.	Sheep	1133.66	1238.72	(+) 9.3	65.07	74.26	(+) 14.1
5.	Pig	983.88	850.82	(-) 13.5	10.29	9.06	(-) 12.0
6.	Camel	30.47	37.51	(+)23.1	0.40	0.25	(-) 37.5
7.	Horse	56.81	59.04	(+) 3.9	0.63	0.34	(-) 46.0
8.	Mule	9.33	7.94	(-) 14.9	0.20	0.084	(-) 58.0
9.	Ass	47.35	50.58	(+) 6.8	0.32	0.124	(-) 61.3
10.	Chicken	20472.71	25915.32	(+) 26.6	692.65	807.89	(+) 16.6
11.	Duck	1127.72	1177.35	(+) 4.4	23.54	33.51	(+) 42.4

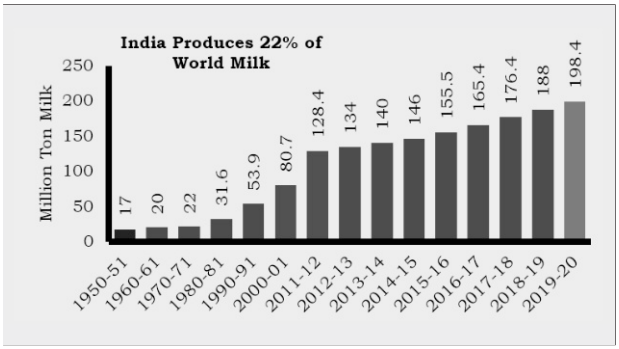
India possesses 536.8 million livestock and 581.5 million poultry, as per the 20th Livestock Census (2019). The census indicated that more than 99.5% of total livestock is represented by 5 major species viz, cattle (36.04%), buffalo (20.5%), sheep (13.8%), goat (27.7%) and pigs (1.69%). About 95% of total avian AnGR is represented by only fowl (chicken). In world, India has maximum population of buffalo (53.7% of world population), 2nd largest population of cattle (12.8% of world population) and goat and 3rd largest population of sheep. The Indian livestock population shows high degree of diversity in its composition. There are more than 200 indigenous breeds of different livestock. Out of which 50 are recognized breeds of cattle, 17 breeds of buffalo, 34 breeds of goat and 44 breeds of sheep. The total cattle population has declined from 204 million in 1992 to 194.5 million in 2019. This decline is mainly due to tremendous decrease in indigenous stock of the country in last three decades. With increased mechanization of crop production and declining farm size making many marginal farmers unable to keep draught cattle. Moreover, indigenous cows produce lower milk yield than buffaloes and cross-bred cattle, so there is a tendency to replace the indigenous cattle with dairy buffaloes and crossbred cattle. The buffalo population has increased from 84.2 million in 1992 to 109.85 million in 2019. The total number of sheep, goat and pigs in the country are 74.3, 148.9, and 9.06 million, respectively.

Milk Production and Productivity

India is the Highest Milk Producing Country in World

- Milk is most widely studied food and bovine milk is most consumed milk globally
- In India, there was more than 12 folds growth in milk production in last 7 decades
- ICMR recommended per capita milk in India- 280 gm/day

- Per capita milk availability in India- 394 gm/day
- Average per capita milk availability in world is 229 gm/day



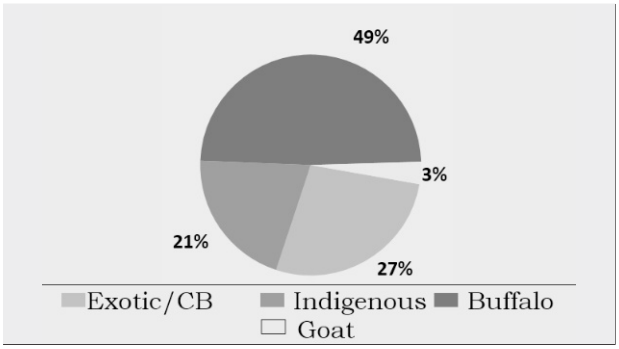
Unlike, developed countries, the dairy production system in India is unique. It is the best example of "Production by masses rather than mass production". But the biggest strength of Indian livestock sector is constant and sustainable growth despite limited investment from public and private sectors. Till date, smallholders are the backbone of Indian dairy production, however, in recent days witness a slow transformation from smallholder to either semi-commercial or commercial mode of livestock production. In future such transformation requires adequate readiness in terms of technological back stopping, machineries, input delivery mechanism, value addition and marketing. Further, adequate availability of trained manpower in commercial dairy production is also a pre-requisite for successful transformation. In the past four decades, Indian dairy production has undergone tremendous changes due to various developmental programmes. Before the start of the World's largest dairy development programme "Operation Flood", the milk production in India was only 17 million ton (1950-51), but today India is the largest producer of milk in the World, with an annual production of 198.4 million ton in 2019-20. Globally, the growth rate in milk production is at 1.3%, however in India it is 6.5%. In early, 1970(s), India's milk production was only 1/3rd of US and 1/8th of EU but today it is twice of US and 25% more than EU. The state of Uttar Pradesh produces 16% of total milk of India. The milk production in UP has increased from 11.2 million ton in 2010-11 to 29.05 million ton in 2017-18 and then 31.8 million ton in year 2019-20. The future global milk production predictions indicate that most of the increase in milk production will be in Asia, Latin America and the Caribbean. Asia is expected to account for most of the increase in milk production in the coming years. Within Asia, India would continue to be the largest milk producing country. Expansions in herd size, increased production and productivity coupled with better dairy efficiency and reduction in operating cost are the major factors that could contribute to maintain the status of India at the top in the world in dairying. However, certain factors including climate change, shortage of feed and fodder diminishing pasture land, declining cultivable land for fodder production and massive urbanization are the perceived constraints that may limit the growth of Indian livestock sector in future. The top 10 milk producing states in the country indicated that Uttar Pradesh produces highest milk and

