Vision 2050




National Research Centre on Meat

Indian Council of Agricultural Research

Vision 2050

National Research Centre on Meat
(Indian Council of Agricultural Research)
Hyderabad

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संदेश

भारतीय सभ्यता कृषि विकास की एक आधार रही है और आज भी हमारे देश में एक सुदृढ़ कृषि व्यवस्था मौजूद है जिसका राष्ट्रीय सकल घरेलू उत्पाद और रोजगार में प्रमुख योगदान है। ग्रामीण युवाओं का बड़े पैमाने पर, विशेष रूप से शहरी क्षेत्रों में प्रवास होने के बावजूद, देश की लगभग दो-तिहाई आबादी के लिए आजीविका के साधन के रूप में, प्रत्यक्ष या अप्रत्यक्ष, कृषि की भूमिका में कोई बदलाव होने की उम्मीद नहीं की जाती है। अतः खाद्य, पोषण, पर्यावरण, आजीविका सुरक्षा के लिए तथा समावेशी विकास हासिल करने के लिए कृषि क्षेत्र में स्थायी विकास बहुत जरूरी है।

पिछले 50 वर्षों के दौरान हमारे कृषि अनुसंधान द्वारा सृजित की गई प्रौद्योगिकियों से भारतीय कृषि में बदलाव आया है। तथापि, भौतिक रूप से (मृदा, जल, जलवायु), बायोलोजिकल रूप से (जैव विविधता, हॉस्ट-परजीवी संबंध), अनुसंधान एवं शिक्षा में बदलाव के चलते तथा सूचना, ज्ञान और नीति एवं निवेश (जो कृषि उत्पादन को प्रभावित करने वाले कारक हैं) आज भी एक चुनौती बने हुए हैं। उत्पादन के परिवेश में बदलाव हमेशा ही होते आए हैं, परन्तु जिस गति से यह हो रहे हैं, वह एक चिंता का विषय है जो उपयुक्त प्रौद्योगिकी विकल्पों के आधार पर कृषि प्रणाली को और अधिक मजबूत करने की मांग करते हैं।

पिछली प्रवृत्तियों से सबक लेते हुए हम निश्चित रूप से भावी बेहतर कृषि परिदृश्य की कल्पना कर सकते हैं, जिसके लिए हमें विभिन्न तकनीकों और आकलनों के मॉडलों का उपयोग करना होगा तथा भविष्य के लिए एक ब्लूप्रिंट तैयार करना होगा। इसमें कोई संदेह नहीं है कि विज्ञान, प्रौद्योगिकी, सूचना, ज्ञान-जानकारी, सक्षम मानव संसाधन और निवेशों का बढ़ता प्रयोग भावी वृद्धि और विकास के प्रमुख निर्धारक होंगे।

इस संदर्भ में, भारतीय कृषि अनुसंधान परिषद के संस्थानों के लिए विजन-2050 की रूपरेखा तैयार की गई है। यह आशा की जाती है कि वर्तमान और उभरते परिदृश्य का बेहतर रूप से किया गया मूल्यांकन, मौजूदा नए अवसर और कृषि क्षेत्र की स्थायी वृद्धि और विकास के लिए आगामी दशकों हेतु प्रासंगिक अनुसंधान संबंधी मुद्दे तथा कार्यनीतिक फ्रेमवर्क काफी उपयोगी साबित होंगे।

(राधा मोहन सिंह)

केन्द्रीय कृषि मंत्री, भारत सरकार

Foreword

Indian Council of Agricultural Research, since inception in the year 1929, is spearheading national programmes on agricultural research, higher education and frontline extension through a network of Research Institutes, Agricultural Universities, All India Coordinated Research Projects and Krishi Vigyan Kendras to develop and demonstrate new technologies, as also to develop competent human resource for strengthening agriculture in all its dimensions, in the country. The science and technology-led development in agriculture has resulted in manifold enhancement in productivity and production of different crops and commodities to match the pace of growth in food demand.

Agricultural production environment, being a dynamic entity, has kept evolving continuously. The present phase of changes being encountered by the agricultural sector, such as reducing availability of quality water, nutrient deficiency in soils, climate change, farm energy availability, loss of biodiversity, emergence of new pest and diseases, fragmentation of farms, rural-urban migration, coupled with new IPRs and trade regulations, are some of the new challenges.

These changes impacting agriculture call for a paradigm shift in our research approach. We have to harness the potential of modern science, encourage innovations in technology generation, and provide for an enabling policy and investment support. Some of the critical areas as genomics, molecular breeding, diagnostics and vaccines, nanotechnology, secondary agriculture, farm mechanization, energy, and technology dissemination need to be given priority. Multi-disciplinary and multi-institutional research will be of paramount importance, given the fact that technology generation is increasingly getting knowledge and capital intensive. Our institutions of agricultural research and education must attain highest levels of excellence in development of technologies and competent human resource to effectively deal with the changing scenario.

Vision-2050 document of ICAR-National Research Centre on Meat (NRCM), Hyderabad has been prepared, based on a comprehensive assessment of past and present trends in factors that impact agriculture, to visualise scenario 35 years hence, towards science-led sustainable development of agriculture.

We are hopeful that in the years ahead, Vision-2050 would prove to be valuable in guiding our efforts in agricultural R&D and also for the young scientists who would shoulder the responsibility to generate farm technologies in future for food, nutrition, livelihood and environmental security of the billion plus population of the country, for all times to come.

(S. AYYAPPAN)
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Preface

India has attained a distinction of largest producer and exporter of buffalo meat in the world with an annual total meat production of 6.29 MT during the year 2012, however shrinking arable land, low productivity of livestock and unhygienic meat due to inadequate infrastructure pose great challenge to meet the nutritional security of fast growing population in the coming years.

Considering these challenges, National Research Centre on Meat under the aegis of Indian Council of Agricultural Research has been striving for innovative approaches to develop modern organized meat sector in the country. It is in this background that the formulation of a perspective plan with a visionary approach for the next 35 years is quite necessary. This document articulates a vision of meat research for the next 35 years with an integrated frame work building through a multi-disciplinary and multi-institutional participation including international collaborations for International recognition of the National Research Centre on Meat as a premier institution of meat research to solve the problems and face the challenges of meat and allied sectors development. The mission set is apt to develop a modern organized meat sector in the country with appropriate R & D interventions.

The guidance from Hon'ble DG, DDG (AS), ADG (AN&P) and other members of Animal Sciences division has been the spirit in visualizing different concept areas and peer review members of QRT, RAC and IMC who made valuable contributions in identifying priority programmes. This document would be useful to the researchers, teachers and students in the area of meat science and technology besides planners and entrepreneurs in meat and related sectors.