Top 10 Milk Producing States in India (2019-20)

S.No.	State	Milk (mt)	% of Total
	All India	198.5	------
1.	Uttar Pradesh	31.80	16.02
2.	Rajasthan	23.67	11.92
3.	Madhya Pradesh	15.91	8.02
4.	Andhra Pradesh	15.04	7.58
5.	Gujarat	14.49	7.30
6.	Punjab	12.60	6.35
7.	Maharashtra	11.66	5.87
8.	Haryana	10.73	5.41
9.	Bihar	9.82	4.95
10.	Tamil Nadu	8.36	4.21

contribute about 16% in total National milk pool. The per capita milk availability in India during 2019-20 was around 394 g/day, which is well above the ICMR recommended level (280 g/person/day).

Contribution of Milk by Different Dairy Animals in India



During 2019, buffalo contributed to 49% of the total milk produced in the country, while cattle contributed to 48%. Indigenous Indian breeds of buffaloes (17 recognized breeds) produced about 73% of the milk produced by the buffaloes, while the remaining 27% was from the non-descript buffaloes. Among total contribution of cows, exotic and crossbred cows contributed to 56.3% of the total cow milk. The contribution of indigenous breeds of cows was to the extent of 25% while the non-descript cows contributed to 9% only. In Uttar Pradesh, the contribution of buffalo and cows in total milk production is about 64% and 32% (exotic cows 19% and indigenous cows 13%), respectively.

Regarding individual animal milk productivity, the national average productivity of crossbred cows, indigenous cow and buffalo remained at 7.95, 3.73, and 6.19 kg/day, respectively. Over the period, the enhancement in the productivity was more visible in the indigenous cows than in exotic and crossbred. The empirical evidence based on the large sample surveys indicate that the level of milk production for 36 % households is only ?500 litres/annum and for another 27% households, it is between 500-1000 litres /annum. Although this tiny scale of milk production can provide nutritional benefits to the family, but not enough surpluses for the market. Only 15 % households produce milk, which is >2000 litres/annum and available for market chain.

Though the milk production in India has shown an impressive growth during the last four decades, as compared to global average, the per animal productivity is very low due to huge number of nondescript cattle which needs upgradation. For improving the productivity further, the Government of India has taken a mega project in the form of "Rashtriya Gokul Mission" for conservation and improvement of indigenous breeds of cattle.

The milk productivity/cow/ year in developed countries like-USA, Denmark, Sweden, Finland, Netherlands etc. are above 9000 Kg, whereas in India the average milk productivity/cow/year is only 1169 Kg indicating enough scope to improve the productivity. At global level 83.2% of total milk comes from the cows but in India its contribution is about 48% of the total milk production.

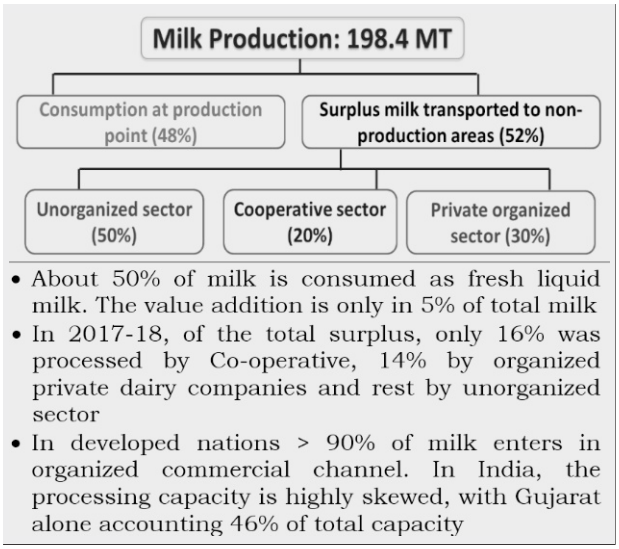
The country needs an effective road map to address the problems and challenges being confronted by this sector. There is also a need for change in existing policies and strategies to adjust the new technologies, changing demand patterns, upcoming value chains, newer communication technology, institutional innovations and globalization in the livestock production system. Often, policies are focused on breed improvement, without looking at their implications for the dairy farmers. Unless growth and development of dairy farming leads to improvement in welfare of farmers, it cannot be sustainable. There is need to reconsider and reshape the good dairy farming practices including animal health, clean milk production, animal welfare, quality of feed, environment and social issues, suitable

for Indian dairying in present farming scenario.

Processing and Value Addition in Indian Dairy Sector

Milk is highly perishable and requires efficient processing and marketing along its entire value chain to realize its best value. Although even after decades of economic development in the country, the marketing of milk and milk products remain largely unorganized, traditional and fragmented. In the last few decades, the organized institutional arrangements in dairy cooperative and private sector have successfully been established in many states and regions. Milk moves from producers to consumers through various value chains that vary depending on the state and the production system. It is estimated that nationally about 48 percent of total milk is consumed by producers themselves and 52 percent surplus is marketed. Of surplus 52%, about 50 per cent through unorganized traditional chains, 30 per cent through organized private chain and 20% through co-operative sector are marked. Dairy co-operatives, first started in Gujarat and then spread throughout the country with the "Operation Flood Programme". The evidence indicates that over the years, dairy co-operatives have played an significant role in production, marketing and processing of milk and dairy products, thereby contributing towards livelihood security of the millions of milk producers in the country. However, partly due to their skewed concentration in few states of west and south of the country and partly due to socio-economic-political factors, their performance and impact is not universally discernible across the entire length and breadth of the country.

Milk Processing Scenario, 2019-20



Functional Dairy Foods

Fusion trend has also influenced the dairy food formulations and blending of raw materials from different food groups either for better nutritional status or for the improvement of quality of resultant product and this has gained momentum in last few decades. Development of low calorie and / or no fat products required substantial alteration in formulations, although, removal of milk fat and sugars or salt may also have some undesirable consequences on organoleptic attributes of finished products. Addition of inulin and other non-digestible polysaccharides also have well documented health benefits, acting as prebiotic by assisting the proliferation of bifidobacteria and lactobacilli and improving the overall gastro-intestinal health. Other claimed benefits of different available functional dairy foods include increased calcium absorption with positive effects for bone health, a lowering of serum lipids with relevance for heart health, a positive effect on feeling of satiety with potential positive consequences for weight management, a potential effect to enhance resistance to infections and to stimulate the immune system. Among more than 1000 phytochemicals, few such as carotenoids, flavonoids, phytosterols, phytoestrogens, glucosinolate and soluble fibres have been utilized in certain

dairy products. These phytochemicals primarily act as antioxidants and perform putative functions mainly in life-style associated mortality and morbidity including cardiovascular diseases, diabetes and cancer. Phytosterols exhibit anti-inflammatory, anti-neoplastic, anti-pyretic and immune-modulating activity. Saturated phytosterols appear to be more effective than unsaturated ones in decreasing cholesterol concentrations in the body. These actions reduce serum or plasma total cholesterol and low-density lipoprotein cholesterol. The major focus in development of milk based therapeutic products has been towards the incorporation of probiotic microorganisms that harbour our gastro-intestinal tract and are frequently associated with health promoting attributes such as anti-microbial activity, anti-mutagenic and anti-carcinogenic effect, modulation of immune response, anti-diarrheal and anti-allergenic reactions.

Thermal treatment of milk is not only effective in improving the digestibility of milk proteins but heating of milk is also known to produce various intermediates as Maillard reaction products. Many of these Maillard reaction products have been identified with antioxidant potential; on the other hand, these also have been implicated in allergic responses and carcinogenesis. Biologically active milk peptides are of particular interest for food and pharma industry because they have been shown to play different physiological roles, including opioid-like activity, antimicrobial, immunomodulatory and anti-hypertensive. Upon oral administration, bioactive peptides may affect the major body systems-namely the cardiovascular, digestive, immune and nervous systems. The potential of certain peptides sequences to reduce the risk of chronic diseases or boost natural immune protection has aroused a lot of scientific interest over the past few years. These beneficial health effects may be attributed to known peptide sequences exhibiting antimicrobial, antioxidative, antithrombotic, antihypertensive and immunomodulatory activities. Further, the healing power of milk nutrients is known for centuries, and recent scientific investigations have also proved the disease preventing or alleviating properties of milk nutrients.

Probiotics science is another area for functional dairy food. Several species of Lactic acid bacteria and bifidobacteria assist in maintenance and improvement of gut health besides providing several other health benefits. It has been exploited all over the world for the development of probiotic dairy foods. Further, dairy foods have been considered the best food matrix for probiotics, which is explained in following two boxes.

Dairy Foods: An Ideal Probiotic Delivery Vehicle

- Dairy foods and probiotics are a perfect combination for human consumption
- Fermented Dairy Food is the excellent food matrix for optimal expression of probiotic functionality
- Many pharmacological activities of probiotics are expressed during fermentation of milk.
- Some important genes encoding probiotic functions are induced on exposure to fermented milk
- Milk possesses inherent properties to buffer acid in the stomach and increase the survival of probiotic strains in gut
- Refrigerated storage of milk and milk products further provides stability to probiotic organisms

- There is consumer's positive perception about dairy products as:
  - It is an integral part of diet and considered as healthy
  - Consumers are aware of live bacteria used in fermented dairy foods
  - Consumers prefer when functional ingredients are supplemented in natural food products

Advantages of Probiotics in Milk and Cultured Dairy Products

Dairy Foods can Protect Probiotic Bacteria	Refrigeration Keeps Probiotic Bacteria Stable and Viable	Cultured Dairy Products are a Complete Healthy Food
• Many bacteria are unable to survive the acidic environment of the stomach • Dairy products, such as milk, yogurt and cheese, can buffer stomach acid and increase probiotic's chance for survival	• Dairy foods are refrigerated to prevent spoilage • Probiotic bacteria in cultured dairy products benefit, as they remain the most stable in this storage condition	• It is well known that dairy foods contain a unique combination of nutrients that work together to improve health • Consumers now perceive health benefits not only from calcium, vitamin D, and protein in cultured dairy foods but also from natural friendly bacteria

Novel functional dairy food product categories such as antioxidant enriched, omega-3 fatty acids enriched, herbal dairy products, low calorie indigenous dairy foods and minerals and vitamins fortified functional dairy products and low cholesterol dairy foods will have future market potential for consumers preference and health. Application of nanotechnology needs to be explored in the development of novel functional food with special reference to encapsulated bioactive components. For commercial exploitation of the value-added dairy foods, extension of shelf-life assumes greater importance. In this regard, high hydrostatic pressure, pulsed electric field, ohmic heating and membrane technology, packaging interventions involving nanotechnology are the emerging technological options with promising future applications on industrial scale. These alternative technologies have great potential not only in improving the energy and processing efficiencies but also for maintaining the "wholesomeness" of the processed products.