V.V. Kulkarni
Director

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Context

World meat consumption is outpacing the sale of other major agricultural commodities, especially in developing countries, according to "Agricultural Outlook 2012-2021" report by the UN Food and Agriculture Organization (FAO) and the Organization for Economic Co-operation and Development (OECD). According to the FAO study, the rapidly growing world population will be consuming two-thirds more animal protein by 2050 than it does today. The BRICS (Brazil, Russia, India, China and South Africa) countries which account for more than 50% of the world's total population represent most of the animal protein demand. Burgeoning population and disposable income are fuelling an ongoing trend toward greater per capita consumption of animal protein in developing countries. The prime concern of the populous country like India is to ensure sustainable livelihoods for its masses. Livestock sector is one of the most important components to ensure food security and nutrition. Therefore, development of Indian meat sector is important for sustaining livestock production activities towards contributing food security, nutrition and livelihood.

India has huge livestock wealth and ranks first in the world for buffalo population (Table 1). India also has second largest number of cattle and goats, third largest number of sheep and fifth largest number of chicken in the world (FAO, 2014). Livestock sector serves as an important source of milk and meat proteins. It provides employment to millions of rural people and contributes enormous amount of draught power and biomass that enriches the agricultural fields of our country. India has been witnessing impressive growth in meat production with an annual production of 6.29 million tonnes during the year 2012 (Table 2). India is a top buffalo meat producer in the world mainly due to an expanding dairy herd, efficiency improvements, increased slaughter and price-competitiveness in the international market. In the year 2013-14, India's export of buffalo meat touched a record 26,458 crores (Figure 1). Buffalo meat is the second largest commodity exported from India mainly to Middle East and South East Asian nations (APEDA). India is also the second largest producer of goat meat in the world.

National Research Centre on Meat

ICAR-National Research Centre on Meat (NRCM), Hyderabad

Table 1 Livestock population-2013 in India and World ranking

Species of animals	Population (in millions)	World ranking
Cattle	214.00	II
Buffalo	115.42	I
Goats	162.00	II
Sheep	75.50	III
Chicken	950.00	V
Pigs	9.30	-------

Source: FAO (2014)

Table 2 Meat production (million tonnes) in India and World in 2012

Type of meat	India	World	Proportion (%)	Ranking in the World
Buffalo meat	1.53	3.59	42.45	1
Goat meat	0.60	5.29	11.41	2
Chicken	2.21	92.70	2.53	9
Beef	1.09	62.73	1.70	----
Mutton	0.29	8.48	3.39	----
Pork	0.32	108.50	0.30	-----
Others	0.25	20.71	1.20	-----
Total	6.29	302.00	2.08	

Source: FAO (2014)

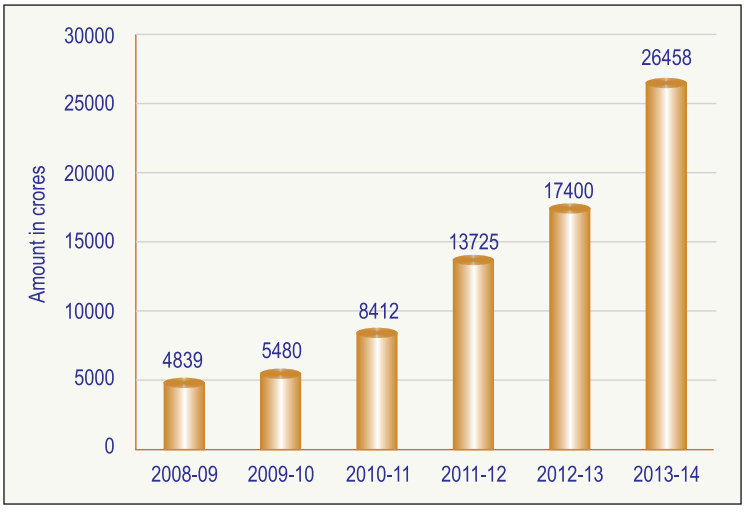

Fig. 1 Buffalo meat exports from India (APEDA)

was established with an overall objective to conduct basic and applied research, to promote quality meat production, value addition, training, consultancy, contract research projects and entrepreneurship development and to provide policy support to line departments. Some of the salient achievements of NRC on meat are listed below.

- With an objective to promote value addition and further processing, the institute has done significant work on value addition and development of varieties of value added meat products viz., nuggets, sausages, smoked mutton hams, chicken curves, chicken and mutton bites biryani, chicken samosa, chicken soup, pickle etc. The Institute has trained more than 300 micro, small and medium scale entrepreneurs from across the nation and has signed 12 MoU's for transferring these technologies to entrepreneurs.
- The Institute has developed the technologies for utilizing various locally available natural ingredients viz., pomegranate fruit juice, honey, clove oil, cinnamaldehyde, drumstick leaves, gongura leaves, ragi flour, texturized soya proteins etc. as natural antioxidants, antimicrobial agents or binding agents to improve quality attributes or extend the shelf life of processed meat products. Centre has also undertaken the projects to develop various meat based functional products using natural phenols from pomegranate rind powder and dietary fibres from citrus fruits and grape fruit wastes and sorghum flour. In these areas, the Centre has successfully completed sponsored research projects with private multinational companies.
- NRC on Meat has standardised several processing methodologies for improving the palatability/quality attributes of meat from spent chicken, emu, sheep and goats. Different chemical (bicarbonates, polyphosphates and ammonium hydroxide), physical (blade tenderization) and other methods (emulsion technology) were optimized for utilizing meat from spent animals and birds.
- NRC on Meat has developed technology and established the facilities for identification of meat species (detection of meat adulteration) and sex differentiation of different livestock and poultry using DNA based method. The Centre is regularly providing these services to different organizations, meat processors and exporters. The Institute has also developed the traceability model mainly for buffalo meat to address much needed traceability issues in meat sector.
- The Institute has generated baseline data on chemical residues in different meats and fish varieties. Undertaken the project to estimate the yield of dressed carcass, meat, by-products and other slaughterhouse wastes in different parts of India.

- NRC on Meat has undertaken several awareness programmes on zoonotic diseases (Brucella), clean meat production, value addition and exclusive training programmes to butchers, veterinarians and personnel from export meat plants. Faculty development programmes, student in-house trainings were conducted besides participating in various exhibitions.
- The Centre has successfully completed a National Agricultural Innovation Project (NAIP) on 'Value chain for clean meat production from sheep' with mission to augment clean meat production. Under this project, one model slaughterhouse for small ruminants and two rural feed processing units were established. Technology was demonstrated in the farmers' fields to rear ram lambs under intensive system by utilizing locally available crop residues in the form of complete feeds. Through this approach meat productivity in ram lambs was increased by around 40% without increasing additional burden on existing feed recourses. Several awareness programs and trainings to different stakeholders involved in meat sector were organized. Through farmer's interventions, 5000 ram lambs were reared in different districts of Andhra Pradesh to optimise the slaughter weight.

National Research Centre on Meat, Hyderabad is an exclusive meat research institute in India catering to the needs of large group of meat animal producers, meat processors, exporters, butchers, entrepreneurs and consumers. The Centre is working towards developing organized meat sector in India. However, the Indian meat industry is still at

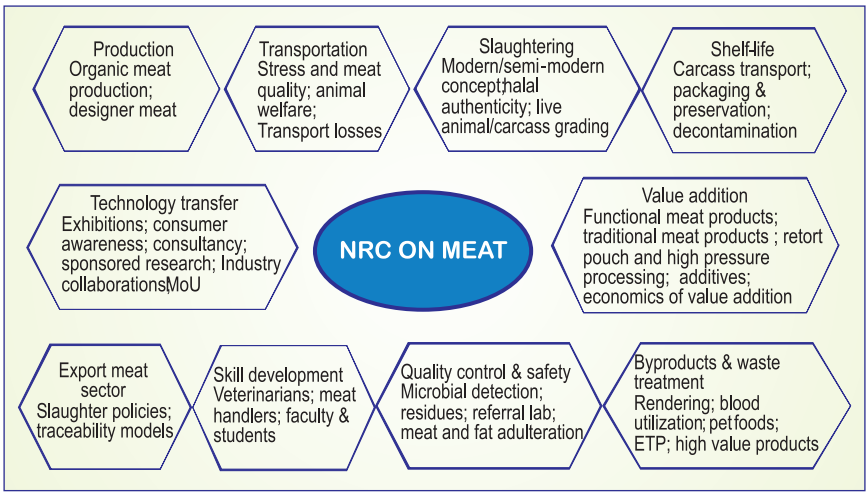

Fig. 2 Different areas of meat sector covered in NRC on Meat Vision-2050

nascent stage in many aspects and much need to be done, in order to provide clean and safe meat. The "Vision 2050" document is targeted to address the problems and concerns in different areas of meat sector as mentioned in Figure 2.

❑

Challenges

World population is expected to reach 9.1 billion by 2050 (FAO). United Nations population division has clearly indicated that developed countries will have fewer young people compared to elderly people. On the contrary, developing countries will have far more young people relative to elderly. It is quite evident that large chunk of young population will consume more meat and meat products and it is true for India as well. India's greatest challenge lies with providing adequate, nutritious, healthy and safe food to more than 1.6 billion population by 2050 which includes more than 52% urban population (Figure 3). With shrinking land, labour, feed resources, climate change issues and mobilization of farming community to urban areas, it is a challenge before the nation to ensure food and nutritional security. Contribution from all sectors including livestock sector is of utmost important to meet this burgeoning demand. With more than 70% non-vegetarian population, India needs increased quantity of quality meat and meat products in order to meet consumer demand.

In spite of huge potential for Indian meat sector both in domestic and export market, it is also buoyed with several challenges. The major breakthrough in meat production and trade can only be achieved by strong and consistent political will and policies. There is a great need for

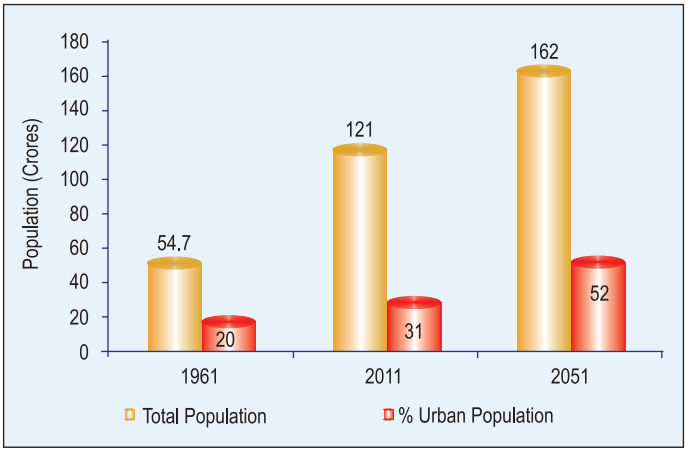

Fig. 3 India's population from 1961-2051 (total and urban)

mass education and mass awareness in the public about the production, processing and availability of clean and safe meat. All the stakeholders need to be convinced of the importance of meat sector development with appropriate infrastructure facilities for effective utilization of meat animal resources. It is all the more important in the current context of TBT, Sanitary and Phytosanitary requirements by the importing countries attached to meat exports. A number of R&D programmes with pragmatic policy approaches are required for development of organized meat sector. Important challenges faced by the Indian meat sector which need to be addressed are explained below.

Low-productivity of Livestock

Investment in livestock sector in general and livestock for meat production in particular is very low. In India, animals are not specifically bred, reared and fed for meat production. In case of cattle and buffaloes, after completion of productive or reproductive functions, they are utilized for meat production. Breeding stocks (sheep and goat) are usually slaughtered after completion of their productive life or when they become uneconomical for rearing. Meat animal production has not been taken up on scientific and modern lines due to socio-economic reasons. Even though Indian livestock population is high, per animal productivity is low which is leading to low carcass yields (Table 3). This is mainly due to lack of proper feeding during appropriate growth phase of animals. Further, farmers are forced to distress selling of meat animals especially lambs and kids.

Table 3 Carcass yield of domestic animals in India

Species	Live weight (kg)	Carcass weight (kg)	Dressing %
Sheep	20.79	9.56	45.98
Goat	19.16	9.00	46.97
Buffalo	310.38	149.69	48.22
Cattle	219.22	99.46	45.36
Pig	67.92	45.56	67.07
Chicken	1.59	0.96	60.37

Source: MOSPI, Govt. India (2014)

Inadequate Infrastructure for Hygienic Slaughter

There are about 4000 registered public slaughterhouses. Typically, a large number of these have only primitive facilities and follow time-old floor slaughter and dressing procedures. Meat inspection is customary

and carcasses and edible offal are handled and marketed in unhygienic manner. Meat obtained from municipal slaughterhouses and from unrecognized slaughterhouses lack proper ante-mortem and post-mortem inspection. This situation warrants immediate attention and proper training to officials posted at these places must be given to improve the quality of meat.

Meat sector activities have received very little attention till X five year plan and only during XI plan, various schemes from Ministry of Food Processing Industries, Govt. India have been launched for upgradation and modernization of abattoirs. In the XII plan, National Mission on Food Processing and National Livestock Mission (NLM) are expected to address the problems related to modernization/upgradation of existing abattoirs, construction of new abattoirs, utilization of culled/dead animals etc. Therefore, it is necessary to understand the existing slaughter practices and meat production pattern and develop suitable models for slaughterhouses of different capacity and for different livestock, keeping in mind animal welfare, clean meat production, safety and hygiene, chilling, freezing and packaging, by-products utilization, effluent treatment, retailing etc.