The development of innovative dairy foods would be possible through further exploitation of the different kinds of healthy organisms viz. dairy starters, probiotics etc., The value addition of the dairy foods through the development of newer biotechnological and micro and nano-technological approaches would bring in a new era of foods that would address the future needs of the mankind. Studies on the diversity of the micro-organisms would further help in developing novel dairy foods with enhanced health attributes. There is an urgent need for developing rapid and reliable techniques for monitoring quality and safety management of dairy foods. This can be made possible through the development of biosensors and bioassay techniques. The innovations in molecular biology would greatly help in achieving the objectives of quality and safety of dairy foods.

Potential and Scope of Small Ruminants in Food and Nutrition Security

Small ruminants (goat and sheep) together constitute 223.14 million which is 41.65% of total livestock population (535.78 million) of India. The indigenous breeds of small ruminants are ubiquitous, and contribute significantly to the subsistence, economic and social upliftment, livelihood and food security of large human population who are landless, small and marginal farmers especially in arid, semi-arid and other eco-fragile region of the country, where crop production is always at risk both species are reared under extensive management system on community rangeland. In India, population of goat is the 2nd highest after China. From 2007 to 2019, the goat population in India has increased at the rate of 3.5% annually, despite of slaughter of 56% population ever year. As such goats has become the most inclusive species of livestock and there are 34 registered breeds of goats. The small ruminant rearing is less capital intensive thus suitable for large number of rural population where capital is a major limiting factor. Goat and sheep with their multi-facet utility for meat, milk, skin, wool, hair and manure, contribute about 9 and 3%, respectively in National livestock GDP. Telangana (19.1 million) is housing highest number of sheep, followed by Andhra Pradesh (17.6 million), Karnataka (11.1 million), Rajasthan (7.9 million) and Tamil Nadu (4.5 million). Rajasthan, in addition to housing the highest number of goats, also had the highest camel population (213 thousand) followed by Gujarat (28 thousand) and Haryana (5 thousand). Overall, the camel population in India has declined from 4 lakh (2012) to 2.5 lakh (2019). In Rajasthan the present population of camel is lowest in last 70 years.

In goat milk production, India occupies the first position in world, and contributes 3% (6.4 million ton) in total milk of the country. Goats also contribute 13.53% (1.1 mt) meat in total production of meat in India. The top 5 goat milk producing states are Rajasthan, UP, MP, Gujarat and Maharashtra (about 80% of total goat milk).

Milk of Small Ruminants and Camels

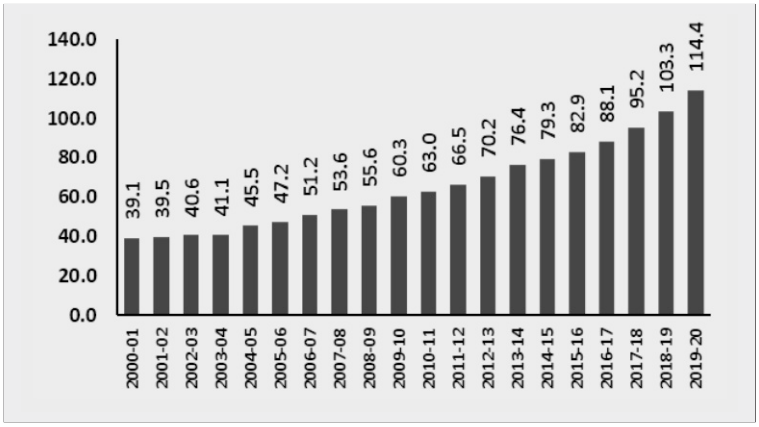
- The milk of camel, sheep and goat have several nutritional and therapeutic attributes
- Goat milk contain 4-5 times higher oligo saccharide than cow milk and 10 times more than sheep milk
- It is super rich in calcium and very similar to human milk in respect of other constituents
- Goat milk has smaller size of fat globules so has more digestion and has more anti-inflammatory property. It is a very rich source of CLA. It has higher proportion of medium chain fatty acid, which acts as antiviral and dissolves the cholesterol deposits in body. It has more iron, copper, Vit B, zinc and selenium, which are the key components in boosting the immune system in consumers
- Sheep milk contains almost twice protein as compared to goat and cow milk, and also has more Vit B12, A, D, E and other micronutrients. Sheep milk is rich source of minerals. The level of Ca, P, Mg, Zn, Mn and Cu is higher than in cow milk. Sheep milk has higher level of medium chain fatty acids, which helps in digestion and absorption of lactose, which is useful in lactose intolerant people. Further, sheep milk is very useful in management of high blood pressure, as it has very important AchE inhibitory peptides in high concentration. It is also extremely gentle to digestive system

- The therapeutic role of camel milk in liver dysfunction, diabetes, arthritis, long bone pain, allergy, autism and tuberculosis have been established

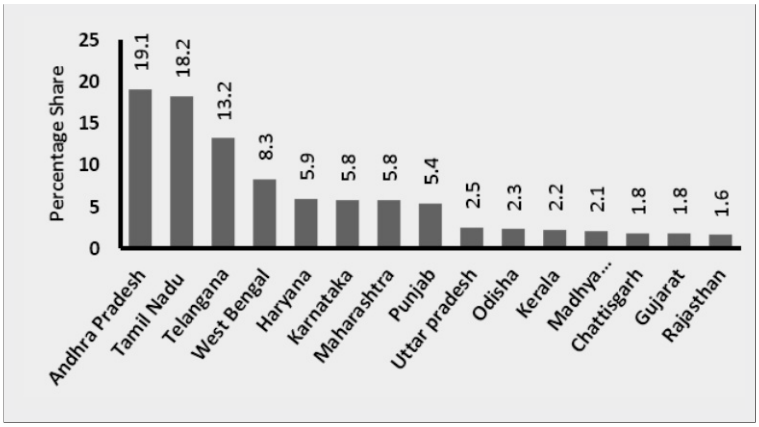
Potential and Scope of Poultry and Meat Sectors in Nutrition Security

In last four decades, the poultry sector in India has emerged from an unorganized farming practice to commercial production system. This industry has made a remarkable growth of 8.51 and 7.52% in egg and broiler production, respectively. The latest estimate indicated that Indian poultry sector contributed more than USD 17.31 billion in total domestic gross value, in which the organized sector has contributed nearly 70% of total output. India is the 3rd largest egg producing country after China and Brazil. China is the largest egg producing country (661.79 billion) and one out of each 3 eggs of world is being produced in China. In India, Andhra Pradesh is the largest egg producing state and one out of 5 eggs of India is being produced in this state. As per 20th Animal Census, in India the poultry population is 851.51 million and the egg production is 103.3 billion in 2018-19 and 114.38 billion in 2019-20. The per capita availability of egg in 2018-19 was 79 eggs per person per year. Andhra Pradesh is having the highest per capita availability of eggs of 372 per year followed by Tamil Nadu (265 per year).

Egg Production in India (2020)



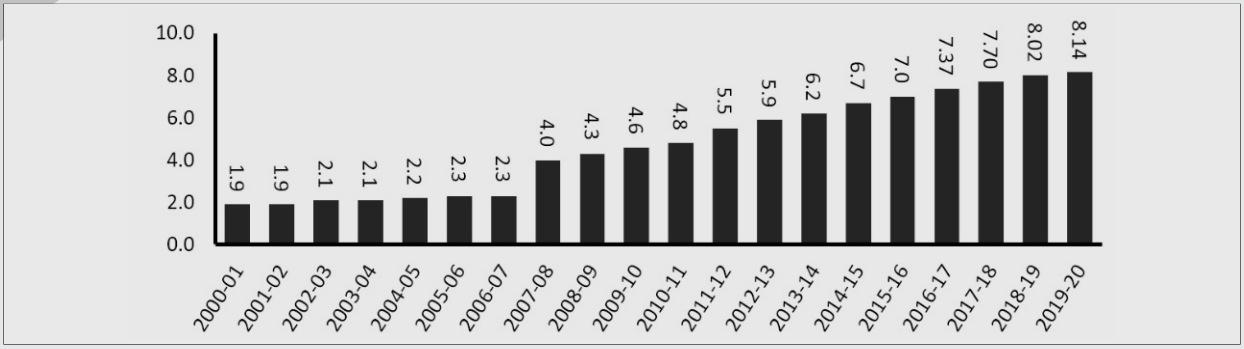
Share of Egg Production (%) of Major Egg Producing States (2018-19)



The total meat production in India has been growing with significant and noticeable rate. In 2006-07, the meat production was only 2.3 m ton, which has increased to 5.5 m ton in 2011-12, then to 5.95 m ton in 2012-13, 7.4 m ton in 2016-17 and 8.14 m ton in 2018-2019. Poultry sector is contributing 4.06 m ton i.e., about 50% of total meat production in India. In order to meet the ICMR recommendation for per capita availability of egg (180 per year) and meat (11 Kg per year), the volume of existing production of eggs and meat must expand to 4 and 6 folds, respectively.

Further as far as slaughtering facilities are concerned, although there is a well-established marketing and supply chain network for export of meat, but in the domestic marketing system it does not demonstrate the equal quality and standard. About half of the total meat production comes from un-registered, make-shift slaughter houses

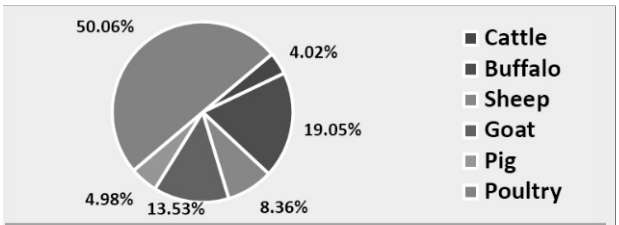
Meat Production in India (2020)



- India is the largest exporter of buffalo meat and the third largest exporter of total meat after Brazil and Australia. In India, UP is highest exporter of buffalo meat
- In order to meet per capita availability of meat (11kg/person/year) the meat production must expand 6-folds
- Out of 8.14 MT; 4.06 MT is broiler meat
- Uttar Pradesh contributes highest share (15%) in National meat production followed by Maharashtra (12%), West Bengal (10%), Andhra Pradesh (9.3%) and Telangana (8.4%)

Major Challenges in Artificial Insemination and Animal Health Sector

Species-wise Meat Contribution in India (2019)



- Bovines are the 2nd largest source of meat in India after poultry
- In world, India is second in goat meat production, sharing 12-13% of world share, though per animal productivity of sheep and gaoat meat is much below than world average

India has one of the largest animal breeding infrastructures in the world. During recent decades, no doubt, the intense genetic selection has increased the milk yield, however, this selection has also changed the reproductive physiology of the cow which led to decrease in reproductive efficiency. For instance, it has been reported that over the past 50 years, the percentage of oestrus animals, that stand to be mounted has declined from 80% to 50%. The duration of oestrus time has reduced from 15 h to 5 h and the first service conception rate has reduced from 70 to 50 per cent. The pregnancy rate has decreased, while the days open and services per conception has increased. The inappropriate management of high milk producing dairy cows is the main factor for poor fertility rather than direct impact of genetics. As such it is very reasonable to comment that the demands for high milk production have negatively impacted the fertility in high producing cows. During 2016-17, the country produced 115.9 million frozen semen doses and performed 75.6 million artificial inseminations with the average conception rate of 35%. However, the overall coverage of AI is only 29.7% and the availability of breeding bulls and frozen semen straws is far less than the requirement. To achieve the national target of 50 % of AI coverage, the country requires high number of superior breeding bulls. The quality

semen production must reach from the present dose of 115.9 to 170 million doses. In addition to limited availability of breeding bulls, the other limiting factor in achieving the required numbers of frozen semen straws is the poor-quality semen produced by the breeding bulls especially the crossbred bulls.