Increasing Demand for Meat

During the period from 2007 to 2012 the meat production (species wise) has increased in India from 1.41 to 1.53, 0.53 to 0.60, 0.26 to 0.29 and 1.75 to 2.21 million tonnes (MT) from buffalo, goat, sheep and chicken, respectively (Figure 4). However, marginal increase in cattle meat (beef) production (1.01 to 1.09 MT) and decrease in pork production (0.38 to 0.32 MT) was observed. Besides increase in export, internal demand for meat and value added meat product is also increasing. It is estimated that by 2050, the domestic demand for meat and meat products would increase by 3 times the present domestic demand (Figure 5) (ICAR, Vision 2050). It is envisaged that proper attention and commensurate investment could usher impressive growth of this vital sector and further play a pivotal role in national economy. Meat and meat products are demand driven as compared to the supply driven commodities. It is anticipated that there will be increased demand for animal products in the first part of this century.

Meat animals, particularly in case of male buffalo calves, sheep and goat are slaughtered at younger age resulting lower meat yields. In spite of being number one for buffalo and number two for cattle and goat population in the world, their meat production potential is not fully exploited. Production of animals on scientific lines with

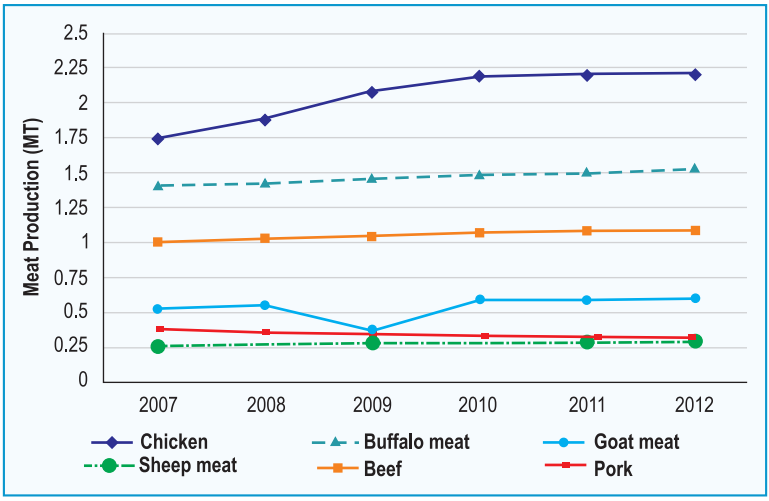

Fig. 4 Meat production pattern in India during the year from 2007-2012 (FAOSTAT, 2013)

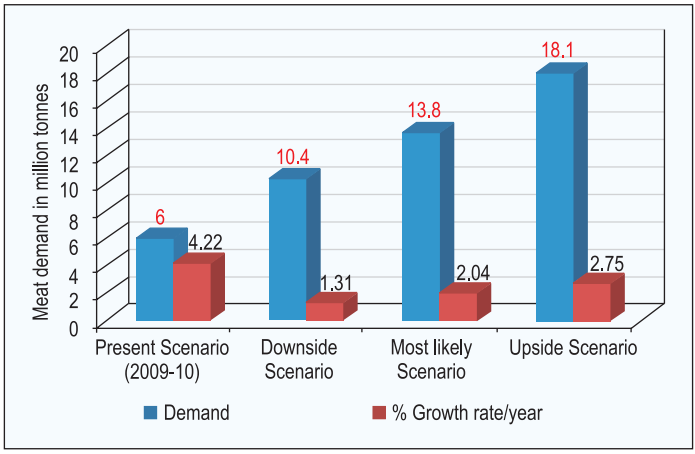

Fig. 5 Total domestic demand for meat and meat products in India by 2050 (*Source:* ICAR VISION 2050)

pragmatic approaches for their efficient utilization will be an important achievement. Augmenting meat production through pigs and alternate poultry species like turkey, ducks, emu and pigeon etc. will help to meet the increasing demand.

Inadequate Value Addition

The organized development of processed meat sector is important to realize full benefits from meat animal and contribute for sustained

meat production. The growth of processed meat sector assures the farmers a regular off take of their produce at reasonable prices and provides a variety to the consumer. This is more so in poultry sector, when the market prices fall due to excess supply. Poultry could be processed and stored to be released into market at an appropriate time and farmer's returns could be protected to sustain his operations. With the rapid growth in poultry industry, availability of layer and broiler hens as culls has also increased which could be beneficially utilized for products processing to the benefit of producer and consumer. In addition, employment potential would be substantial. Also, it is necessary to produce quality value added meat products to meet the requirements in the post WTO regime for effectively facing global competition both to check large scale imports to the detriment of domestic sector and to promote exports. However, at present further processing and value addition of meat in India remains less than 2.0% with the exception of poultry where ~7.2% of meat undergoes processing.

Small scale ventures of value added products including traditional would go a long way in improving the economics of livestock production and meeting the consumer demands. Further, it is estimated that the organized retail sector in India is expected to reach USD 184 billion by 2020. Indian cold chain industry is expected to grow at a compound rate of 26% to reach USD 11.8 billion by 2017 (ASSOCHAM). By 2015 India is expected to have more than 1000 multinational quick serving restaurants in more than 100 cities. The global market for processed meats is estimated to be USD 362 billion in 2012 and is projected to reach USD 799 billion by 2018 with a compound annual growth rate of 14.3%. The market for meat processing equipment is USD 7.7 billion in 2012 and by 2018 it is projected to reach USD 11.5 billion with a CAGR of 7.2%.

Some of the processed meat products developed/refined in NRC on meat include: meat emulsion, sausages, patties, nuggets, slices, kababs, croquettes, balls or kofta, meat bites, enrobed drummets or wingets, tandoor legs and breasts, smoked chicken legs or chicken breasts, smoked chicken curves, chicken soup, chicken pickle, dried meat, mutton ham. Compared to broiler industry which is growing at 12-15% per annum, the ready to eat meat products segment is growing at more than 20% in India. Value addition is an important avenue for efficient utilization of livestock resources with increased demand and higher returns. Development of processed meat sector is an important requirement to benefit meat producers and consumers.

Underutilization of Animal By-products and Improper Disposal of Waste

Municipal slaughterhouses in India are regulated by local bodies. Though byproducts are being collected and processed by some agencies, many times they are underutilized or wasted. Further, no attention is paid for proper disposal of wastes such as blood and rumen contents, and is left accumulated in the premises. This results in odour and pollution problems affecting image of the meat sector. Local bodies need to facilitate proper disposal of waste in order to maintain sanitary conditions of slaughterhouses. Organized facilities for small scale primary processing of some of the byproducts such as intestines, horns/hoofs, blood and bile etc. within the plants should be provided. Proper collection of the by-products, chilling/cold store and transportation need to be addressed. This would not only contribute for better economics of slaughterhouse but also for improving image of the meat sector. On the contrary, integrated meat export plants in India have established large scale rendering plants and effluent treatment plants for effective utilization of byproducts and effluent treatment resulting in good management of environment in the plants and surroundings.

Poor Meat Quality and Safety Concerns

Inadequate slaughtering facilities coupled with lack of hygienic practices, quality control and prevalence of animal diseases warrants greater measures to ensure food safety. Majority of the existing municipal slaughterhouses in India lacks the minimal infrastructural facilities to ensure clean and safe meat production. Slaughtering and dressing operations are carried out on the floor without any chilling, freezing and packaging of meat. The carcasses or cut-up parts are transported in open vehicles and meat is sold as hot meat. These municipal slaughterhouses do not follow the standard guidelines prescribed by Food Safety and Standards Authority of India (FSSAI), Good Manufacturing Practices (GMP), Hazard Analysis and Critical Control Point (HACCP) and ISO-9000 standards to ensure the safety of consumers. Therefore, in addition to up-gradation/modernization of slaughterhouses adoption of quality control and safety protocols to meet the domestic and global requirements should be considered. Development of advanced research tools to address meat adulteration, chemical residues, traceability, halal authentication etc. are other important challenges need to be addressed.

Lack of Skilled Manpower and Awareness

Livestock sector provides employment to over 400 million rural people and contributes enormous amount of draught power and biomass

that enriches the agricultural fields of our country. According to the All India Meat and Livestock Exporters Association (AIMLEA), export abattoirs-cum-meat processing plants in India registered with the export regulatory authority (APEDA), employs 74,000 personnel directly and 1,50,000 indirectly. Most of the workers engaged in meat industry are illiterate, even though they possess professional skills. Majority of meat industry personnel (meat animal handlers, butchers/artisans, and retailers) lack the awareness about good hygienic practices, personal and meat plant hygiene, meat borne zoonotic diseases, health risks, proper handling and transportation of carcasses and meat and the concept of clean meat production. Attention is needed towards animal and poultry transport on meat quality and welfare issues. Transport of animals and poultry in our country needs much attention, as slaughterhouse personnel and retail processors do not understand the quality aspects of meat obtained from ill-treated animals. Effective awareness programme can help the practice of animal welfare regulations among slaughterhouse personnel and retail processors for production of quality meat with better image to meat sector.

Appropriate training of persons at different levels in the meat sector is important. Improvement of slaughterhouses and meat processing facilities need to be linked with training programme. The NRC on Meat has already initiated skill development and capacity building programs within the state of Telangana, however, large number of activities are required at several places throughout the country to meet the requirements.

Nutritional Security through Meat and Meat Products

Indian meat production forms less than 2.0% of world's total meat production and the average per capita meat consumption is about 5.5 kg per year (Table 4) compared to world's average of 40.0 kg, developed countries 80.3 kg, and developing countries average of 28.9 kg. National Nutrition Policy desired augmentation of production of protective food crops, such as vegetables, fruits, milk, meat, fish and poultry to ensure nutritionally rich foods. Expert Committee of ICMR has recommended 66 g of protein/day with net protein utilization (NPU) of 0.65. Without substituting vegetable protein with adequate amount of animal protein it would not be possible to achieve protein quality of NPU 0.65 in the National diets. Also, per capita consumption of pulses which are major source of vegetable protein for supplementing cereal protein, has decreased from 60.7 g in 1951 to 29.4 g in 2007. Thus a minimum requirement for animal protein would be targeted at

20 g per capita per day compared to the present availability of 10g or world average of 29g. This 20g target was also envisaged in the vision document of Department of Animal Husbandry and Dairying, Ministry of Agriculture, which could be provided through milk (50% or 10 g), meat (20% or 4g), fish (20% or 4 g) and eggs (10% or 2g). The requirement for a population (1260 m comprising non-vegetarians 882 m and vegetarians 378 m) based on the demand for animal products by 2020 to provide targeted 20 g animal protein would be milk 170 mt, total meat 10.78 mt, fish 10.78 mt and eggs 106 billion. The triple effects of population increase, income growth and urbanization will fuel the growth and demand for animal products. The gap between the expected demand and availability is likely to increase. Hence, the production of meat has to be increased to meet the national nutritional security. Besides, FAO has projected that poultry meat consumption of world would double from the present level consumption of 10 to 18 kg/capita/year in 2030.

Table 4 Per capita meat consumption in India

Meat source	Kgs
Bovine meat	2.1
Sheep and goat meat	0.7
Pig meat	0.4
Poultry meat	2.2
Other meats	0.1
Total	5.5

Operating Environment

The operating environment of meat production, processing, marketing and R&D programs is complex and frequently changing due to countless stakeholders viz. livestock producers, supply chains, industry bodies, government authorities and research organizations. Indian meat industry is still facing lots of challenges to reach global leadership. The existing situation of both domestic and export meat sector in India including livestock sector is presented below.

Domestic Meat Sector

According to 19th Livestock census conducted by Department of Animal Husbandry, Dairying and Fisheries, Government of India except for buffaloes, the population has reduced by 4.10, 9.07, 3.82 and 7.54% for cattle, sheep, goat and pigs respectively during the period from 2007 to 2012 (Figure 6). There was a marginal increase in buffalo population from 105.34 to 108.70 million (3.19%) during 2007 to 2012. However, the population of chickens increased significantly from 617.73 to 692.64 million (12.13%). India is producing 2.08% of the global meat (302 MT) and has the distinction of producing largest amount of buffalo meat in the world (42.61%). It is also a 2nd (11.34%) and 9th (2.38%)

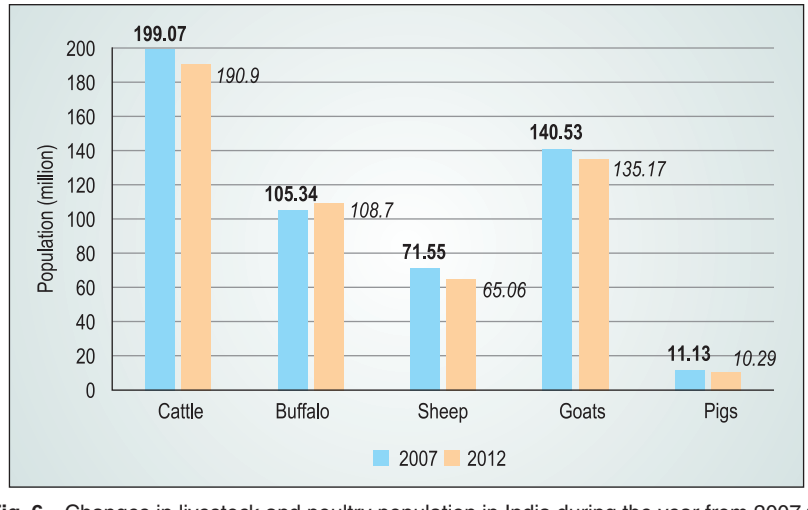

Fig. 6 Changes in livestock and poultry population in India during the year from 2007 to 2012 (Dept. Animal Husbandry, Dairying and Fisheries, Govt. India)

largest producer of goat meat and chicken in the world. During the period from 2007 to 2012 the meat production has increased in India by 7.33, 7.84, 11.66, 10.34 and 20.81% for cattle, buffalo, goat, sheep and chicken, respectively. Slaughtering of male buffalo calves is banned in several states. In the year 2013 Indian poultry meat production is 3.8 million tonnes and stands 4th in the world next to USA, Brazil and China (Asian Agribiz). The poultry market in India is worth Rs. 58,000 crores. The broiler industry is growing annually at 12-15% compared to layer industry which is growing at 6-8%. Meat and meat products are demand driven as compared to supply driven cereals.