The livestock health sector is facing several new challenges-like increased incidence of emerging and re-emerging diseases and vulnerability to exotic disease. Further, it is also presumed that many new diseases will surge upon during changing climatic scenario. The outreach of veterinary health care services to the livestock farmers is also very low. Lack of awareness and timely non-availability of vaccines, diagnostics and other inputs for preventive measures leads to high incidence of diseases and epidemics in the country. It has been estimated that brucellosis cost India to at least Rs350 million every year on account of the loss of animal production and loss of man-days. In India, the annual economic loss incurred to dairy industry on account of only udder infections (mastitis) have been estimated to about Rs 6053.21 crore. Out of this, loss of about Rs 4365.32 crore (70-80%) has been attributed to sub-clinical udder infections (subclinical mastitis). The direct economic loss due to FMD in India is estimated at about Rs 20,000 crore per year. Small, marginal and unorganized poor livestock farmers are most sufferers by these diseases. FMD also affected the export potential of the livestock industry as milk and milk products, meat and hides are not accepted by the disease-free importing countries. If only FMD is controlled in India, the milk production will jump by at least 5-7% annually and the export of meat could be enhanced by 3-5 times than the present level.

In sheep and goat husbandry, very high morbidity and mortality can be prevented with prophylactic care, vaccination and improved method of rearing. PPR or goat plague is the most important disease of sheep and goats causing an economic loss to the tune of Rs 1800 million/annum. It has been witnessed that the mass scale vaccination of PPR vaccine resulted in reduction of $>75\%$ disease incidence.

In poultry health the viral diseases such as Avian Influenza (Highly Pathogenic and Low Pathogenic), Newcastle/Ranikhet Disease, Infectious Bursal Disease (IBD), Avian Infectious Bronchitis (IB), Infectious Laryngotracheitis (ILT), Turkey Rhinotracheitis and Duck Viral Hepatitis (DVH) are the most important diseases. Except for avian influenza, all disease outbreaks are going almost unnoticed hence are always under reported. Chronic Respiratory Disease (CRD) caused by M. gallisepticum, complicated CRD (due to mycoplasma) and avian pathogenic E. coli (APEC) are the most important limiting factors for broiler production in the country. In India, the presence of ILT seems to be phylogenetically closely related to strains of used vaccine obtained from Italy, China, Brazil and USA, indicating that unplanned, haphazard and extensive use of ILT vaccines might be responsible for field outbreaks and it may also be referred as "vaccinal laryngotracheitis".

Emerging and re-emerging zoonotic diseases are a serious challenge to the animal and human health worldwide. The importance of zoonotic diseases can be gazed from the fact that out of 1415 species of pathogens known to be pathogenic to humans, 61% (868) are considered to be zoonotic in nature. About 175 pathogenic species are associated with diseases considered to be 'emerging' and out of these emerging pathogens, 75% (132/175) are considered to be zoonotic. The emergence and re-emergence of zoonotic diseases is not new but over the past 3-4 decades the onset of outbreaks of viral diseases emerging from animal reservoirs to infect humans has increased. Few examples, are Ebola virus, highly pathogenic avian influenza (HPAI) viruses H5N1, H1N1, Severe Acute Respiratory

Syndrome (SARS) coronavirus and Middle East Respiratory Syndrome (MERS) coronavirus. Many pathogens originate in wildlife and create havoc in the human populations. A novel SARS-CoV-2 is the recent example, that how a pathogen originated from wildlife have threatened the human life and vice versa.

Urgent Need to Strengthen the Livestock Health Services

- The new diagnostic and therapeutic technologies must be integrated with the indigenous knowledge and practices of livestock owners and farmers
- There is an implicit need to change the attitude of the field veterinarian from a "clinic-centred" activity to a "pro-active disease prevention" activities, so that the sporadic incidences of various diseases do not assume epidemic proportions
- The disease forecasting and information system in the country should be strengthen by integrating the forecasting station
- A comprehensive package about disease awareness, epidemiology surveillance, management and control measures are to be developed for education of farmers to control the disease incidence
- Launching of systematic disease control and eradication programmes for OIE listed diseases along with effective disease surveillance on the lines of "Rinderpest Eradication Programme", and strict enforcement of Sanitary and Phytosanitary conditions in processing of livestock products, are very critical in promoting the international trade
- Required quantity of vaccines against common diseases of cattle, buffaloes, sheep, goats, pigs, horses, and poultry are to be arranged (either import or manufacture in India) on priority.
- A well-planned and operational livestock disease control programme involving PPP mode could be an option to ward off huge economic losses due to changing climatic conditions and to newer emerging and re-emerging diseases
- Emphasis should also be given to prevention and control of the zoonotic diseases

Avian influenza, since its first outbreak in 2006 emerged as an economically most important disease with very significant impact on marginal and rural backyard poultry farmers. The outbreaks of avian influenza were epidemic during 2008-09 and thereafter it was settled as sporadic in occurrence. The continuous of outbreaks of avian influenza since 2009 costs the Indian poultry industry a loss of about USD 4.1 million.

The Future Science for Indian Livestock Sector in Next Decade

(i) The cow side tests for diagnosis of sub-clinical mastitis, early pregnancy and ensuring metabolic disorders should be developed

(ii) The development of "electronic nose" for oestrus detection in cattle and buffalo is need of the day

(iii) The puberty age of cattle and buffalo is very long, as such research on reducing the age of puberty

in both male and female should be taken on priority

(iv) To reduce the number of unproductive and low producing dairy animals, the technologies for sexed semen and sexed embryos should be developed for Indian breeds of cattle and buffaloes

(v) The rearing of male calves to become the bulls, with good management practices should be encouraged. It will help in reducing the gap between demand and availability of male germ plasm

(vi) The biotechnological tools for prediction of fertility of bull at calf-hood level should be worked out. It will encourage farmers to rear male calves

(vii) We have also to develop the tools for selection of animals not only on the basis of productivity but also based on "input use efficiency"

(viii) The technology for environment friendly livestock waste disposal is needed most

(ix) Modern science should be used for increasing the shelf life of milk and meat and their products

(x) Exploring the nutritional health attributes of milk specially of non-bovine milk should be undertaken on priority

(xi) Exploring the full potential of biotechnology and newer methodologies for development of vaccines against emerging and re-emerging diseases in cattle, buffaloes, sheep, goats, poultry and other animals

(xii) Strengthening the surveillance and epidemiological data of disease, responsible for economic loss to dairy and poultry sectors and of zoonotic diseases and antimicrobial resistance

Selected References

1. DAHDF (Department of Animal Husbandry, Dairying and Fisheries) Annual Report (2018-2019). Ministry of Agriculture and Farmers Welfare, Government of India. Chapter 4, Dairy Development, pp 69-90 and "Rastriya Gokul Mission", pp 69-90.
2. FAO (2021). The State of Food Security and Nutrition in the World https://www.fao.org > sofi > 2021; https://www.fao.org > stateofsecurity…
3. FAO, IFAD, UNICEF, WFP and WHO. (2017). The State of Food Security and Nutrition in the World 2017. Building resilience for peace and food security. Rome, FAO.
4. FAO, IFAD, UNICEF, WFP and WHO. (2018). The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition. Rome, FAO. Licence: CC BY-NC-SA 3.0 IGO.
5. Global Hunger Index (2021).https://www.insightsomindia.com/ghttps://www.globalhunger index. org
6. Global Malnutrition Statistics (The UNICEF/WHO/WB Joint) Child Malnutrition Estimates (JME Group); https://www.who.int > News > item
7. Grover, S., Kumar, A., Srivastava, A.K. and Batish, V.K. (2013). Probiotic as Functional Food Ingredients for Augmentation of Human Health. In: Innovation in Healthy and Functional Foods. (Eds.) Dilip Ghosh, Santanu Das, Debasis Bagchi and R.B. Samanta, CRC Press (Taylor and Francis Group), New York, pp 387-418.
8. Kumaresan, A. and Srivastava, A.K. (2016). Status and Strategies for Developing Dairy Enterprises for Upliftment of Rural Poor. In: Livestock Production under Diverse Constraints ISBN 978-93-84649-44-9. Ed. N.S.R. Sastry, pp 146-150.
9. Kumar, P., Joshi, P.K. and Mittal, S. (2016). Demand vs Supply of Food in India- Futuristic Projection. *Proceedings of Indian National Science Academy*, 82(5):1579-1586

10. Lopez Sobaler, A.M., Aparicio, V.A. and Ortega, R.M. (2017). Role of Egg in the Diet of Athletes and Physically Active People. *Nutricion Hospitalaria*, 34: 31-35
11. Malia Frey (2021). Milk nutrition facts and Health benefits. Nutrition Facts-Dairy (www.medicalnewstoday.com)
12. Malik, R.K., Garg, S., Grover, S. and Srivastava, A.K. (2015). Dairy Foods as a Career Matrix for Probiotics. In: Transforming health and well-being. (Eds.) B.S. Ramakrishna, G. Balakrish Nair and Y. Tekeda. Probiotic Micome and Gut Function. Elsevier, pp. 40-64.
13. Mourad, G., Bettache, G. and Samir, M. (2014). Composition and Nutrition Value of Raw Milk. Biological Science and Pharmaceutical Research 2(10): 115-122; (http://www.journalissues.org/IBSPR/http://dx.doi.org /10.15739/ibspr.005)
14. National Dairy Development Board-Annual Report (2018-19). Enhancing Productivity: Minimum Standard for Production of Bovine Frozen Semen, pp 12-23.
15. NHP-National Health Profile (2019). 14th Issue. Central Bureau of Health Intelligence, Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India: WHO Collaborating Centre on Family of International Classifications.
16. Singh, B.B., Kharkar, M.S., Aulakh, R.S., Gill, J.P.S. and Dhand, N.K. (2018). Estimation of health and economic burden of human brucellosis in India. *Preventive Veterinary Medicine*, 154:148-156.
17. Singh, A.K. and Srivastava, A.K. (2011). Functional Dairy Foods from Concept to Products. In: Functional Dairy Foods, Concept and Applications. (Eds.) S.K. Tomar et al. Satish Serial Publication House, New Delhi, pp 1-8.
18. Srivastava, A.K., Kumaresan, A., and Patil, G.R. (2015), Dynamics of Dairy Animals in India. In: "SAARC Dairy Outlook" (Ed) Nure Alam Siddiky. SAARC Agriculture Centre, BARC Complex, Farm Gate, Dhaka-1215, Bangladesh, pp 8-22.
19. Stefaan, De. S. and Els, V. (2016). Meat: The balance between nutrition and health- A Review. *Meat Science*, 120: 145-156.
20. UNICEF / WHO / World Bank Group (2016). Child Malnutrition Estimates Key findings of the edition; Levels and trends in Child Malnutrition (UNICEF- uni.cf/jmedashboard; WHO-www.who.int/nutgrowthdb/estimates; World Bank Group- data.worldbank.org/ child-malnutrition)
21. United Nations Children's Fund (1990). Strategy for improved nutrition of children and women in developing countries. New York, USA
22. World Health Organization (2021). Fact sheets- Malnutrition; https://www.who.int
23. World Health Organization (2017). The double burden of malnutrition. Geneva, Switzerland
24. World Health Organization (2009). Zoonotic diseases: Emerging Public Health threats. 61st Session of Regional Committee. http://www.emro.who.int
25. World Health Organization (?2019)?. Trends in maternal mortality 2000 to 2017: Estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. https://apps.who.int/iris/handle/ 10665/327595. License: CC BY-NC-SA 3.0 IGO
26. World Hunger; Key Facts and Statistics (2021). https://www.actionagainsthunger. org > https://datatopics. worldbank.org > c;https://www.globalhunger index.org
27. World Population Prospects (2017). Published by Population Division, Department of Economic and Social Affairs, United Nations, New York, NY 10017, USA. https://esa.un.org/unpd/wpp/Publications/Files/WPP2017_ Wallchart.pdf