India has around 4000 registered slaughterhouses, and 25,000 unregistered premises where animals are slaughtered for domestic consumption. The meat produced in India for the domestic market is sold as hot meat (pre-rigor meat without chilling). Goat/sheep meat is marketed in villages by slaughtering 5-10 animals once/twice in a week or during special occasions. In the big towns and cities slaughtering is performed in designated abattoir or slaughterhouses and most of the meat is consumed on the same day or kept in a refrigerator in the households. The slaughterhouse byproducts are underutilized with improper disposal of waste. Modernization of abattoir scheme has been scaled up during 12th five year plan with a plan to construct 25 new slaughterhouses and upgrade 25 existing slaughterhouses across India with involvement of local bodies (Municipal corporations and panchayat)/Public undertakings/Co-operatives or private investors with PPP model. Poultry meat is mostly sold as fresh meat by slaughtering the live birds in the presence of the consumers. However, there are a few modern processing plants where poultry is slaughtered; chilled, packed and frozen chicken is sold in big cities. Compared to other meats, reasonable amount of poultry meat undergoes further processing into range of value added meat products like sausages, patties, lollipops, breaded nuggets, fried drumsticks and various traditional meat products for different markets. To add further about 70% of the population in India is considered non-vegetarians and majority are in south and north east region.

Export Meat Sector

There are 57 integrated modern abattoirs with complete online slaughtering, dressing, chilling, packaging, blast freezing facilities mainly catering to export market. These export plants mainly slaughter buffaloes with small numbers of sheep and goats. They have facilities for utilization of all slaughterhouse by-products, wastes and effluent

treatment plant. In the recent years there is a great demand for Indian buffalo meat in the international market. The domination of buffalo meat in the export trade continues. Indian buffalo meat has become important foreign exchange earner with a 31% increase in quantity and 52% rise in value terms in 2013-14. Frozen buffalo meat dominated the exports with a contribution of over 97%. The demand for buffalo meat in international market has sparked a sudden increase in the meat exports from India. Indian buffalo meat is witnessing strong demand in international markets due to its lean character and near organic nature. India's exports of Animal Products (Table 5) was Rs. 27,751.91 crores in 2013-14, which include the major products like Buffalo meat (Rs. 26,458 crores), Sheep/Goat meat (Rs. 694 crores), Poultry products (Rs. 565 crores), Dairy products (Rs. 3318 crores), Animal casings (Rs. 28 crores), Processed meats (Rs. 6.91 crores). The major international markets for Indian buffalo meat and other related animal products are Vietnam, Malaysia, Egypt Arab Republic, Saudi Arabia, UAE, Mauritius, Jordon and Philippines. In the last decade there have been increased exports to African nations mainly to Gabon and Angola. Islamic Republic of Iran, Afghanistan and Iraq have also started importing meat from India. India's exports of processed meat attained 480 tonnes with the value of Rs. 6.91 crore in 2013-14. India's export of sheep/goat meat has increased from 11 tonnes with the value of Rs 255 crores in 2011-12 to 22 tonnes with the valued of Rs. 694 crore in 2013-14. The major destinations for export of Indian sheep/goat meat are Saudi Arabia, U.A.E, Qatar, Oman and Kuwait. The major importers of Indian poultry products are U.A.E, Kuwait, Oman, Germany and Japan.

Table 5 Export of meat products from India

Type of animal product	2011-12		2012-13		2013-14	
	Quantity	Value (Crores)	Quantity	Value (Crores)	Quantity	Value (Crores)
Buffalo Meat	0.98 MT	13725	1.1 MT	17400	1.45 MT	26458
Sheep & Goat Meat	11 T	255	16 T	425	22 T	694
Poultry Meat	0.62 MT	457	0.57 MT	494	0.43 MT	565
Processed Meat	0.57 T	9.49	0.79 T	9.37	0.48 T	6.91
Casings	0.9 T	27	0.6 T	18	0.35 T	28
Total Meat & By-products		14494		18358		27751.91

Source: APEDA; MT-Million tonnes; T-Tonnes

New Opportunities

The demand for meat research to accelerate continued productivity gains, more and multivariate meat products, better human health in the form of quality, nutritious and safe meat products, enriched biosecurity, environmental benefits in the form of efficient utilization of by-products and wastes disposal, animal welfare for the production of high quality meat, and the vivacity of rural communities are mounting. Even though India is having lot of potential in the form of huge livestock wealth, our share in the global trade is meager. This scenario pressurizes to develop innovative products, processes and technology of global stature. Some of the opportunities for Indian meat sector are explained below:

- Availability of liberalized global market for export creates new opportunities
- Increasing awareness among people for wholesome food leads to increased demand for hygienically processed and packed meat and meat products
- Increased income, purchasing power of young population and changing consumption patterns
- Entry of private entrepreneurs for establishing meat based industries
- Increased employment opportunities in the meat and allied sector
- Scope for cottage industries for preparing traditional meat products which have good demand in urban areas
- Integration of development in contemporary technologies such as electronics, material science, bio-technology etc. offer vast scope for rapid improvement and progress

The National Research Centre on Meat, Hyderabad is focused on frontier areas of research, education, training and economics that will serve the public needs. Considering the future trends based on the available wealth and trained man power in India, the following research opportunities have been identified for the vision 2050.

Augmenting Meat Production

Though India has a huge animal population, the meat production potential of these animals is low as compared to developed countries. The productivity of these animals need to be improved through carefully planned breeding, feeding and management programs to increase

the meat yield without increasing the animal numbers. Appropriate utilization of agricultural byproducts, feeding the animals during peak growth period, salvage of male buffalo calves, culling of unproductive animals, tapping the potential of alternate poultry like turkey, pigeon, duck, emu etc., will help in augmenting meat production.

Production of Organic Meat

Organic farming is an up-and-coming field for crop and livestock production, processing, marketing, trade and consumption, and, therefore, for research all over the world. In developed countries it has already reached significant level but in the developing countries especially the Asian countries are in the stage of beginning only, as far as organic livestock production is concerned. In the coming years lot of emphasis must to be given to focus more research on organic meat production since it has huge of potential. Protocol for organic meat production and processing needs to be standardized. The quality attributes and shelf life of organic meat and meat products, their demand and economics of production needs to be addressed.