Previous Dr C. M. Singh Oration / Memorial Lectures

Dr C.M. Singh Oration Lecture	
2005 Dr Utpal Sengupta	Recent Advances in immunology and immunopathology of mycobacterial diseases
Dr C.M. Singh Memorial Lectures	
2006 Prof. T.P. Singh	Clinical structural proteomics and structure-based new drug discovery: Opportunities and challenges
2006 Dr M.S. Swaminathan	Food safety and food security
2007 Dr S.P.S. Ahlawat	Animal genetic resources and their conservation for the social transformation in the foot hills of Himalayas
2008 Dr R.B. Singh	Biosecurity for food security
2010 Dr M.C. Sharma	Cancer in Pet animals: Incidence, diagnosis and its management
2012 Dr Chanda Nimbkar	Biotechnology for the benefit of smallholder sheep owners in the context of a theory of livestock breeds improvement
2018 Prof. Panjab Singh	Indian agriculture-challenges and resolves
2020 Dr B.N. Tripathi	Transforming Livestock Production Through Technology Intervention and Policy Reforms

NB: Most of Dr C.M. Singh Lectures may be downloaded from Trust website (cmset.org)

Prof. (Dr) A.k. Srivastava

Prof. (Dr) A.K. Srivastava, the former Director and Vice Chancellor of ICAR-National Dairy Research Institute, Karnal and former Chairman, ASRB, DARE, Govt of India, is a distinguished Veterinary, Dairy and Animal Scientist. He is presently working as Member (Animal Sciences), Agricultural Scientists Recruitment Board, Ministry of Agriculture and Farmers Welfare, Government of India. Prof. Srivastava has also served as Dean, Faculty of Veterinary Science and Animal Husbandry and Director Resident Instructions and Dean, PGS at Sher-e-Kashmir University of Agricultural Sciences & Technology, Jammu and Head, Department of Pharmacology and Toxicology, PAU, Ludhiana. He is Post Doctorate from Institute of Toxicology, München, Germany. Prof. Srivastava is honoured with Doctor of Science (Honoris Causa) from Veterinary University, Mathura and Veterinary University, Jabalpur. Presently, Prof. Srivastava is President, National Academy of Dairy Science (India), President, Association of Mastitis and President, Probiotic Association of India. He is also Patron of Indian Dairy Association. Earlier, Prof. Srivastava served as Vice President and Secretary of National Academy of Agricultural Sciences and the President, Indian Society of Veterinary Pharmacology and Toxicology. Dr Srivastava is Founder Authority Member of Food Safety and Standard Authority of India (FSSAI) and Member of International Dairy Federation. He was also Chairman, Indian Dairy Association, Chairman, FAD 19 and Bureau of Indian Standard Committee, BIS, Govt. of India.

Prof. Srivastava is distinguished Member of National Academy of Sciences (India) and Fellow of National Academy of Agricultural Sciences, National Academy of Dairy Sciences, National Academy of Veterinary Sciences, National Academy of Biological Sciences, Punjab Academy of Sciences and Uttar Pradesh Academy of Agricultural Sciences and Fellow of more than 12 prestigious professional societies. He is Member, Board of Governing Council of Agriculture Skill Council of India, Ministry of Skill Development, Advisory Committee of Indian Institute of Packaging, Ministry of Commerce and Industries, GOI and Chairman R&D, Ministry of Food Processing Industries, GOI, New Delhi. Earlier, Prof. Srivastava has also served as Secretary, Vice President and President of Indian Agricultural Universities Vice Chancellors Association. He has been decorated with numerous prestigious awards and honours including the prestigious ICAR Jawaharlal Nehru Award; International National Organic Chemical Industries (NOCIL) Award; National Alarsin Awards in 1987-88 and 1999-2000; Dr B.D. Garg Outstanding Pharmacologist Award, 2018 and many more. He has been conferred the Life Time Achievement Award by the Indian Society for the Study of Reproduction and Fertility and Indian Society of Buffalo Development. He has also received the Chellappa Memorial Oration Award, Mansinhbhai Memorial Oration Award, Dr Sunderasan Memorial Award and Prof. S. Kannaiyan Memorial Award, 2019, by National Academy of Biological Sciences and Dr V. Kurien Memorial Oration Award. He has published more than 280 research papers, authored 8 books and several National policy papers in his credit and has guided more than 30 PhD and MVSc students.