Hygienic Slaughter and By-products Utilization

- Developing models for semi modern slaughterhouse for different species
- Optimization of stunning methods for humane slaughter of meat animals
- Utilization of offal for pet food formulation
- Development and evaluation of simple technologies for blood utilization and fibrin extraction
- Isolation of antioxidant/anti-microbial bio active peptides from lung, liver and blood
- Developing improved method for effluent treatment using Ozone and/or UV

Quality Control and Safety

Live animal and carcass grading

In India, farmers sell their animals to the middle man by the numbers and assessment of approximate live weight which leads to exploitation of producers. Grading system which predicts the carcass yield and meat quality can be used as a tool for assessing the value of animals/carcasses. The need for developing a grading system is a must in the future to promote the meat industry and research must be focused

in this area. Application of non-invasive techniques to predict the yield and quality of meat needs to be standardized .Video imaging, NIRS etc. for predicting the carcass confirmation, marbling and lean to fat measurements have to be adopted in the future.

Meat Safety

Achieving clean meat production through improvement of slaughterhouse is a primary requirement of meat sector to monitor food safety aspects and promote public health. Cost effective kits to identify/ quantify microbial and chemical contaminants, meat species identification needs to be developed. Simple and effective methods to decontaminate meat from microbial and chemical contaminants must be developed.

Developing traceability model

Traceability has emerged as a major issue in international meat trade with the potential for a large impact on Indian meat trade. National livestock identification system needs to be compulsorily implemented in the future. Development of traceability models for different livestock for both domestic and export meat sector is required.

Value Addition in Meat Processing

Development of functional foods, use of natural ingredients, high pressure technology, development of shelf stable products, active/smart packaging and quality evaluation and preservation of traditional meat products are some of the areas which need to be undertaken in the coming years.

Application of Genomics and Proteomic Tools in Improving the Productivity, Quality and Safety of Meat

Meat safety and consistent quality are two important issues to be addressed in the future research. New tools in biological research viz., genomics and proteomics offer significant potential to address the quality and safety issues that are of great concern to meat industry.

Genomics

Consistent meat quality is important for consumer's satisfaction. Therefore, the meat industry is looking for genetic markers to predict the ability of animals to produce consistent quality meat. The development of genomics allowed the identification of markers for muscle growth potential, marbling and tenderness of livestock and poultry meat.

Proteomics

Proteomics is an important cornerstone in functional genome characterization, and like all other functional genomics tools, including transcriptomics and metabolomics, the aim of proteome studies is to translate genome information into useful biological insight, that will allow scientists to build and test better hypotheses, with the ultimate goal to find better solutions to challenges in meat production and quality enhancement. Proteomics will also be helpful for developing analytic assays for authenticity of food products, like the verification of an animal's origin. When established, biomarkers for growth, development, and meat quality traits may be used in selective breeding, while other markers may be further developed into technological markers that can facilitate more precise labeling and sorting of meat and for optimizing production methods and meat processing technologies.

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Goals and Targets

In view of the challenges and the new opportunities in meat sector various strategies have been devised for holistic development of Indian meat industry. Different programs visualized for next four decades along with salient quantified targets for undertaking research activities are as follows:

Sustainable Meat Animal Production System

- Developing protocols for organic meat production from sheep, goat, and pigs.
- Area specific interventions to promote meat production and processing viz., pig, alternate poultry and male buffalo calves.
- Designing comprehensive grading system for live animals/carcasses/ meat, relevant to Indian meat industry.
- Developing transportation protocol to meet the animal welfare requirements of different meat animals.
- Nation-wide survey on slaughtering of animals, meat and by-products production, yield, meat retailing and economics of meat value chain.
- Revisiting slaughter policies, male buffalo calves rearing and export of meat.
- Development of laboratory grown artificial meat through tissue engineering technology.

Hygienic Meat Production and Effective Animal By-products Utilization

- Developing semi-modern/modern abattoir models with varying capacities for different livestock and poultry.
- Development of HACCP, GMP and standard operating protocols (SOP) for clean meat production.
- Optimization of stunning methods for humane slaughter of meat animals.
- Development of different formulations for pet foods utilizing animal byproducts.
- Isolation, purification and characterization of bioactive compounds from animal byproducts and development of high value products.
- Development and evaluation of simple technologies for small scale blood utilization.

- Developing improved method for effluent treatment using Ozone and/or UV.
- Facilitating establishment of model slaughterhouses with participation of municipalities and entrepreneurs with rendering and effluent treatment facility for clean and green environment.
- Develop strategies for reducing water usage in slaughter and dressing operation and meat processing.
- Development and application of robotic technology in clean meat production.

Enhancing Quality and Safety of Meat and Meat Products

- Use of natural preservatives and hurdle technology in shelf-life extension.
- Developing non-invasive techniques (near infrared reflectance spectroscopy, NIRS) for determination of composition and different meat quality parameters like tenderness, colour etc.
- Identifying gene/protein biomarkers influencing meat quality and whole proteome characterization of different buffalo breeds of India.
- Isolation, purification and characterization of meat based bioactive compounds viz. ACE inhibitory peptides, antioxidative peptides etc.
- Developing and establishing comprehensive meat traceability model suitable to Indian meat industry.
- Development of innovative techniques for meat species identification and halal authentication.
- Establishment of referral laboratory for microbial and chemical quality evaluation of meat and meat products with special reference to emerging meat borne pathogens, chemical and antibiotic residues.

Developing Need Based Value Added Meat Products

- Development of protocols for need based value added meat products like functional meat products, organic meat products, use of meat from alternate poultry like emu, turkey, pigeon and duck.
- Development of active/smart packaging and bio-based packing materials/nanotechnology applications for improving shelf life of meat and meat products.
- Development of innovative organic and natural meat products.
- Studying application of high pressure processing technology for improvement of quality of meat and meat products.
- Development of low sodium, low fat, high fibre and reduced nitrite functional and fermented meat products.

- Development of shelf stable meat products through retort processing techniques.
- Development of extruded meat products.
- Quality and shelf life improvement of traditional meat products.

Skill Development Programmes, Consultancy and Entrepreneurship Development

- Conducting hands-on training for meat handlers/butchers, veterinarians and other stakeholders on clean meat production.
- Organizing awareness programs on meat processing, value addition and clean meat production.
- Studying dynamics of meat animal and meat products marketing.
- Preparation of model project reports for meat processing industries.
- Adoption of retail meat shops and slaughterhouses for demonstration of clean meat production.
- Providing consultancy services to different entrepreneurs and development of training modules for self-help groups and women in meat processing.

Base Line Data Generation

Realistic data on meat production, handling, transportation, pre and post-harvest losses, marketing and consumption pattern, traditional meat products, microbial, chemical and antibiotic residues is lacking in our country. Definite strategy for growth of meat sector could only be evaluated by having basic information on all these parameters. Studying dynamics of meat production would enable identifying appropriate interventions.

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SETTING UP OF R&D ACTIVITIES ON TIME SCALE

<table>
<tr><th colspan="8">YEAR</th></tr>
<tr><th>2012 - 17</th><th>2017-22</th><th>2022-27</th><th>2027-32</th><th>2032 – 2037</th><th>2037 - 42</th><th>2042 - 47</th><th>2047 – 52</th></tr>
<tr><td colspan="8">Programme I: Sustainable meat animal production system</td></tr>
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Developing improved method for effluent treatment using Ozone and/or UV	Development and application of robotic technology in clean meat production
Programme III:Enhancing quality and safety of meat and meat products	
Use of natural preservatives and hurdle technology in shelf-life extension	
	Developing non-invasive techniques (near infrared reflectance spectroscopy, NIRS) for determination of composition and different meat quality parameters like tenderness colouretc
Developing and establishing comprehensive meat traceability model suitable to Indian meat industry	
Identifying gene / protein biomarkers influencing meat quality and whole proteome characterization of different buffalo breeds of India	
	Isolation, purification and characterization of meat based bioactive compounds viz. ACE inhibitory peptides, antioxidative peptides etc
Development of innovative techniques for meat species identification and halal authentication	
Establishment of referral laboratory for microbial and chemical quality evaluation of meat and meat products with special reference to emerging meat borne pathogens, chemical and antibiotic residues	
Programme IV: Developing need based value added meat products	
Development of protocols for need based value added meat products like functional meat products, organic meat products, use of meat from alternate poultry like emu, turkey, pigeon and duck	
Development of innovative organic and natural meat products	Development of active / smart packaging and bio-based packing materials / nanotechnology applications for improving shelf life of meat and meat products
Development of low sodium, low fat high fibre and reduced nitrite functional and fermented meat products	Studying application of high pressure processing technology for improvement of quality of meat and meat products

Development of shelf stable meat products through retort processing techniques	Quality and shelf life improvement of traditional meat products
Development of extruded meat products	
Programme V: Skill development programmes, consultancy and entrepreneurship development	
Conducting hands-on training for meat handlers / butchers, veterinarians and other stakeholders on clean meat production	
Organizing awareness programs on meat processing, value addition and clean meat production	Studying dynamics of meat animal and meat products marketing
Preparation of model project reports for meat processing industries	Adoption of retail meat shops and slaughterhouses for demonstration of clean meat production
Providing consultancy services to different entrepreneurs and development of training modules for self-help groups and women in meat processing	
Programme VI: Promoting organized marketing	
Studying meat animal market dynamics with reference to middle men exploitation	
Enhancing acceptability of stakeholders for value based marketing of meat animals	
Studying entrepreneurial economics of semi-intensive and intensive meat animal production at the field level	
	Collection and compilation of meat statistics for use of stakeholders
Evaluating the feasibility of large scale intensive farming for small ruminants	Designing and popularizing value based marketing of meat animals using live animal grading system
Programme VII:Base line data generation	
Realistic data on meat production, handling, transportation, pre and post-harvest losses, marketing and consumption pattern, traditional meat products, microbial, chemical and antibiotic residues is lacking in our country	

Way Forward

In order to develop the meat sector in the country into an organized one, NRC on Meat needs to expand its research activities and work with multipronged approach addressing all the issues right from meat animal production, meat quality and consumption. With the initiatives from Govt. of India, up-gradation/modernization of slaughterhouse are expected to happen in the coming years in most of the metro cities and big towns. There is a pressure on small ruminant (sheep/goat) population to meet the growing demand for meat in both domestic and export sector. National Livestock Mission (NLM) has been mainly initiated to support requirement for small ruminant production. It is projected that demand for meat in 2050 will increase from the present 6.29 MT to 18.1 MT and per capita meat consumption will increase to 13.8 kg from present 5.5 kg (FAOSTAT). Maximum increase in consumption of poultry meat by 2030 will happen in India compared to any other country in the world. As per the records, 14 million male calves perish annually. If 70% can be salvaged, reared and processed @ 175 kgs per head (including edible offal) and when reared they could yield 1.72 million tonnes of additional meat per annum. The processed meat industry is expected to grow by 20%. To promote value addition Ministry of Food Processing Industries (MOFPI) has launched a new Centrally Sponsored Scheme (CSS), National Mission on Food Processing (NMFP) with the basic objective, decentralization of implementation of food processing related schemes for ensuring substantial participation of State/UT Governments. Indian cold chain industry is expected to grow at a compound rate of 26% to reach USD 11.8 billion by 2017 (ASSOCHAM). All these developments coupled with stringent quality control measures in both domestic and export meat sector, the Indian meat export may enter into developed nations.

To cater to these requirements, the institute should undertake research and development activities in the areas like (i) meat animal production (ii) animal welfare and meat inspection (iii) fresh meat technology (iv) processed meat technology (v) meat biotechnology and nanotechnology (vi) animal byproducts technology and waste disposal (vii) meat quality control and regulation (ix) extension, marketing and economics.

For this the existing facilities at NRCM need to be strengthened

manifold both in terms of infrastructure and manpower to upgrade NRC on Meat to a National Institute for Meat Research (NIMR)

National Research Centre on Meat is expected to provide lead in developing the meat industry. The center needs to establish a vibrant linkage with various research, development and educational organizations to carryout research activities as well as to implement developmental programmes. Linkages will be developed with following agencies for effective implementation of the targets:

Research Activities

- Different Animal Sciences Institutes of ICAR–DPR, Hyderabad, CSWRI, Avikanagar, CIRG, Makhdoom and CIPHET, Ludhiana
- Central Leather Research Institute, Chennai
- Central Food Technology Research Institute, Mysore
- Defense Food Research Laboratory (DFRL)
- International meat/food research organizations
- Food Science Institutes
- National Institute of Food Technology, Education and Management (NIFTEM)

Developmental Activities

- Agricultural and Processed Food Products Export Development Authority (APEDA)
- State Animal Husbandry Departments
- Export Inspection Agency (EIA)
- National Bank for Agriculture and Rural Development (NABARD)
- Central Pollution Control Board (CPCB)
- Ministry of Food Processing Industry
- Private entrepreneurs and cooperatives
- Food and Agriculture Organization
- International Congress of Meat Science and Technology (ICOMST)

Educational

- State Agricultural/Veterinary Universities
- Indira Gandhi National Open University
- Department of Science and Technology
- Department of Biotechnology

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NOTES

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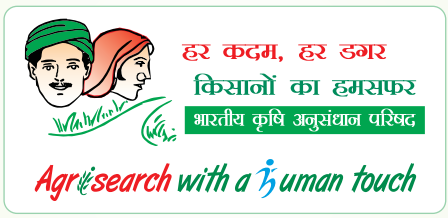
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